PAGES

MISSING

Volume 28. Toronto, February 18, 1915 Contents of this issue on page 5

The Canadian Engineer

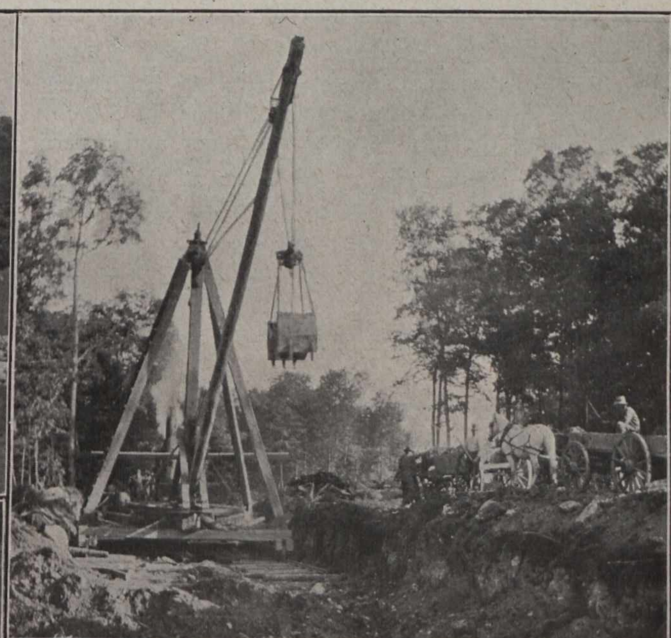
A weekly paper for engineers and engineering-contractors

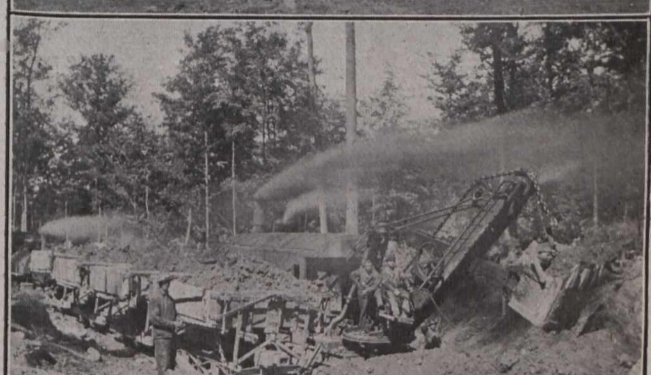
EUGENIA FALLS EARTH STORAGE DAM

BELONGING TO THE DEVELOPMENT NOW NEARING COMPLETION ON THE BEAVER RIVER FOR THE ONTARIO HYDRO-ELECTRIC POWER COMMISSION — SOME NOTES ON ITS CONSTRUCTION.

By **R. T. HYLAND,**
The Hyland Construction Company, Toronto.

HYDRO-ELECTRIC energy will shortly be supplied to a number of municipalities in the vicinity of Owen Sound as a result of the exhaustive power investigations and subsequent development of a generating site on the Beaver River at Eugenia Falls. The project has already been described by *The Canadian Engineer* as one of the most interesting of its kind that the utilization of Canadian water powers has presented up to this time. It is the second plant to be put into operation by the Hydro-Electric Power Commission of Ontario for the generation of its own power. It is to operate under a head of about 550 feet, the highest in Canada with the exception of one or two plants in British Columbia. The development involved the building of a dam above the falls, a diversion canal leading from the reservoir thus formed, and about 4,900 feet of pipe line. This dam, of concrete-steel construction, was described in the issue of December 10th, 1914. Additional pondage at the end of the canal and at the head of a 3,350-ft. wood stave pipe line is provided by another large earth dam, which it is the purpose of this article to describe.



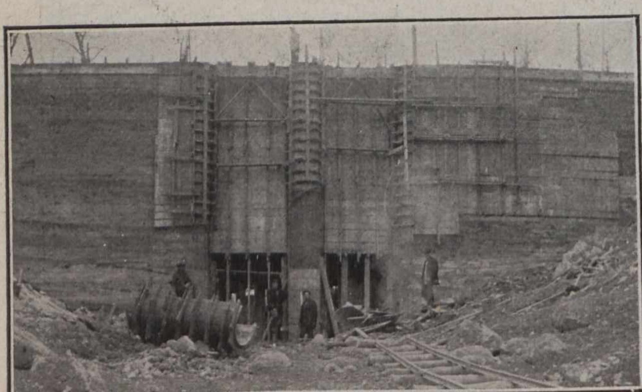


Earth Dam Construction at Eugenia Falls, Ont., Showing (1) Method of Construction; (2) Method of Excavating for Puddle Core, and (3) Transportation of Excavation from Canal.

The dam is 960 ft. in length with a maximum height of 30 ft., the crest being flat and 10 ft. in width. The slopes, which are 3 : 1 on the upstream side and 2 : 1 on the downstream side, are supported by rock toes, the upstream slope being riprapped. It is provided with a puddle core, in the centre of which is placed a cut-off of double-lapped sheet piling, driven to refusal by a steam hammer suspended from a tripod. An auxiliary puddle cut-off is situated a short distance in from the upstream toe. Drainage is provided by means of a line of 8-inch tile running along the line between the inner and outer third of the downstream side. A series of 4-inch lateral drains are taken off at 45-ft. centres, discharging into the rock fill at the downstream toe.

Flume Line Excavation, Providing Fill for Dam.

The site of the dam was first cleared of underbrush and trees, and the sub-soil removed by means of slip scrapers. The cut-off trench for the puddle core was then excavated to an average depth of 5 ft. and width of 8 ft. The sheet piling was driven and the auxiliary cut-off and drainage tiles completed. Excavated material for the construction of the dam was brought to the site from the canal and from the flume line. This excavation was accomplished with a 45-ton Marion shovel, and brought to the site by 4-cubic yard dump cars and two dinky engines. Before placing, the material was sized and deposited in 6-inch layers by means of slip scrapers. It was then rolled and watered. The water supply was procured from the river about 4,000 ft. distant, a 3-inch duplex pump delivering to a 10,000-gallon tank situated on a hill near the site of the dam.



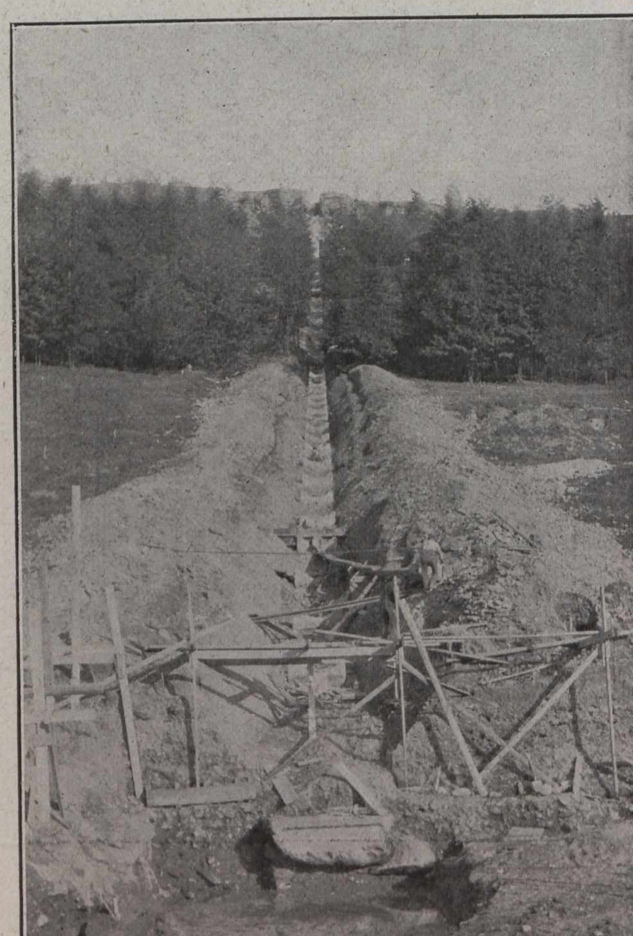
Headworks Under Construction.

A travelling derrick operating an Owens clam-shell bucket loaded the puddle clay into dump wagons, which placed the material in the core wall, where it was thoroughly hand-tamped by means of wooden tampers.

Over 47,600 cubic yards of material were used in the construction of the dam. It has the distinction of being the largest earth dam in Ontario.

Leading to it is a canal about 5,068 ft. in length with a bottom width of 6 ft. and 1½:1 and 2:1 slopes on the sides. Its construction involved the excavation of some 70,000 cubic yards of earth and rock.

Leading from the dam will ultimately be two wood-stave pipe lines, only one of which is being installed at the present time, and the entrance to which is a reinforced concrete gate house. Its design provides for two water inlets and the necessary racks, gates, etc. A 66-inch motor-operated butterfly valve for regulating the supply to the pipe lines, is located in each inlet. The pipe lines are 3,350 ft. in length and of 46-inch internal diameter. They lead to a surge tank 100 ft. high and 12½ ft. in diameter. At the surge tank the wood-stave pipe, riser to the tank, and the steel penstock meet in a large concrete head block.



Line of Concrete Saddles for Steel Penstock.

The concrete for the gate house was poured by means of a Smith batch mixer, which was run chiefly at nights, form work being carried on during the day.

The flume was excavated, as in railroad work, by means of wheel and slip scrapers.

The excavation to grade of the 1,550-ft. steel penstock line, 52 inches in diameter, leading to the power house, was followed by the construction of concrete saddles spaced at 20-ft. centres. Four anchor blocks were placed on the line at approximately 400-ft. centres. An interesting feature of the construction of these saddles, etc., was the pouring of concrete by means of chutes over 700 ft. long.

It may be of interest also to note that, owing to the inaccessibility of the site by rail, some little difficulty was experienced in the transportation of plant and equipment. The large shovel was brought into the work under its own steam over a distance of about 7 miles. This took about eight days of ten hours each. When the work was completed the shovel was dissembled and removed in parts. The frame, weighing about 20 tons, was placed on sleighs specially built and equipped with runners 6 inches wide. A snow plow provided a track over about 7 miles of hilly road and the frame was removed by nine teams of horses.

The work was commenced in July, 1914, and the several portions which the contract covered were completed in remarkably fast time. The Hyland Construction Company, Toronto, were awarded the contract, including canal and flume excavation and the construction of the earth dam, gate-house, foundations of steel penstock and the power house.

PROPOSED WATERWORKS EXTENSIONS FOR CALGARY.

CALGARY'S rapid growth during recent years has necessitated many extensions and alterations to its waterworks system. At times the resources of the municipal waterworks department have been somewhat severely taxed, but, the importance of a pure and abundant water supply has been kept clearly in mind and the extensions authorized from time to time were timely and strictly in accordance with the demand of the increasing population.

The system has been in operation since 1891 and is owned by the city. The source of supply is the Elbow River, about 12 miles distant. A gravity pipe line provides about 8,000,000 gallons per day. An auxiliary steam and electric plant increases the capacity, by pumpage from the Bow River of 9,000,000 gallons per day. In 1913 a new pump house was constructed providing for the installation of two 7½ million gallon units, provision also being made for the installation of a 5 million gallon electrically driven pump previously in operation in the former pump house, which had become old and out-of-date.

Looking forward to additional growth, the civic authorities have had under consideration the securing of a more abundant water supply. In 1913 Mr. A. W. Ellson Fawkes, city waterworks engineer, presented a report outlining two feasible propositions. One related to piping by gravity from the head waters of the Elbow River, a distance of from 32 to 39 miles from the city, together with storage reservoirs, dams and other appurtenances. The alternative scheme consisted of a pumping plant within the city limits with the addition of a filtration plant.

In his report, Mr. Fawkes refers to survey work early in 1913 in connection with the first scheme, whereby four probable storage sites, suitable for the construction of dams, were located, and a route for the proposed pipe line established. These sites are situated at 39, 38, 36 and 32 miles respectively from the city, the estimated cost varying from $2,159,673 to $1,718,343. The estimates are based upon market conditions as they obtained at that time. They include wood-stave pipe and various grades of steel and cast iron pipe for the supply line.

As to the city's future requirements, the present consumption of 16,000,000 gallons per 24 hours by a population of 80,000 gives a consumption per capita of 200 gallons. It is suggested in the report that this excessive consumption could successfully be reduced to 125 gallons or less by careful inspection and the introduction of a meter system. Mr. Fawkes estimates the probable consumption 30 years hence as being 50,000,000 gallons per day and his calculations are based upon this amount.

The report recommends that a gravity water system be installed; and that provision be made for 50,000,000 gallons capacity, using a wood-stave pipe line and a masonry dam, the latter to be located at a suitable place within the limits of the Rocky Mountain Forest Reserve; that a suitable site be selected and a large stand-by reservoir be constructed within reach of the city, sometime in the near future. This recommendation was concurred in by Mr. Geo. W. Craig, city engineer.

The scheme is recommended on the following grounds: It provides ample storage for probably 500,000,000 gallons of water which can be increased or decreased according to the height of dam. Frazil ice troubles can be eliminated by placing the intake pipe 20 ft. or so below the level of the water in the storage reservoir. This reservoir will act as a sedimentation or settling basin. Turbidity will be eliminated by placing the intake about 15 ft. above the bottom of the storage reservoir. The location of the supply being in the Rocky Mountain Forest Reserve, which is beyond human habitation, the water would be free from pollution, thus insuring the city a pure supply.

With the aid of controlling valves and surging chambers in the gravity pipe line, demands for water up to 50,000,000 gallons could be easily met. Besides, these valves and surging chambers would prolong the life of the pipe line by relieving it of any undue pressure, and of a static head exceeding 200 ft. at any point, except in the last few miles of pipe line where a static head would be required sufficient to empty into a reservoir at some high ground near the city.

UTILIZING WASTE HEAT OF GAS ENGINES.

A method of utilizing some of the waste heat of the jacket water of a gas engine is described by J. B. Meriam in "Practical Engineer." A small centrifugal pump is used to circulate at high velocity through the jacket and into an adjoining closed tank, which is kept about half full of water, and back to the jacket. Steam escapes at the water level and a pressure of about 75 lb. gauge is maintained. All the heat that the engine gives to the jacket water, estimated at 38% of the heat units in the fuel, is found in the steam. With a well-designed exhaust gas boiler, half of the 38 per cent. of the heat of the fuel which is lost in the exhaust gas could be recovered and added to that recovered from the water jacket. The high speed of the water through the jacket sweeps away any steam bubbles that may form on its surface and thereby avoids the trouble of overheating the cylinder which usually comes from having too high a temperature of the jacket water.

