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CANADIAN PEAT FUEL INDUSTRY.

The forward movement begun by the Mines Branch in June, 1906, to solve the problem of providing a cheap domestic fuel for the middle provinces: Quebec, Ontario, and Manitoba—where there is no coal, but very extensive peat bogs—has made considerable progress, and owing to recent new fields for peat fuel there would appear to be ample grounds on which to investigate the various peat deposits in the above mentioned provinces.

During the autumn of 1910, some 500 tons of peat fuel, manufactured at the Alfred plant, Ottawa, were sold at $3.25 to $3.50 per ton to private individuals in Ottawa, for domestic use. The reports coming in from the consumers—showing that the peat has given great satisfaction as a fuel for open fire grates, cooking stoves, and even in furnaces for heating the house; and the numerous inquiries from business men and capitalists are so encouraging, that, with the advent of spring it is confidently anticipated there will be a marked revival of interest in the peat industry throughout the provinces where there is no coal.

Since 1907, according to a report published by the Department of Mines, ten peat bogs have been investigated, delimited, and plants made thereof. In 1910, only one was investigated, viz., the Holland peat bog, situated in Simcoe county, Province of Ontario. This is the largest peat bog so far examined and delimited by the Mines Branch. It covers over 16,000 acres, and should produce over 9,000,000 tons of peat fuel. The report of Mr. Anrep shows that the surface of this immense bed of peat is free from trees, hence can be worked economically by labor-saving machinery; while the quality as regards ash, and calorific value is satisfactory.

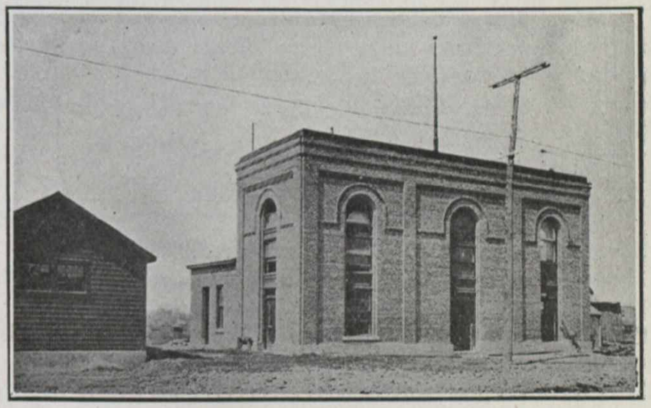
In 1909 the Dominion Government erected an experimental and fuel testing plant at Alfred, Prescott county, Ont. The equipment, exclusive of storage bins, etc., includes a Körting peat gas producer, with the necessary attachments, a 60 h.p. gas engine of the same make, a 50 kw. dynamo (Westinghouse) portable resistance of 60 kw. capacity, used in load absorption when testing, and a switchboard with suitable complements of measuring and testing instruments, etc.

The main building, shown in Fig. 1, is divided into two portions, one containing the peat gas producer and auxiliaries; the other housing the engine and dynamo, also an ore dressing laboratory concentrating machinery and gas testing equipment.

It has been possible to utilize the by-products of peat fuel manufacture as material for fruit packing, etc. In fact, the manufacture of this "litter" and its by-product "great mull" has become a well established industry in Sweden, Holland and Germany. As Canada is taking a prominent position among fruit growing countries, doubtless this article would find a ready market. Several shipments of this mosslitter have been made from Holland to the United States at an average cost of $6.00 per ton.

The equipment of the laboratory was begun in July, 1910, but it was not until September that the laboratory benches were installed, and that it was possible to begin chemical work there. The equipment includes the pieces of apparatus which were originally purchased for the coal tests carried out for the Mines Branch at McGill University, but which have now been installed in this laboratory.

The work which has been done in connection with the laboratory, in addition to the considerable work of equipment, has included: tests on Blaugas; tests on Fisher's fuel economizer; tests of peat tar; micro-photography of coal dust taken from the mine at Bellevue, Alta., after the explosion on December 9, 1910; 30 determinations of the calorific value of peat and coal; 65 determinations of the calorific value of gas; 65 analyses of gas; 20 determinations of tar and dust in producer gas; and a number of determinations of moisture, ash, volatile matter, etc., in peat, coal, and coke. The samples tested include: 21 samples of peat from the Government peat bog at Alfred, Ont.; 11 from the Holland peat bog at Bradford, Ont.; 4 from Walkerton, Ont.; and 4 sundry peat samples; 12 samples of coal from Edmonton; 1 from Pittsburg; and 1 sample each of cannel and anthracite coal; 1



Fuel Testing Station, Ottawa.

sample of gas coke. The work of this laboratory has been seriously hampered, owing to being housed in a room 17 ft. by 11 ft., the only room available, and will be, until it is possible to provide suitable accommodation. Gas analyses and calorimetry—which require a room of constant temperature; furnace work, and all general chemical work in which heat is generated; weighing, etc.—which ought to be done in a clean room, free from chemical fumes liable to attack the balances; chemical work and the preparation of samples, which causes dirt, have all to be done in the same room.

Three tests—to determine the consumption of peat per B.H.P. hour—were made with peat manufactured at Victoria Road peat bog. This peat had been manufactured some two years previous to the erection of the machinery at the fuel testing plant, and during this period was stored in a shed fully protected from the weather. It was consequently very dry, containing only 13 per cent. moisture. But inasmuch as the producer was designed to gasify peat containing from 25 to 30 per cent. moisture, the results of the tests with this peat cannot be considered as a criterion of the performance of the producer when working under proper conditions, viz., utilizing peat with from 25 to 30 per cent. moisture.

The results, however, were excellent, both as regards fuel consumption and behavior of the fuel in the producer. The fuel consumption for the three tests averaged a little less than 2.2 pounds per brake horse-power hour.

After the completion of the gas analytical laboratory a complete 30 hour test was made with the peat manufactured at the Government bog at Alfred. The peat used during this test averaged 30 per cent moisture. During the entire test samples of gas were taken and analyzed every hour. The calorific value of the gas was determined every 30 minutes by means of the Junker's calorimeter. Readings of both the voltmeter and ammeter were taken every 15 minutes. From these readings the effective horse-power of the engine developed during the test was calculated.

Before making the foregoing test, considerable time was spent in ascertaining the most suitable size to which it was necessary to crush the peat in order to obtain best results in the producer.

As determined by experimentation the peat should be of about the size of a hen's egg—for peat containing 30 per moisture. For peat containing less moisture larger sizes may be used, although the smaller sizes offer no difficulties to the operation of the producer regardless of the moisture content.

The satisfactory operation of the producer depends on the condition of the material fed to the lower zone, i.e., the material must be as free from volatile matter as is possible—since any tar distilled from the fuel in the lower zone cannot possibly be broken up, and, therefore, leaves the producer as a deleterious ingredient of the gas.

When these conditions are understood and the proper method of operating the producer learned it requires scarcely any attention from one day to another.

A few of the principal details of this test are as follows:

Producer cleaned and filled with peat	11.00 a.m.
Test started	11.00 a.m.
Test terminated and producer cleaned and filled	5.00 p.m. next day
Duration of test	30 hours.
Total fuel fired	4,900 lbs.
Total ashes	153.5 lbs.
Pounds coke lost through cleaning doors when poking and to be subtracted from total fuel fired	22.5 lbs.
Average load on engine	58.18 B.H.P.
Consumption of fuel as fired, 30 per cent. moisture per B.H.P.H.	2.80 lbs.
Consumption of fuel per B.H.P.H. fired dry	1.87 lbs.

Average heating value of gas:—

Gross	124 B.T.U. per cubic foot.
Net	116 B.T.U. per cubic foot.

The producer was poked every two hours—the vacuum on the gas main throughout the entire run varied but little from 28 cms. of water (11 in.). No trouble was experienced during this run nor subsequent runs from clogging of the cleaning system.

An average sample of the total peat charged was taken for analysis and a gas sample taken and analyzed every hour. The calorific value of the gas was determined every 30 minutes by means of a Junker's calorimeter.

Composition of the Gas by Volume.—The composition of the gas remained remarkably uniform throughout the later test.

The average composition was as follows:—

CO_2	9.9%
O_2	0.4"
C_2H_4	0.4"
CH_4	2.0"
H	9.8"
CO	20.6"
N	56.9"
	100.0%
Combustible gas	32.8%

Central Canada is not alone in these peat investigations, as Ireland has for generations sought methods and means to utilize this fuel in the place of coal. Investigation has generally shown former attempts in this direction to be without commercial possibilities. However, lately, according to the Dublin correspondent of the London (Eng.) Times, a really successful attempt has been made to use peat instead of coal for industrial purposes.

A 900 horse-power engine was installed two months ago by Crossley Brothers in the linen factory of Hamilton Robb at Portadown, County Armagh. Mr. Robb's manager states, as a result of his experiment, that with this engine an outlay of $57 a week on peat produces the same energy as was obtained by an expenditure of $69.50 a week on anthracite coal.

The new product has the further advantage of extracting tar from the peat to the value of $35 a week, making the actual cost of fuel only $22.

At Arvika, Sweden, experiments have been conducted using peat powder in the reduction of iron ore in the electric furnace.

The bottom electrode was found to cause damage to the hearth, hence was replaced with an iron electrode situated between the two carbon electrodes. Very good results were obtained.

Recently the Swiss succeeded in getting 2.65 tons of iron per H.P. year; 445 kilograms (981 pounds) of peat powder being required for the reduction.

The loss in weight of the iron electrode was found to be only a few kilograms per charge. The loss of the carbon electrodes was not determined, but was rather considerable.

The furnace is now being rebuilt with a view to utilizing the furnace gases for preheating the charge, and roasting the ore.

The Swedish government have decided to grant to Dr. G. de Laval—the distinguished inventor—the sum of $5,130 for further experimentation on his new process of wet-carbonizing peat. The Government peat engineer reports that de Laval's new process may solve the problem of continuous manufacture of fuel, independent of air-drying, which will be able to successfully compete with coal in many branches of manufacturing.

The following are the result of an analysis recently made in the Farm Laboratory of samples of peat from the Government bog at Alfred.

No. 1 is the sample supplied from the Alfred bog.

No. 2 is a sample submitted by an Ottawa purchaser.

	No. 1.	No. 2.
Moisture	24.07	27.78
Organic matter	71.23	67.81
Mineral matter or ash	4.70	4.41
	100.00	100.00

Composition of Ash.

	No. 1.	No. 2.
Mineral matter insoluble in acid	19.30	17.46
Oxide of iron and alumina....	23.30	20.20
Carbonate of lime	42.50	44.64
Phosphoric acid	0.797	0.604
Potash....................	0.65	0.48

Some few weeks previous to making the above analyses a correspondent who was burning this peat in an open grate submitted a sample of the ash so obtained, the object being to ascertain the fertilizing value of the ash for garden purposes. This ash afforded the following data:—

	Per cent.
Lime*........................	26.55
Phosphoric acid	0.80
Potash........................	0.695

*Equivalent to carbonate of lime, 47.41%.

Analysis of Ash.

SiO_2........................	19.30
Al_2O_3........................	7.78
Fe_2O_3........................	6.22
CaO........................	31.39
MgO........................	14.33
K_2O........................	1.51
P_2O_5........................	1.03
CO_2 (by diff.)	18.44
	100.00

The tests so far made have demonstrated that peat can be economically and efficiently utilized in producer gas engine plants, for the production of power. The operation of the Government peat gas producer plant has proven to be as simple as that of an anthracite producer gas plant: and may be economically substituted for those producer plants using imported coal—when the price of coal is in the vicinity of $3.50 per ton, and the price at which peat can be obtained is not more than $2 per ton.

EFFICIENT METHODS OF MIXING, TRANSPORTING, AND PLACING CONCRETE ON SUBWAY WORK.

In building section 11-A-3 of the Fourth Avenue Brooklyn Subway, the Tide-Water Building Company and T. B. Bryson, of New York, employed methods in connection with the concrete work which are particularly interesting at this time when there is so much discussion regarding the efficiency of contractors' plant and field arrangements. A careful investigation of the actual operations performed in handling the sand, gravel, and cement, and the subsequent concrete shows that the arrangement and selection of suitable machinery, such as the mixer, cranes, etc., with adequate means for the transportation and placing of the material, has been most successful. The concrete construction was of such a nature that an overload frequently had to be thrown on the entire system, requiring the continuous operation at a very rapid rate, of all machinery from the Ransome mixer and conveying machinery down to the crane at the point under construction for a period of from 12 to 16 hours. These periods of hard, continuous service occurred on the days when one of the 80-ft. monolithic sections was concreted. Though the concrete plant was designed for an output of 45 yards per hour, with the 1-yard Ransome mixer it continually exceeds this considerably; in fact, the contractors have a record of placing 305 yards of concrete in 5½ hours, and this time includes unavoidable delays, such as shifting the position of the chute leading from the elevated hopper on the forms to the part being concreted. To date, about 40,000 yards of concrete have been placed and there has not been a hitch in the entire system since its inauguration.

The gravel and sand are unloaded from the barges at the company's dock on the Gowanus Canal by a locomotive crane which empties its clam-shell bucket into overhead bins that discharge through swinging gates into 4-yard side dumping cars which are hauled to the mixing plant one-half mile distant by 18-ton locomotives. Entering the cut at street grade the cars dump the sand into a depressed bin holding about 1,000 cubic yards on one side of the mixing building and the gravel into a 2,000 cu. yd. bin on the opposite side. Directly underneath each of these bins is a continuous horizontal belt conveyer which carries the aggregate to a centrally located belt and bucket elevator running up to the small bins above the mixing platform which is situated on the same level as the material track. All the conveyers are driven by one induction motor. From the sand and stone bins chutes with gates guide the material to the measuring hopper, the top of which is level with the mixing platform on which the bags of cement are placed ready for use. The water is measured by two tilting barrels connected to a 400 cu. ft. tank on the outside of the roof, the tank being supplied by the city mains. After the ingredients are proportioned 1:2½:4½ they are released into the 1-yard Ransome mixer directly below. This mixer is driven by an induction motor and runs about 12 R.P.M. It is operated by one man who controls the gate from the hopper and raises and lowers the tilting chute from which the mixture is further guided by chutes into 2-yard automatic bottom dumping buckets on cars below which run on either of two parallel tracks at about the subway grade.

The concrete is then hauled by locomotives to the section under construction where a locomotive crane hoists and empties the buckets into an elevated hopper located on and about ten feet above the forms. The mixture runs down an inclined chute by gravity and as the chute is pivoted to the hopper and has a wheel at its extended end it may be swung to any part desired to be concreted.

The standard section of the subway is 60 ft. wide and 19 ft. high, the four tracks being separated by walls. Collapsible travelling steel forms were used on the work and were made up in units of 40 ft. length with the section the shape of the tube. The concrete was run directly into the forms already described, but on the roof it was spread over the surface by hoes when finishing. About 2,500 tons of reinforcing steel and 60,000 yards of concrete will be finally used in this work.

The contractors report that the cost of labor in mixing, transporting, and placing the concrete in the steel forms averages about 30 cents per yard. As the concrete was handled mechanically throughout, no skilled labor was required in this connection. During the month of March 6,135 yards were placed, according to the Public Service Commission's measurements, and concrete at all times were rigidly inspected by their engineers.

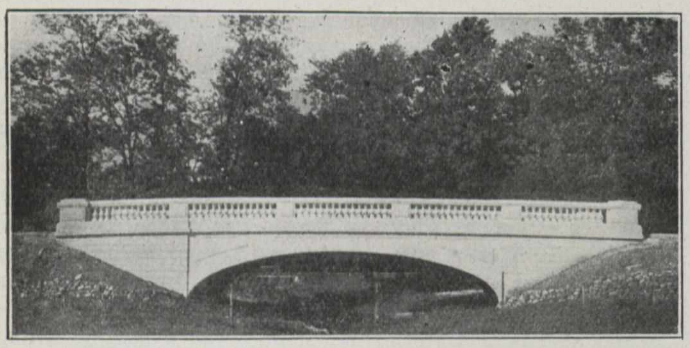
This subway is being built for the City of New York, under the Public Service Commission, for the First District, of the State of New York, Alfred Craven, Acting Chief Engineer; Frederick C. Noble, Division Engineer; Henry L. Oestreich, Senior Assistant Division Engineer; by the Tide-Water Building Company & Thomas B. Bryson, of New York, Stephen Pearson Brown, Chief Engineer; Claude T. Wilson, Principal Assistant Engineer; Robert Eldredge, General Superintendent.

AMERICAN ROAD BUILDERS' ASSOCIATION.

By E. A. James.

The American Road Builders' Association which held their 8th convention at Rochester, N.Y., November 14th to 17th, was organized in 1902, as the American Road Makers' Association. In 1910 its name was changed to the American Road Builders' Association, and it was chartered, without capital, under the laws of New York. At a meeting held in New York City in August of this year, the constitution and by-laws were changed so as to extend and facilitate the work of the association, and changes were made in the methods of administering its affairs.

The objects of the association are the bringing together of those engaged or interested in road and street work, the dissemination among its members of information relative to such work, and the holding of conventions for the study and discussion especially of the problems of organization, construction and maintenance arising in the carrying out of highway improvement. Its scope is national and its membership, which at first consisted chiefly of state highway officials, now includes also engineers, contractors, city, town and county highway and street officials, members of farmers' and automobilists' organizations, public men and others who take an interest in the subject of roads. Its membership includes many of the foremost authorities on road and street work in the United States and Canada.



Type of Bridge Used on the New York Good Roads System.

Since its organization the association has held seven annual conventions, the first at Detroit, Mich., and the subsequent ones at Port Huron, Mich.; Hartford, Conn.; Pittsburg, Pa.; Buffalo, N.Y.; Columbus, O.; and Indianapolis, Ind. An exhibition of road building equipment and materials was held in connection with the Columbus convention in 1909, and was repeated at the Indianapolis convention last year.

The association has five classes of members: Active, honorary, associate, contributing and life. The officers for 1910-11 were: President, Harold Parker, Boston, Mass.; First Vice-President, Samuel Hill, Seattle, Wash.; Second Vice-President, Nelson P. Lewis, New York, N.Y.; Third Vice-President, James Owen, Newark, N.J.; Secretary, E. L. Powers, New York, N.Y.; Treasurer, W. W. Crosby, Baltimore, Md.