SOME FACTORS IN MUNICIPAL ENGINEERING.

A PAPER of considerable merit and interest to municipal engineers was presented to the American Society of Mechanical Engineers at its annual meeting in December and published in the February issue of the Journal. The author, Mr. M. L. Cooke, of Philadelphia, calls attention to the wide opportunity for the activity of engineers in municipal work and to the fact that at the present time a large part of this field is either not covered at all or covered by non-technical men. He emphasizes, however, the necessity for the cultivation on the part of the profession of a broader and more collective interest in public affairs. There is a note of warning that with the growing consolidation of manufacturing and other enterprises, especially in the utility field, there is danger that the cities of the country will be left without proper engineering advice in certain of their engineering questions. The author points out that the matter of viewpoint and a genuine public interest are as essential in the engineer who is to advise a city as ability and experience.

An important part of the paper is the reference to the function of advertising, both as affecting the professional activities of the engineer and in the movement to educate the public to the necessity for having public work done on an engineering basis. He holds that certain kinds of municipal engineering, street cleaning for instance, are based on a growing appreciation on the part of the public of the factors of the problem, and that this can only be developed through systematic and aggressive advertising methods.

The effectiveness of the engineer in public employ is very largely dependent upon the support given to him by his profession in the education of the public to proper policies of administration. The engineer holding a public position is not "in politics," and to be a success must have the collectve support and advice of his profession. There are too many matters that should be determined by technical and scientific considerations now decided by vote. Attention is called for instance to the archaic systems of appropriation and control of the budget now in general use in our municipalities with suggestions for remedies.

Civil service as it applies to filling the higher technical positions is referred to and a note of warning sounded as to the growing complexity of all governmental problems. Lines along which municipal agencies may be simplified are indicated, and a suggestion is made for a municipal reference library as a branch of the Engineering Societies' library.

Quotations follow from different sections of the paper:—

The test by which the role of the engineer is to be determined will be the development in our profession of a genuine spirit of public service. The community is apparently ready to accord the engineer a leading, perhaps a controlling part, if the engineer will consider that in every decision and act there shall be the clearest possible recognition of the public interest. We should remember that democracy can use the engineer without giving him either a leading or a controlling hand in affairs. This use of engineers has been conclusively demonstrated by public utilities companies, especially during the last thirty years. In most of our larger cities during this period there have been operating one or more so-called "big business" men, who have built large fortunes and a certain kind of fame in the development of enterprises in which engineering was an important factor and in which it should have been the paramount and controlling factor. In these enterprises engineers have necessarily been used, but not in a leading or controlling capacity.

That profession which considers only its own and its clients' interests without a proper regard for those of the general public will be accorded the same position which history has always given those who are led by no higher star than self-interest, however enlightened that self-interest may be. I firmly believe that the engineering profession is rising to meet its broader responsibilities with perhaps an even more quickened pace than that which during recent years has wrought such sweeping changes in the medical profession and that of architecture. There are certain kinds of engineering in which financial and almost all other kinds of preferment depend on an attitude of mind which, while not necessarily anti-social does not provide sufficient opportunity for entertaining a virile public point of view.

As a representative of public, rather than private interest, it is my duty in choosing the advisers of the city, which I have the honor of serving, to satisfy myself not only as to the ability of those we employ, but also as to their disinterested—yes, their public point of view.

No matter how able a man may be, how broad his experience nor how high his standing, his service to those who employ him must at all times be consistent with the public interest if, from my point of view, he is to be available for public employment.

Judged by this standard, there are in certain fields of engineering almost no engineers who are at present available for the service of the public and who at the same time have had sufficient experience for large undertakings. In the past few years we have had unusual opportunities for seeing at close range the professional attitude of those equipped with the technical knowledge required in advisers to cities on utility matters. It has been practically impossible to secure the services of those with reputations already made in the electrical field. Some of our experiences could be considered on the whole rather amusing were it not for the fact that we are left under the obvious conclusion that for the average city official to get good advice on these matters is well nigh impossible. What is more objectionable is that this condition is one quite generally recognized as true by city officials.

I must be careful to emphasize the fact that no criticism of any individual is embraced in these remarks, and that I am simply pointing out a danger almost necessarily confronting the engineering of an industry dominated by financiers having no knowledge aad little appreciation of such professional standards as engineers are supposed to have.

The same tendency is to be noted in other branches of our profession. An eminent authority on concrete, who is in intimate touch with the men who are practising in this line, was recently asked for the name of an engineer who was not in any way affiliated with the large manufacturers of this material, and after considerable study was able to think of only one man. There is nothing necessarily improper in this situation—it may simply mean that all the competent men in this line receive retainers from manufacturers. Some months ago I wanted to retain an engineer fully posted on the details of a certain sub-division of railroad operation. It was extremely difficult to find a man without recognized affiliations which would preclude his retention. Again, I am informed that there are no asphalt experts who do not receive retainers from the manufacturers. It is a condition which should be provocative of thought by engineers.

Public employers up to the present have been almost a negligible factor in furnishing opportunity for employment or for the making of a reputation. It is perfectly natural, and it is in accord with former ideals, that engineers should feel their first duty to be to these private employers. But in this time of broader and deeper social consciousness, it seems to me that this standard must change.

The point I wish to make is that engineering has now reached the stage of development where it has become a profession in the highest sense of the word. The engineer being a scientist, his responsibility should be for the development of facts, regardless of whose advantage they may serve. I have in mind that the service of an engineer should be as the service of a judge, as opposed to the service of a lawyer, who confessedly seeks out and represents the interests of his client, and often "makes the worse appear the better cause." This is justified by the fact that lawyers are not scientists, and by the assumption that there shall always be opposing counsel.

If this municipal field is to be one in which engineers of ability, sincerity of purpose and high ideals are to find a permanent and satisfactory outlet for their energies, our profession acting as a profession will be one of the main agencies bringing about certain fundamental changes in the attitude of the public. In the minds of too many engineers, participating collectively in matters pertaining to municipal engineering means "getting into politics." Architectural work being a part of the business of the Department of Public Works in Philadelphia, we have had the co-operation of the American Institute of Architects and of its Philadelphia chapter from the beginning. . . . We have had the constant, indefatigable and valuable support of the secretary of the American Society of Mechanical Engineers in our efforts to maintain the highest professional standards in the work of the department. But engineering bodies as such have given us no assistance, and so far as I know have taken no part in the discussion of federal, state and municipal engineering, except in the matter of conservation, which for some reason is considered as innocuous as a prayer meeting.

Many municipal engineers in this country are beginning to adopt the European system of employing non-residents for certain highly specialized positions. Whenever this is practised it excites criticism and abuse. As yet no technical organization, so far as I know, has recognized the opening thus made for technical merit and given moral support to the movement. Again I have tried to get support from organized engineers in the obviously necessary procedure of employing experts outside our regular staff, but without results.

The public must be taught that public service is not different from private service in that forward steps come frequently, even usually, as the result of a large amount of preliminary investigation. Again, the public, of which please remember we are a part, must be educated to place more responsibility on individuals, thus making it possible to do away with the great inefficiencies which inevitably accompany board and committee management. As long as we have boards and committees they will vote —and they will insist on voting—on matters that are not questions of personal opinion, but questions of facts which ought to be determined by the facts. It is one of our duties as technical men to carry on a propaganda which will show to the public the difference between those problems of policy and public interest, that are properly settled by public opinion and those scientific problems which are improperly settled unless they are settled according to the facts. Mr. Frederick W. Taylor, Past-President of the Society, in recent lectures has very forcibly and lucidly suggested this fundamental difference. For instance, my opinion may be as good as that of any other citizen's as to how fast as automobile should be allowed to operate in different sections of a large city. The opinion of any member of this Society is as good as that of any other citizen as to the penalty which should be inflicted for false registration. On the other hand, the designs for a bridge; or the specifications for a sewer; or the plans for the laying out of a public park; or the organization of the police department; or the fighting of fires; or the elimination of mosquitoes are necessarily the work of experts. Such work will always be indifferently done if done by voting; whether the voting is by the people at large or by a committee or board acting for the people. Notwithstanding all the boards and commissions that are created in the generally approved laws of to-day, there should be no uncertainty as to what questions they may vote upon. It is, therefore, one of the duties of the educated to carry this message to the people, and in doing so I do not think there will be any more powerful method than to give the great mass of the people a larger and larger knowledge of expert work.

I am not one of those who feel that all our shortcomings are "the fault of the people." I would rather assume my share of the responsibility for conditions as they are and then join with my professional associates and the community at large in bettering them. If we engineers are to have any prominent part in this there are fundamental changes which we shall have to make in our own equipment for the work. In the first place, we have to get rid of the now old-fashioned idea that advertising is a crime. I admit that as a part of my work as a public official I put in a great deal of thought on what may be quite properly called advertising. By that I mean that I pay less attention in my reports to dignity of form and diction than to making them sufficiently interesting to be read. It is only as we engineers who are public officials learn to make the public, sometimes against its will, understand our work, that we are to get that degree of popular support for it which will make it possible for it to be done in an efficient manner.

In my opinion it is going to become more and more a necessity, not only in public but in private work, for engineers to be able to popularize what they are doing. It is true to-day that a man who wants to do really good and efficient work can do so only after an aroused public opinion. You cannot drive people in a democracy. So I admit that in offering employment to an engineer, other things being equal, I want what might be called a good advertiser. You can secure appropriations for work more easily when it is well advertised. The Panama Canal is a good example of this principle. Again, advertising is the best possible check against all-advised expenditures. In building our Byberry and Bensalem Service Test Roadway we erected sign-boards on each of the 26 sections giving to the layman the exact method of its construction in non-technical language. If the public knows how a street is supposed to be constructed or cleaned, you do not require as many paid inspectors on the job.

The development of some varieties of municipal engineering is absolutely dependent upon the development of public opinion and must proceed with it. The matter of street cleaning is largely a question of an improved public taste in the matter of street paving. Unless streets are well paved they cannot be well cleaned except at a prohibitive cost. To jump from one degree of cleanliness in this respect, to another, without a supporting public opinion, may be enough to wreck an administration and to set the tide of civic improvement running in the opposite direction.

The newspaper is the great educator in these matters to-day. But we are already using in Philadelphia moving pictures, parades and exhibitions. The possibilities of these and other means of publicity are not yet fully understood.

Take, for instance, the movement which has led to the formation of large numbers of business men's associations and improvement associations. This affords one of the very best examples of the present vitality of American public life. Our leading men should accept them as something that has come to stay and co-operate with them in such a way as to direct their activities into profitable channels. It seems to me they afford the most promising agency through which, in the first place, the thought of the public on civic questions can be crystallized; and secondly, through which that thought can be given expression in definite public procedure. I have found these associations ready and anxious to hear from men who had definite knowledge on matters of public interest. It should be the attitude of any engineer who wants to play his part in the community, to affiliate with one of these organizations and to help to make it an influence. You can rest assured that the man who is in public life for his own personal advancement is bending every energy to defile and degrade these institutions and to divert them from the high mission which they have it in their power to carry out. So they need our help.

In such a discussion as this, one cannot ignore the civil service. It is always a pleasure to say that personally I could not hold public office if it were not for the safeguards and reliefs that our Civil Service Act affords. At the same time, without repeating what I have said in other public papers on the subject, I want to call attention to one fundamental misconception under which the entire civil service question in this country apparently rests. Civil service appears to be founded on the theory that the best man for the position will apply for it. I think it is the experience of every employer of men —and this is especially true in filling the higher positions —that the best man will not apply. On the contrary, you will usually have to go out on the scriptural highways and hedges to find the best man, and then having found him, fall on your knees and beg him to accept the positions offering such opportunities for public service and professional independence as are most likely to secure him.

This is the way to get good public servants. It is almost impossible to find men who have many of the qualifications for our work combined with a willingness to enter the public employ. Even if public employment should come to be considered more desirable than it is at the present moment, I think that this difficulty in finding the best man would still be encountered. Therefore, if we are to have the highest class of men in important engineering positions we must develop some merit system by which the appointing officer is given a greater opportunity than he now has of finding the man for the job. In this work it is impossible for our engineering societies to take an important part.

I believe, for instance, that if the secretaries of the four national engineering societies could be authorized by their several councils to associate themselves as a civil service board to act in an advisory capacity to federal, state and municipal civil service commissions, it would be a decided step in the right direction. Suppose the president of the Borough of Manhattan should want to secure a competent engineer to put in charge of the highway department. Through the New York City Civil Service Commission he would state the problem to this suggested advisory board, which, in turn, would appoint, say, three engineers to act as his counsellors in finding the man. The appointing officer would keep these counsellors in touch with the search and when he was ready to make a choice, secure their approval before entering into a contract. In this way the merit system would act as a check against favoritism, but would allow the appointing officer the widest possible opportunity to search for the best man available.

This procedure is a radical departure from the present idea of civil service, which is based on the assumption that it is impossible to allow the appointing officer to have anything to do with the selection of his men. Even under the most advanced forms of civil service the appointing officer is confined to a full statement of the qualifications he is trying to secure. One never exactly fills a position with just the kind of man in mind when the search started. It is a question of compromise, and the appointing officer is the one who is in the best position to know where concessions can be made and which among the several requirements are the most indispensable. There would be no objection to a check on this action of the appointing officer through some kind of a written test. But to choose men for positions paying $5,000 to $25,000 a year on the results of a written examination is absolute folly. So far as I know, engineers have never taken a hand in the discussion of methods under which engineers shall be chosen for positions in the public service, and it seems to me high time they should do so.

TORONTO RAILWAY COMPANY—1904-1914.

The 23rd annual report to the shareholders of the Toronto Railway Company presents the following statistical statement for the years 1904 to 1914:—

	Gross Income.	Operating, Maintenance, etc.	Net Earnings.	Passengers Carried.	Transfers.	Percentage of Charges, etc., to Passenger Earnings.
1904	$2,444,534.24	$1,424,179.54	$1,020,354.70	60,127,460	20,480,270	58.2
1905	2,747,324.58	1,560,437.42	1,186,887.16	67,881,688	23,625,752	56.8
1906	3,109,739.61	1,646,515.27	1,463,224.34	76,958,488	28,159,558	52.9
1907	3,511,197.86	1,893,236.41	1,617,961.45	85,574,788	31,370,825	53.9
1908	3,610,272.98	1,889,046.62	1,721,226.36	89,139,571	32,700,576	52.9
1909	3,926,828.43	1,995,914.64	1,930,913.79	98,117,991	38,151,596	51.4
1910	4,377,116.19	2,237,187.75	2,139,928.44	109,415,264	42,630,756	51.6
1911	4,851,541.42	2,653,361.86	2,198,179.56	120,997,884	48,730,671	55.2
1912	5,448,050.36	2,866,550.12	2,581,500.24	135,786,573	56,176,985	53.4
1913	6,049,018.92	3,123,308.55	2,925,710.37	151,236,925	63,083,118	52.2
1914	6,127,096.77	3,529,546.22	2,597,550.55	152,966,153	65,778,022	58.4

THE BRIQUETTING OF SASKATCHEWAN LIGNITE.

INVESTIGATIONS have been carried on by the Government of Saskatchewan with a view towards better methods of utilizing the lignite beds of the province by way of drying, carbonizing, and briquetting the deposits. This material is practically the only source of fuel between the great lakes and the coal fields of Alberta. The annual production ranges around 200,000 tons and has done so for a number of years, with, if anything, a slight decrease despite the large increase in population. Western and eastern coals, the latter even at $14 a ton in some parts of the province, are the cause of this, in view of the fact that some of the physical characteristics of the lignite, in its raw state, are much against it. For instance, the following is an average of a number of samples:

Moisture	26.13
Volatile hydro-carbons	28.11
Fixed carbon	38.16
Ash	6.86
Sulphur	.74

When the lignite is mined and exposed to warm air and sunlight, the evaporation of this moisture causes the coal to disintegrate or slack very rapidly; it also fires very quickly from spontaneous combustion; hence it is not practicable to ship it long distances or to store it. Its light gases distil before the fixed carbon reaches the temperature of ignition and, in the ordinary furnaces, escape unconsumed. The lignite has no coking quality whatever, and when thrown onto the fire crumbles very quickly, giving rise to difficulties in firing and substantial loss through the grate bars.

The results of some exhaustive investigations into the physical characteristics of the lignite and into its value as a source of power, domestic and furnace fuel and by-products of hydro-carbon and ammonia, are contained in the recent Government report of Mr. S. M. Darling. He describes apparatus in use in Germany and the United States for the burning of raw lignite, but as the large water content and rapid slacking characteristics of the Saskatchewan product are not conducive to direct consumption in raw state, no emphasis is put upon the methods or apparatus.

The suggested treatment for the better utilization begins with crushing it to about 2 inches and drying it.

The double-cylinder rotary dryer is recommended for the purpose, the apparatus having a capacity of 20 tons per hour, including crushing, screening, elevating, etc. The cost of the process is but a few cents per ton. After drying, the fuel should be screened to three sizes, (1) dust to 1/8 inch, (2) 1/8 inch to 1/2 inch, (3) 1/2 inch to maximum size, 2 inches. Size 1 can be practically all marketed as a powdered fuel. Size 2 and part of size 3 can find a market for use on automatic stokers and fuel-gas producers. The balance should be carbonized and briquetted.

In this process there is no waste. The drying process, besides supplying the demand for powdered fuel and dried lignite for automatic stokers and fuel-gas producers, speeds up the carbonizing process to the extent of the water removed before the lignite reaches the carbonizing retorts. It has the advantage, too, of removing a substantial amount of disagreeable lignite dust, preventing it from reaching the carbonizing oven and choking the gas off-take pipes.

The report describes a very suitable dryer for lignite briquettes, from which favorable results were obtained with samples of Saskatchewan coal. These dried lignite briquettes are serviceable in hand-fired furnaces. Having a large volatile content, they burn fiercely, with a long flange, very much like wood. They are excellent as a locomotive fuel, and in the territory adjacent to the lignite fields will compete with eastern and western coals brought in by the railroads for their own use. They are not so serviceable in house-heating stoves and furnaces as the carbonized lignite briquettes, which burn more like anthracite. Of course, no by-products are obtained when the lignite is merely dried.

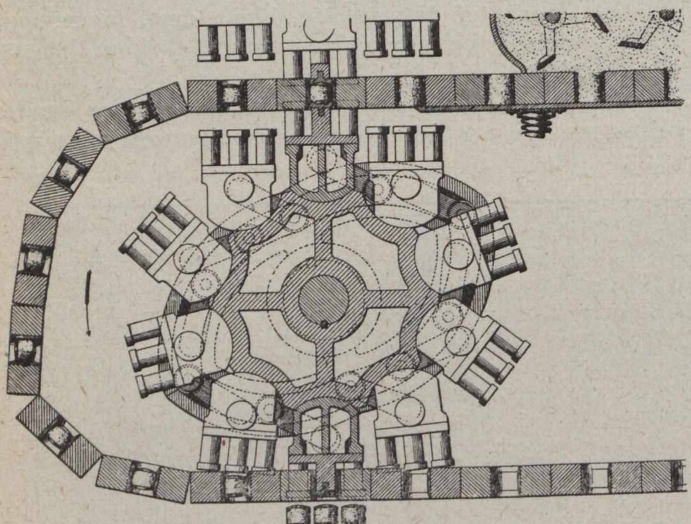
The Saskatchewan Lignite Carbonizing Plant at Estevan.

Mr. Darling does not recommend, in briquetting the Saskatchewan lignite, the German process of briquetting without the addition of any binding material, as he has found it impracticable to do so on a commercial scale. The process is described, however, and it is observed that the Saskatchewan raw material is a very much harder and more nearly true coal, so that the problem to be met, both from mechanical and chemical viewpoints, must be solved in a different way. The lignites lie in solid seams and are mined by the shaft and room and pillar system like ordinary coal.

As for carbonized lignite, the carbonizing process comprises the extraction, by means of destructive distillation of all the volatile matter in the lignite, and the utilization of the resulting gases, ammonia compounds, liquid hydro-carbons, and residual carbon or coke in the various ways for which they are best adapted.

The problem of an efficient lignite carbonizing oven has not been an easy one to solve. Elaborate and very efficient devices have been evolved to carbonize or coke bituminous coal. In all of these, hovever, the work is done at high temperatures, to get a large yield of gas, rather than at low temperatures, with a view to an increased amount of hydro-carbon by-products.

Then, too, because of the fact that bituminous coal cokes, very different apparatus is necessarily needed to handle it from that required for lignite, which has no



A Type of Lignite Briquette Press.

coking or intumescing quality whatever, but instead crumbles when carbonized.

The writer describes the early efforts to carbonize lignite and traces its development up to the present. He refers to the experimental carbonizing oven of the Saskatchewan government at Estevan, in which he has been in charge. This plant was established to treat the lignite on a sufficiently large scale as to be able to use the products in every-day commercial work. The carbonizing bench erected there is a vertical chamber oven similar in principle to the horizontal by-product chamber ovens which are termed the most efficient devices for the coking of bituminous coal. The Estevan oven is charged and discharged continuously instead of intermittently.

The heating value of the gas thus obtained averages about 400 B.t.u.'s, and it makes a good town gas for heating and cooking. It is very serviceable for industrial fuel and power in furnaces and gas engines.

The yield of oil and tar, on distillation is as follows:

1. Light oils, benzine, etc. .... 11.5 per cent.
2. Carbolic oils, some naphthaline ...... 13.5 per cent.
3. Creosote oils .... 34.1 per cent.
4. Anthracene oils, some paraffin .... 16.4 per cent.
5. Pitch, hard .... 24.5 per cent.

The simple distillation products of this oil can be put to many uses—fuel oil for furnaces and internal combustion engines, creosoting oils for the preservation of timber, waterproofing and preserving oils for leather and cotton and other fabrics, tar paper, roofing pitch, etc.

The ammonia is easily recovered by passing the gas, after tar extraction, through a sulphuric acid solution. The anhydrous ammonia has, of course, a limited market in that province, but its use as fertilizer is bound to develop.

When carbonized, the lignite is practically charcoal. It does not coke like bituminous coal. It is about the same, in analysis, as anthracite and has an equivalent heating value. It is not so dense in structure and therefore has more bulk per ton.

After passing through the carbonizing bench, it is screened into several sizes, the smaller sizes and dust being briquetted and the larger lumps being available for use in gas producers.

Carbonized lignite can be used to great advantage in the production of gas for power purposes, yielding in the producer a clean, practically tar-free gas. The amount of gas is equal to that from anthracite; it is richer; it has less tar and clinker, and it burns more freely. About two dozen gas producer plants now using anthracite coal in Saskatchewan are looking forward at an early date to a supply in sufficient quantities of carbonized lignite, as it will mean a reduction of at least 50% in their fuel bills.

The carbonized lignite screenings and that portion not marketed for gas producer purposes, will be briquetted. A binding material is required, particularly in the case of the carbonized product. The best available binders are coal tar pitch and lignite tar pitch. As in the case of the dried lignite, the briquette is improved by the addition of 7 per cent. of coking coal or 2 per cent. of flour, the binding ingredient of which, of course, is the starch which is turned into a form of dextrin by the heat employed in preparing the mixture for the press.

While the addition of the starch or coking coal may be necessary in a briquette which is burned in a large industrial furnace, because of the severe usage to which the fuel is subjected, it is not absolutely necessary in a briquette used in domestic service—house-heating furnaces, fireplaces and cooking ranges. When a briquette in which pitch alone is used is thrown onto the fire, it is quickly warmed to the melting point of the pitch and if it is poked at that particular time, it will go to pieces. But if it is not disturbed for a few minutes longer it becomes sufficiently hard to withstand rough handling, and may even be withdrawn red hot from the fire and dropped into water without disintegrating.

The results obtained with samples of carbonized lignite from Saskatchewan in the different types of coal briquetting presses on the market have been so satisfactory as to demonstrate conclusively the commercial feasibility of the process. The report observes that the tests were not made in a laboratory, but in commercial plants and the fuel came through the different processes at the rates of from 5 to 40 tons per hour. The report illustrates and describes the workings of the various machines upon which the tests were made.

The briquettes have 11,500 to 12,000 B.t.u.'s per lb. They burn with a short flame, no odor, no smoke (except a very little resulting from the volatilizing of some of the pitch binder when first thrown on the fire), and no clinker. They can be used wherever anthracite or bituminous coal is burned. They retain their structure in the fire until completely consumed. They do not disintegrate or lose value in the weather, and can therefore be stored for any length of time.

As between the carbonized lignite briquette and the merely dried lignite briquette the question is essentially one of cost and market demand. In the latter case only the 25 per cent. of moisture is removed; while in the former the reduction in weight, in moisture and volatile is 50 per cent.; but this loss in carbonizing is more than offset by the by-products obtained.

The estimated cost of the first unit of a carbonizing and briquetting plant, capable of turning out 200 tons per day, or a minimum of 50,000 tons per annum, is $75,000, including $15,000 for the drying equipment, consisting of a crusher, rotary dryer, necessary elevators, rotary screen and bins. This is assuming that the lignite mine is already in operation, with switching tracks, etc., and that the carbonizing and briquetting plant can be located alongside the tipple. The expenditure suggested is about as small as would be advisable from a commercial standpoint for the first unit. Additional equipment would, of course, be added as rapidly as was practicable. To quadruple the output it would not be necessary to much more than double the investment.

The estimated cost of manufacturing is:

Lignite, 97,383 tons, at 90 cents	$ 87,644.70
Carbonizing (portion chargeable to)	11,686.00
Labor, at 25 cents per ton of briquettes	12,500.00
Binder, 5 per cent. coal tar pitch, 2,500 tons at $15 per ton, 2 per cent lignite tar pitch (produced at plant)	37,500.00
Interest, 6 per cent. on $75,000	4,500.00
Depreciation, 10 per cent. on $75,000	7,500.00
Incidentals, oil, waste, etc.	2,000.00
Power (portion chargeable to briquetting plant)	5,000.00
Management, general office, laboratory, chemist, etc., (portion chargeable to briquetting plant)	2,000.00
Gross cost of 50,000 tons of briquettes..	$170,330.70
Gross cost of 1 ton of briquettes	3.41

TUNNELING AT ROGER'S PASS.

The following table, compiled from data received from Messrs. Foley Bros., Welch and Stewart, general contractors for the Canadian Pacific Railway, on the construction of the five-mile tunnel at Roger's Pass, gives the footages tunneled during the months of November, December and January:

East end centre heading—

Nov.	Dec.	Jan.	Formation.
558	523	443	Schist with some quartzite.

East end pioneer heading—

Nov.	Dec.	Jan.	Formation.
529	544	594	Quartzite with some schist.

West end pioneer heading—

Nov.	Dec.	Jan.	Formation.
817	852	932	Slate with small quartzite bands.

West end centre heading—

Nov.	Dec.	Jan.	Formation.
654	686	701	Slate with small quartzite bands.

The January record in the west end pioneer heading is 80 feet over the previous record and 122 feet over the American record established in the Mount Royal tunnel in 1913. The 932-footage will probably stand as the American record for some considerable time.

SPIRIT LEVELLING IN NOVA SCOTIA DURING 1913.

THE summary report for 1913 of the Department of Mines (Canada) Geological Survey, describes spirit level work performed near New Glasgow, N.S., during that season. Levels were run in two short circuits in the New Glasgow map-area; the first circuit was along the Intercolonial Railway from Stellarton railway station to the Allan shafts of the Acadia Coal Company, thence via the Albion Mines Railway to the McGregor slopes of the same company, returning via wagon roads to the starting point; the second continues along the Intercolonial Railway from the Allan shafts to Woodburn station, thence along the wagon road via Weirs Mills to Thorburn, and the Vale Colliery Railway back to the Intercolonial Railway. The instrument work was done by Mr. B. R. MacKay.