Rochester, the meeting place for 1911, has a population of 225 000, with an area of 20.86 square miles and 202 miles of paved streets, and 148 miles of unimproved streets.

The convention opened at 11 o'clock Tuesday. The president, Harold Parker, of Boston, Mass., presided. Mr. C. Gordon Reel welcomed the delegates. Mr. Reel spoke as follows:

It was with keen regret that I learned on Saturday morning that it would be impossible for either Governor Dix or Lieutenant Governor Conway to be with us to-day to extend to you a cordial and hearty welcome to this convention. Their absence is unavoidable on account of important public matters which demand their personal attention. I am, however, much gratified and honored to be delegated to perform so pleasant a duty as that of welcoming you to our Empire State.

Our system of state and county highways leaves much to be desired. In the first place largely because of the provisions of our Highway Law, we have not built any sort of a comprehensive continuous system of trunk lines, but on the contrary have built little disconnected roads here, there and everywhere throughout the state without reference to through lines of travel. This condition will be materially remedied by this year's legislation, and if certain amendments to the Highway Law can be effected next year, it will be possible for us to build a system of state roads which will really serve the people.

As regards the construction of the roads themselves, a woeful lack of judgment was shown in building one kind of road practically for all kinds of traffic conditions. The result is that many of our roads were built in such a way as not to be able to withstand the traffic they had to bear, and conversely altogether too expensive roads were built in rural districts which did not meet the local requirements. Complaints come into our office daily about roads built for farmers' use which are so slippery that horses cannot keep their footing and the people have to either drive through the fields or scramble along the shoulders of the roads the best way they can, and, strange as it may seem, a much cheaper kind of road would have been entirely satisfactory and serviceable. There is, therefore, an opportunity for the present Commission to work a great benefit to the state by simply building roads of the right kind to meet local conditions, and there is a further opportunity to greatly reduce cost by using local materials, labor and machinery.

Question of Maintenance.—The burning question with us, as I suppose it is with all of you, is that of maintenance. We have been deceiving ourselves into the belief that we were maintaining roads when, as a matter of fact, we were not maintaining them at all. Any system of maintenance which allows a road to wear out and require complete rebuilding and resurfacing is not maintenance. Nothing can be more axiomatic than that if maintenance is to maintain, the structural strength of the road itself must not be impaired. You can get some idea of what our maintenance charges are when I tell you that our system of town roads costs six and one-half million dollars this year, sixteen hundred thousand of which the state paid, and that our system of state and county roads cost almost a million and a half for maintenance and repairs alone, twelve hundred thousand of which the state paid. The state has, therefore, spent almost three million dollars this year for maintenance of state, county and town roads and with the great extension of state and county roads and considering their rapid deterioration as now built, the amount the state will have to contribute will reach ten million dollars a year upon the completion of the contemplated system.

If the present commission is to best serve the interests of the people in the state it must be empowered to build roads where they are needed and of a kind and at a cost which comport with the local requirements.

I again welcome you and sincerely hope that your deliberations will result in much progress and lasting benefit to this all-important cause, which is so near the heart of every citizen.

Welcome by Mayor.—Mayor Edgerton spoke as follows:

It is a pleasure to be here this morning and to extend to the Road Builders the welcome of the citizens of Rochester. We have a beautiful city, with beautiful homes; a clean city morally and for fear no one else will say so, I will say myself that we have a good, clean city government. We have miles of clean streets and improved pavements. Monroe County, outside of Rochester, has 900 miles of improved road and if they will give us only a little more time, we will have 400 miles more of improved highway. I hope the time will come when every road in the county will be an improved road. I trust that your deliberations here will be not only pleasant, but profitable, and that you will go away anxious to return.

Favors Convict Labor.—Sheriff Willis K. Gillette spoke of the problem of using convict labor in improving roads, and declared himself unqualifiedly in favor of it. He claimed that not only would the state be benefitted, but the convicts themselves would receive good.

Mr. Samuel Hill, speaking in reply to the address of welcome, covered briefly many points in road building.

This question of good roads is the most vital one that is before the American public to-day. It is five times more important than the tariff. Statistics show that the Americon farmer has to pay 30 cents a ton for the transportation of his crops where the European farmer pays only 10 cents, a loss in initial transportation of 20 cents.

The three greatest needs of the farmer are good roads, telephone service and schools. But the most imperative need is the first. Good roads bind the scattered homes together, localize the schools and make possible central high schools. They aid in the development of the domestic, social and spiritual life of the people, for they render easy of access the homes, schools, churches, hamlets, towns and cities.

What has the Federal Government done for good roads? It has not even lived up to its Constitution, for where does it build and maintain post roads? The only appropriation made for roads by the last Congress was $10,000 incorporated in an an agricultural bill, and this $10,000 was to be expended in building a road in the District of Columbia that runs alongside the golf links used by President Taft.

We propose to know just what the government has done in the matter of roads, and this will be the purpose of a resolution I shall introduce in the convention. Mr. Taft talks about the benefits of the Panama canal and a great Mississippi water highway, but let me say that there are no roads today in the Prairie or Southern States over which crops could be hauled to the Mississippi river.

The cost of freight transportation begins at the barn door. If the farmer has good roads, he will be able to transport his crops at all seasons and await the best prices in the market. The fearful conditions that beset our roads now at some seasons force him to haul when it is most suitable to do so.

Our country needs morê farmers. In 1870 the population that lived by the soil was 49 per cent. In 1900 it has shrunk to 29 per cent. We must populate our farms and we must make them worth while by giving the tillers the best advantages to make a living. The existence of the republic depends upon the farmer, and if the foundation is not maintained the nation must be swept away.

The ten-mile stretch of road that I am building now at Maryhill, Wash., is an ideal illustration of the kind of road our farmers need. We had to construct it of materials that would not become gummy under a temperature of 110 degrees or become as brittle as molasses candy under a temperature of 10 degrees below zero. Professor S. C. Lancaster, of Jackson, Tenn., is in charge of the construction of this road and I believe that he will be the man who will revolutionize the country and national life of America through the building of good roads. He understands them.

We are carrying on a campaign of education. It is necessary to awaken the people to the crying demand for good roads. They are the greatest economic principle we have and we must understand that, unless we are economical in the transportation o four crops, we are adding to our burden of production. The railroads are to blame in this matter. They should long ago have begun to teach the people that crops cannot be transported by rail alone, but that there must be good roads upon which to haul the crops from the farms to the stations. No, I cannot say that the railroads, as a body, now are agitating the good roads proposition. In fact, I know one railroad president who draws a salary of $50,000 a year and is opposed to it.

Work Done by a Tractor.—We are using at Maryhill a tractor that, with four steel wagons, hauls and distributes over the bed thirty tons of rock. In two trips a day it distributes sixty tons of rock and, going and coming, rolls it into the bed. This is all done at a cost of just $6—think of it! One steel wagon, carrying one cubic yard of stone, when drawn by mules, costs for a ten-mile trip $5. It would, therefore, cost $300 to haul alone—not distribute, mind you—the same quantity that the tractor hauls for $6—and distributes.

A good road outlives all other works of man. This is witnessed by the survival of the ancient Roman militarv roads. Soon I am going abroad on my thirty-seventh trip to Europe to study the roads of France and Northern Africa.

Samuel Hill, President of the Washington State Good Roads Association, presented resolutions on Wednesday morning providing that students at West Point and all agricultural colleges be taught scientific road building, and also for an investigation as to what the Federal Government is now doing in road building. The resolutions were taken up by the Committee on Resolutions. The resolution follows:—

"Be it resolved: By the American Road Builders in congress assembled:

"First—That this association believes that the matter of education in road building is of primary importance, and to that end it hereby appoints a committee of three to be designated by the chair, whose duty it shall be to lay before the President of the United States, Congress and the Secretary of Agriculture the request of this association urging the importance of establishing in the Military Academy at West Point and in several agricultural colleges throughout the United States a chair or department to be occupied by a man versed in the art of scientific road building and to use al' reasonable endeavors to have the intent of this resolution carried into effect in the manner above designated.

"Second—That this committee be empowered and directed through the channels above named, or otherwise to ascertain what steps are being taken by the United States Government to carry out provisions of Article VIII. of the Constitution of the United States, which provides for the establishment of Post Office and Post Roads.

"Third—It shall be the duty of this committee to ascertain what sums of money are now being spent by the National Government, if any, for the construction of government highways, and to ascertain what money has been appropriated by Congress and placed in the hands of the Agricultural Department for the improvement of highways, or instruction in the art of building same; and whether in the opinion of such committee the sums so appropriated are being spent to the best advantage.

"Fourth—It shall be the duty of this committee to make a report to the Executive Committee of the American Road Builders' Association and also to the members of such association through the official organ of this association, and, if necessary, to urge upon Congress, or other proper government authority to take such steps as may be necessary and conducive to the advancement of the cause of highway improvement."

Address by New York Engineer.—Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, spoke Wednesday morning on "Adaptability of Roads and Pavements to Local Conditions." Engineer Lewis' address was a lengthy and able one, in which he took up the various types of road surfaces or pavements which are recognized as possessing different qualities in varying degrees. He said the most conspicuous physical qualities were durability, smoothness or light resistance to traffic, slipperiness, facility of repair, and sanitary features. In addition to these, there was the most important quality of economy, not low first cost, but the lowest annual cost for construction and maintenance when spread over the entire period of the life of the pavement.

Mr. Lewis said that there had always been a disposition to draw a sharp distinction between streets and roads, the former being considered as belonging to cities and large towns, and the latter to villages and rural districts. They were, however, he said, all highways, and the same considerations of suitability and economy in the selection of the road surface should apply to both. There are many village streets and inter-urban highways which sustain a far greater traffic both in number of vehicles and in tonnage than do the residential streets which happen to lie within the red lines indicating the corporate limits of a great city.

Mr. Lewis said that in most cases the important question of careful consideration of local conditions, the rate of grade, the amount and character of the traffic which passes over the highway or which will probably be attracted to it by reason of the proposed improvement, had been determined by the preferences or prejudices of some of the abutting owners, or by those whose alleged opinions had been judiciously accelerated by an enterprising agent of some particular kind of a pavement.

Face Local Prejudice.—There may in some cases be local prejudice against considering adaptability to motor car traffic in determining the kind of construction to be employed, but it must be remembered that in the state of New York, owners of automobiles will, during the current year, pay into the highway fund of the state in the form of registration and license fees, the sum of $900,000, or enough to pay interest and sinking fund on some $18,000,000, and the receipts from this source will doubtless increase, rather than decrease. If motor trucks and traction engines are to come into general use, it would be manifestly fair to impose an additional tax upon all vehicles designed for a load, of, say, 2,500 pounds or more on each wheel.

The problem with which we are confronted at the present time is the creation of a great system of good highways, the aggregate mileage of which will be enormous. Nearly all of these highways will be in rural districts, where the cost of their construction cannot be assessed upon the abutting property. The expense must, therefore, be met by the state, or by the state, county and town jointly. The money must be borrowed through the issue of bonds or must be raised when needed by direct taxation. While the annual cost of maintaining these roads will be a serious burden, and this burden should be reduced to the lowest possible amount consistent with efficiency, and while the type of road to be built should be determined with regard to ease and economy of maintenance, the selection of the type of surface will, in most cases, be controlled by consideration of first cost.

A discussion of the adaptability of pavements should not exclude the consideration of city streets. While the annual expense of constructing, maintaining and renewing pavements in a large city is very great, the first consideration is not, or should not be, one of cost. The health, comfort and convenience of city dwellers is so dependent upon smooth, clean, sanitary and quiet pavements, that they are cheap at almost any price. In paving city streets it is customary to impose upon the abutting property the cost of at least one pavement, and it is but fair and equitable that the pavement so assessed should be as durable as possible and should be placed upon a substantial foundation, which will be available for those which may be subsequently laid; in fact, it would not be unreasonable to say that the underlying foundation is the real pavement and the visible surface only the protection for it.

Variation in Pavements.—There are some streets where quiet is such an important consideration that a short lived pavement which is fairly noiseless is much preferred to one which is more durable and therefore cheaper in the end. The money value of a clean and quiet pavement on a street devoted to office buildings or high class hotels and residences is so great, that the cost of frequent renewals, if imposed upon the owners in the shape of assessments, would be a small price to pay for the luxury in view of the greater rental value of offices and rooms, while in front of schools, hospitals and churches, such pavements are essential if the institutions are to properly perform the functions for which they are designed.

Some of the most serious problems in highway construction and maintenance are caused by the presence of surface railway tracks within the paved area of the highway. Many suburban and country roads have been almost ruined for ordinary traffic by the laying of such tracks. The desire for high speed has resulted lately in the location of such railways on private rights-of-way, or at least well without the travelled roadway if located within the highway limits.

In conclusion Mr. Lewis said that it was better to recognize the tracks on city streets as a proper and necessary part of the streets, and place between them a pavement which would best meet the exacting conditions without regard to which kind may be used on the sides of the street. His closing remarks were:

"The right to lay tracks in our public streets is a very valuable one, and the corporations enjoying such rights can reasonably be expected to lay and maintain pavements within the space occupied by them in the best possible manner and at their own expense."

Highway Referendum.—State Engineer John A. Bensel spoke on "Highway Administration." He took up the subject of road building and highway organization, and said that it might be wise for the people of this state to try the referendum on highway administration. In part, he spoke as follows:—

It cannot, I think, be claimed that there is as yet a sufficient amount of data to place road building in a definite class of engineering. Some engineering work has to be done in connection with the work, but the lack of definite data to reduce it to a science can be understood fron an inspection of the work in the various states.

The basic principle involved in highway administration would seem properly one of economics, but it does not appear as yet that this aspect of the case has received anything but the most casual consideration.

Legislators have directed just where the improved roads were to be built, and we have a fine example of this kind of administration in this state, where you may note that the worst roads are as yet those connecting lines between the principal cities.

Proper administration of highways may be reduced to the proposition of selecting administrators of known capacity to carry on this work which is of such importance to the whole community, and in the carrying out of the work to leave them with as free and unhampered control as is possible under the laws of the state in which they are working.

The sums of money which are now being expended in this country for the construction of highways are of considerable magnitude, aggregating, I am informed, for the year 1911 about $150,000,000; out of this amount probably $50,000,000 will be obtained by a direct bond issue, and in many cases, the means taken for the redemption of these bonds are not altogether apparent. Further than this the experience in this state shows that from 10 to 15 per cent. of the amount expended in the roads needs to be expended annually to maintain the roads as they have been built up to the present time.

Careful Study Necessary.—It may readily be seen, therefore, that it will not be necessary to go far before it may become apparent that any state may be bankrupted by carrying out all desires for new and improved highways in sparsely settled communities. Careful study should therefore be made of each section of the state and the road construction adapted to the needs of the inhabitants, with such changes as may be necessary in order that through routes may also be provided along the lines of maximum travel from the main centers of population, and after this is done it still remains to have some proper administration of highway officials to devise a road which in its maintenance will not take all of the good from the people which the construction of the road in the first instance seemed to imply.

Mr. Bensel was followed by George W. Cooley, State Engineer of Minnesota, who spoke on conditions in Minnesota, and said that road patrols were a necessity to good maintenance. Minnesota uses convicts as road patrols with good success. President Parker also spoke in the discussion, and said that maintenance of roads was of equal importance to their construction. R. A. Meeker, State Supervisor or Roads for New Jersey, was the last speaker, and explained the road administrative system adopted in New Jersey.

Problems of Construction.—By Major W. W. Crosby, Chief Engineer of Maryland State Roads Commission.

The speaker called attention to proper grading and installing of underground structures, drainage, subgrade and surfacing. He also spoke of the reconstruction of old roads. Regarding underground structures, he said they should be installed as early in the proceedings as possible, especially those which cross the road. He said that such procedure not only insures their being out of the way, but also allows more careful construction and better results in the back-fill.

Major Crosby thought the matter of subgrading one of the most important of all construction problems. In his judgment more failures in surfacing have had their rise in defective subgrades than any other source.

Best Highway Commissioner.—The discussion was led by R. A. Meeker, State Supervisor of Roads of New Jersey, and Charles W. Ross, Street Commissioner of Newton, Mass. For his description of what a good road should be in a general way, Mr. Meeker quoted from Isaiah the following passage:

" 'Every valley shall be exalted and every hill brought low. The crooked shall be made straight and the rough places smooth.' What better description could you want of a main highway?" asked Mr. Meeker.

In regard to adding bituminous substances to road surfaces, he said he was convinced that a return must be made to rolling and puddling roads thoroughly before placing the bituminous matter. Referring to the statement made at the morning session that engineers were not always essential, he said that civil engineering was condensed common sense and experience. He said that too often when county or city officials had decided what they wanted they required engineers to do in five minutes what had taken the officials two years.

Charles W. Ross, Street Commissioner of Newton, Mass., was introduced by President Parker as the best street commissioner in Massachusetts. Mr. Ross said that in his opinion the most necessary thing was first to look after the surface water. He said that sewer, gas and water mains should be made to connect with the back of sidewalks. Too often, according to the speaker, corporations came along to tear up the streets after they had been made, and in resurfacing them an inferior material was used. He advocated the resurfacing of a torn up road by the city instead of the corporation for whom it was torn up.

Congressman Danforth Speaks.—Congressman Henry G. Danforth gave an interesting talk, in which he advocated following the line of the least resistance. He outlined the philosophy and history of road making, beginning with the Indian, who made a trail on the highest ground and forded rivers at their shallowest points, down to present times, and concluded with a statement relative to the cost of construction. He said:

"If you are going to build roads at the cost of $13,000 a mile, when the total value of farms along the highway may not be worth that, the cost is excessive." Another interesting talk on water-bound macadam roads was made by George C. Hoyen, of Rochester, a State Highway Inspector.

"Problems of the Contractor," by C. A. Crane, Secretary of the General Contractors' Association, and an informal discussion on bonds and deposits, delayed payments, labor laws, percentage bidding and lump-sum and unit-price bids.

The organization of which Mr. Crane is secretary has a membership in New York city of eighty-seven companies and he addressed the convention at length on contracting problems. Harold Parker, the president, yielded the chair for the day to the third vice-president, James Owen, of Montclair, N. J. Mr. Owen was particularly earnest in his support of the proposal to have a committee named to draw up a contract that would cover the various demands that have to be considered in the building of roads.