A 15-inch Y level and New York target rod were used. The line was run only once. Both levelman and rodman read the rod independently and kept separate notes. Temporary benchmarks were established about every mile, and permanent standard bench marks, with the elevation stamped thereon to the nearest foot, were established about every 3 miles, and at points convenient for local use. The standard bench marks are of two kinds, a plate for use in rock and masonry, and a pipe for use in soil. The plate bench mark is a brass plate, 3¾ inches in diameter, bearing the inscription "B. M. Geological Survey of Canada, Elevation ...... Feet"; on the under side is a fluted bolt 3 inches long, whereby the plate is cemented into a drill-hole in rock or masonry. The pipe bench mark is a heavy, 3-inch iron pipe 5 feet long, the lower end of which is split for about 9 inches and spread out to form a T-bearing surface; on the upper end is riveted a brass cap bearing the inscription "B. M. Geological Survey of Canada, Elevation above sea ...... Feet." This pipe is buried to within 8 or 10 inches of the surface of the ground.

The elevations are based on mean sea-level as carried to Stellarton, N.S., by the precise levels of the Geodetic Survey of Canada. The datum used was B. M. MCCC of the Department of Public Works. Two determinations of the elevation of this bench mark have been made, one by the Department of Public Works and one by the Geodetic Survey, with the following results; the values given are rod readings without adjustment:—

B. M. MCCC of Department of Public Works.

	Feet.
Elevation as determined by the precise levels of the Department of Public Works	64.91
Elevation as determined by the precise levels of the Geodetic Survey	64.61

The adjusted elevation not being yet available, the Geodetic Survey value, 64.61 feet, has been adopted.

The first circuit, 4 miles long, closed to —0.005 feet; the second, 16 miles long, to —0.123 feet. These closures have been adjusted in the different circuits proportionately to the distance.

The value of the mineral production of the Province of Quebec in 1913 was $12,918,109, the principal items being:—Asbestos $3,825,959, cement $3,361,292, limestone $1,570,455, copper and sulphur ore $866,774, and mica $117,038.

ROAD NOMENCLATURE.

IN *The Canadian Engineer* for January 7th, 1914, the conclusions were given of a report prepared by a special committee on materials for road construction, for presentation at the annual meeting of the American Society of Civil Engineers. The committee also submitted a list of terms of frequent use in expressions relating to highway work, setting forth their meanings, and recommending their recognition by the Society. This list is given below:

Definitions.—Aggregate—The mineral material, such as sand, gravel, shells, slag, or broken stone, or combinations thereof, with which the cement or the bituminous material is mixed to form a mortar or concrete. Fine aggregate may be considered as the mineral inert material which will pass a ¼-in. screen, and coarse aggregate the material which will not pass a ¼-in. screen.

Asphalt—Solid or semi-solid native bitumens, solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleums or derivatives thereof, which melt on the application of heat, and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

Asphalt Block Pavement—One having a wearing course of previously prepared blocks of asphaltic concrete.

Asphalt Cement—A fluxed or unfluxed asphaltic material, especially prepared as to quality and consistency, suitable for direct use in the manufacture of asphaltic pavements, and having a penetration of between 5 and 250.

Asphaltines—The components of the bitumen in petroleum, petroleum products, malthas, asphalt cements, and solid native bitumens, which are soluble in carbon disulphide, but insoluble in paraffin naphthas.

Asphaltic—Similar to, or essentially composed of, asphalt.

Base—Artificial foundation.

Binder—(1) A foreign or fine material introduced into the mineral portion of the wearing surface for the purpose of assisting the road metal to retain its integrity under stress, as well as, perhaps, to aid in its first construction. (2) The course, in a sheet-asphalt pavement, frequently used between the concrete foundation and the sheet-asphalt mixture of graded sand and asphalt cement.

Bitumen—A mixture of native or pyrogenous hydrocarbons and their non-metallic derivatives, which may be gases, liquids, viscous liquids, or solids, and which are soluble in carbon disulphide.

Bituminous Cement—A bituminous material suitable for use as a binder having cementing qualities which are dependent mainly on its bituminous character.

Bituminous Concrete Pavement—One composed of stone, gravel, sand, shell, or slag, or combinations thereof, and bituminous materials incorporated together by mixing methods.

Bituminous Macadam Pavement—One having a wearing course of macadam with the interstices filled by penetration methods with a bituminous binder.

Bituminous Material—Material containing bitumen as an essential constituent.

Liquid Bituminous Material—Bituminous material showing a penetration at normal temperature under a load of 50 grammes applied for 1 sec. of more than 350.

Semi-solid Bituminous Material—Bituminous material showing a penetration at normal temperature under a load of 100 grammes applied for 5 sec. of more than 10, and under a load of 50 grammes applied for 1 sec. of not more than 350.

Solid Bituminous Material—Bituminous material showing a penetration at normal temperature under a load of 100 grammes applied for 5 sec. of not more than 10.

Bituminous Pavement—One composed of stone, gravel, sand, shell or slag, or combinations thereof, and bituminous materials incorporated together.

Bituminous Surface—A superficial coat of bituminous material with or without the addition of stone or slag chips, gravel, sand, or material of similar character.

Blanket—See "Carpet."

Bleeding—The exudation of bituminous material on the roadway surface after construction.

Blown Petroleums—Semi-solid or solid products produced primarily by the action of air upon originally fluid native bitumens which are heated during the blowing process.

Bond—The combined action of inertia, friction, and of the forces of adhesion and cohesion which helps the separate particles composing a crust or pavement to resist separation under stress. Mechanical bond is the bond produced almost wholly, in a well-built broken-stone macadam road, by the interlocking of angular fragments of stone and the subsequent filling of the remaining interstices with the finer particles.

Bound—Bonded.

Water-bound—Bonded with the aid of water.

Bituminous-bound—Bonded with the aid of bituminous material.

Brick Pavement—One having a wearing course of paving bricks or blocks.

Bridge—A structure for the purpose of carrying traffic over a gap in the road-bed measuring 10 ft. or more in the clear span.

Camber of a Road—See "Crown."

Camber of a Bridge—The rise of its centre above a straight line through its ends.

Carbenes—The components of the bitumen in petroleums, petroleum products, malthas, asphalt cements, and solid native bitumens, which are soluble in carbon disulphide, but insoluble in carbon tetrachloride.

Carpet—A bituminous surface of appreciable thickness, generally formed on top of a roadway by the application of one or more coats of bituminous material with gravel, sand, or stone chips added.

Cement—An adhesive substance used for uniting particles of other materials to each other. Ordinarily applied only to calcined "cement rock," or to artificially prepared, calcined, and ground mixtures of limestone and silicious materials. Sometimes used to designate bituminous binder used in bituminous pavements, when the expression "bituminous cement" (q. v.) is understood to be meant.

Cement-concrete—An intimate mixture of gravel, shell, slag, or broken stone particles with certain proportions of sand or similar material, cement, and water, made previous to placing.

Cement-concrete Pavement—One having a wearing course of hydraulic cement concrete.

Cemented—Bonded. Referring to water-bound macadam, the term "cemented" is used to designate that condition existing when, after rolling the stone forming the crust, the remaining voids have been filled with the finer sizes, and the stone dust or "flour" has, under the action of water, taken a "set," as does cement itself.

Chips—Small angular fragments of stone containing no dust.

Clay—Finely divided earth, generally silicious and aluminous, which will pass a 200-mesh sieve. Also see "Gravel."

Coal-tar—The mixture of hydrocarbon distillates, mostly unsaturated ring compounds, produced in the destructive distillation of coal.

Coat—See "Carpet." (1) The total result of one or more single surface applications. (2) To apply a coat.

Coke-oven Tar—Coal-tar produced in by-product coke ovens in the manufacture of coke from bituminous coal.

Consistency—The degree of solidity or fluidity of bituminous materials.

Course—One or more layers of road metal spread and compacted separately for the formation of the road or pavement. Courses are usually referred to in the order of their laying as first course, second course, third course, etc. Also a single row of blocks in a pavement.

Crown—The rise in cross-section from the lowest to the highest part of the finished roadway. It may be expressed either as so many inches (or tenths of a foot), or as a rate per foot of distance from side to centre, *i.e.*, "the crown is 4 in.," or "the crown is ½ in. to the foot."

Crusher Run—The total unscreened product of a stone crusher.

Crusher-run Stone—The product of a stone crusher, unscreened except for the removal of the particles smaller than remaining on about a ¼-in. screen.

Crust—That portion of a macadam or similar roadway above the foundation consisting of the road metal proper with its bonding agent or binder.

Culvert—A structure for the purpose of carrying traffic over a gap in the road-bed, measuring less than 10 ft. in clear span.

Cut-back Products—Petroleum, or tar residuums, which have been fluxed each with its own or similar distillates.

Dead Oils—Oils, with a density greater than water, which are distilled from tars.

Dehydrated Tars—Tars from which all water has been removed.

Ditch—The open-side drain of a roadway, usually deep in proportion to its width, and unpaved.

Drainage—Provision for the disposition of water.

Side-drainage—That along the sides of the roadway.

Sub- or Under-drainage—That below the surface.

Surface Drainage—That on the roadway or ground surface.

V-Drainage—That provided by the construction of troughs in the sub-grade of the roadway, which troughs are like a "V," with flat sloping sides, and are filled with stone.

Dust—Earth or other matter in fine, dry particles, so attenuated that they can be raised and carried by air currents. The product of the crusher passing through a fine sieve.

Dust Layer—Material applied to a roadway for temporarily preventing the formation or dispersion under traffic of distributable dust.

Earth Road—A roadway composed of natural earthy material.

Emulsion—A combination of water and oily material made miscible with water through the action of a saponifying or other agent.

Expansion Joint—A separation of the mass of a structure, usually in the form of a joint filled with elastic material, which will provide opportunity for slight movement in the structure.

Fat—Containing an excess. A fat asphalt mixture is one in which the asphalt cement is in excess and the excess is clearly apparent.

Filler—(1) Relatively fine material used to fill the voids in the aggregate. (2) Material used to fill the joints in a brick or block pavement.

Fixed Carbon—The organic matter of the residual coke obtained upon burning hydro-carbon products in a covered vessel in the absence of free oxygen.

Flour—Finely ground rocks or minerals pulverized to an impalpable product.

Flush Coat—See "Seal Coat."

Flushing—(1) Completely filling the voids. (2) Washing a pavement with an excess of water.

Flux—Bitumens, generally liquid, used in combination with harder bitumens for the purpose of softening the latter.

Footway—The portion of the highway devoted especially to pedestrians. A sidewalk.

Foundation—The portion of the roadway below and supporting the crust or pavement.

Artificial Foundation—That layer of the foundation especially placed on the sub-grade for the purpose of reinforcing the supporting power of the latter itself, and composed of material different from that of the sub-grade proper.

Free Carbon—In tars, organic matter which is insoluble in carbon disulphide.

Gas-house Coal-tar—Coal-tar produced in gas-house retorts in the manufacture of illuminating gas from bituminous coal.

Grade—(1) The profile of the centre of the roadway, or its rate of rise or fall. (2) Elevation. (3) To establish a profile by cuts and fills or earthwork. (4) To arrange by sizes, broken stone, gravel, sand, or combinations of such materials.

Gravel—Small stones or pebbles usually found in natural deposits more or less intermixed with sand, clay, etc., but in which mixture, the particles which will not pass a 10-mesh sieve predominate, gravel clay, gravel sand, clayey gravel, and sandy gravel indicate the varying proportions of the finer-sized particles. The differentiation between gravel, sand, silt, and clay should be made on the following basis:

Size of particles.	Names.
Retained on a 10-mesh sieve	Gravel.
Passing a 10-mesh and held on a 200-mesh sieve.	Sand.
Passing a 200-mesh sieve	Silt or clay.

Pea Gravel—Clean gravel the particles of which equal peas in size.

Grit—Stone, slag chips, or small gravel free from finer material.

Gutter—The artificially surfaced and generally shallow waterway provided usually at the sides of the roadway for carrying surface drainage. Occasionally used synonymously with "ditch," but incorrectly so, as "gutters" are always paved or otherwise surfaced, and ditches are not.

Haunches—The sides or flanks of a roadway. Sometimes also called "quarters."

Highway—The entire right of way devoted to public travel, including the sidewalks and other public spaces, if such exist.

Layer—A course made in one application.

Loam—Finely divided earthy material containing a considerable proportion of organic matter.

Macadam—A road crust composed of stone or similar material broken into irregular angular fragments compacted together so as to be interlocked and mechanically bound to the utmost possible extent.

Mastic—A mixture of bituminous material and fine mineral matter suitably made for use in highway construction and for application in a heated condition.

Mat—See "Carpet."

Matrix—A composition or material forming a cushion, or binding the aggregate together.

Mesh—The square opening of a sieve.

Metal—See "Road-metal."

Mortar—A mixture of fine material such as sand, cement, and water or other liquid suitably proportioned and incorporated together for the purpose for which it is used.

Mush—A greasy mud sometimes found on bituminous crusts.

Normal Temperature—In laboratory investigations, 25° Cent. (77° Fahr.).

Oil-gas Tars—Tars produced by cracking oil vapors in the manufacture of oil gas.

Patching—Repairing or restoring small isolated areas in the surface of the metalled or paved portion of the highway.

Palliative—A short-lived dust layer.

Pavement—The wearing course of the roadway or footway, when constructed with a cement or bituminous binder, or composed of blocks or slabs, together with any cushion or "binder" course.

Penetration—In laboratory investigations, the distance, expressed in tenths of a millimeter, entered a sample by a No. 2 cambric needle operated in a machine for the purpose and under known conditions of loading, time, and temperature. The degree of solidity of bituminous materials.

In construction, the entrance of bituminous material into the interstices of the metal of the roadway.

Penetration Method—The method of constructing a bituminous-macadam pavement by pouring or grouting the bituminous material into the upper course of the road metal before the binding of the latter has been completed.

Pitch—Solid residue produced in the evaporation or distillation of bitumens, the term being usually applied to residue obtained from tar.

Hard Pitch—Pitch showing a penetration of not more than ten.

Soft Pitch—Pitch showing a penetration of more than ten.

Straight-run Pitch—A pitch run in the initial process of distillation, to the consistency desired without subsequent fluxing.

Pocket—A hole or depression in the wearing course.

Pot-hole—A hole extending below the wearing course.

Profile—A longitudinal section of a highway, generally taken along the centre line.

Quarters—The four sections of equal width which, side by side, make up the total width of a roadway.

Ravelling—The loosening of the metal composing the crust.

Refined Tar—A tar freed from water by evaporation or distillation which is continued until the residue is of desired consistency, or a product produced by fluxing tar residuum with tar distillate.

Renewals—Extensive repairs over practically the whole surface of the metalled or paved portion of the highway.

Repairs—The restoration or mending of a considerable amount of the metalled or paved portion of the highway, but not usually of a majority of the surface area. More extensive than "Patching" but less so than "Renewals."

Resurfacing—The renewal of the surface of the crust or pavement.

Road—A highway outside of an urban district.

Road-bed—The natural foundation of a roadway.

Road Metal—Broken stone, gravel, slag, or similar material used in road and pavement construction and maintenance.

Roadway—That portion of a highway particularly devoted to the use of vehicles.

Rock Asphalt—Sandstone or limestone naturally impregnated with asphalt.

Rock Asphalt Pavement—A wearing course composed of broken or pulverized rock asphalt with or without the addition of other bituminous materials.

Sand—Finely divided rock detritus the particles of which will pass a 10-mesh and be retained on a 200-mesh screen. Also see "Gravel."

Sand-clay Road—A roadway composed of an intimate mixture of sand and clay.

Scarify—To loosen and disturb superficially.

Screen—In laboratory work an apparatus, in which the apertures are circular, for separating sizes of material.

Screenings—Broken rock of a size that will pass through a ½-in. to ¾-in. screen, depending on the character of the stone.

Seal Coat—A final superficial application of bituminous material during construction to a bituminous pavement.

Setting Up—The relatively quick change such as takes place in a bituminous material after its application to a roadway, indicated by its hardening after cooling and exposure to atmospheric and traffic conditions, as opposed to the slower changes later occurring gradually and almost imperceptibly.

Shaping—Trimming up and preparing a sub-grade preparatory to applying the first course of the road metal or artificial foundation.

Sheet-asphalt Pavement—One having a wearing course composed of asphalt cement and sand of predetermined grading, with or without the addition of fine material, incorporated together by mixing methods.

Sheet Pavement—A pavement free from frequent joints such as would accompany small slabs or blocks, and which has an appreciable thickness (say, in excess of 1 in. on the average) for its wearing course.

Shoulders—The portion of the highway between the edges of the road metal or pavement and the gutters, slopes, or watercourses.

Side Drain—See "Drainage."

Sidewalk—The portion of the highway reserved for pedestrians.

Sieve—In laboratory work an apparatus, in which the apertures are rectangular, for separating sizes of material.

Silt—Naturally deposited fine earthy material, which will pass a 200-mesh sieve. Also see "Gravel."

Spalls—Fragments broken off by a blow, irregular in shape, and of sufficient size to be comparable to the original mass.

Squeegee—A tool with a rubber or leather edge for scraping or cleaning hard surfaces, or for spreading and distributing liquid material over and into the superficial interstices of roadways.

Squeegee Coat—An application by means of the squeegee.

Stone Block Pavement—One having a wearing course composed of stone blocks quite or nearly rectangular in shape.

Street—A highway in an urban district.

Sub-grade—The upper surface of the native foundation on which is placed the road metal or the artificial foundation, in case the latter is provided.

Superficial Coat—A light surface coat.

Surface Coat—See "Carpet."

Surfacing—(1) The crust or pavement. (2) Constructing a crust or pavement. (3) Finally finishing the surface of a roadway. (4) Treating the surface of a finished roadway with a bituminous material.

Surface Treatment—Treating the finished surface of a roadway with bituminous material.

Tailings—Stones which after going through the crusher do not pass through the largest openings of the screens.

Tar—Bitumen which yields pitch upon fractional distillation and which is produced as a distillate by the destructive distillation of bitumens, pyro-bitumens, or organic material.

Telford—Properly an artificial foundation advocated by Thomas Telford (1757-1820), and consisting of a pavement of stone about 8 in. thick, laid by hand, and closely packed and wedged together. The individual stones were desired to be about 16 sq. in. in section, and about 8 in. in length. They were set close together on the prepared sub-grade, their longest dimensions vertical and on their larger ends, their interstices chinked with smaller stones, and the whole rammed (or rolled) until firm and unyielding.

Telford Macadam—Macadam with an artificial foundation of Telford.

Underdrain—See "Drainage."

Up-keep—Maintenance.

V-Drain—See "Drainage."

Viscosity—The degree of fluidity of bituminous materials.

Volatile—Applied to those fractions of bituminous materials which will evaporate at climatic temperatures.

Water-bound—Bound or bonded with the aid of water.

Water-gas Tars—Tars produced by cracking oil vapors in the manufacture of carburetted water-gas.

Wearing Coat—The superficial layer of the crust or pavement exposed to traffic.

Wearing Course—The course of the crust or pavement exposed to traffic.

Wood Block Pavement—One having a wearing course composed of wood paving blocks, generally rectangular in shape.

ASSUMPTIONS IN REINFORCED CONCRETE BEAM DESIGN.

THE common theory of reinforced concrete beam design is based on the assumption that a section which is a plane before bending remains a plane after bending. Such an assumption is derived from the common theory of flexure, and is so familiar to engineers, through its application to beams of homogeneous material that the correctness of applying it to beams of reinforced concrete is seldom questioned. The difference, however, between a beam of homogeneous material and a composite beam of reinforced concrete is of such a magnitude that an assumption which is reasonable in the case of the former is not necessarily so for the latter.

A mathematical justification of this theory has been given by Mr. Ralph E. Goodwin, recently, in the proceedings of the American Society of Civil Engineers. His proof is based upon the principle of least work, and, as will be noted in the following abstract, the value of the conclusions depends on the accuracy of the assumptions.

It is assumed that the correct value of j (arm of resisting couple) is the value which develops any given M (resisting moment) with the minimum of work expended in bending the beam. The method of proof used is to compute the value of j by the method of least work and to show that the value thus determined is the same as that in common use.

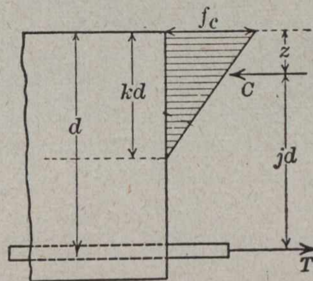


Fig. 1.

In his treatment of the subject the assumptions usual to the theory of reinforced concrete design are made, with the exception of that of a plane before and after bending, which is assumed to be true of the compression side of the beam, but not of the beam as a whole. (Fig. 1.)

The symbols used are the standard notation. In addition,

dl = the distance between two adjacent cross-sections of the beam before bending.

W_{dl} = the work done in straining a section of the beam of length, dl.

W_{dl} = (work of straining steel on tension side) plus (work of straining concrete on compression side).

According to the principles of mechanics, the work done by a load gradually applied is one-half the force multiplied by the distance.

Hence,

$$W_{dl} = \frac{1}{2} C \frac{2}{3} \frac{f_c}{E_c} \times dl + \frac{1}{2} T \frac{f_s}{E_s} \times dl$$

$$= \frac{1}{2}\left(\frac{f_c b k d}{2}\right) \frac{2}{3} \frac{f_c}{E_c} \times dl + \frac{1}{2}(A f_s) \frac{f_s}{E_s} \times dl$$

$$W_{dl} = \frac{f_c^2 b k d}{6 E_c} \times dl + \frac{f_s^2 A}{2 E_s} \times dl \quad \ldots\ldots\ldots\ldots\ldots (1)$$

$$M = \frac{f_c b k d}{2} \times j d = f_s A j d;$$

$$f_c = \frac{2M}{b k j d^2} = \frac{2M}{3b(1-j) j d^2}; \quad f_s = \frac{M}{A j d}.$$

Substitute these values in Equation (1).

$$W_{dl} = \left(\frac{2M}{3b(1-j) j d^2}\right)^2 \frac{3b(1-j)d}{6E_c} \times dl + \frac{M^2}{2A j^2 d^2 E} \times dl$$

$$= \frac{M^2}{2\,d^3\,b\,E_c}\left\{\frac{4}{9\,(1-j)\,j^2} + \frac{1}{p\,n\,j^2}\right\} dl$$
$$= \frac{M^2}{2\,d^3\,b\,E_c}\left\{\frac{4\,(j^2-j^3)^{-1}}{9} + \frac{j^{-2}}{p\,n}\right\} dl.$$

To find the value of j which will make W_{dl} a minimum, set the first derivative with respect to j equal to zero.

$$\frac{d\,(W_{dl})}{d\,j} = 0 = \frac{M^2}{2\,d^3\,b\,E_c}\left\{\frac{-4\,(j^2-j^3)^{-2}(2j-3j^2)}{9} - \frac{2j^{-3}}{p\,n}\right\} dl;$$
$$0 = \frac{4\,(2\,j-3\,j^2)}{9\,(j^2-j^3)^2} + \frac{2}{p\,n\,j^3};$$
$$0 = \frac{1}{j^3\,(1-j)^2}\{4\,p\,n - 6\,j\,p\,n + 9\,(1-j)^2\}.$$

Each factor, when set equal to zero, gives a root of the equation. The root desired lies in the last factor,

$$0 = 4\,p\,n - 6\,j\,p\,n + 9\,(1-j)^2;$$
$$0 = j^2 - \frac{2}{3}\,j\,(p\,n+3) + (1 + \frac{4}{9}\,p\,n).$$

Solving for j by completing the square in the above equation gives,

$$j = 1 - \frac{1}{3}\left(\sqrt{2\,p\,n + (p\,n)^2} - p\,n\right) = 1 - \frac{1}{3}\,k.$$

Hence $k = \sqrt{2\,p\,n + (p\,n)^2} - p\,n.$

This is the value of k in common use.

For beams reinforced for compression and for T-beams the demonstration is similar to the foregoing, up to and including the placing of the first derivative equal to zero. From that point the general solution becomes so complicated that it is best to continue as follows:

(1) Assume numerical values for p, p', d, d', n;
(2) Compute the numerical value of k from the formula in common use;
(3) Substitute the foregoing values in the following equation:

First derivative of work with respect to $k = 0$.

It will be found that the equation in (3) is always satisfied by the values assumed in (1) and (2).

NEW ROAD MATERIAL TESTER.

The Dulin rotarex is a centrifugal machine designed for extracting bituminous aggregates, and is especially adapted for analyzing paving and road compounds, such as bitulithic macadam, and ordinary surface mixtures. A simple speed changing switch on the base accommodates the machine to various mixtures. This little machine does in a few minutes the work that required several hours with older methods. Tests have proven that an inexperienced operator can do the work of three and one-half hours in six minutes. Samples can be taken from mixers or wagons and their constitution determined before dumping, and without delaying the work. Hence exact information can be obtained at every step, proportions checked, weighings verified, etc., without loss of time or risking faulty work. The States of New York, Pennsylvania, Maryland, West Virginia and New Jersey, and many of the largest cities rely entirely on this little machine. The rotarex is small and can be easily carried from place to place. It is driven by a Westinghouse Electric high speed motor, which will operate on any lighting circuit. It is manufactured by the Braun Corporation, Los Angeles, Cal.

A demonstration to the public of the variety of uses to which electricity may be put is being arranged for by Mr. E. M. Wilcox, 62 Temperance St., Toronto. This will take the form of an electric show to be held in the Arena, Toronto, April 12th to 17th.

POWER DEVELOPMENT AT KANANASKIS FALLS

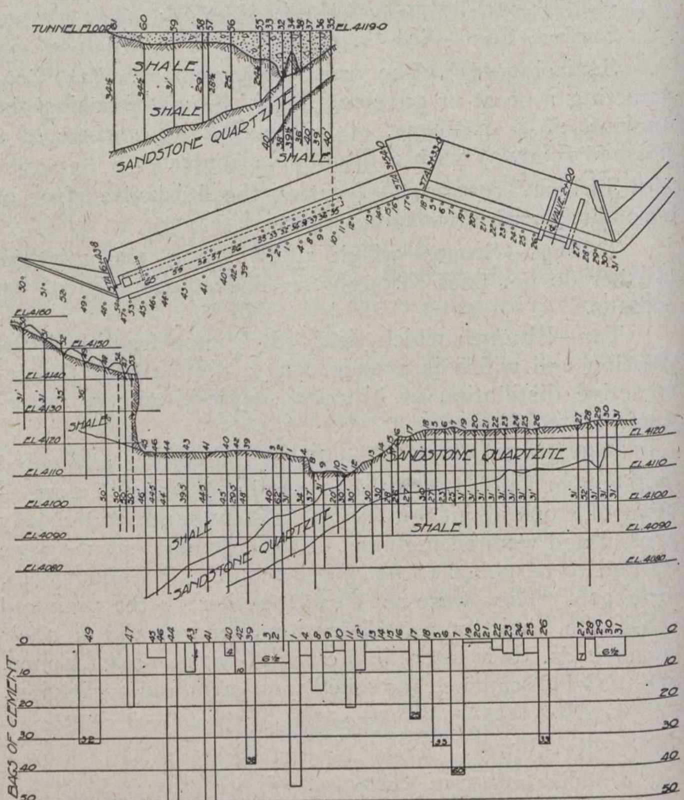
PART III.

By K. H. Smith, B.A.

Power House.—Work on the various phases of the power house construction was carried on throughout the whole period of construction. The main quantities involved, including wheel pits and draft tubes, are as follows:—

Excavation	8,226 cu. yds. rock.
Excavation	2,335 cu. yds. earth.
Excavation	5,000 cu. yds. earth adjacent to power house.
Concrete	4,000 cu. yds.
Brickwork	8,000 hollow tile, 72,000 brick.

The power house is placed in a site almost wholly excavated, so that the maximum depth of excavation from the surface was about 100 feet. All the spoil was handled by derricks and skips loading into standard-gauge dump-



Calyx Drilling and Pressure Grouting Record (Referred to in Part II. of Article).

cars. At the proper level, headings were begun for the pressure tubes. There were no special features connected with this work. Its proximity to the river bank gave natural drainage so that no pumping whatever was required.