Barge Canal Contracts Scored.—Mr. Crane criticized the barge canal contracts. He said that the specifications are too one sided and make the contractor responsible for the engineer's mistakes. Unsatisfactory and unreliable information is furnished to the contractors, Mr. Crane said, and the strict requirements prevent the contractors from making the money that is their just due. In part he said:

"It is unfortunate that there is a more or less prevalent tendency to associate contractors on public work with politics and graft. You men who plan and supervise the work know that, in the main, the contractor gives full value for money received. The exceptions are no more frequent in the contracting than in any other business."

Two provisions of the labor law were severely rapped by Mr. Crane. He said these impose hardships on contractors and there is no reason for the prohibition that none except citizens of the United States shall be employed on state work. Mr. Crane also opposed the provision that compels contractors to pay the prevailing wage. He declared that if the courts should uphold the clause barring alien labor, the state work would have to come to an end, as there are not enough citizen laborers to perform it.

Incompetent Engineers.—The speaker held that it was impossible to establish a prevailing wage. He said that if the state imposed fewer statutory restrictions in its contracts there would be less trouble between contractors and engineers, as the former naturally sought to beat a game that appeared framed up to beat them.

Mr. Crane also scored what he termed the niggardly policy of the state in employing inefficient engineers solely because they may be had at small salaries. He asserted that if the salaries were large enough to make it worth while, the higher grade of engineers, men qualified to do the work, could be employed instead of men who held their positions solely because they were too incompetent to obtain better positions.

The formal discussion of Mr. Crane's paper was conducted by F. E. Ellis, a director of the American Road Builders' Association, and E. F. Van Hoesen, secretary of the New York State Road Builders' Association. Both speakers held that the ideal contract is still to be attained, while the present form is too full of specifications that are so meagre that they leave too much to the discretion of the engineer and hamper the contractor in fulfilling the contract.

The chairman said that in his road work in New Jersey he made it a requirement that the contractor should have his own engineers, so that there might be no disagreements. State Engineer George A. Cooley, of Minnesota, declared that the roads of his state had been built on the "hit and miss patch and pack again" plan, and it had been his experience that the letting of contracts for road work had always proved unsatisfactory to the taxpayers.

Continuing the informal discussion of contracting problems, E. A. Stevens, Commissioner of Public Roads of New Jersey, said that the engineers obtainable in his state under the money available were either inexperienced youngsters or failures who could not command good positions. W. J. Robinson, Road Commissioner, of Washington, declared that contracting problems are governed largely by the conditions.

Touching upon the difficulties encountered, Mr. Robinson said that one road in Washington, 150 miles in length, had cost $600 a mile to locate and this excessive figure was considered reasonable, in view of the fact that the engineers were required to do away with trees eight feet in diameter and 300 feet in height.

"It took four boxes of giant powder to blow out some of the stumps," Mr. Robinson said, "and powder is cheaper than man power."

Pay for Work Delayed.—A. J. Rockwood, a Rochester contractor, made a strong plea for better methods of payment after a contract has been completed. After asserting that the automobile had changed the conditions of road construction, Mr. Rockwood said:

"Contractors on the New York state roads have a great deal of difficulty with deferred payments. At present we don't even know who is going to accept the road when completed, nor do we know when we will get our money. I built eight miles of road in less time than it has taken to pay me for it, and three sets of officials inspected it, too. I am speaking plainly because I have been up against it. The contract specifications are too verbose and contain many things that the state does not expect to use. Many times the road work is placed in the hands of boys just out of college and different interpretations of the clauses are made.

"Rarely are the specifications, though lengthy, complete in carrying out their intention. The boys just out of school who administer the contracts seem to think that they are hired just to 'bust' the contractor."

This statement caused hearty laughter and C. A. Caruth, of Rochester, assistant engineer to the State Highway Commission, rose to state that he had worked with Mr. Rockwood and knew that many things he said were true.

Engineers Handicapped.—"The engineers want to do right," said Mr. Caruth, "but they are hampered by too much red tape. The state engineering department should give its men liberty of action and allow those who are on the job to use their own judgment about many matters. No man who is incompetent should be entrusted with road work."

Thomas N. Brennan, Road Superintendent of Niagara county, said that his experience had taught him that a college education was no drawback to a man naturally gifted with common sense. Several other delegates took part in the discussion, all averring that the present form of contracts is hampering and, while exacting, too lax in requirements that are important to successful contracting work.

It was at this point Mr. Owen stated that it is planned to have a committee appointed to draw up what will be, from the contractors' standpoint, an ideal contract.

Among the Canadians attending the Convention were: W. A. McLean, Provincial Highway Engineer; G. G. Powell, Principal Assistant Engineer, City of Toronto; W. Kennedy, President of the Ontario Good Roads Association, and E. A. James, Engineer on the York Highway Board.

EXPERIMENTS ON THE FLOW OF WATER IN WOOD STAVE PIPES.*

This paper is a description and discussion of certain experiments on loss of head in wood stave pipes, made under authority of the United States Reclamation Service, on the Sunnyside project, in the State of Washington. The experiments had their inception in the following circumstances, which shows that necessity is the mother of investigation, as well as of invention.

In the spring of 1908 the writer was called upon to determine the required size of a wood stave pipe to carry water across the Yakima River to irrigate some 9,000 acres of land under the Sunnyside project. Having had no previous experience in similar calculations, nor any knowledge of actual flow under similar conditions, he was forced to resort to the published data on the subject. These data were rather meagre and are replete with inconsistencies, as brought out in the various discussions on them; and any attempt to co-ordinate the results is apt to be discouraging. However, in the above instance, the writer interpreted the results as best he could, and calculated the size of the pipe required.

There are quite a large number of wood stave pipes in service on the Sunnyside project of the U.S. Reclamation Service. Since the data on the subject were not complete, it was decided to make some experiments for friction losses in these pipes. The experiments were made in 1909 and 1910, chiefly during August and September of each year. Those months were selected because at that time a greater variation could be made in the flow of the various pipes without interfering seriously with the process of irrigating. Even at this time it was not possible to vary the flow as much as was desired, on account of the lateral at the intake or outlet not being able to take care of extreme variations in the water supply. However, this difficulty probably had no effect in vitiating the results of the experiments, for it is not likely that the conclusions would have been different had greater variations been possible. As it was, the field of velocities, from 0.4 to 6 ft. per sec., was quite thoroughly explored. All statements

*Abstract of a paper by E. A. Moritz, Assoc. M. Am. Soc. C.E., in Vol. XXXVII., No. 8, page 1065, Proc. Am. Soc. C.E.

made herein must be considered as applying to velocities within these limits.

Scope of Tests.—Observations were taken on pipes of the sizes and lengths given in Table 1.

Table 1.—Sizes and Lengths of Pipe.

Year.	Diameter, in inches.	Length, in feet.
1909	55¾	2,848.2
1909	14	3,637.0
1909	8	3,394.5 and 2,002.0
1909	6	500.4
1909	5	1,822.0
1910	55¾	2,848.2
1910	22	2,087.0
1910	18	2,802.5 and 2,774.2
1910	14	3,637.0
1910	12	2,022.0
1910	8	3,515.2 and 4,054.9
1910	6	1,801.0, 1,892.0, 2,021.0
1910	4	.109.5 and 603.0

The 55¾-in. pipe is of continuous-stave construction, and the others are of the so-called machine-banded, jointed-stave type, manufactured in usual lengths of from 8 to 20 ft,. which mortise and tenon ends, which are driven together in the trench and not otherwise jointed.

The pressure heads were measured with water gauge columns for the lower heads and mercury columns for the higher heads, when scaffolding would have been necessary in order to use a water column. The gauges were attached to the pipes by a ½-in. wrought iron nipple, threaded at both ends and screwed into a hole bored in the wood pipe. All connections were through a single tap at the top of the pipe.

Discharge Measurements.—In all the experiments the quantities were measured over weirs. Those for the 55¾-in. pipe were measured over an 18-ft. rectangular weir with a crest of No. 11 gauge iron. This weir was at the intake of the pipe. During the 1909 observations there was considerable velocity of approach above the weir. This was estimated by taking 8-10ths of the surface velocity, measured by floats, as the average velocity. In order to determine this velocity of approach more accurately, and with the hope of obtaining a check on the weir formula, measurements of discharge were made for the 1910 observations with a Price current meter. The meter was operated from a bridge across the canal about 75 ft. up stream from the weir. For heads higher than 0.8 ft. over the weir, Smith's formula for contracted weirs agreed very closely with the meter results, but, for all lower heads, no formula seemed to give quantities as high as the current meter. The channel in front of the weir was badly silted up during all the observations, and it was difficult to determine the velocity of approach, especially for the smaller quantities. It has been concluded, therefore, that the current meter measurements are the more reliable, especially in view of the fact that uniformly good results had been obtained previously with the current meter in other channels. The quantities determined by the current meter have been used in the deductions.

The discharges from all other pipes were measured over Cippoletti weirs. No attempt was made to measure velocities of approach, but care was taken to erect a suitable baffle wall across the approach channel in all cases when velocity of approach was likely to assume dangerous proportions.

The difference in elevation between zero of gauges was determined with a wye-level.

Plan of Observations.—During a test observers were stationed at each manometer and at the intake. Most of the pipes are in open and gradually sloping country, and each observer was able to see the others, either with the naked eye or with a field glass, so that it was possible to signal back and forth at will. After all the measuring apparatus had been properly attached and tested, and the flow into the pipe approximately adjusted to a desired quantity, some time was allowed—usually about ½ hour—for the flow to become steady, as indicated by the action of the gauges. Sometimes, due to various causes, a much longer time than this was required before a consistent set of readings could be obtained, and especial care was always taken to make sure that the flow was not under the influence of abnormal conditions. Each test lasted 30 min., during which time the pressure gauges were read at intervals of 1½ min. The gauges nearly always fluctuated slightly, and the maximum, minimum and average readings were recorded. For each test, therefore, sixty gauge readings were recorded for each manometer. The valve between the pipe and the gauge was always closed down until the fluctuations of the column were almost entirely destroyed, but not enough to involve any danger of shutting off the connection entirely. Thus the fluctuation of the column was reduced to such an extent that the greatest normal vibration was about 0.003 ft., except in the 55¾-in. pipe, where the fluctuations at times were somewhat higher, but never more than 0.006 ft. Greater fluctuations were observed in several cases, but were caused by the presence of air, which was a source of some annoyance in the smaller pipes. In using a water column connected to the top of the pipe, it was practically impossible to read the instruments when any appreciable quantity of air was being carried. When such conditions arose, the test was stopped and steps were taken to prevent air from entering the pipe, no further readings being taken until this source of disturbance was overcome.

On account of the comparatively large loss of head in the smaller pipes, it was found to be an unnecessary refinement to apply temperature corrections to the gauge readings, consequently their reduction to pressure at the station was a simple matter. However, for 55¾-in. pipe the total loss of head was so small between the two observation stations that temperature corrections were made.

In this short abstract we cannot give the extensive tabulated results and diagrams of the observations which are printed in the original paper. However, we are here giving a brief description of each pipe line since these descriptions contain interesting data on the condition of wood pipes after a few years' service.

The 55¾-in. pipe is a continuous wood stave pipe built by the U.S. Reclamation Service in 1908. It was placed in operation in May, 1909, and had been in use 5 months before the first test was commenced. Corresponding diameters measured before and after the experiments agreed to the nearest 1-16th in. This is very surprising, as the pipe had been in use for 2 years. There was no growth of any kind on the interior surface. The length tested was 2,848 ft.

The 22-in. jointed wood stave pipe was built in 1906 and had been in use for four irrigation seasons of 7 months each. It was probably almost empty during the other 5 months of each year, as it contained several small leaks. The greatest discharge of this pipe during the experiments was 8 cu. ft. per sec. The pipe has warped out of shape about 1 in. The length tested was 2,087 ft. There has been constant trouble with leaks on this pipe, due to defective materials and workmanship. Frequent repairs have been necessary.

The 18-in. jointed wood stave pipe was built in 1908 and has been in use for two seasons. The pipe is distorted about ½-in. at the outlet. The length of pipe tested was 2,802 ft.

The 14-in. jointed wood stave pipe was built in 1905 and has been in use five seasons. Measurements at the intake showed an average diameter of 14 ins. During the experiments a piece of rotten stave was blown out of the top by the increased pressure, and this afforded an opening through which an additional measurement of the diameter was taken. This also showed an average of 14 ins., the distortion being about ¼-in. There was no growth of any kind on the interior surface at this point, but there was evidence of considerable wear on the staves. The softer portions of the fir lumber had been worn down, leaving the harder parts to form axis of the pipe. This was the only place affording access to the interior, therefore it is not known that this condition obtained at other points. In any case, its effect on the friction losses would be difficult to predict. Experiments were made on this pipe in both 1909 and 1910. The losses found in 1910 are smaller by 3 per cent. than those found in 1909. It is possible the pipe had become smoother, and it is also possible that errors of observation existed in 1909. The length tested was 3,637 ft.

The 12-in. jointed wood stave pipe was built in 1910 and had been in use about 3 months at the time of the observations. It was built to supplement the 22-in. pipe previously described and parallels it. No leaks were observed and no distortion was apparent. The length tested was 2,022 ft. The losses observed were abnormally high. The writer believes this to be due to the presence of silt deposits which the low velocity of 0.8 ft. per sec. could not scour out. The presence of such deposits would give velocities higher than the calculated values and so materially affect the apparent relation between velocities and losses of heads.

The 8-in. jointed wood stave pipe was built in the spring of 1909 and had been in use about 5 months before the first experiments were performed. Tests were also made in 1910. The lengths tested ranged from 2,002 ft. to 4,055 ft. The carrying capacity in 1910 was 110 per cent. greater than in 1909 due, it is thought, entirely to drawing off the air at a summit in the line.

The 6-in. jointed wood stave pipe tested in 1909 was built in the spring of 1909 and had been in use about 5 months before the experiments were made. The length tested was 500 ft. The portion tested in 1910 was built in 1910 and had been operated about 4 months before the experiments were made. The length tested was 1,801 ft.

The 5-in. jointed wood stave pipe was probably about 2 years old at the time of the experiments. The length tested was 1,822 ft. The pipe seemed to be in good condition.

The 4-in. jointed wood stave pipe was built in 1907 and had been in service 3 years. Lengths of 1,109 and 603 ft. were tested.

Derivation of Formula.—The writer assumed that the loss of head in any wood stave pipe can be represented by an equation of the general form:

$$H = K D^z V^x;$$

where K, z, and x are constants to be determined by experiment:

H = the loss of head, in feet per 1,000 ft.;
D = the diameter of the pipe, in inches;
and V = the mean velocity of flow, in feet per second.

By assuming that $K D^z = m$, the formula can be broken into two equations, as follows:

$$m = K D^z \quad \ldots\ldots\ldots\ldots (1)$$
$$\text{and } H = m V^x \quad \ldots\ldots\ldots\ldots (2)$$

Both of these, being exponential equations, will plot as straight lines on logarithmic scales. The experimental data give the corresponding values of H and V, and after plotting these for each pipe, the values of m and x can be readily determined, thus making the required constants known. A diagram in the original paper contains a comprehensive plotting of the entire set of experiments. The scales used are logarithmic.

Mr. Moritz determined all the constants in the general equation from a study of the diagram of the results of the experiments. He has adopted for his use the formula:
in which H = the loss of head, in feet per 1,000 ft.

$$H = 8.6 D^{-1.26} V^{1.8}$$

D = the diameter of the pipe, in inches;
and V = the mean velocity of flow, in feet per second.

Reducing this formula to a more practical form, and expressing the diameter in feet instead of inches:

$$Q = 1.353 D^{2.70} H^{0.555}.$$

This formula is not recommended for adoption until more data are available and some of the uncertain points have been cleared up, but until this is accomplished, the writer feels fairly safe in using it. With good conditions, and scientific and careful operation and maintenance, it should give results within 10 per cent. of the true quantities for velocities from 0.5 to 6 ft. per sec.

THE FORESTER'S WORK.

Mr. James Lawler, Secretary of the Canadian Forestry Association, spoke before a special meeting of the University of Toronto Forester's Club. Mr. Lawler gives, in the form of a popular lecture, a good conception of what forestry, a much talked of but little understood word, really is, and shows by means of some excellent lantern slides, scenes in the work of foresters.

The forester is not necessarily a planter of trees, but a harvester, who, unlike the average lumberman strives to remove his crop in such manner as to insure reproduction, looking toward future crops. He is the man with the axe, not the spade.

The forest engineer must be an estimator, must be able to determine accurately the species, quantity, condition and value of timbers on a tract—value as timber, fuel, etc., or as protective covering for slopes or head-waters of streams.

Trees will grow on land, so poor that no other crops can be profitably raised on it, such as rocky hill-sides, sand dunes and other sites unfit for agriculture. Photographs of such lands in the Gatineau Valley and in Norfolk County were shown, where once splendid timber stood, and which should be allowed to grow again to trees, or, if necessary, replanted artificially. One photo, presented by the U.S. Forest Service, showed a 16-year-old plantation of pine, thrifty and in good condition, planted by Dr. B. E. Fernow, in the sand-hills of Nebraska. A critic said at the time of planting, that the Lord had never put trees on those hills and it was foolish for man to try. The trees, however, are doing well.

Some good pictures of seed-beds at various nursery stations were shown and the lecture is illustrated throughout by new slides, making it very interesting and instructive.

METHOD OF TESTING REINFORCED CONCRETE BEAMS.*

In view of the unsatisfactory character of the results obtained from compression tests on concrete cubes, Dr. F. von Emperger proposed, as far back as 1903, that these tests should be abandoned entirely as a basis of calculation, and should be replaced by loading tests on specially prepared reinforced concrete beams. Although the method was then described in detail, it received little attention, and a further account has therefore been prepared by Dr. G. Neumann, and issued as Part XIV. of the excellent "Research Memoirs in Reinforced Concrete Construction," of Messrs. W. Ernst & Son, Berlin.

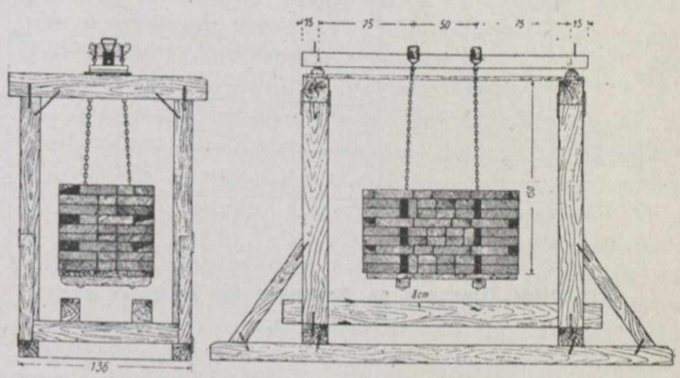
Defects of Cube Test.—The principal objections to the compressive tests with cubes are, that it requires a properly equipped laboratory with skilled assistants, and that small differences in the degree of ramming, the parallelism of the faces of the cube, etc., exert a very great influence on the results. The difficulty of ensuring that the cubes are fair samples of the concrete used on the job has contributed to bring the system of testing into discredit.

The New Test.—The new test is intended to be carried out on the spot, the test-beams being prepared from the materials there in use, and the testing apparatus being fitted up close at hand, from parts which are packed in portable cases, which also contain bent steel rods as models to be copied by the workmen preparing the test beams. It is best to prepare four such beams for each test, two of which are reinforced with a single longitudinal rod (Type I.), and two with two parallel rods (Type II.). The beams are 2.30 metres (6 ft. 8 in.) long, 7 cm. (2¾ in.) broad, and 10 cm. (4 in.) deep. The reinforcing rods are 12 mm. (½ in.) in diameter, and are bent up and turned over at the ends as shown in the diagram on page 765.

Moulding the Beams.—Double-wooden moulds, lined with sheet iron, are used. After oiling, they are fitted together by means of distance pieces; two loops to serve as handles are placed in position, and the sides are accurately adjusted by means of a gauge until the middle third has exactly the correct width. The reinforcing rods are then laid in position on the distance irons and handles. The concrete is then introduced, and tamped in the same way as in the construction of a floor. The moulds may be removed in two or three days, after which care is taken that the beams are exposed to the same conditions of temperature and weather as the work to be controlled. If four beams are used, two are tested after three weeks, and two after six weeks, but for rapid tests intended to determine whether centring may be removed, a single beam is sufficient.

Conducting the Test.—The framework used in making the loading test is shown on this page. The two hardwood knife edges, with iron edges, are placed exactly 2 metres apart, and the load is then hung from two wooden riders, placed as shown at a distance apart of 50 cm. (1 ft. 8 in.). The chains must allow the loading platform to swing freely, without allowing too great a fall when destruction occurs. It is advisable to place a board (not a thick plank) immediately under the beam to receive the broken halves and prevent complete collapse. A vertical scale may be attached to this board at the middle point to measure the deflection before fracture. The load is applied by means of bricks, which are added symmetrically, according to a definite scheme, by two workmen, and are counted until fracture occurs. The mean weight of a brick is determined separately, and the breaking load is then made up of the weights of the bricks and the loading apparatus, and two-thirds of the weight of the beam. (When loading is applied at four points, corresponding with a test under distributed load, the whole weight of the beam must be included).

Calculation of the Results.—Calling the breaking load P, the compressive stress reached in the concrete is, for Type I. of reinforcement, $\sigma_B = 0.384\,P$, and for Type II., $\sigma_B = 0.3285\,P$. It remains to be determined, however, whether this stress was the cause of fracture—that is, whether the maximum compressive strength was utilized. This is most readily determined by inserting $Mo = \frac{P}{2}$ in the graphical diagram here shown. It will be seen from this table that for the best qualities of concrete it is advisable to use Type II., with 4 per cent. of reinforcement. The maximum stress obtainable in concrete by the use of this type of beam is considerably in excess of that ever attained in actual practice. The error due to accidental shifting of the reinforcing rods during the preparation of the beams does not exceed 2 per cent. of the stress.



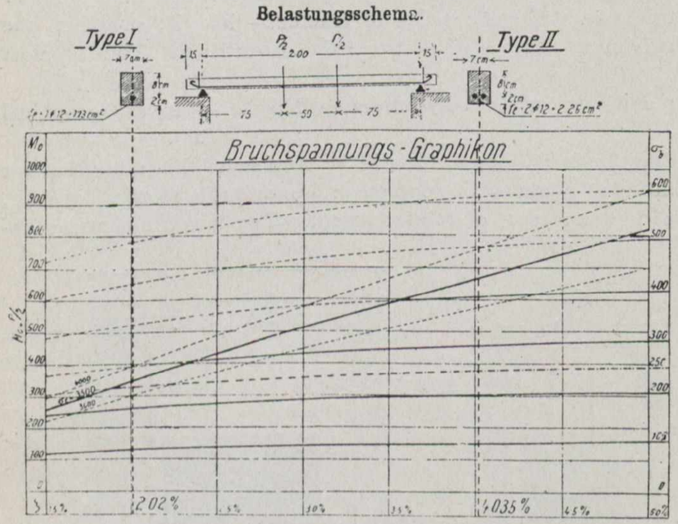
Testing Apparata.

The Use of the Graphical Diagram.—The diagram on page 624 has the percentage of reinforcement as abscissæ, and the values of the breaking moment, Mo, as ordinates. The dimensions of the test beams are so chosen that Mo = ½. The strength of the steel is taken as its elastic limit, which is generally 3,500 kg. per sq. cm., shown as a thick curve on the diagram. Actually, failure of the steel is very rarely observed. In the neighborhood of its elastic limit, the steel unloads itself at the expense of the concrete, and the resulting shifting of the neutral axis upwards, and increase of the compressive stress in the concrete, causes fracture of the concrete, really from a secondary cause. If the value of $Mo = \frac{P}{2}$ falls below the steel curve, fracture is due to failure of the concrete, and the strength of this may be determined by the aid of the second group of curves; if above, fracture is due to the steel, and we cannot tell whether the maximum strength of the concrete has been reached or not.

An Example of the Use of the Test.—Dr. von Emperger gives a fully worked example of the test, in a case in which it was required to decide between two aggregates. The choice was between a machine-broken stone of known good quality, and the cheaper ballast dredged from the Danube, only one-quarter of which is broken in order to supply the missing fragments of medium size. Contrary to expectation, the natural ballast gave results throughout 25 per cent. better than the broken stone, although all the tests were fairly good. The limit of the steel was reached in two cases. The differences are attributed to the sand rather than to the coarser fragments.

*From "Concrete and Constructional Engineering."

The Factor of Safety.—The Prussian regulations require that in parts subjected to bending, the compressive stress in the concrete shall not exceed one-sixth of its compressive strength. This is usually taken to mean the strength of cubes in compression. The actual factor of safety is then $1.6 \times 6 = 9.6$, or nearly 10. A beam should then, after 28 days, show a compressive strength in the concrete of 384 kg.



Graphical Diagram as Proposed for Austrian and German Use.

per sq. cm., which is quite impossible. The Swiss regulations would, under the same conditions, call for 240 kg. per sq. cm., an easily attainable figure. A comparison with the Austrian regulations, which gives figures according with experiments, suggests that in the Prussian regulations the distinction between compressive strength in cube tests and in bending tests has been overlooked, and that the factor 6 should refer to the latter. With the materials available in Vienna, a strength of 250 kg. per sq. cm. should be reached easily after 6 weeks.

Suggested Specification.—It is suggested that the regulation of the Austrian Concrete Association should be modified to run as follows:

"In the regular course of building, four test-beams should be prepared for every 100 cubic metres of concrete, and should be tested before removal of centring in the case of floors, otherwise after intervals of 3 and 6 weeks. Such tests are to be repeated in case of any observed irregularity in the preparation of the concrete, especially at the approach of frost, whenever the temperature falls below + 5° C., or sufficiently often to test any floors constructed in cold weather before the removal of their centring. These test-beams must be clearly marked by labels attached to their handles." Further, "the centring may be removed from any structural member when the specified minimum strength is reached, that is, 4 times the stress shown by calculation under full load." In good weather—that is, when the temperature is above 5° C.—this strength is reached in about a week.

The Strength of Concrete.—A graphical comparison of Dr. von Emperger's results with those obtained by Professor Mörsch and by Professor von Bach, shows that greater uniformity is found in the bending tests than in the compression tests with cubes. A few of Professor von Bach's results with compression tests of 1:2:3 mixtures may be quoted. All the cubes were tested when 45 days old:

Cement, Dresden pit sand, and Rhenish gravel, 238 kg. per sq. cm.

Cement, Rhenish sand, machine-broken basalt, 233 kg. per sq. cm.

Cement, crushed basalt sand and machine-broken basalt, 178 kg. per sq. cm.

Cement, broken limestone sand, and Rhenish gravel, 191 kg. per sq. cm.

These results are in very good agreement with those obtained from Danube ballast. The decrease in strength obtained by using crushed stone instead of sand is very marked in all cases.

The average variation in the results of the bending tests is about 7 per cent. to 8 per cent. of the mean value, these variations being attributable to differences of temperature, moistness of air, etc., and in some cases also to the fracture of the beam taking place at different parts. The corresponding compression tests with cubes exhibit much greater irregularities. Excluding the most irregular values, the ratio of the breaking stress in bending tests to that in compression tests is from 1.3 to 1.6 : 1.

Tests made on the works at temperatures below 5° show a great diminution in the strength of concrete, but the minimum permissible strength was always exceeded after 23 days, so that the centring could then be safely removed. This factor is of such great importance that provision is made on the testing sheets for the entry of the daily maximum and minimum temperatures.

Size of Beams.—It is well known that different values of the compressive strength are obtained by using cubes of different sizes. The experiments with beams conducted by Professor von Bach, Professor Mörsch and the Amsterdam Cement Works were with test-beams of very different dimensions, but little variation of the results was observed. A diminution of resistance under bending load occurs when the section is T-shaped instead of rectangular.

Conclusions.—The cheapness and simplicity of the test, as well as its trustworthiness, are adduced as reasons for its introduction as a means of systematic control of building operations. The same advantages make it a very suitable means of instruction in colleges and classes where engineers and others receive training in constructional engineering. For this reason, it has already found an entrance into the systematic courses of instruction in several important colleges.

PRODUCTION OF WOOD SHINGLES.

The production of shingles increases steadily in Canada. Compared with the Canadian lumber cut, the entire shingle industry amounted to less than the value of each of the most important species, spruce, white pine, Douglas fir, hemlock and cedar, during 1910. Considered separately, the shingle production assumes considerable importance especially in British Columbia. This province is far in advance of the eastern provinces as a shingle producer and made up approximately half of the Canadian 1910 production of nearly two billion shingles, worth over three and a half million dollars. Over one quarter of the shingles were manufactured in Quebec, where the five hundred and thirty-nine million pieces reported were an increase of sixty per cent. over the 1909 amount. Ontario and New Brunswick produced nearly equal amounts in 1910, one-tenth of the Canadian production being from each of these provinces. Ninety-eight per cent. of the total production was in the above four provinces, although shingles are made in every province of the Dominion. Nova Scotia, Saskatchewan, Prince Edward Island, Alberta and Manitoba together produced two per cent. of the total. The average price of shingles in 1910 was $1.80 per thousand, the values ranging from $1.51 for shingles in Nova Scotia to $2.27 in Saskatchewan.

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CONTENTS OF THIS ISSUE.

INTERNATIONAL DEEP WATERWAYS COMMISSION.

The personnel of the Canadian section of the International Deep Waterways Commission has just been announced. In an editorial in our issue of October 26th we noted that there was a likelihood of the removal of the previous Commission, and we remarked then that it was a matter of regret that the Government had never seen fit to appoint an engineer as a member of this body.

The new Commissioners are Messrs. C. A. Magrath, T. Chase Casgrain, and H. A. Powell, and replace Sir George Gibbons, Aime Geoffrion, and A. P. Barnhill.

Mr. Magrath's appointment is one on which the Government are to be congratulated, for he is eminently well qualified for the work. He is an engineer who has had many years' experience, and he has made a close study of the International Waterways question. Mr. Casgrain and Mr. Powell are both lawyers.

We are pleased to note the appointment of an engineer to this Commission, for their work is mainly of an engineering nature, dealing as it does with the power situation along the international boundary. With the appointment of Mr. R. W. Leonard to the chairmanship of the Transcontinental Commission and with this appointment of Mr. Magrath, the engineering profession has taken a step forward into the broader fields which have been considered to the present time as belonging to the lawyer and the business man.

The Canadian section of the International Deep Waterways Commission just replaced have left a sorry heritage for the new Commission in connection with the treaty dividing the available power at Niagara Falls. Canadian interests were sacrificed in that treaty, and the reason was that the Canadian Commissioners were not technical men. The new Government have evidently appreciated that fact in making Mr. Magrath's appointment, and we feel satisfied their confidence will not be misplaced.

GOOD ROADS.

Some of the universities in the United States have already established courses in Highway Engineering, and there is also a strong Department of Public Roads, which has done much to aid goods roads there. In Canada, however, although the necessity is just as great, if not greater, than in the country to the south of us, to the present time there has been little done by the Government towards pushing the question of good roads. The whole question is so bound up with the economic development of the country that it is a surprising fact that so little interest has been taken in the subject.

Mr. N. W. Rowell, the new leader of the Opposition in the Ontario Legislature, expressed the opinion in a recent speech that the engineering schools should take up the question of the education of the student with regard to road building and roadway engineering.

We noticed also a short time ago the formation of a new association in British Columbia having as its aim the obtaining of assurances from the Provincial Government there of aid to highway development. It is now reported that the Dominion Government is working upon a comprehensive scheme under which the provinces will be subsidized for good road building, the expenditures to be made on definite lines to be laid down by the Dominion Government. It has not apparently been finally decided as to whether there will be a separate commission to deal with the road question, but to our mind this is an absolute necessity, and no doubt the Government will find this out on investigation. These signs of awakening to the importance of this question are significant. The public are at last beginning to appreciate the economic value of good highways, and their thoughts are being expressed in the actions of those in charge of legislation.

It is to be hoped that both the Dominion Government and the several Provincial Legislatures will have the importance of this movement fully at heart, and that the movement for better roads and more of them will go forward with an added interest. At the same time, the fact that engineers must be educated for this work must not be overlooked, and the requisite aid given to the universities to develop courses in highway engineering.

WATER WASTE.

Water waste in many of our cities is becoming an exceedingly important factor, not only in the cost of annual upkeep, but also in the consequent necessity of extension of many plants before legitimate use of water would warrant. The Water Commissioner of St Louis in a recent report emphasizes this fact, and notes that, unless means for curtailing the waste are very soon used, very costly extensions will be necessary. He estimates that by the installation of 68,000 meters at a cost, ready for use, of about $1,360,000, it will be possible to save annually about $120,000. By so doing heavy expenses for new pumping engines and clarifying reservoirs can be indefinitely postponed.

For any city, which from necessity, must purify its water, it would be well to study the problem of curtailing the waste, either by very rigid inspection of services or by the installation of meters. In an investigation recently into water waste in Toronto, it was found in one residential district that the flow per capita was eighty-six gallons per day. The mains were found to be in first-class condition, and that the water was going into the houses. On following the matter up, it developed that in many cases the tenants were using the water for cooling purposes, and keeping a constant flow through the taps. When we consider that twenty-five gallons per day is a liberal amount, we appreciate what this waste means. It has been found in many of the cities of the United States where meters have been installed that the total amount of water used has been decreased in nearly every case to one-half that used before metering.

The average user of water, however, has a distinct aversion to a meter, and this feeling is rather hard to understand. If he is buying from the grocer or butcher, he expects the merchant to use a scale as a measure in selling him what he asks for. A person who is using the water in a legitimate manner should not object to any means which will prevent its waste; for waste will in the end mean increased cost to him.

As we have noted, in many of our towns and cities it would be possible to avoid costly extensions to waterworks plants for a long time by taking measures to reduce the criminal waste of water. Very often it will not be necessary to resort to meters if a severe inspection is instituted and an educative campaign carried on to show the evils of waste.

The importance of these facts is appreciated by many engineers and waterworks managers, but they should press the facts home at every opportunity.

EDITORIAL COMMENT.

Congratulations to McGill! She has passed the million and a half mark in the canvass for increased endowment.

* * * *

The city of Quebec are spending the sum of $750,000 on new waterworks; also a large sum for street improvements and the reorganization of the fire department and equipment of the same. It looks as though Quebec was waking up to modern industrial conditions, and is getting in shape to reap some of the commercial expansion coming to Canada.

* * * *

The new water power plant of the city of Winnipeg at Point du Bois is now operating with a peak load of about 3,000 k.w. It is noteworthy that the plant was placed in operation without the slightest hitch. Mr. W. G. Chace, who has been directly in charge of the design and construction of the plant, is to be congratulated on the capable manner in which the work has been handled.

* * * *

The Improvement Commission of Ottawa are coming in for censure at the hands of the Royal Institute of Architects. Some day the public will appreciate the importance of having commissions which deal with technical matters made up of technical men. However, until they do, the same incompetence and lack of result will be shown, as has developed recently in connection with so many of our public commissions.

* * * *

During the past week we have noted many comments in the United States press to the effect that the United States Government will lend the Dominion of Canada the assistance of their experts and mechanical appliances in building the new Quebec bridge. However, the facts are that the United States Bureau of Standards are loaning a type of extensometer by which the stresses in the main members can be followed during construction.

* * * *

The Office of Public Roads of the United States Department of Agriculture has just issued a bulletin which is of considerable interest to the engineer. In it the offer of free engineering for highway bridges and culverts is made to any local body desiring technical advice on this subject. It seems to us that the United States Government has overstepped the bounds of what is fair and square to the engineering profession. The men who have placed their names on this bulletin, two of the most prominent engineers in the country, have placed themselves in an unenviable position with respect to the other members of the profession. It is to be hoped that the Canadian Government does not become susceptible to such a fit of generosity.