The draft tube forms were each built in two pieces to facilitate handling them, and were placed by the derrick used for handling spoil without any special trouble. The forms for the scroll cases were also built on the surface and lowered into place intact, these scroll cases being very strongly reinforced. All material, including turbine foundation rings and some concrete was handled by the derrick. Most of the concrete in the substructure was placed by chutes from a hopper supplied by dump cars from the main mixing plant, a small portable mixer was also used in connection with the concrete for the power house and intake structure. Above the power house floor, elevation 4,125, a spur line of track was run right into the power house, so that all the turbine and generator machinery was brought in on this track in car lots as it was shipped, and unloaded by the power house crane. The crane rails were so nearly at the same level as the adjoining ground, that the crane itself was set up on the ground, and run into place before the end of the power house closed. Power for the crane was supplied from the local service, which by this time was augmented by a supply from the existing Horseshoe Falls plant.

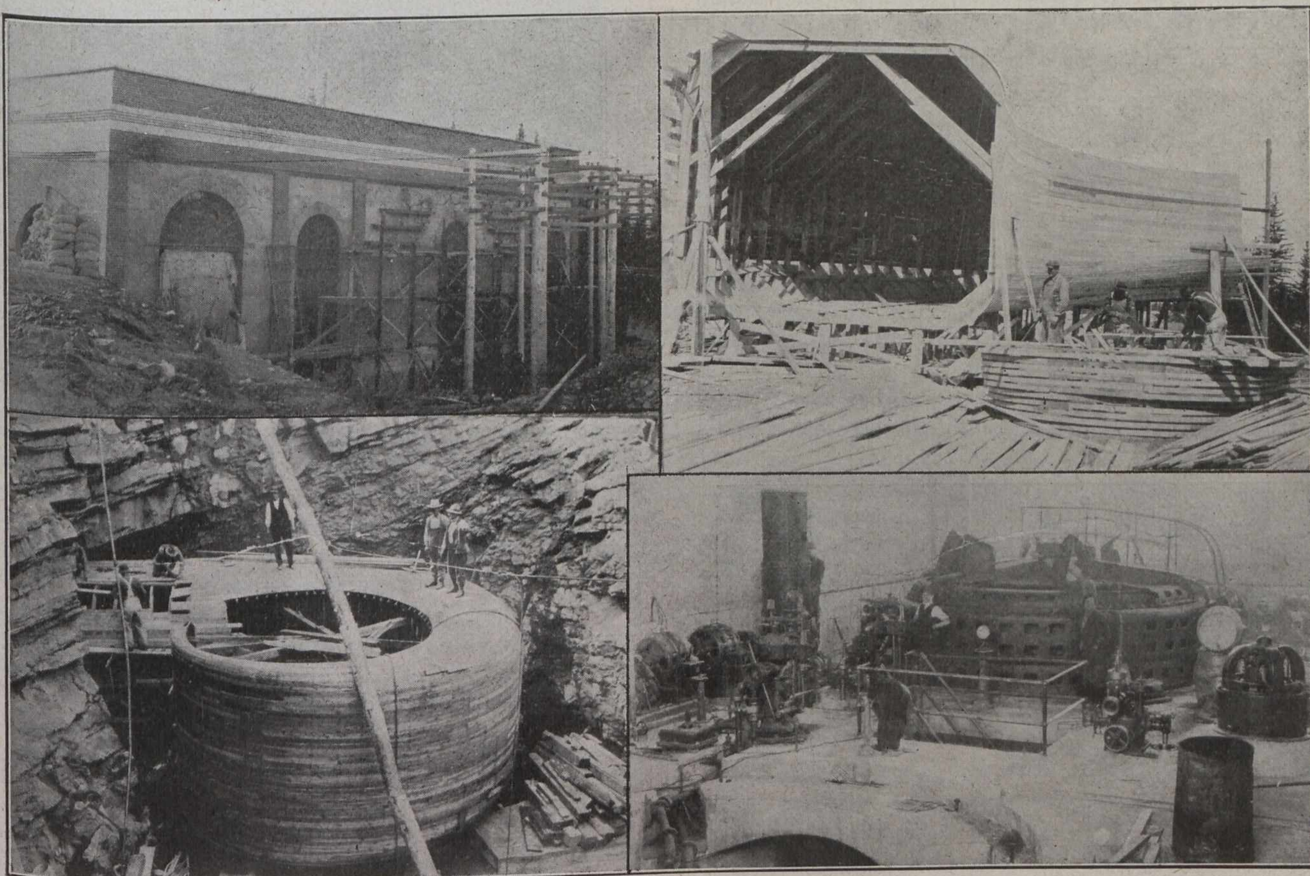
The substructure and back wall of the power house is of concrete, plain and reinforced, while the other walls are of hollow tile and brick with a steel framework. The hollow tile is plastered with cement plaster, while the walls are relieved by plain brick pilasters. The roof is supported by steel trusses, covered with material 2 inches by 4 inches, sized and dressed, placed edgewise. This is covered with an asbestos felt roofing.

The general scheme of development has already been outlined, and there follows herewith a more detailed description of the hydraulic and electrical machinery installed in the power house.

There are two main turbines set vertically in concrete scroll cases moulded in place and direct connected to the two main generators. The turbines were supplied by the Allis-Chalmers Company, and are of the single runner type, designed to deliver 5,800 h.p. at 164 r.p.m., under a normal effective head of 68 feet. They were guaranteed to give 85 per cent. efficiency at ⅝ gate, to maintain their normal speed and capacity under heads varying from 65 to 72 feet, and to have a runaway speed not exceeding 270 r.p.m., when operating under 68 feet head. There is also a small single runner turbine operating under the same conditions as the main units, in a cast iron scroll case with vertical shaft direct connected to an exciter. This is designed to give 150 b.h.p., at 600 r.p.m., with a runaway speed not exceeding 1,000 r.p.m.; water is supplied to this unit by intakes from each main scroll case.

Governing of both the main units is accomplished by automatic oil-pressure governors with the actuating flyball mechanism driven by shafting geared to the main shaft. The motor-driven oil pumps are interconnected, and each pump is large enough to operate both units at the same time. The governing mechanism is guaranteed to maintain constant speed within one-half of 1 per cent. at all times at constant load, and to allow a variation in speed of not more than 15 per. cent. on a change of load amounting to the full rated capacity of the turbine. The small exciter unit is governed by a self-contained oil-pressure type governor.

The two main generators, the turbine-driven exciter, and the motor-driven exciter, were supplied by Messrs. Kilmer, Pullen and Burnham, of Toronto, agents for the General Electric Company of Sweden. The two main



Views of Power House Construction at Kananaskis Falls.

Design of Power House—Ends Similar with Two Windows Each. Solid Wall at Back.

Scroll Case and Pressure Tube Forms Being Connected Up.

Draft Tube Form, Viewed from Outlet End.

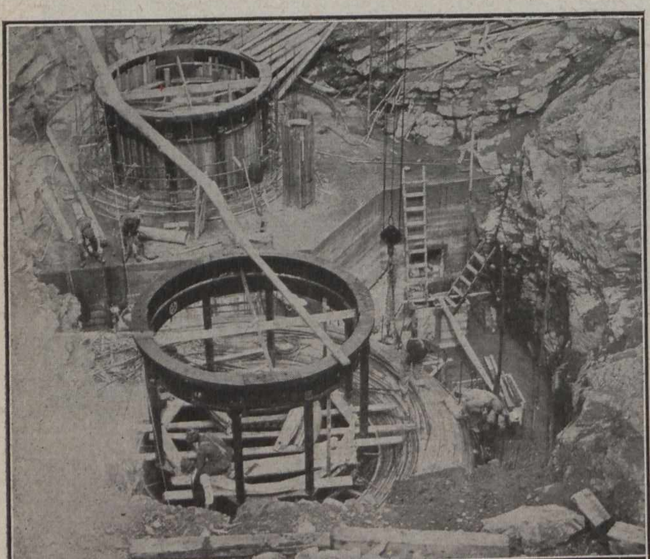
Power House Interior, Showing Main and Exciter Units and Oil Pressure System Complete.

generators are 4,250 kva., 3-phase, 60-cycle, 12,000-volt, 164-r.p.m., vertical shaft machines. They are designed to carry a momentary overload of 100 per cent., and a dead short circuit for two minutes without injury, or straining any of their parts. The turbine-driven exciter generator is a 75-kw., 600-r.p.m., 230-volt, direct current machine, while the motor generator set consists of one 75-kw., 860-r.p.m., 230-volt, shunt-wound, interpole direct current generator, direct connected to one 110-h.p., 860-r.p.m., 2,200-volt, 3-phase, 60-cycle, squirrel cage induction motor.

The switch board and all appurtances for the control of the whole electrical output was supplied and erected by the Canadian Westinghouse Company of Hamilton. The main switchboard consists of eleven panels, six feeder panels, two generator panels, two exciter panels and one Turill regulator panel. There is also one auxiliary panel, controlling two 2,200-volt circuits, and a battery panel controlling a storage battery with the necessary charging set.

All the high-tension transformers and apparatus are situated at the Horseshoe Falls plant, which is less than 2 miles distant, and from which the 50-mile transmission line to Calgary leads. Current from the Kananaskis plant may either be sent to the Horseshoe Falls plant at the generator voltage, and there stepped up to the Calgary transmission line voltage, or sent direct to the Exshaw cement plant at the generator voltage over a line some five miles long. The power house is equipped with one 50-ton, 3-motor Shaw crane.

Tailrace.—After passing through the wheels, the water from each unit is led through concrete draft tubes

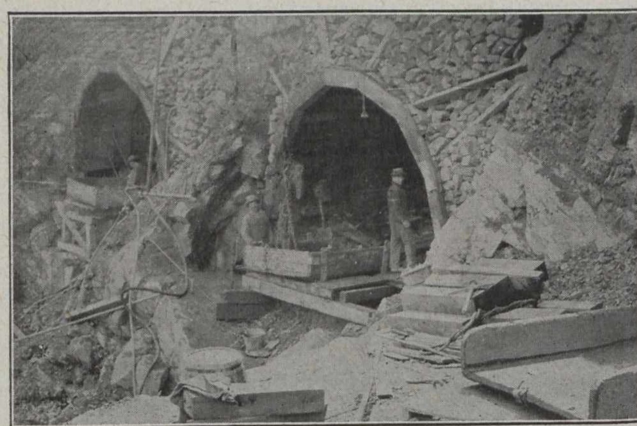


Placing of Turbine Foundation Rings and Separator Bolts.

moulded in place to tailrace tunnels which extend some 160 feet through solid rock to the river. These two tailrace tunnels are 14 feet wide inside and 11 feet high to the springing line, with a semi-circular arch of 7 feet 0 inches radius above that. They were first thoroughly timbered and lined with concrete to a minimum thickness of 6 inches. Their outlets are provided with stop-log gains and a slot for gauging purposes.

The driving of these tunnels presented no unusual difficulties and the usual top heading and bench method was used. Progress in the heading was made at the rate of about 6 feet per day of two 10-hour shifts.

General Remarks.—From a construction standpoint, the site of the Kananaskis Falls developments is particularly well situated. It is directly on the main line of the Canadian Pacific Railway; gravel for concrete was found on the immediate grounds, while cement is manufactured within 5 miles of the site. On the other hand, at least



Method of Timbering Tailrace Tunnels.

two of these favorable features had some disadvantages; considerable expense was involved in protecting the Canadian Pacific Railway against high water as previously outlined, and also in protecting the shale pit which provided the raw material for the cement plant. This shale pit adjoins the river within the flooded area, and, while attempts were made to secure shale elsewhere, it was in the end found necessary to build an earth dyke to protect this pit at a cost of some $8,000.

While the whole scheme of development presented no unusual difficulties, still there are some considerations which might be of special interest.

(1) The system of drainage and inspection tunnels, combined with extensive drilling and grouting operations, the necessity and efficacy of which was conclusively shown throughout construction operations.

(2) The method adopted for lining the canal, previously described, and the permanent success of which remains to be seen.

(3) Concrete-lined pressure tubes excavated through rock to the scroll cases.

(4) The use of Tainter gates at the intake of these pressure tubes.

(5) The location of the power house in a site almost wholly excavated. This site was chosen after very extensive investigations in various places, and the decision was based on questions of cost and hydraulic efficiency, having in mind the accessibility of the site from the railroad.

(6) The use of vertical settings with Kingsbury bearings throughout.

(7) It is expected that operation in conjunction with the Horseshoe Falls plant of the same company, the normal headwater of which is practically the normal tailwater of the Kananaskis plant, will present an opportunity for high efficiency with respect to the power possibilities of this section of the river.

It is thought that this development throughout represents the best present-day practice in hydro-electric design and construction, and its rapid and satisfactory completion is largely due to a particularly efficient and smooth working construction organization.

STOPING METHODS IN MINING.

IN sound rock, excavations of considerable size may be made without the necessity of immediately supporting the walls and roof; but even in such cases unprotected ground usually becomes dangerous in the course of time, and in the case of weaker or more shattered rock, supports are required for the roof and often also for the walls at an early stage in the excavation.

Drifts and shafts being narrow work, naturally stand better than larger openings, but even they are usually protected—except in very sound rock—as their integrity is essential to the operations of mining. Shafts in particular are virtually always substantially timbered or walled, not only for safety, but also to carry the hoisting guides, ladders, etc., which are a present part of the mine equipment.

Stopes are more or less temporary in character, and when small they can often be excavated with little or no support, but large stopes almost always require protection of some sort or other. The methods most commonly in use for this purpose form the subject matter of a paper read on January 14th, before the mining section of the Canadian Society of Civil Engineers by Mr. C. A. Macaulay, who writes from experience gained in several years of actual mining work, chiefly in central and northern Ontario. These methods are grouped under six general heads, *viz.*: (1) Timbering with setts; (2) filling with waste; (3) leaving pillars or ribs of ore; (4) filling with broken ore over dry walls; (5) the underground drift method; (6) caving in descending slices.

The suitability of any one of these general methods for working any particular deposit, still more its detailed development, is dependent on a number of factors, of which the most important are: The form of the deposit. Its size and particularly the width. The dip. The character of the walls. The character of the ore. The extent to which the ore or the walls have been shattered by movement; penetrated by dykes, etc., and the cost of labor and materials, and the grade of the ore, etc. This last consideration may almost be said to govern all the rest.