* * * *

In an address to the Engineers' Club of Toronto on November 23rd, Mr. Isham Randolph, one of the experts on Toronto's Water Supply Commission, outlined a scheme to make the flow of water over the Niagara Falls more uniform. Mr. Randolph stated that he had approached the United States Government, and was now negotiating with the Canadian Government. If this scheme is taken up and works as well as the previous one at Niagara Falls, we are prone to think not much credit will reflect on Mr. Randolph. The other dam of his design, built of concrete blocks and tipped into the river, serves the purpose mainly of catching all the driftwood and ice in that part of the river, and deflecting into the power house intake there, or holding it as an eyesore and rubbish heap at the brink of the Falls. In our opinion Mr. Randolph would do well to forget this scheme.

SCHOLARSHIPS FOR McGILL.

Two free scholarships covering four years' tuition in the faculty of applied science in McGill University have been offered by the C.P.R to apprentices and other employees enrolled on the permanent staff of the company, as well as to sons of the railway's regular employees.

The conditions attached to the scholarships specify that all candidates must be under twenty-one years of age. The competitive examination will be the regular entrance matriculation to McGill University.

NOVA SCOTIA SOCIETY OF ENGINEERS.

The fifth annual meeting of the Nova Scotia Society of Engineers was held on November 15th and 16th, in Halifax. The programme of the meeting was as follows:—

NOVEMBER 15th—

Morning, 10 a.m.—Visit dry dock, H.M.C.S. Niobe under repairs.

Afternoon 2 p.m.—Business meeting in the Nova Scotia Technical College, Spring Garden Road.

Evening 8.30 p.m.—"At Home" for members and their friends, in the Nova Scotia Technical College. Address on the Foreign Systems of Technical Education, by Professor F. H. Sexton, Director of Technical Education for Nova Scotia.

NOVEMBER 16th—

Morning 10 a.m.—Reading and discussion of the following papers:—

"Development of Electric Power at the Pit Mouth," by P. A. Freeman, Chief Engineer and Superintendent Halifax Electric Tramway Company.

"History of Roads in Nova Scotia," by J. W. MacKenzie, Assistant Road Commissioner.

"Notes on Cement and Concrete Work," by H. C. Burchell, Manager, Sydney Cement Company.

Afternoon 2 p.m.—Visit the Nova Scotia Car Works.

The Canadian Engineer will print these papers in the near future.

UNIT TIMES AND COST KEEPING IN CONSTRUCTION WORK.*

The term "unit times" may be defined as follows: "Unit times" are the times required to perform the elementary or unit operations into which a piece of work may be divided. The purpose of unit times is to separate the elements that are alike in various pieces of work from the elements that vary or which occur a different number of times.

It is evident that the term may apply to different degrees of division. For example, in the construction of a plain wall, the units consist of the operation of laying one face brick, laying one corner brick, and so on, this degree of separation being all that is required for the purpose. On the other hand, for the elementary time study of motions, the units are taken as the individual motions required in laying a single brick.

Unit costs are the costs of unit operations.

"Time study" is the process of analyzing an operation into its elementary operations and observing the time required to perform them. These unit times are taken with a view to recombining them into other operations.

The plan to follow in cost keeping is dependent, in a measure, upon the method of recording the work of each man. Under the ordinary type of management, the timekeeper goes his rounds and records, frequently by guess, the classes of work upon which the different men are engaged. Under the more systematic plans, where the work of each man or group of men is indicated on separate time cards, the cost records are made up from these cards. The purposes of time-study are entirely different from those of cost-keeping. The aim of time-study is to systematize the work and to set tasks for the workman, while the aim of cost-keeping is to show how much the work is costing.

Contractors and engineers throughout the country are coming to realize the value of keeping accurate cost records, either separately or in connection with the time keeping, so as to divide the labor costs into the different classes of work, (1) to determine whether the work is being carried out on schedule time, (2) to see whether the costs are falling within the estimates, and (3) (perhaps more important than either) to give each foreman a daily or weekly report showing the cost of the work under his charge, so that he can see where he is going wrong before it is too late.

The more advanced construction companies have so organized their records that by ten o'clock each day each foreman is given a record of the work which his men accomplished on the previous day.

The great difficulty, even with the best organizations, as they have existed in the past, has been that it has been impossible with ordinary methods to divide the work into sections or divisions which can be properly compared one with another. For example, in bricklaying a mason one day may lay 2,600 brick in a 32-in. wall, while on the next day, working with the same energy and industry, he may lay only 150 brick in an ornamental house front. It is evident that records of his work are valueless unless they are accompanied by an exact description of the details of his work and this description frequently has not been given in the past.

Even in the simplest concrete mass work the labor cost varies with the handling of the raw materials, the output of the mixing machine, the distance to which it is transported, and numerous other variable elements.

*From "Concrete Costs," by Frederick W. Taylor and Sanford E. Thompson. Copyright, 1912, by Frederick W. Taylor.

Metallurgical Comment

T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

THE PHYSICAL PROPERTIES OF CAST IRON.*

John Jermain Porter.

It is perhaps not too much to say that the adoption of chemistry by the foundry has been responsible for a large part of the amazing advance of this industry during the past decade. Within this period mixing by analysis has become the rule rather than the exception, and so much has been published and is now available along this line that further discussion seems superfluous. There is, however, a related point in connection with the selection of pig iron for the mixture, which has thus far received scant attention, but which is, in my opinion, worthy of most earnest consideration by foundrymen, and perhaps even more so by iron merchants and manufacturers. I refer to the great difference which exists in the behavior of many brands of pig iron and which apparently cannot be accounted for on the basis of chemical composition as ordinarily determined.

In former days, now happily past, the old time founder, innocent of chemistry, swore by brands and possessed as part of his stock in trade a list of such as had proved in his experience satisfactory and unsatisfactory. To the chemist this was ridiculous. From his standpoint two irons having the same composition must have the same properties and give the same results, irrespective of brand name or anything else, and so earnestly has this doctrine been preached that his theory has won very general acceptance. It is far from my intention to belittle the value of chemistry in the foundry or to deny the utility of analysis as a means of judging of the quality and fitness of an iron. Nevertheless, I must take exception to the view still held by many chemists that analysis is everything, and maintain that there is something to be said for the arbitrary preferences of the older generation of founders. I believe it to be the case that there are many irons which have practically identical analyses and yet show marked differences in such important properties as strength and shrinkage, and I will now offer what evidence I have to support my views on this point.

Evidence as to Pig Iron Differences.—Perhaps the most convincing evidence that has come to my notice is contained in a paper entitled "An Introduction to the Effect of Structure Upon the Physical Properties of Cast Iron," presented by F. J. Cook and G. Hailstone before the British Foundrymen's Association in 1909. In this paper it is recorded that of two mixtures practically identical in chemical composition the one was invariably much lower in tensile strength than the other, and this difference persisted through a great many heats and over a long period of time. The poorer mixture averaged about one-half of the strength of the better mixture, and in none of the 60 cases given is the strongest bar of the poor iron equal to the weakest bar of the good iron. The following analysis and tests are given as typical of the series, and in view of the exceedingly close agreement of these analyses it is evident that we must look elsewhere for the cause of the very great difference in strength:

	A.	B.
Tensile strength, tons per sq. in.	9.1	18.3
Total carbon	3.250	3.092
Graphitic carbon	2.397	2.289
Combined carbon	0.853	0.903
Silicon	1.328	1.314
Sulphur	0.095	0.101
Phosphorus	0.923	0.909
Manganese	0.290	0.335
Iron, by difference	94.114	94.149

A few years ago I was called into consultation by a certain foundry regarding a persistent case of trouble with shrink holes in small chunky castings. It had been found by the foundry superintendent that the extent of the trouble apparently bore some relation to the mixture used, and hence experiments were carried out to determine what constituent or constituents were responsible for the difficulty. I am not at liberty to give full details of the results of these tests, but an outline of the experiments is as follows:

There were six brands of pig iron on the yard at the time, representing both Northern and Southern irons. Each of these irons was melted separately by using it alone in the first charge and separating the rest of the day's heat by a blank of coke. Working in this way some 20 of the small castings which had given the greatest trouble were poured from each kind of iron. All conditions were kept as uniform as possible and the experiments were repeated several times with different lots of the various irons to minimize the danger of accidental interference of other factors. Finally, the castings were examined for shrinkage cavities, with the following results:

Brand No. 1.—Castings all good; not a shrink hole in the lot.

Brand No. 2.—Fifty per cent. perfect castings, 50 per cent. with small trace of shrinkage.

Lot No. 3.—Ten per cent. perfect castings, 90 per cent. with small trace of shrinkage.

Brand No. 4.—None perfect; all showed a little shrinkage.

Brand No. 5.—All castings with small shrinkage cavities.

Brand No. 6.—All castings very bad, with large shrink holes.

All of these irons were the ordinary No. 2 and No. 3 foundry grades, and while there was some variation in the analyses there is absolutely no traceable connection between the percentage of any element or combination of elements and the results as to shrinkage. Moreover, the irons were each completely analyzed by a competent chemist and it was determined that the differences in behavior could not be attributed to the presence of any unusual elements or to unusual variations in the proportions of the carbons. Since these original experiments were carried out, others have been made on various mixtures of these brands, and it has been shown that the behavior of any mixture is approximately proportional to the behavior of its constituents, so that with equal parts of Nos. 1 and 6 most of the castings will show just a little shrinkage. It has also been found that the remelt from these irons affects the shrinkage in much the same way as the original pig.

It is quite well known among both foundrymen and blast furnacemen that pig iron made in whole or in part from "mill cinder" is less desirable than that made entirely from ore, although the use of the mill cinder will not as a rule change materially the composition of the pig. The points of inferiority of cinder pig do not seem to be very clearly defined and have probably never been scientifically investigated. Nevertheless they are real enough to affect its sales value,

*A paper read at the meeting of the Pittsburg Foundrymen's Association, November 6, 1911.

and in England are recognized by the creation of the grades of "cinder pig" as opposed to "all mine pig." I have had some experience in the use of mill cinder in the blast furnace and have noticed that when using a considerable proportion of it the iron was noticeably easier to break on the blocks, and there was invariably a decided increase in the unreduced iron in the slag.

Charcoal and Coke Pig Iron.—Again we have the case of charcoal iron, which in spite of the threats of foundry chemists to drive it from the field, is still produced in this country to the extent of some 400,000 tons per year, and is still regarded as indispensable for many classes of work. As far as analysis goes there is but little average difference and no essential difference between charcoal and coke iron. Charcoal iron averages lower in sulphur, but any coke furnace can and often does produce iron with the sulphur down under 0.01 per cent., which is as good as is expected from charcoal iron. Again charcoal iron averages somewhat lower in total carbon than most coke irons, but here again the difference is not universal, and, if we should judge by analysis only, many coke irons could easily pass as the product of the charcoal furnace.

Coming to the properties of the two kinds of iron, however, it is within the experience of almost every foundryman that there is a difference. This is perhaps most generally noticed in the matter of toughness or strength, which in charcoal iron is much greater, the grains having a tenacity which causes the iron to tear to a marked degree rather than breaking off short. It is also noticed, however, in the properties of shrinkage, tensile strength and depth and character of chill, and since there is such a difference in properties and such a similarity in composition I think it safe to say that we have here a notable example of that elusive difference which escapes the arts of the chemist.

Finally, I might cite the experience and opinions of many competent foundrymen who have found the facts to be as I have stated. One authority in particular, Dr. R. Moldenke, has repeatedly called attention to these conditions, and if time permitted I might read many quotations from his papers confirming the facts which I have just brought out.

Theories in Explanation.—Although we may recognize the fact that differences in pig iron may exist which cannot be accounted for by analysis, the explanation of these differences is another and a very difficult matter. It is true that, as in the case of steel, the methods of metallography furnish a clue, and under the microscope the structure of cast iron often shows remarkable variations. Cook in the example first cited found that his strong iron showed under the microscope a peculiar net work structure of the phosphide eutectis combined with much finer graphite than existed in the weak mixture. It is well known that charcoal iron is finer in grain than coke iron of similar composition and that this closer grain is an almost invariable accompaniment of strong iron. Hence we may assume that a part at least of the differences in pig iron is due to the variations in size, shape and arrangement of the graphite flakes. This is all right as far as it goes, but is only pushing the matter back one step and is not satisfactory as an ultimate explanation. In seeking the real explanation five possible theories have suggested themselves, and these I will take up in order.

1. The Manner of Cooling.—It has been known for many years that the rate of cooling is an important factor in determining the percentage of combined carbon, and lately it has become appreciated that it may also affect iron in other ways than through the combined carbon. For example, Custer, in his work with permanent molds, has shown that graphite size may be controlled without change in ultimate composition by varying the rate of cooling through the solidifying range; and others have found that hardness and electrical properties may be varied through quite wide limits by controlling the rate of cooling through a much lower range and without appreciably affecting the carbons. In my opinion this possibility is due to a change in the allotropic state of the iron which takes place at about 1400 deg. F. and which is not made evident by chemical analysis.

However, though granting that the manner of cooling may produce many important changes, I still cannot believe that this theory is competent to account for the examples previously given. In the case of both Cook's experiments and those coming within my own experience, rate and manner of cooling were as nearly similar as it was possible to make them, and the number of pieces tested was too great to permit of the possibility of a coincidence of accidental variations in this factor. Moreover, the persistence of the differences after the remelting of the irons cannot be explained on this basis.

2. Form of Combination of Constituent Elements. Another theory which may possibly be thought by some to afford an explanation is the manner in which the elements of the pig iron are combined. There are six elements present in cast iron and some 12 or 15 constituents are possible through the different forms of combination of these elements. There is, however, nothing to indicate that there is anything in this theory, and even if we could account for it on this basis there would still be the question why two brands of the same elementary composition should have their elements combined in such different ways as to produce different properties.

3. Dissolved Nitrogen.—Of late years considerable attention has been given to the gaseous impurities of steel, and it has been found that nitrogen is a rather common and a very detrimental impurity. May it not be the case that the presence of more or less of this element (which is not determined in the ordinary analysis) explains the differences which I have described. This appears a more likely explanation than any of those thus far cited. I do not, however, regard it as the right one, or at least the chief one. There is very little evidence either for or against it, but such as there is appears to be against it. The well-known experiments of Braune (Stahl und Eisen, 1906), seem to indicate that nitrogen is seldom or never an important factor in gray cast iron, although it may be sometimes in white or chilled iron; and Gayley (Trans. A.I.M.E., 35, 986) has described some tests made on the nitrogen content of different classes of pig iron in which he found that there was apparently no relation whatever between the amount of nitrogen and the quality.

4. Dissolved Oxygen or Oxides.—Perhaps the most generally accepted theory to account for otherwise unexplainable differences in cast iron is to assume the presence of variable amounts of oxygen in the metal. This theory is due more especially to Dr. Moldenke, who in several papers has cited considerable evidence in its support. Perhaps the most conclusive evidence is the actual isolation of magnetic oxide, Fe_3O_4, from samples of iron which have been badly burnt on the hearth of an air furnace and which are known to have had the characteristics commonly attributed to oxidized metal. This theory fits in well with all that is known regarding the relation between blast furnace practice and the properties of the iron made. For example, mill cinder is a particularly difficult material to reduce, and, as before mentioned, it has a well marked detrimental effect on the quality of the pig iron produced. Still another example mentioned by Dr. Moldenke is the difference in quality between malleable Bessemer made in a lightly blown furnace and regular Bessemer made in a furnace driven to the limit.

5. Oxysulphides.—While accepting as probably substantially correct this last theory, I would suggest that possibly a modification of it may be still nearer the truth. It is generally assumed that the oxygen is present as dissolved oxide of iron, but it seems to me possible if not probable that it may be rather in the form of an oxysulphide of iron. This compound has been shown by Campbell (Iron and Steel Inst. Jour., 1903) to be capable of existing in iron and steel at high temperatures and to have remarkable powers of diffusing through the solid metal. LeChatelier has also proved its existence.

The evidence as to its presence and influence in commercial iron and steel is only indirect, but there is some circumstantial evidence pointing in that direction. It is quite noticeable in blast furnace practice that following a slip bringing unreduced ore into the hearth there is a most evident association of badly oxidized iron and very high sulphur. It is also well known that it is particularly difficult to keep the sulphur down when smelting mill cinder.

In Lake's "Composition and Heat Treatment of Steel," page 82, I find the statement that steel which has been completely freed from gaseous impurities can be quite high in sulphur without its quality being apparently injured. Again in a paper by Herbert Pilkington on "Cast Irons for Foundry Purposes," read before the British Foundrymen's Association in 1911, it is stated that many of the best cold blast charcoal irons contain 0.10 per cent. sulphur and up, and that this quantity, which would be ruinous to ordinary pig, does not in this case produce unsoundness or other bad effects. Finally, I know of several observant foundrymen who are quite certain that sulphur is sometimes much more injurious than at others, and this fact, if such it be, may or may not be caused by its association with variable amounts of oxygen in the form of oxysulphide.

The Effect of Varying Blast Furnace Practice.—Thus far my discussion has been largely academic. A more practical question is the relation between blast furnace practice and the presence in the pig iron of these injurious properties, however they may be caused. Unfortunately we have not enough data to draw exact conclusions, or, indeed, any conclusions. My observations have led me to accept as a tentative theory the rule that the less oxidizing the conditions under which the iron is made the better will be its quality. In other words, satisfactory iron should be made from easily reducible ores, with a moderate rate of driving and with not too much economy of fuel. These conditions, if correct, are rather hard on the furnaceman and it is to be hoped that further information may modify them somewhat. It is a significant fact, however, that in a large number of cases the irons having the highest reputation for low shrinkage and general good casting properties are made in small furnaces inadequately provided with blowing capacity and hence lightly driven, and using brown hematite or other easily reducible ore.

I have thus far been unable to determine whether those factors in the operation of the furnace which are within the control of the furnace manager have any important effect upon these properties of pig iron, but it is probable that to some extent they have. It is a well-known fact that the grain of the pigs may be varied within wide limits without regard to composition by varying the basicity of the slag and the temperature of the hearth. It is also well known, however, that upon remelting the character of the grain is changed and becomes normal, and so far as I know it has never been shown that the size of the grain in the original pig bears any relation to the properties of the iron after remelting—at least none which cannot be explained on the basis of composition.