Timbering.—The author states that some years ago sett timbering was almost the universal method of supporting stope excavation, but gradually other methods have crept in, replacing it, so that to-day, in a large majority of districts, framed timbering in stopes is a thing of the past, although there are some very important districts that still adhere to it.

In general, however, stoping with timber should give place to later methods, not for one, but for a combination of many reasons, the chief of these being in most districts the increasing and often prohibitive price of timber. Then there is the danger of creep and crush, and in after years of subsidence, and added to all this there is the risk of fires.

Filling With Waste.—This method is of comparatively recent use in this country, so far at least as it concerns replacing timber in stopes. The system necessarily calls for a large amount of waste rock, and although a certain amount of waste is ordinarily made in cutting the stopes themselves, there is never enough to fill the stope. Resort is made usually to waste rock from development work and to rock house waste, mill tailings, etc. The latter, in conjunction with dry walls of rock or waste, is largely used, since it is easily available and may be cheaply handled.

The main feature which requires care in this system is that winzes must be kept open. To work to the best advantage the winzes through the block of ore under attack should be kept in alignment with similar winzes from above, so that filling may be sent down from the surface or from any intermediate level. The logical place for these winzes is in the hanging wall of the stope, as the waste will then reach the foot wall of the stope with a minimum of handling.

The disadvantage of this system is that a certain amount of timber must be used for chutes and in the dry-walls as binding matter. The building of dry walls for the tramways and the placing of timber and lagging required to cover them is a heavy expense, as is the first cost of timber necessary.

Compared with all timber methods (such as square setts) the filling method has the advantage of more effective support to the mine, less danger of creep and much less danger of fire, and in most cases is by far the cheaper of the two.

Pillars of Ore.—As a method of supporting stopes in the type of mine under consideration, the use of ore pillars alone, strictly speaking, has no place. This method can be used only in mines where the walls are exceptionally strong, and where the backs show no tendency to cave at all.

Ore bodies of this character are rare, and even when they occur this method is only applicable to a moderate depth as no ore pillar of reasonable size will stand the great pressures that are unavoidable at great depths. Another objection to this method is that a large amount of ore is locked up in the pillars, and only part of it can usually be recovered when the stopes are abandoned.

In shallow mines, however, the method works very well and pillars carry the back in a series of very high arches, and the ore is taken out by breast and bench stoping, a back of about 30 ft. being left to be broken down from the level above when the stope below has been worked out.

The disadvantages of this system in addition to the loss of ore in pillars are: the heavy expense of scaling necessary to keep the backs free from loose ground which would be liable to fall and thus endanger the miners below. Also the expense of mucking, since all muck must be shovelled from the sill floor into cars for tramming.

Broken Ore Filling Over Dry Wall.—This method of support entails the construction of dry walls and ore-chutes, as in the filling with waste method, but it disposes with the winzes necessary for that method, and makes it possible to place nearly all of the filling by gravity.

The method is to stope out the sill floor and then to dry-wall along one or both sides of the proposed tram line, using ore with a timber binding and a timber lagging overhead; then to back stope the broken ore, filling the stope between and over the haulage-ways. Chutes must be built up to keep pace with the filling, and as the broken ore occupies from 30 to 45% more space than the ore in place, the surplus ore must be drawn off; this is done continually through the chutes as the stone is broken towards the level above. The remaining 55 to 70% is left in the stope, affording a temporary support to the walls and a working floor to the miners. When the stope is completely broken through to the level above, it will be full of broken ore which may then be entirely drawn off. The dry-wall of the level above will come down with this also, as the last work in the stope will be the shooting out of the floor pillar between the working stope and the one above.

The advantages of this method are that practically no shovelling is necessary in the stopes, since the ore will cone around the chutes, and when the angle of rest is exceeded, will roll into them. A greater distance between levels is possible and fewer raises and winzes are required. The cost of filling the stope is practically nothing since the ore has to be broken anyway.

The system has its disadvantages, however, the chief of these being that the ore must be broken fine enough in the stopes to prevent blocking in the chutes.

The Under-drift Method.—This method, although it has been very successful in so far as it has been used, has not as yet really had sufficient application to varied problems to justify one in calling it a standard method. It is probably one of the most simple and inexpensive systems for filling that has as yet been developed. The salient and new feature of this method is that we eliminate the sill floor timber entirely, in the sense in which the term is ordinarily used, and place the haulage roads in the floor pillar instead of on top of the floor as is usual.

To eliminate the timber on the sill floor the method is as follows: When laying out a level the first 15 to 20 feet of the ore-body above the floor level is left in place, instead of being stoped out as usual; this ultimately forming part of the floor pillar or back of the stope which in due course will be cut below. This flat pillar is necessarily left until such time as the stopes above and below are worked out and are ready to have their broken ore drawn off.

The drifts and crosscuts which are to serve for haulage ways for the stopes are driven in this floor pillar. From these haulage ways raises or box holes are driven vertically upward, or at an incline, to the level of the bottom of the proposed stope which, as stated above, is from 15 to 20 feet above the floor of the crosscut. These box holes are usually about 25 feet apart and are placed alternately on opposite sides of the haulage ways and are provided with chute gates. The lay-out of the haulage ways depends on the size and shape of the ore-body. In most cases they would be planned and spaced in the same way as the dry-walls roads for ordinary shrinkage stopes. Entrance for men to the stopes is secured by means of manways which are generally placed in the pillars, but in the case of a narrow ore-body they may be placed in the walls a few feet back from the contact. In both cases the manways are usually connected to the stope about every 25 feet (vertically). The stope is then opened out to connect with the top of the box holes, and this broken ore, or rather the surplus, is drawn off through the box hole gates into mine cars run just under the lip of the gate and are loaded by gravity so that practically all shovelling is done away with.

The actual stoping by this system, once the development is done, is the same as in any ordinary shrinkage stope; that is to say, back stoping proceeds in a series of rills, the broken ore supporting the walls and forming a working floor. A unique feature of this system is that the pillars, as they have raises in them serving as manways, may be drilled out as the work is driven up, the holes being plugged, and when the stope is worked out they may be shattered by blasting, and largely, if not totally, recovered. In the case of rib pillars the recovery would be less complete unless there were two or three raises, but even with a single raise a large part of the rib should be saved for, where the ground is weak enough to require rib pillars, it would probably be weak enough to break pretty completely when partly shattered and the support removed.

This system has all the advantages which ordinary shrinkage stoping possesses over dry-wall, with the added advantages that accrue from having no timber in the stopes. An excellent example of this method of stoping is to be seen at the Dome Mine, South Porcupine, Ont. It is also successfully used at the Frood Mine, near Sudbury, Ont.

Caving.—Mr. Macaulay does not dilate upon this system, as it is not strictly a stoping method, and is in general rarely suitable for as hard ores as those which have been considered. Caving systems are, however, exceedingly cheap and satisfactory where practicable, and are very largely used not only in the soft iron ores on which they were first developed, but also in a number of the large, soft and medium copper ores in the southwestern parts of the United States.

Comparison of the Various Systems.—In comparing the various systems of stope support, it is to be remembered that no two ore bodies are exactly alike in size, shape, character of walls and a dozen other features, and that, as mining is a matter of good practical engineering rather than pure science, there are, therefore, almost as many detailed methods of mining as there are miners.

The rapid disappearance of forests, and the consequent advance in prices of timber has already greatly affected the mining industry, and further rise in prices will soon make "mining without timber" an essential feature of the economic operation of low-grade deposits.

It is probable that this matter of timber engrosses the attention of the most up-to-date mining operators more than any other single factor in their profession at the present time, and any system that can effect an economy in the use of timber, without loss of efficiency in other ways, must either now or in the comparatively near future, be given preference over the older systems that are so extravagant in their use of this once over-abundant material. In reality the whole question is one of dollars and cents; the systems that can give the greatest ultimate realization of profits are naturally the systems that will be used.

Greater temporary profits are often to be had from a wasteful or extravagant method, but they often mean lesser ultimate profits for the whole property owing to loss of ore, etc. Again, a given system as applied to a particular mine may be very cheap to operate, but dangerous, and the cost of resulting accidents may greatly overbalance temporary gains. These are problems, however, which can only be solved by a thorough study of the individual property which one desires to develop, and no more need be said of them here.

If we now compare, in a general way, the timbering and shrinkage or waste filling methods, we can see that where the walls and ore are reasonably strong to resist caving, the latter methods have a decided advantage over the former in that they require so much less timber, and are practically on an equal with it in all other respects.

As to the ore pillar system, we can hardly compare it to the other systems since it requires such exceptional strength of walls and ore that it can never come into very general use.

It is also obvious that the under-drift method is as far in advance of the shrinkage and waste filling methods as they are ahead of timbering methods, since it requires no timber at all.

The elimination of timber in the mine is a big factor in preventing fires underground. Such fires have proved very disastrous, but in a mine with up-to-date equipment such as reinforced concrete shaft walling and ore pockets, etc., and with steel or reinforced concrete wherever support is necessary, and virtually no timber in the stopes, there is practically no chance of fire.

Editorial

THE LIGNITE RESOURCES OF SASKATCHEWAN.

The recently issued report of investigations carried on by the government of Saskatchewan with a view toward better methods of utilizing lignite by way of drying, carbonizing and briquetting it, and to determine its value as a source of power, domestic and furnace fuel, and hydro-carbon and ammonia by-products, contains much information of great interest to the Canadian West, where the question of coal fuel is such an important one. In parts of Alberta, Manitoba and Saskatchewan waterpower cannot be economically developed, but these districts are all within easy reach of great deposits of lignite. In these deposits lies the solution of the problem, not only of cheap industrial power, but also of a domestic fuel supply. These are the two most important problems in the prairie provinces to-day, and the government report on the suitability of the lignite deposits for the solution of both is a matter of considerable moment.

The lignites with which these provinces abound are quite superior to those with which Germany and the United States have demonstrated that cheap power can be produced by the gas engine. In the Souris River coal field, according to Mr. S. M. Darling, who prepared the report, there are billions of tons, the principal seam lying about 80 feet below ground and varying in thickness from 7 to 20 feet; with other seams at different depths, even as low as 900 feet. He estimates the manufacture of briquettes, including the lignite itself, labor, management, and all incidentals, to cost $3.41 per ton. Tests have shown the superiority of the product over anthracite as gas producer fuel. The latter varies in price from $10 per ton in Winnipeg to $14 per ton in some parts of Saskatchewan. Further, as the output of the lignite industry increases, the cost per ton should decrease.

Another important feature with regard to the utilization of lignite is that every pound of coal broken from the seam will be utilized, either as powdered fuel, dried lignite briquettes, carbonized lignite, or carbonized lignite briquettes. The products of the industry will consist of gas, for the production of cheap electrical power, etc., and for heating and domestic use; power, derived from surplus gas in the process of manufacture, and costing practically nothing; and by-products, from the tar and ammonia compounds.

It is obvious that the industrial development of the prairie provinces will depend in no uncertain way upon the utilization of this vast natural resource.

HARBINGERS OF ENGINEERING ACTIVITY.

The past few weeks have contributed more toward increased activity in engineering work of a sound and stable character than has been in evidence since the war began. Assuredly bright spots of any kind are not amiss, but it is encouraging to note that municipal development is rapidly coming to the fore with the early approach of the constructional season. There is little doubt that concerted effort on the part of all, to usher in the spring with a stout adherence to the "Business as Usual" policy, has had a good deal to do in the bringing about of a more favorable condition in engineering practice.

It is of interest to note, for instance, that January's list of Canadian municipal bond sales was in excess of that for January of 1914, the figures being $2,024,947 and $1,953,137. Bond sales for December, 1914, aggregated $953,522. To the total for January, Saskatchewan and Ontario were high contributors, with sales amounting to $896,850 and $792,897 respectively. New Brunswick came third with $280,000.

Bright as January sales were, in indication of an early revival of engineering work, the February list to date outshines it in practically every phase of municipal development. Since the beginning of the month Canadian cities have sold considerably over $8,000,000 worth of bonds or short-term debentures for waterworks, sewerage systems, roads, and other work. A few of the outstanding items are as follows: Toronto, $2,000,000; Ottawa, $2,500,000; Calgary, $2,000,000; Vancouver, $750,000; Lachine, $250,000; Hamilton, $200,000; Sault Ste. Marie, $500,000; St. Vital, Man., $240,000; etc.

In addition, bonds to the amount of over $40,000,000 have been sold by the provincial governments since the beginning of the year.

The recently announced estimates of the Dominion Government for the year ending March 31st, 1916, do not show as large a decrease in public works as had been anticipated in many quarters. The estimate for railways and canals is $3,833,890 below that of last year, while for public works, exclusive of the marine department, the estimate is under that of 1914 to the extent of $3,321,300. The Dominion Government's policy with respect to public works this season has been well defined. It is stated that funds are being provided in every case to continue work already commenced or promised, but that few new public works will be undertaken during the year.

While the decrease may be smaller than anticipated by some, it is regrettable, nevertheless, that provision has not been made for more public works at the present time than in recent years of normal activity. In the past the Government has not, like so many municipalities, made heavy expenditures upon work for the distant future rather than for the necessities of the present. Some cities have developed their waterworks, sewerage systems and paved thoroughfares to such an extent that at the present time there is little of an ordinary nature to be done. The Dominion Government has not erred in this regard, and, in the interest of balancing good times with bad, many important undertakings might be proceeded with. At such a time as this, when considerable savings in the cost of construction are possible, there is the more reason for avoiding petty economies that would militate against larger savings being availed of to the full. The Government cannot be charged with having gone too fast in its development of public works in days of high costs and scarcity of labor. On the other hand, it would be most encouraging to obviate any indication of falling steam pressure now that the unemployment problem has attained such proportion, and is so insistent in its demands that money be spent in its behalf.

However, the present situation has more bright engineering prospects than dull. This could not have been said a few weeks ago, when prospects of any material improvement were indeed doubtful. Apparently the tide has turned, and each day records a marked improvement.