On the other hand, I have noticed certain indications which lead me to believe that it is possible to accomplish something by the way the furnace is handled. For example, it appears that the bad effects of mill cinder may be at least partly nullified by slow driving and the use of some excess of fuel. Again, magnetic ore appears to make a satisfactory foundry iron, although it is very hard to reduce, but furnaces using it are generally driven rather slowly. Reasoning entirely from theory, it seems likely that the presence of ferrous silicate in the ore, the formation temperature of the slag (not the melting point), the temperature of the hearth and the freedom from slips may all have something to do with the quality of the iron. It would be interesting to follow up some of these points; for example to compare the iron made by the use of dry blast with that made under otherwise similar conditions but using moist blast. Dry blast greatly increases the hearth temperature, thus producing conditions identically opposite to those under which cold blast charcoal iron is made; yet it is quite possible that it may produce an effect of the same kind on the pig, although less in degree.

Practical Applications.—The practical application of the facts which I have here tried to bring out may not seem to be of any great importance, but I am not so sure that this is the case. Some time ago I had a talk with a foundry superintendent of very broad experience, and in discussing the experiments on fluid shrinkage previously described he insisted that to many foundries this property is one of the most important and difficult problems and is responsible for a much larger number of defects than is generally supposed. According to this gentleman, the question of the influence of brands upon this property is well worth the study of the practical foundryman. There are, of course, many foundries where neither fluid shrinkage nor high strength is of any particular importance; but on the other hand there are some classes of work where one or both of these properties is of very great importance, and in such cases it appears to me that a knowledge of brand characteristics is almost indispensable.

As there is no published and very little privately held information along these lines, it is necessary for each founder to gather his own data, and the procedure which I recommended is as follows:

1. A fluid shrinkage and transverse strength test from each heat.

2. A continuous record of the results of these tests and the mixtures used.

3. Occasional tests of the different brands melted separately.

In regard to the test for fluid shrinkage I have found that originally recommended by Cook and consisting of a casting in the shape of a K with the legs about 1 in. square in section to be very satisfactory. When this casting is broken at the junction of the legs any tendency towards fluid shrinkage will be evident there. In using this test it is convenient to construct a scale consisting of a series of from four to eight broken K castings of varying degrees of badness. These are mounted in a box and given suitable numbers. Thereafter, it is sufficient to compare any test piece with this scale and record as its shrinkage the number on the scale most nearly resembling it.

It will be evident that obtaining these data need not be at all burdensome to the foundry undertaking it, since no special apparatus is called for, except a transverse testing machine, and the extra work involved will hardly amount to 20 minutes per day of a helper's time. Even the special tests of separate brands need not interfere with ordinary foundry routine since they can be run as the first charge in a regular heat.

Another conclusion which might be drawn from the facts brought out is that there is a great opportunity for some of the manufacturers and sellers of foundry pig iron to make strong selling points of these special virtues, once they have found them in their brands. I am quite convinced that the larger commission firms would find it very much to their advantage to have the properties of the brands they handle thoroughly tested so that they could sell them more intelligently. A pig iron salesman armed with this information and some foundry lore would indeed deserve a better name than the now sometimes given title of "hot air artist."

Finally it appears to me that the recognition of the injurious effects of the gaseous impurities in cast iron will give a fresh argument to the electric furnace man. I have long thought that it should be practicable to use an electrically heated receiving ladle or mixer in connection with either a blast furnace or cupola. Here the iron could be partly refined, treated with deoxidizing alloys, adjusted in composition and brought to any desired casting temperature. And since there would be no melting to do, the amount of electrical energy needed would be relatively small. Operated on a sufficiently large scale to take care of the fixed charges, it appears to me that this combination could be made profitable for some lines of work.

RAIL FAILURES IN THE UNITED STATES.

A report covering 11,759,000 tons of rails has lately been issued in the United States by the Committee on Rails of the American Railway Association, and shows a noticeable difference between the number of failures of open-hearth and of Bessemer rails. The failures for the year ending October 31, 1910, were 11.5 per 10,000 tons for open-hearth material, and 33 per 10,000 tons for Bessemer. It may however, be pointed out that whereas the open-hearth material has mostly been introduced during and since the recent. rail agitation in the United States, and the failures cover, therefore, material on which considerable care was expended in manufacture, the influence of methods till recently in vogue in connection with the manufacture of Bessemer rails is probably still felt with resulting heavy failures. The failures are classified as 29¼ per cent. breaks, 55¼ per cent. head failures, 7 per cent. web failures, and 8½ per cent. base failures. In 1909 the head failures amounted to 66½ per cent., so that this part of the rail is apparently still unable to stand up to the heavy loads common on American roads.

SHOP FLOORS.

In a paper on Factory Construction and Arrangement, presented before the New York meeting of the American Society of Mechanical Engineers, October 9, 1911, by L. P. Alford and H. C. Farrell, in which the arrangement and construction of the reinforced concrete buildings of the United Shoe Machinery Company at Beverly, Mass., were described, the concrete floors were discussed as follows:—

"When these buildings were developed, the use of reinforced concrete as a material of construction was new and much of the work that was done had no foundation in precedent. The authors can recall with some amusement discussions over points considered of major importance, for which an easy solution was later found. One of these was the floors. A lengthy discussion took place as to whether or not a concrete floor was suitable for machine-shop purposes. It was finally determined that concrete floors should be used with the single exception of the stair treads, which were to be of wood. These concrete floors have been found to be so satisfactory that they were continued in the additions of 1906-1907, and will be used in the additions now in progress.

"One of the arguments against a concrete floor upon which persons must work is its hardness, but our experience shows this to be unfounded. The real objection to a concrete floor lies in its coldness. Concrete is a much better conductor of heat than wood, and for that reason, a cold concrete floor will rapidly withdraw bodily heat from the feet of anyone standing on it. Therefore, the only floors which need special attention are those which are in contact with the ground. The lower floors of these buildings are of concrete some 12 in. thick, and between the under floor and the upper floor are three thicknesses of waterproofing felt mopped in with asphalt. When the employees were transferred from the old factories with wooden floors to the new, some complaints were heard for the first few weeks, or until the men had become accustomed to the change. Thereafter, there has been no difficulty except on the part of a new man, who has to go through his own period of becoming wonted to the new conditions. Further objections raised to the use of these floors were those of wear due to the grinding action of the wheels of trucks, the chipping action of the ends of pinch bars used for moving heavy machines, the scouring action of metal boxes dragged over it, and, by far the most important, the difficulty of making floor repairs. On the first floor of one building, a floor devoted to the heaviest work done in the plant, requiring the largest machine tools and receiving the largest and heaviest castings, the floor of the center bay has been refinished by adding 1½ in. of a one-to-two granolithic mixture. This, of course, covers the area that has received the greatest amount of wear, as in all of the buildings a central passageway 8 ft. wide was left between the machine tools and other permanent fixtures.

"The greatest difficulty in maintaining these floors has been found to lie in the making of minor repairs, namely, those necessitated by the crumbling away of the edges of the grooves with which the original floors were marked out, or the edges of cracks and repairs to small depressions caused by the wearing away of soft spots in the surface. Repairs made with any cement mixture have been uniformly unsuccessful, provided the area repaired was comparatively small. At present, such repairs are being made by using an asphalt mixture which is applied to the surface in a plastic condition and then bonded to the concrete by the application of heat from gasoline blow torches. This method is much more successful than the use of cement mixture, although it does not entirely prevent the crumbling of the edge of the concrete where the concrete and asphalt join. It was also feared that the oil required in an automatic screw machine department would penetrate the concrete and tend to disintegrate it, but it has been proved that this fear was unfounded. Repeated investigations throughout the past six years have failed to show that there is penetration through the glaze of the finish even in departments where the floor is constantly wet with oil. Where cracks are present the oil will find an entrance; its penetration beyond the limits of the crack is very little, and is not the cause of any apprehension whatever. With regard to the possible injury from dust due to wear on the floors, there is no reason to believe that there has been any greater wear on the moving and sliding members of the machine tools than would have been the case in any other type of building."

SURFACE TREATMENT FOR DUST LAYING AND ROAD PRESERVATION.*

By W. A. McLean, Provincial Engineer of Highways.

Dust prevention has long had a recognized place in urban communities of Ontario, the watering cart during the dry summer weather being the remedy commonly applied with moderate success. At best, however, there are intervals when temperature and breeze are too nimble for the water supply, and the man on the watering cart is deluged with complaints proportionate to the dust that descends on pedestrians and adjacent lawns. When an adequate service is available, and the driver uses intelligent discretion as to the amount of water applied, the sprinkling wagon is an agreeable means of subduing dust—but very rarely is the right combination of service and intelligence applied to the work, with the result that, as a means of subduing dust, water sprinkling has not been effective.

The oiling of roads in California, Pennsylvania and other petroleum regions has been a matter of rumor and experiment for some years, but it was not until 1909 that a serious test was made in Ontario, when a residium of petroleum with a paraffin base was used on the streets of Toronto. Vox populi was at once heard in complaint and objection. "The odor of the oil was offensive, and the oiled mud ruinous to paint, clothing and carpets." But the disagreeable odor passed away in a few days. A small quantity of oiled mud or dust was found no more injurious to clothing and carpets than was a large amount of dry dust. The dust nuisance was remedied to an extent unknown before on macadam and earth roads. Citizens no longer inhaled clouds of dust. Continued experience in 1910 in Toronto, and in other parts of the province, has confirmed the use of oil as a success, a measure of comfort and sanitation, in which the benefits outweigh the objectionable features.

A new factor, the motor vehicle, has of recent years entered the domain of traffic, and has placed new demands upon the public highway. Ten years ago traffic on the roads of England had only 5 per cent. of motor vehicles, while last year 70 per cent. was motor traffic. The number of motor vehicles in Ontario is increasing rapidly, farmers are now among the users, and it is evident that the use of the public highways by this new mode of travel and transportation has tremendous possibilities. Already the motor traffic on some of the roads of the province has brought the dust problem into association with country roads, with attendant discomfort to users of the road, and injury to crops, fruit, lawns and houses.

The scattering of dust by rapid and frequent motor traffic is a serious injury to the road itself, in that the dust is a necessary bonding material for the stone composing the road, and when this is removed, the road "unravels," roughens and deteriorates. Present motor traffic in some cases is now demanding dust-laying treatment; and future traffic will, in the writer's opinion, require it upon a considerable mileage of heavily travelled roads in the province as a matter of preserving them from destruction.

Dust-laying treatment may be little more than a palliative in which the dust is prevented from rising, and remains as a cushion coat over the stone. Or treatment may go further, and may provide for a stronger and tougher road-surface that will resist wear by bonding and protecting the stone. As palliative treatments may be considered the use of the old sprinkling wagon, of calcium chloride, oil emulsions and petroleum, oils with paraffin base. With the protective treatments may be included the use of asphalt and asphaltic oils now being so largely tested in the United States, and the several tar treatments adopted as standard practice in England and Scotland.

Calcium chloride in solution is merely an improved method of water sprinkling. A salt with an affinity for moisture, the principal effect of calcium chloride is to retain the moisture of the atmosphere, thus lessening the necessity of so frequent watering. The effect, however, is temporary, and its use is limited.

Oiling Roads.

To oil roads successfully requires a thorough understanding of the oil used, its constituents and method of preparation. A petroleum oil is generally employed, but some of these, such as the California oils, have an asphaltic base, while those of Ontario and Pennsylvania have a paraffin base. Asphalt is a binder, while paraffin is not, and in an asphaltic oil will destroy the binding properties of the latter. While heavy asphaltic oil, free from paraffin, may be used within the body of the road, or sprinkled over the surface, paraffin oils can be used only by the latter method.

Paraffin oil such as that used in Toronto may be sprinkled from an ordinary watering cart, and on country roads during the past season, crude, home-made distributers attached to common water wagons were made from perforated gaspipe, with success. The oil should be applied to the road in warm, dry weather. Two applications early in the season, followed by two or three later, according to the weather, have been found sufficient to keep down the dust, using for the season on a country road about 3,500 gallons. About 1,500 gallons per mile should make the first two applications. The cost varies according to local conditions, but has been about 4 cents a gallon, and 1 cent for applying.

Asphaltic oils may contain a varying percentage of asphalt up to about 80 per cent. Great care is needed in putting it on the road, to avoid splashing and inconvenience to traffic. Oils with a high percentage of asphalt have to be heated to apply to the road. Special sprinklers are desirable, with the distributers close to the road surface to avoid splashing. One-half of the road only should be oiled at a time to prevent inconvenience to users of the road. Immediately, or within a few hours after applying, the surface should be sprinkled lightly with clean, coarse sand or stone chips. Before applying, the road should be swept clean and sprinkled to slightly moisten the surface, but the weather should be dry. If rain approaches, be sure to get the oil covered and partly absorbed by the screenings, otherwise the oil will be splashed out to the roadsides. One-quarter of a gallon of oil to the square yard in each of two applications will last one season, and in some cases more.

Oil emulsions in which alkali or acid chemicals are used to "cut" the oil are more easily applied, but their effect is temporary.

The cost of two applications of asphaltic oil in two applications each of one-quarter gallon per square yard is given by the chairman of the Massachusetts State Highway Commission, as follows:

	Cents.
Cleaning and sweeping	0.56
Patching old surface	.16
Oil	3.19
Heating oil	.31
Delivering oil	.38
Distributing oil	.29
Furnishing sand at road	1.65
Spreading sand	.73
Watering	.12
Rolling	.02
Supervision	.25
Total per square yard	7.66

*Paper read before Ontario Land Surveyors' Association, 1911

Asphaltic Binders.

In American practice, one of the most recent departures is the use of heavy asphaltic oil as a road binder, applied by the penetration process. That is, over the main road foundation is spread a surface coat of 1½ or 2-inch stone, about two or three inches in thickness. After being once rolled, the heated asphalt oil, containing about 80 per cent. asphalt, is poured into the interstices of the stone. Over this is spread a light coat of stone screenings, and the steam roller completes consolidation. A paint course of asphaltic oil is then applied, and this is followed by a final dust coat of stone chips, well rolled in. By the same method, lake asphalt, fluxed with oil in the usual manner, is employed in the road.

Lake asphalt fluxed with oil may be heated and mixed with stone, but the mixing process is found too expensive for country roads. The penetration method itself is only suitable for roads of heavy traffic, in which the cost of repair would otherwise be large, because of constant motor or heavy team traffic.

The cost of bituminous pavements in New York State last year was approximately 20 cents per square yard for each inch in depth of the penetrated matrix. The stone was usually penetrated to a depth of two or three inches. This class of treatment was used principally on state road metalled to a width of 18 feet.

Tarred Roads.

The tarring of roads for preservation and dust prevention has become the standard practice in England, and is applied in several ways, which may be classified as (1) tar painting or spraying, (2) tar grouting or penetration, (3) tar macadam, (4) tar matrix.

The tar in England is coal gas tar, and is of a more uniform quality than that produced in this country. Tar varies greatly according to the coal used and process of gas manufacture in which the tar is obtained. This lack of uniformity has, in part, been responsible for much of the inferior tar macadam roads in Ontario, and for the feeling among engineers that its use is too uncertain a quantity.

In general the tar should be refined by heating to drive off volatile oils and other ingredients are added. After refining, tar for spraying may have added to it a quantity of linseed oil to cause it to flow more smoothly. The tar painting or spraying method is a surface treatment, and may be by hand or by machine, the tar being spread over the surface of a macadam road in a thin layer and a light coating of stone chips or fine gravel rolled in.

The tar grouting process is similar to the penetration method of the United States. The tar is heated, fluxed with oil, and is then poured into the interstices of a surface coat of broken stone. When the tarring is finished, the surface is sprinkled with a coat of stone screenings or clean gravel, and is thoroughly rolled; then is completed with a paint course topped with screenings and rolled. The cost of a grouted surface of tarred stone in English work is about 42 cents a square yard.

In tar-macadam the stone and tar are hand-mixed, both stone and tar being heated. The mixture used for this purpose usually contains tar, pitch and creosote oil. The proportions are about 50 pounds of pitch, 12 gallons of tar, 2 gallons of creosote oil, and one ton of broken stone. The pitch is broken into fragments and put in the tank, the tar is then poured in, and when these reach boiling point the creosote oil is added. Constant stirring is necessary until a uniform consistency is reached. The stone having been heated until quite dry, the tar and stone are mixed and turned over several times, and the mixture is then spread on the road. The material is usually put on in three layers; the bottom layer 3 inches thick of 2½-inch material; the second layer 2 inches thick of 1½-inch material, and the top layer 1 inch thick of ¾-inch material. The last course is dusted over with coarse, clean sand, and is rolled until consolidated. The cost is usually about $1.00 a square yard, but this is found too expensive for country roads.

The tar matrix process is one in which a fine grade of gravel or broken stone is mixed with refined tar, and is spread to a depth of 1½ or 2 inches over an old roadbed or well-rolled stone foundation, On this is spread a 3-inch layer of 2½-inch stone, and this is rolled until the tar matrix is brought to the surface, thoroughly sealing it. This is usually followed by a "paint" course and a dusting of screenings to seal the surface completely. Or, instead of being placed below, the tarred matrix is spread over the new stone and is rolled down into it. And a third method, the "Gladwell" system, is a combination of the two, an intermediate layer of broken stone being sealed from above and below with the tarred matrix.

Special Materials.

The demand for a road material that will be dustless and durable has caused a large number of patented materials to be placed on the market. Roseate qualities are claimed for many, and while some are clever and promising compounds, the important test—the time test—is one which has yet to be satisfied by all, for experience is necessarily very limited. Glutrin is prepared from a waste of wood pulp manufacture, a dark brown liquid, which is diluted with water and sprinkled from an ordinary watering cart. Tarvia is a preparation or blend of tars designed to meet the need of a standard and uniform grade of refined tar. It has been used on Beverley Street, Toronto, in several ways, with a view to testing its value. Westrumite is said to be an emulsified asphalt or asphaltic oil. Rocmac is a liquid which, mixed with powdered limestone, produces on exposure to the atmosphere, silicate of lime. Several test sections have been laid in the province, and its action in the road is of an interesting kind Good results are reported from England and Scotland, but with many other materials, its permanence has yet to be determined.

In general, the situation at the present time has shown the value of petroleum oil with paraffin base for easy application as a dust palliative. Petroleum oil without paraffin and with an asphaltic base can be applied to make a more permanent dust preventive, and, containing a large amount of asphalt, may be used as a protective coat or as a grout. Some grades of lake asphalt applied by the penetration or grouting process have a high value in making, at a reasonable cost, strong bituminous roads for heavy country traffic, free from dust, and reducing the cost of maintenance. The use of tar is a promising field in Canada, as in England, and affords an opportunity of being less dependent upon patented materials and the larger asphalt and oil trusts.

The quality of stone used in the road has a marked influence upon durability, no matter what binder may be employed. Western Ontario has only limestone, while some parts of Eastern Ontario are better favored with granite and the more durable rocks. Field stone, where used, should be selected to remove inferior and decayed limestone and sandstone. For roads of heavy traffic, much would be accomplished by securing for the wearing surface a three or four-inch coat of trap or good granite, but at the present time the cost of securing these would appear to be beyond reach.

SPECIFICATIONS FOR OVERHEAD CROSSINGS OF ELECTRIC LIGHT AND POWER LINES.*

General Requirements.

1 Scope: These specifications shall apply to overhead electric light and power line crossings (except trolley contact lines), over railroad right of way, tracks, or lines of wires; and, further, these specifications shall apply to overhead electric light and power wires of over 5,000 volts constant potential, crossing, or constructed over telephone, telegraph or other similar lines.

2. Location: The poles, or towers, supporting the crossing span preferably shall be outside the railroad company's right of way.

3. Unusually long crossing spans shall be avoided wherever practicable.

4. The poles, or towers, shall be located as far as practicable from inflammable material or structures.

5. The poles, or towers, supporting the crossing span, and the adjoining span on each side, preferably shall be in a straight line.

6. The wires, or cables, shall cross over telegraph, telephone, and similar wires wherever practicable.

7. Cradles, or overhead bridges, shall not be used.

8. Clearance: The side clearance shall be not less than 12 ft. from the nearest rail of main-line track, nor less than 6 ft. from the nearest rail of sidings. At loading sidings sufficient space shall be left for a driveway.

9. The clear headroom shall be not less than 30 ft. above the top of rail under the most unfavorable condition of temperature and loading. For constant potential, d. c. circuits not exceeding 750 volts when paralleled by trolley contact wires, the clear headroom need not exceed 25 ft.

10. The clearance of a. c. circuits above any existing wires, under the most unfavorable condition of temperature and loading, shall not be less than 8 ft. wherever possible. For constant potential, d. c. circuits, not exceeding 750 volts, the minimum clearance above telegraph, telephone and similar wires may be 2 ft. with insulated wires and 4 ft. with bare wires.

11. The separation of conductors carrying a. c., supported by pin insulators, for spans not exceeding 150 ft. shall be not less than

Line Voltage.	Separation.
6,600 volts	14½ in.
6,600 to 14,000	24 in.
14,000 to 27,000	30 in.
27,000 to 35,000	36 in.
35,000 to 47,000	45 in.
47,000 to 70,000	60 in.

For spans exceeding 150 ft. the pin spacing should be increased, depending upon the length of the span and the sag of the conductors.

Note.—This requirement does not apply to wires of the same phase of polarity between which there is no difference of potential.

With constant potential, d. c. circuits not exceeding 750 volts, the minimum spacing shall be 10 ins.

12. When supported by insulators of the disc or suspension type, the crossing span and the next adjoining spans shall be dead ended at the poles or towers, supporting the crossing span, so that at these poles, or towers, the insulators shall be used as strain insulators.

*From Report of Committee of American Street Railway Association at Annual Convention, Oct. 9, 1911.

13. The clearance in any direction between the conductors nearest the pole, or tower, and the pole, or tower, shall be not less than

Line Voltage.	Clearances.
14,000 volts	9 in.
14,000 to 27,000	15 in.
27,000 to 35,000	18 in.
35,000 to 47,000	21 in.
47,000 to 70,000	24 in.

14. Conductors. The normal mechanical tension in the conductors generally shall be the same in the crossing span and in the adjoining span on each side, and the difference in length of the crossing and adjoining spans generally shall be not more than 50 per cent. of the length of the crossing span.

15. The conductors shall not be spliced in the crossing span nor in the adjoining span on either side.

16. The method of supporting the conductors at the poles, or towers, shall be such as to hold the wires, under maximum loading, to the supporting structures, in case of shattered insulators, or wires broken or burned at an insulator, without allowing an amount of slip which would materially reduce the clearance specified in paragraphs No. 9 and No. 10.

17. Guys: Wooden poles supporting the crossing span shall be side-guyed in both directions, if practicable, and be head-guyed away from the crossing span. The next adjoining poles shall be head-guyed in both directions. Braces may be used instead of guys.

18. Strain insulators shall be used in guys from wooden poles carrying any power wire of less than 6,600 volts. Strain insulators shall not be used in guying steel structures, nor required on wooden poles carrying wires all of which are 6,600 volts or more.

19. Clearing: The space around the poles, or towers, shall be kept free from inflammable material, underbrush and grass.

20. Signs: In the case of railroad crossings, if required by the railroad company, warning signs of an approved design shall be placed on all poles and towers located on the railroad company's right of way.

21. Grounding: For voltages over 5,000 volts, wooden crossarms, if used, shall be provided with a grounded metallic plate on top of the arm, which shall be not less than ⅛ in. in thickness and which shall have a sectional area and conductivity not less than that of the line conductor. Metal pins shall be electrically connected to this ground. Metal poles and metal arms on wooden poles shall be grounded.

22. The electrical conductivity of the ground conductor shall be adjusted to the short-circuit current capacity of the system and shall be not less than that of a No. 4 B. & S. gauge copper wire.

23. Temperature: In the computation of stresses and clearances, and in erection, provision shall be made for a variation in temperature from — 20 deg. Fahr. to + 120 deg. Fahr. A suitable modification in the temperature requirements shall be made for regions in which the above limits would not fairly represent the extreme range of temperature.

24. Inspection: If required by contract, all material and workmanship shall be subject to the inspection of the company crossed; provided, that reasonable notice of the intention to make shop inspection shall be given by such company. Defective material shall be rejected and shall be removed and replaced with suitable material.

25. On the completion of the work, all false work, plant and rubbish incident to the construction shall be removed promptly and the site left unobstructed and clean.

26. Drawings: If required, by contract,............... ( ) complete sets of general and detail drawings shall

be furnished for approval before any construction is commenced.

Loads.

27. The conductors shall be considered as uniformly loaded throughout their length, with a load equal to the resultant of the dead load plus the weight of a layer of ice ½ in. in thickness and a wind pressure of 8.0 lbs. per sq. ft. on the ice-covered diameter, at a temperature of 0 deg. Fahr.

28. The weight of ice shall be assumed as .57 lbs. per cu. ft. (0.033 lb. per cu. in.).

29. Insulators, pins and conductor attachments shall be designed to withstand, with the designated factor of safety, the tension in the conductors under the maximum loading.

30. The pole, or towers, shall be designed to withstand, with the designated factor of safety, the combined stresses from their own weight, the wind pressure on the pole, or tower, and the above wire loading on the crossing span and the next adjoining span on each side. The wind pressure on the poles, or towers, shall be assumed at 13 lbs. per sq. ft. on the projected area of solid or closed structures and 1½ times the projected area of latticed structures.

31. The poles, or towers, shall also be designed to withstand the loads specified in paragraph No. 30, combined with the unbalanced tension of: two broken wires for poles, or towers, carrying five wires or less; three broken wires for poles, or towers, carrying six to 10 wires; four broken wires for poles, or towers, carrying 11 or more wires.

32. Crossarms shall be designed to withstand the loading specified in paragraph No. 30, combined with the unbalanced tension of one wire broken at the pin farthest from the pole.

33. The poles, or towers, may be permitted a reasonable deflection under the specified loading, provided that such deflection does not reduce the clearances specified in paragraph No. 10 more than 25 per cent. or produce stresses in excess of those specified in paragraphs Nos. 65 to 69.

Factors of Safety.

34. The ultimate unit stress divided by the allowable unit stress shall be not less than the following: Wires and cables, 2; pins, 2; insulators, conductor attachments, guys, 3; wooden poles and crossarms, 6; structural steel, 3; reinforced concrete poles and crossarms, 4; foundations, 2.

Note.—The use of treated wooden poles and crossarms is recommended. The treatment of wooden poles and crossarms should be by thorough impregnation with preservative by either closed or open-tank process. For poles, except in the case of yellow pine, the treatment need not extend higher than a point two feet above the ground line.

35. Insulators: Insulators for line voltage of less than 9,000 shall not flash over at four times the normal working voltage, under a precipitation of water of 1/5 in. per minute, at an inclination of 45 deg. to the axis of the insulator.

36. Each separate part of a built-up insulator, for line voltages over 9,000, shall be subjected to the dry flash-over test of that part for five consecutive minutes.

37. Each assembled and cemented insulator shall be subject to its dry flash-over test for five consecutive minutes.

The dry flash-over test shall be not less than:

Line voltage.	Test voltage.
9,000 to 14,000	65,000
14,000 to 27,000	100,000
27,000 to 35,000	125,000
35,000 to 47,000	150,000
47,000 to 60,000	180,000
60,000	3 times line voltage

Each insulator shall further be so designed that, with excessive potential, failure will first occur by flash-over and not by puncture.

38. Each assembled insulator shall be subjected to a wet flash-over test, under a precipitation of water of 1/5 in. per minute, at an inclination of 45 deg. to the axis of the insulator.

The wet flash-over test shall be not less than:

Line voltage.	Test voltage.
9,000 to 14,000	40,000
14,000 to 27,000	60,000
27,000 to 35,000	80,000
35,000 to 47,000	100,000
47,000 to 60,000	120,000
60,000	twice the line voltage

39. Test voltages above 35,000 volts shall be determined by the A.I.E.E. Standard Spark-Gap Method.

40. Test voltages below 35,000 volts shall be determined by transformer ratio.

Material.

41. Conductors: The conductors shall be of copper, aluminum, or other non-corrodible material, except that in exceptionally long spans, where the required mechanical strength cannot be obtained with the above materials, galvanized or copper-covered steel strand may be used.

42. For voltages not exceeding 750 volts, solid or stranded conductors may be used up to and including 0000 in size; above 0000 in size, stranded conductors shall be used. For voltages exceeding 750 volts, and not exceeding 5,000 volts, solid or stranded conductors may be used up to and including 00 in size; above 00 in size, conductors shall be stranded. For voltages exceeding 5,000 volts, all conductors shall be stranded. Aluminum conductors for all voltages and sizes shall be stranded.

The minimum size of conductors shall be as follows:

No. 6 B. & S. gauge copper for voltages not exceeding 5,000 volts.

No. 4 B. & S. gauge copper for voltages exceeding 5,000 volts.

No. 1 B. & S. gauge aluminum for all voltages.

43. Insulators: Insulators shall be of porcelain for voltages exceeding 5,000 volts.

44. Strain insulators for guys shall have an ultimate strength of not less than twice that of the guy in which placed. Strain insulators shall be so constructed that the guy wires holding the insulator in position will interlock in case of the failure of the insulator.

Strain insulators for guys shall not flash over at four times the maximum line voltage, under a precipitation of water of 1/5 in. per minute, at an inclination of 45 deg. to the axis of the insulator.

45. Pins: For voltages of 5,000 and over, insulator pins shall be of steel, wrought iron, malleable iron, or other approved metal or alloy, and shall be galvanized, or otherwise protected from corrosion.

46. Guys: Guys shall be galvanized or copper-covered stranded steel cable, not less than 5/16 in. in diameter, or galvanized rolled rods of equivalent tensile strength.

47. Guys to the ground shall connect to a galvanized anchor rod, extending at least 1 ft. above the ground level.

48. The detail of the anchorage shall be definitely shown upon the plans.

49. Wooden Poles: Wooden poles shall be selected timber, peeled, free from defects which would decrease their strength or durability, not less than 7 ins. minimum diameter at the top and meeting the requirements as specified in paragraphs Nos. 17, 30, 31 and 34.

50. Concrete: All concrete and concrete material shall be in accordance with the requirements of the Report of the Joint Committee on Concrete and Reinforced Concrete.

Structural Steel.

51. Structural steel shall be in accordance with the Manufacturers' Standard Specifications.

52. The design and workmanship shall be strictly in accordance with first-class practice.

53. The form of the frame shall be such that the stresses may be computed with reasonable accuracy, or the strength shall be determined by actual test.

54. The sections used shall permit inspection, cleaning and painting, and shall be free from pockets in which water or dirt can collect.

55. The length of a main compression member shall not exceed 180 times its least radius of gyration. The length of a secondary compression member shall not exceed 220 times its least radius of gyration.

56. The minimum thickness of metal in galvanized structures shall be ¼ in. for main members and ⅛ in. for secondary members. The minimum thickness of painted material shall be ¼ in.

Protective Coatings.

57. All structural steel shall be thoroughly cleaned at the shop and be galvanized, or given one coat of approved paint.

58. Painted Materials: All contact surfaces shall be given one coat of paint before assembling.

All painted structural steel shall be given two field coats of an approved paint.

The surface of the metal shall be thoroughly cleaned of all dirt, grease, scale, etc., before painting, and no painting shall be done in freezing or rainy weather.

59. Galvanized Material: Galvanized material shall be in accordance with the specifications for Galvanizing Iron and Steel (Appendix).

Bolt holes in galvanized material shall be made before galvanizing.

Foundations.

60. The foundations for steel poles and towers shall be designed to prevent overturning.

The weight of concrete shall be assumed as 140 lbs. per cu. ft. In good ground, the weight of "earth" (calculated at 30 deg. from the vertical) shall be assumed as 100 lbs. per cu. ft. In swampy ground, special measures shall be taken to prevent uplift or depression.

61. The top of the concrete foundation, or casing, shall be not less than 6 in. above the surface of the ground, nor less than 1 ft. above extreme high water.

62. When located in swampy ground, wooden crossing and next adjoining poles shall be set in barrels of broken stone or gravel, or in broken stone or timber footings.

63. When located in the sides of banks, or when subject to washouts, foundations shall be given additional depth or be protected by cribbing or riprap.

64. All foundations and pole settings shall be tamped in 6 in. layers, while back filling.

The samples shall not be grouped or twisted together, but shall be well separated so as to permit the action of the solution to be uniform upon all immersed portions of the samples.

(f) Test. Clean and dry samples shall be immersed in the required quantity of standard solution in accordance with the following cycle of immersions.

Example: Poles.

Length of pole 40 ft.

Height of pole above ground 34 ft.

Length of adjacent spans 100 ft. and 120 ft.

Timber—Eastern white cedar.

The specifications on overhead crossings and line construction have the approval of the Postal and Western Union telegraph companies, the Bell Telephone Company and the American Railway Association.

A. F. Hovey, Chairman; G. W. Palmer, Jr., Vice-Chairman; S. L. Foster, E. J. Dunne, William Roberts, A. S. Richey, S. D. Sprong, C. R. Harte and J. J. Brennan (Resigned)—Committee on Power Distribution.

OIL AS FUEL ON RAILWAYS.

Experiments are now being made to apply smokeless engines to various kinds of railway locomotives. Oil engines (smokeless) have, of course, been known for years on English railways, but in these the oil merely took the place of coal, and was used for applying external heat in much the same way as coal. These engines, though satisfactory in working, did not entirely fulfil expectations as to economy, owing to the high cost of oil in England. For many years the Great Eastern Railway ran oil engines, but there are now only about half a dozen liquid fuel propelled engines on their lines. To-day experiments with entirely different kinds of smokeless engines are being made both in Germany and England. The Prussian State railways are at work on an experimental internal combustion engine, and the locomotive engineer of the North British Railway Company recently designed an electric locomotive. The initial source of energy with this engine is a steam turbine, which drives a dynamo that in its turn provides electricity to work electric motors, which drive the train. It has been stated that the working of this experimental engine was not entirely satisfactory as regards economy owing to causes which were partly anticipated when the trial was made. Since then another British railway company has decided to prepare designs for a powerful locomotive of somewhat similar character, but with an internal combustion (oil) engine substituted for the steam turbine. Whether this will work satisfactorily remains to be seen, but if it does it is anticipated that the use of the internal combustion engine will not only render our railways ultimately smokeless, but will reduce the size and weight of locomotives, while its advantages as against the rival scheme of electrification are that it would necessitate no alteration of the existing permanent ways. The rapid increase of electric travel is another of the factors that are working towards a grimeless England. The opinion of experts is that we have only seen the beginning as yet of electricity on local and suburban lines, and even on long-distance main lines. The North-Eastern Railway Company have sent a deputation to the United States to study the use of electricity there in freight traffic, and it is, of course, well-known that every suburban railway company in London has this matter under consideration. The electrification of the Great Northern Railway Company's suburban lines has been discussed for years, the Tilbury and Southend and the North London railways are believed to be seriously meditating action, and the scheme for the electrification of the London, Brighton, and South Coast Railway Company's line as far as Brighton is rapidly progressing. In regard to the existing oil engines of the type used on the Great Eastern, a locomotive expert on this railway explained that it is the present high price of oil which militates against the general use of these engines on British railways. There is no oil in England and coal is exceptionally cheap. So far as England is concerned, while it is true that a ton and a quarter of oil equals two tons of coal in effect, the price of oil is at least double that of coal.

ENGINEERS' LIBRARY

Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer.

BOOK REVIEWS.

Framed Structures and Girders. By Edgar Marburg, C.E., Sc.D., Professor of Civil Engineering, University of Pennsylvania. Published by the McGraw-Hill Book Company, 239 West 39th Street, New York. Cloth 6½ x 9½ ins., 450 pages, including index. Many illustrations. Price $4.00 net.

This is Vol. I. of the book entitled The Theory and Practice of Framed Structures and Girders, and deals with stresses, the whole work being planned to appear in three volumes. This volume takes up mainly the derivation of the fundamental principles of statics, the determination of shears and bending moments in beams, and the analyses of roof and bridge trusses resting on two supports. The work is designed primarily to serve as a text book, but it will also be useful as a reference work, particularly if the two succeeding volumes are up to the standard of this one.

The author has had an extended experience, both in structural engineering practice and in teaching, and is, therefore, well qualified to pick the essentials for incorporation into a work of this nature. Beginning with the assumption that the student knows little of the principles of statics, the earlier chapters of the book are devoted to this work; similarly the general principles governing shears and bending moments in beams are reviewed.

Different types of roof and bridge trusses are taken up in order, and very completely analyzed. The author has devoted a little more than ordinary fullness to the subjects of skew bridges and bridges on curves, as well as the stresses in lateral and sway bracing and in viaduct towers on account of the practical requirements.

Throughout the book, the demonstrations are simple and clear, and therefore easy to follow. As nearly all of the book has been used in the form of reprints in the author's classes, it may be regarded virtually as a second edition.

The Practical Design of Irrigation Works. By W. G. Bligh; second edition revised and enlarged. Published by Constable & Co., London. Cloth, 6½ x 10 inches, 450 pages, including index. Many illustrations, cuts and insert pages. Price $7.50.

The author of this book, a retired executive engineer of the Indian P.W. Department, is eminently well qualified to compile such a book. The second edition of this book shows considerable change from the first edition. The alterations and additions have increased the value of the book considerably. As a result Chapter VI., "Diversion Weirs on Sand Foundation," has been rewritten and placed on a better theoretic basis. The chapters on "Gravity Dams" and "Gravity Weirs" have also been revised.

The work originally was profusely illustrated with critical examinations of existing structures; these have all been retained and greatly augmented by the addition of descriptions of new works. One of the valuable features of the book is the very great number of descriptions of works erected in all parts of the world, showing the different methods used in different countries. The text deals with the theory and methods of design of all the appurtenances used in connection with irrigation works, and includes discussions of retaining walls, dams of different types, piers, abutments and flows, diversion weirs, weir sluices, canal head regulators, canal falls, regulation bridges and bypass channels, cross drainage works, reservoirs and tanks, the design of channels, and screw gear and roller gates.

The work is replete with valuable details, drawings and illustrations of existing irrigation works, and forms one of the best arranged and most valuable treatises on the subject to be found at the present time.

The Design of Walls, Bins and Grain Elevators. By Milo S. Ketchum, C.E. Second edition, revised and enlarged. Published by the Engineering News Publishing Company, New York, and Constable & Co., London. Cloth, 6½ x 9 inches, 546 pages, profusely illustrated. Price $4.00 net.

This book, now in the second edition, needs no introduction to the engineer. It is always with a feeling of pleasure that one opens one of Mr. Ketchum's books. They are always characterized by clearness and a most pleasing use of illustration. Aside from the appearance of the book, the contents are very valuable to the engineer interested in the design of walls, bins and elevators.

In this new edition more than one hundred and fifty pages of new material, including many cuts, have been added. The chapters on "Reinforced Concrete Retaining Walls" and "Methods of Construction and Cost of Retaining Walls" have been rewritten and much new material added. The additions include new chapters on "Rankine's Theory Modified," the "Effect of Cohesion," "Stresses in Bracing of Trenches," "Stresses in Tunnels," additional examples of retaining walls, formulas for the length of the curve of suspension bunkers, additional experiments on the pressure of grain in bins, formulas and details for the design of rectangular bins, methods and forms for constructing grain bins, and descriptions of three additional reinforced concrete grain elevators. There is also an appendix giving a résumé of concrete, plain and reinforced.

This book should be in the library of every engineer interested in the above subject.

Maximum Production in Machine-Shop and Foundry. By C. E. Knoeppel. Published by the Engineering Magazine, New York. Cloth, 5¼ x 7½ inches, 365 pages. Price $2.00.

This volume is one of the Works Management Library, published by the Engineering News. The author is a thoroughly practical man, brought up on the foundry floor, intimately familiar with shop conditions and shop workers, and having a thorough appreciation of the principles of efficiency, being trained under Mr. Harrington Emmerson, one of the greatest efficiency engineers. Most of the material in the book appeared originally in the Engineering Magazine, but has been largely revised, rearranged and adapted so as to form a consistent development of the subject.

The machine-shop and foundry are considered as twin factors in production, so closely related in many branches of metal manufacturing that their problems can best be considered together. Therefore, after laying down the principles of organization and management common to efficient operation and maximum success in both kinds of establishments, the author follows special applications of the same ideas, first in the shop and then in the foundry.

Strength of Materials. By H. E. Murdock, M.E., C.E. Published by Wiley & Sons, New York, Renouf Publishing Co., Canadian agents. Cloth, 5¼ x 7½ inches, 279 pages, 151 cuts and many tables. Price $2.00 net.

The book takes up the different materials of construction, stresses and methods of application, riveted joints, beams, deflections, the elastic curve, columns, torsion, secondary stresses, repeated stresses, resilience, etc. The material is presented in such a manner that the use of the calculus is not necessary for an intelligent understanding of the principles of the strength of materials. The chapter on graphic integration is a treatment of the subject not usually seen in book of this character, and the author is to be congratulated on its inclusion. In preparing the book the author states that he had in mind the needs of students. We must say, however, that we feel that the book is deserving of far wider application than this. The material included is presented in a clear and concise manner, and while there is no unnecessary data, still the whole ground has been covered. A knowledge of the calculus is not essential; however, if the reader is acquainted with the calculus, he will find the graphic treatment a decided aid in obtaining a clearer conception of the calculus method.

Handbook of Steam Shovel Work. By the Construction Service Co., for the Bucyrus Co., South Milwaukee, Wis. Cloth, 4¼ x 6¾ inches, pp. 374; illustrated. Price $1.50.

This book has been compiled for the Bucyrus Company, and in a sense is, therefore, a trade publication. The company are, however, to be commended on having made this material available to the engineer and contractor.

A systematic analysis has been made of a number of shovels working in different kinds of material and the results are presented to the reader in concise form. All the different elements entering into the different locations are shown, and the facts given in considerable detail.

The book is divided into ten chapters. The first four chapters deal with the factors to be considered in calculating the costs of the work done with shovels. The other chapters deal with reports of shovels under operation in sand and gravel, earth and glacial drift, ore and rock. The final chapter gives directions for moving a steam shovel. The book should prove valuable because it shows the different factors which go to make up the total cost of excavation.

PUBLICATIONS RECEIVED.

Canadian Society of Civil Engineers. Transactions of the Society, January to June, 1911; also the Index of Transactions Volumes 1 to 24.

Tide Tables for the Eastern Coast of Canada for the Year 1912, including the river and gulf of St. Lawrence, the Atlantic Coast, the Bay of Fundy, Northumberland and Cabot Straits, and information on currents. Issued by the Tidal and Current Survey, in the Dept. of the Naval Service of the Dominion of Canada.

Tide Tables for the Pacific Coast of Canada for the Year 1912. Including Fuca Strait, the Strait of Georgia, and the Northern Coast. With data for slack water in the navigable passes and narrows and information on currents. Issued by the Tidal and Current Survey, in the Dept. of Naval Service of the Dominion of Canada.

Geology of East Side of Lake Temiskaming. Issued by Canada Dept. of Mines, Geological Survey Department.

The Clay and Shale Departments of Nova Scotia and Portions of New Brunswick. Issued by Canada Dept. of Mines, Geological Survey Department.

The Annual Report of the Minister of Mines for the Province of British Columbia for the year 1910.

Geology of a Portion of Fabre Township, Pontiac County. Issued by the Dept. of Colonization, Mines and Fisheries, Province of Quebec.

Annual Report on Highway Improvements, Ontario, 1911. Issued by the Dept. of Public Works, Parliament Buildings, Toronto.

Inland Revenues Report of the Dominion of Canada for the Year Ending March 31st, 1911. Part 2, weights and measures, gas and electricity. Issued by the Dept. of Inland Revenues, Ottawa.

Summary Report of Mines Branch for Year 1910. Issued by the Canada Dept. of Mines, Ottawa.

Report on the Molybdenum Ores of Canada. By T. L. Walker, M.A. Issued by the Canada Dept. of Mines, Ottawa.

Municipal Statistics. Issued by the Ontario Dept. of Agriculture.

Monthly Report of the Dept. of Trade and Commerce of Canada for August, 1911.

Imports Entered for Consumption, Sept., 1911. Issued by the Dept. of Customs, Ottawa.

The Institution of Mechanical Engineers, Calcutta and District Section. Proceedings for 1910-11. Mr. A. Drydon, Secretary, Calcutta.

Proceedings of Western Railway Club, 1910-11. Published by The Western Railway Club.

Tests of Centrifugal Pumps. Bulletin No. 77, of the New Mexico College of Agriculture and Mechanical Arts. The Agriculture Experiment Station, Agricultural College, New Mexico.

Concrete Silo Construction. Bulletin No. 214, University of Wisconsin Agriculture Experiment Station, Madison, Wis.

Manufacture and Utilization of Hickory, 1911. Bulletin issued by the Forest Service, U.S. Dept. of Agriculture.

CATALOGUES RECEIVED.

Jeffrey Power Transmission Machinery. Issued by The Jeffrey Manufacturing Company, Columbus, Ohio. Canadian office, corner of Cote and Lagauchetiere Streets, Montreal. Contains descriptive matter on the horse-powers of steel shafting, standard methods of key-seating, sizes and dimensions of couplings, etc.

High Vacuum Jet Condensers. Issued by the Wheeler Condenser Engineering Co., Carteret, N.J. Bulletin No. 107, describing the wheeling jet condenser, etc.

The Renold Patent Silent Chains and Sprockets, for high speed driving. Issued by The Hans Renold, Ltd., Manchester, England. Jones & Glasgow, Montreal, Canadian agents.

The Keuffel & Esser Company issue a new circular with price list of their flat wire tapes and band chains to be pasted in a catalogue.

Country House Sewage Purification. The second edition of book issued by Tuke & Bell, Ltd., Sewage Specialists, 69 Leadenhall Street, London, E.C. A very valuable little volume giving the methods of taking care of individual house sewerage.

Pulleys. Booklet issued by The Dodge Manufacturing Co., Ltd., Toronto, Canada, listing their different types of pulleys.

Friction Clutch Mechanism. Booklet issued by The Dodge Manufacturing Company, Toronto, Canada.

The Hayward Buckets and Digging Machinery. Pamphlet No. 577, issued by the Hayward Company, 50 Church Street, New York, N.Y.

The Holiday Gift. Booklet issued by the Canadian General Electric Co., Toronto, illustrating electric heaters, heating appliances, lamps, and small motors for house use.

Descriptive Leaflet 2373, issued by the Westinghouse Electric and Manufacturing Company of East Pittsburg, Penna., describes the No. 303-A box frame interpole motor manufactured by that company. Complete specifications for the motor, brief descriptions of the important parts, and performance curves are given on the sheet. The leaflet is 8½ by 11 inches, so that it readily binds in with the usual letter size sheets. Descriptive Leaflet 2374, recently issued by the Westinghouse Electric and Manufacturing Company gives specifications and brief descriptions of the parts of that company's box frame interpole railway motor No. 310-C. This leaflet is similar in general make-up to the one above described.

"Be Ready for the Long Dark Nights." Bulletin No. 22 just issued by Kerr Turbine Co., Wellsville, N.Y., describing and illustrating installations of their turbo-generator sets for lighting. This folder is well worth reading by any one who is figuring on an independent lighting plant. A copy will be sent upon request.

"Storage Battery Cars." Bulletin No. 13, just issued by the Gould Storage Battery Co., 341 Fifth Avenue, New York. This bulletin explains the economics of the storage battery car, describes the standard type made by the Gould Company, and cites the conditions under which storage battery cars can be used most profitably. A copy will be sent on request.

Bulletin No. 36, Bates Machine Co., Joliet, Ill., describes and illustrates the new Bates inertia valve gear, which is now regularly applied to all Bates Corliss engines. This new gear has attracted much attention because of its positiveness and quiet operation, and the absence of hooks, springs and rollers.

Bulletin No. 20, dealing with the economy improvements and operating conveniences of Kerr turbo-blowers and turbo-pumps, particularly in gas plant service, has just been issued by the Kerr Turbine Co., Wellsville, N.Y. This bulletin contains interesting comparisons with other driving methods for the same work and illustrates a number of installations.

PERSONAL.

Messrs. Wilson, Townsend and Saunders are opening a consulting engineering office in Moose Jaw, Sask. Mr. J. M. Wilson and Mr. R. G. Saunders have until recently been in the city engineering department of Moose Jaw, Mr. Wilson as city engineer and Mr. Saunders as chief assistant. Mr. C. J. Townsend and Mr. Wilson are graduates of the University of Toronto in Engineering.

OBITUARY.

Mr. George W. Hebard, acting vice-president of the Westinghouse Electric and Manufacturing Co., died at his home in New York City on Friday, November 17th. Mr. Hebard was born in Barre Center, Olean County, New York, in 1845.

Besides his active participation in his chosen profession, Mr. Hebard was also very active in social, religious and philanthropic work in New York. He was a member of the Union League, The Lawyers', The Engineers', and several other clubs.

CANADIAN SOCIETY OF CIVIL ENGINEERS' ELECTRICAL SECTION, MONTREAL.

Mr. J. W. Fraser presented a paper before the Engineers' Club recently on the Southern Power Company's Transmission Lines, this company operating in Northern Carolina, U.S.A.

In tracing the early stages of electrical transmission, the lecturer mentioned that the Missouri River Power Plant was the first to operate commercially at 50,000 volts, and the Shawinigan transmission to Montreal was put into service a few months later. The Southern Power Company had been organized in 1905 for the purpose of developing certain water powers on the Catawba and Broad rivers. It had been built in sections, and in 1909 a 100,000 volt line of 250 miles was put in service, and since that time a second circuit had been added and 140 additional miles of two-circuit 100,000 volt lines completed, a total of 1,380 miles of three-phase line. The greater part of the power was used by cotton mills.

ENGINEERS' CLUB LUNCHEON IN TORONTO.

At the Toronto Engineers' Club luncheon on Wednesday, November 22nd, President R. A. Falconer, of the University of Toronto, was the speaker. The aims and ideals of the engineer formed his theme. He spoke of the great development in engineering and its gradual rise to cultural and aesthetic importance. Reference was made to the fact that the modern engineer had to possess a broad education, so that all great universities now possessed an engineering faculty. The aims of modern engineers were very important. They were engaged first in the improvement of buildings in order to make them superior for all purposes to those erected in the past. Then they made a study of nature so that natural beauty and the architectural beauty might blend and procure the best aesthetic results. That was the reason that the modern engineer had to possess the very broadest culture and a finely equipped intellect.

CANADIAN FORESTRY ASSOCIATION.

A meeting of the directors of the Canadian Forestry Association was held on the afternoon of October 20th at two o'clock in the office of the Director of Forestry, Ottawa. Mr. G. Y. Chown, of Kingston, president of the association, was in the chair and there were also present Messrs. Wm. Little, H. M. Price, R. H. Campbell, Ellwood Wilson, J. W. Harkom, J. Lawler, secretary, and F. W. H. Jacombe, assistant secretary.

The chief business before the meeting was the setting of the date and place for the 1912 annual meeting of the association. It was decided that the annual meeting should be held at Ottawa on February 7 and 8 next. This is immediately subsequent to the meeting of the Canadian Lumbermen's Association, which convenes on Tuesday of the same week. Mr. Campbell was appointed as a representative of the Forestry Association on a joint committee of the two associations to make arrangements for a joint banquet on Wednesday evening and other matters to be arranged in common.

A committee of three, consisting of the president and Messrs. R. H. Campbell and Gordon C. Edwards, was appointed to arrange the programme of the annual meeting.

CANADIAN INSTITUTE MEETING, NOV. 25, 1911.

On Saturday evening Dr. J. A. Amyot, Director of Laboratories, Provincial Board of Health, addressed the members and friends of the above association on the subject of "Water Purification."

His address altogether was along the lines of municipal water purification, and brought to the notice of the audience some startling and instructive points regarding this important topic.

Practical methods of purification were filtration, addition of chemicals, storing and chlorination, although the latter is more of an emergency method than the preceding.

Dr. Amyot spoke favorably of slow sand filtration, especially where the water supply had coarse suspended matter in it, as is frequently the case in Lake Ontario after an east storm. There is nothing yet to supplant slow sand filtration where the filtration plant is properly equipped. Dr. Amyot said Buffalo sewage, even after travelling forty miles in the turbulent Niagara River, affected the water at Niagara-on-the-Lake.

A number of views illustrative of the lecture were shown on a screen. President J. B. Tyrrell was in the chair.

COMING MEETINGS.

THE CANADIAN SOCIETY OF CIVIL ENGINEERS.—Nov. 30th. Meeting of the Toronto Branch at the Engineers' Club of Toronto, 96 King Street West, Toronto. Paper on "The Niagara River Boulevard." E. A. James, Secretary.

THE ENGINEERS' CLUB OF TORONTO.—Dec. 13, 96 King Street West, Toronto Luncheon at 1 p.m. Address by the Hon. Mr. Justice William Renwick Riddell. R. B. Wolsey, Secretary.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—Dec. 13-15. Montreal. F. C. Douglas. M.D., D.P.H., Secretary, 51 Park Avenue, Montreal. (The date of the meeting has been changed from Nov. 21-23 to Dec. 13-15)

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Tuesday, Dec. 19th, 1911, lecture by Dr. T. A. Starkey, of McGill University, Professor of Hygiene, on "Ventilation of Public Buildings." No. 5 Beaver Hall Square, Montreal. J. E. Ganier, Secretary.

THE CANADIAN FORESTRY ASSOCIATION.—February 6, 7 and 8, 1912. Annual Meeting, Ottawa. James Lawler. Secretary.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, C. H. Rust; Secretary, Professor C. H. McLeod.

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

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

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

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

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

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw

CANADIAN TECHNICAL SOCIETIES.

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

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

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

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

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

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

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

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

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

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary. H. Mortimer-Lamb, Windsor Hotel, Montreal.

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

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, T. A. Starkey, M.B., D.P.H., Montreal. Secretary, F. C. Douglas, M.D., D.P.H., 51 Park Avenue, Montreal.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

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

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

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

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

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

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

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

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, J. Lorn Allan, Dartmouth, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto

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

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

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

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

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

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg Man. Second Monday, except June, July and August at Winnipeg.