COAL WASTE IN CANADA—AND ITS CONSERVATION PROBLEM.*

By Dr. Frank D. Adams,
Dean, Faculty of Applied Science, McGill University, Montreal.

IN Canada, in the year 1913, the water-power available on the turbine shafts of our electric installations amounted to 1,100,000 h.p. Assuming that under average conditions one h.p.-hr. can be produced in a steam plant from 3 pounds of coal, then 1,100,000 h.p. calculated on a 12-hour basis and taking a load factor of 50%, which is a conservative allowance, represents a saving of 2,750,000 tons of coal per annum. When it is remembered that the total output of coal in Canada for the same year amounted to only 15,115,089 tons, these figures are all the more striking. It is also interesting to note that the development of our water-powers is as yet only in its infancy, that an immense volume of power is annually running to waste and that each horse-power per year that thus runs away unutilized is equivalent to the burning up and destruction of 5 tons of coal.

While Canada contains abundant supplies of coal, the coal beds are chiefly in more or less inaccessible regions. The investigation into the coal fields and coal resources of Canada which was carried out in connection with the meeting of the International Geological Congress held in Canada in 1913, showed that less than 1% of the coal resources of the Dominion are situated in Nova Scotia and New Brunswick, while 87% lie in Alberta, much of this coal being in very remote districts of that province.

The coal seams which are now being worked are those which contain the coal of the best quality and in the most accessible regions and those which are nearest to what are and always will be the great centres of population in the Dominion. They are, therefore, speaking generally, the deposits from which coal can be delivered most cheaply. When coal can no longer be obtained from these districts, or if for any reason it becomes more difficult to extract coal from them, the price of coal will tend to rise.

In a coal-bearing district the measures usually contain several distinct coal beds, overlying one another and often differing more or less in thickness and quality. If, in opening up such a district, the operators, in order to obtain a large supply of good cheap coal at once, select without any regard to ulterior consequences a single bed as that which can be most conveniently worked at the lowest operating charges, and rob this seam of its coal solely with the view to the largest immediate output, the workings, after the extraction of a portion of the coal, will crush in, making it very difficult and often impossible ever to secure the rest of the coal in this particular seam or any of the coal in the other beds overlying it. The final result of this method of mining is that a very small percentage of the coal in the area is won and all the rest is absolutely and inexcusably wasted.

Again, there are beds of coal in Canada which are so thick that it is difficult, in fact in some cases impossible, to work the whole thickness of the seam at once. Consequently the upper or lower part of the seam alone is worked, leaving the rest behind. In such cases, when the workings collapse after the cessation of mining, there is a serious danger of losing the coal in the other half of the seam. The loss, however, even under these circumstances, can be minimized if a proper and uniform plan of working the seam is adopted from the first.

Again, where there are thin seams of coal alternating or interstratified with thicker beds in a series of measures, the coal in the thicker seams, which are easily and profitably worked, is often extracted, leaving the thinner seams untouched. These,—which could be worked at the same time as the thicker seams at a comparatively small cost,—when the thicker seams have been removed and the workings have collapsed, are frequently so much shattered that the coal which they contain is forever lost.

In the methods of working a coal seam which are usually adopted a large part of the coal is left in the mine during the working in the form of pillars for the purpose of supporting the roof. These pillars in the final stages of the mining of any area can be in part removed, but a large part of the coal, which may be stated to be on an average 50% of all the coal originally present in the seam, remains in the mine and is permanently lost. By adopting what is known as the Longwell system where this is possible, a much more complete extraction of the coal may be secured.

The excessive use of powder also entails a loss of coal owing to the fact that it breaks up the coal and in this way develops a relatively very large amount of slack, accompanied with increased danger from fire and explosion.

All these causes of waste are illustrated in the coal fields of Canada. It may be stated that in the coal fields of Nova Scotia the amount of coal which has been wasted is at least as great as that which has been extracted. This is apart from and in addition to the coal necessarily left in the mines under the methods of mining employed. This waste amounts to very many tens of millions of tons. It is a satisfaction to note, however, that the greater part of the waste in question took place in the earlier years of the coal mining industry in this province, at a time when there was no effective government supervision. At the present time every mining company operating under leave from the government of Nova Scotia is required to submit in advance the plans which it is proposed to follow in opening up any coal seam. These plans must be approved by the Chief Inspector of Mines, under whose supervision the actual mining of the coal is also carried out. The waste of coal has thus been greatly diminished and would be reduced still further were it not that in many cases it is now very difficult to introduce the best methods of extraction owing to the condition in which the mines have been left by the early operators.

In the great coal fields of the provinces of Alberta and Saskatchewan, which are now commencing to be opened up and whose mineral wealth is the property of the Dominion Government, by whom the right to mine for coal in certain areas is leased for a certain definite term of years, the experience of the early days of Nova Scotia mining is now being repeated. The Department of the Interior under the Dominion Government has mining inspectors whose functions after the leases have been granted consist essentially of collecting the royalties on the coal extracted; the respective provincial governments also have mining inspectors whose duty consists in seeing that the mining is carried on in such a way that the life and limb of the miners are safeguarded; but so long as the royalties are paid and the mining carried on with due regard to the safety of the man, the operators are at liberty to adopt any methods of mining which they please, no matter how wasteful these may be and without regard to the condition in which the mine will be left when their

*From a report to the Commission of Conservation, Canada, from its Committee on Minerals, January, 1915.

lease expires. The methods which have been used and are now being employed in many parts of these coal fields are eminently unsatisfactory in this respect and steps should be taken now in the early days of the development of the coal fields to render impossible a repetition of the mistakes which are made in the older coal fields of Eastern Canada. To this end, an officer of undoubted capacity and integrity and with wide experience in the mining of coal should be appointed as Chief Inspector of Mines by the Dominion Government, to whom, among other things, all plans for the development of the coal mines working under lease from the Dominion Government should be submitted in advance and whose approval of the same should be necessary before the actual work of mining is begun, as is the case in all mines now worked under lease from the Provincial Government of Nova Scotia, or from the owners of coal lands in Great Britain. The mines should also, as in these cases, be inspected regularly by the Chief Inspector or his assistants in order to see that the plans which have been approved are being properly carried out.

From the coal which is mined and burned under boilers in the usual manner, only about 12% of the total efficiency is developed. And if, as is usually the case, only 50% of the coal is taken from the mine, there is secured only about 6% of the total efficiency of the coal contained in the area worked. If the coal is burned in gas producers and the gas so obtained used in internal combustion engines, a higher efficiency amounting to about 30% of the energy in the coal actually mined, or about 15% of the energy locked up in the coal of the whole area, is obtained. This is a distinct advance in efficiency but still represents an enormous waste. It is a waste, however, which at the present time we are unable to avoid.

On the other hand, the coal may be mined for the production of coke for metallurgical purposes. This was formerly made in the so-called Bee-hive furnaces, from which a relatively smaller yield of coke is obtained and all the other products yielded by the coal—gas, tar, ammonia, benzol, etc.—go to waste. In the best modern practice, however, the coal is coked in what are known as by-product ovens from which a larger percentage of equally good coke is obtained and all these other products are saved. About three-quarters of all the coke produced for metallurgical purposes in North America is still made in the old Bee-hive ovens. They flame for miles in Pennsylvania and excite no comment, while the burning of a $1,000 house would draw a mob, and yet the waste is enormously greater. It has been estimated by Messrs. Campbell and Parker, of the United States Geological Survey, that at the prices which prevailed in 1907 the value of the by-products wasted in the Bee-hive ovens in that country was a little over $55,000,000, and that on the other hand the value of the by-products from the retort ovens in the same year was a little more than one-third the value of the coke produced in them.

In Canada, by-product ovens are used by the Dominion Coal Company at Sydney and by the Algoma Steel Company at Sault Ste. Marie, but these are the only ovens of this type in the Dominion.

The coke which is used for metallurgical operations in Western Canada is all made in Bee-hive or Belgian ovens. While in these latter the gas given off by the coal is drawn off and may be used for heating purposes, the by-products, as in the case of the Bee-hive furnaces, go to waste. There are at present in Canada 2,024 ovens which do not save the by-products as against 730 which do save these valuable constituents of the coal. In Western Canada there are 1,935 ovens of the former class and none of the latter.

Mr. F. E. Lucas, manager of the coke ovens of the Dominion Coal Company, estimates the saving effected by the use of the by-product oven to be $1.93 per ton of coke made. This figure will, of course, vary to a certain extent with the locality in which the coke is produced, but it indicates the great additional yield which is secured when coal is coked by modern methods, more especially when the enormous tonnage of coke consumed in modern smelting is borne in mind. In the year 1912, 405,457 tons of coke were made in Bee-hive ovens in Alberta and British Columbia, representing a waste of approximately 12,569,167 pounds of ammonium sulphate and 43,383,899 gallons of tar; not to mention the benzol, creosote and other minor products and the immense amount of gas which would be available for heating and lighting purposes.

The principal objection which is urged to the introduction of the by-product oven is the expense of installation. But it is hoped that this objection will be overcome wherever possible since, as shown above, the by-products have high economic and market values and there will be a growing demand for them.

The tar is already being used extensively in the Dominion for a variety of purposes, among which may be especially mentioned that of the manufacture of briquettes from slack coal, thus effecting an additional economy in the utilization of this waste product. Ammonia, on the other hand, is a fertilizer of the greatest value, for which there is a great demand abroad and for which an ever-increasing demand will arise in Canada as the necessity of employing improved methods of agriculture is brought home to farmers. The by-product coke ovens of the United States produced in 1912 ammonia and ammonium sulphate to the value of $9,519,268.

For some years past, in England and Germany attention has been paid to the problem of securing the largest possible yield of ammonia from coal during the process of coking. With the methods of coking ordinarily adopted at the gas works in these countries only about one-sixth of the nitrogen in the coal is obtained in saleable form as an ammonium compound. It has been found, however, that by employing certain improved methods the yield of ammonia may be increased by as much as 200 per cent.

The immense volumes of gas given off from the coal in the by-product ovens might be readily utilized in connection with associated industries, as, for instance, the burning of cement.

One of the most important problems which presents itself at the present time is the provision of an adequate supply of cheap fuel for the population of the prairie provinces of Canada. Very large areas of these provinces are underlain by beds of sub-bituminous coal and lignite which are estimated to contain 100,000,000,000 tons of these fuels. As yet, however, practically all the fuel in that portion of the plain east of Brandon is imported from the United States, while that used in the country west of Brandon is brought chiefly from the coal fields of the Rocky Mountains. This entails a long and expensive haul which results in a high priced fuel, and any temporary interruption of the supply results in a coal famine.

The reason why the mineral fuels of the plains have not been utilized is that they are expensive to mine owing to the absence of supplies of mine timber on the treeless prairies and they are also of a lower grade than the fuel from the Rocky Mountains, containing a large percentage of moisture. They thus have a lower heating value than the fuels from the mountains, and furthermore when, after being mined, they are exposed to the atmosphere, they dry out to a certain extent and in so doing crumble to pieces or even fall to powder, so that they cannot be readily handled and will not bear transportation. Such being the case, if these fuels are to be made available for household use, they must be briquetted, or if they are to be used for manufacturing purposes, they must be either briquetted or used in gas producers.

A series of trials of Canadian fuels recently carried out by Dr. Porter and Prof. Durley, of McGill University, for the Mines Branch of the Department of Mines at Ottawa, show that these fuels of the plains are excellently adapted for use in the gas producer and are thus well adapted for the production of power. The question as to whether they can be briquetted when necessary at a sufficiently low cost to make the enterprise commercially profitable, has not yet been established. Fuels of this general type in Germany are briquetted on an enormous scale, and the United States Bureau of Mines is now investigating the possibility of briquetting the lignites of North Dakota. Any lignite can, of course, be briquetted if a suitable binding material is employed. This, however, entails additional expense, but many of the German lignites and some of those occurring in North Dakota can be briquetted without the addition of any binding material. It is thus very important that an investigation should at once be made into the question as to whether there are not, among the great deposits of fuel underlying the Canadian plains and outcropping on their surface some at least which can be worked for the production of a cheap briquetted fuel which will stand transportation and thus supply a need ever more insistant as the population of the prairie provinces increases. Such an investigation is to be commenced next summer by the Mines Branch of our Department of Mines, and the results will be awaited with much interest.

Another source of waste in the case of our fuel supplies is represented by the smoke nuisance which is now becoming very pronounced in our large cities. While it is difficult to prevent the smoke rising from the chimneys of private dwellings—this in the cities of Canada is relatively small in amount for, as a general rule, hard coal is burned for domestic purposes—on the other hand, the immense volumes of smoke emitted from the stacks of many of the great power plants and factories of our large cities as well as by locomotives and steamboats can be greatly reduced or stopped by the installation of proper smoke consumers operated by firemen who have been instructed in their proper use. Investigations show that such plants in many cases at least not only stop the smoke but pay the owners.

The waste of fuel, however, is but a small part of the loss entailed by the smoke in our cities. It disfigures buildings, impairs the health of the population, renders the whole city filthy, destroys any beauty with which it may be naturally endowed and tends, therefore, to make it a squalid and undesirable place of residence, and this at a time when economic influences are forcing into our cities an ever-increasing proportion of our population. These conditions press especially on the poor who must reside in the cities and cannot escape from these evils by taking houses in the suburbs. After all, the conservation of humanity is even more important than the conservation of coal.

Investigations into the best means of abating the smoke nuisance have been and are now being carried on by government and municipal commissions as well as by private individuals in several of the leading countries of the world. Many cities have officials whose time is devoted exclusively to the education of public opinion and the enforcement of existing laws with reference to this matter. The question as to what steps can best be taken to lessen the amount of smoke which is being discharged into the atmosphere in our Canadian cities is by no means a simple one, but the time has come when the Commission of Conservation may very properly make a thorough investigation of the question and ascertain for the benefit of the dwellers in our great cities what can be done to prevent the wholesale pollution of the atmosphere.

COST OF DRILL REPAIRS IN TUNNELING.

In Bulletin 57, of the U.S. Bureau of Mines, Messrs. D. W. Brunton and J. A. Davis present data relating to the cost of repairs to drills used in the excavation of a number of tunnels in the United States. Briefly summarized, this information is as follows:—

From September, 1905, to March, 1906, hammer drills were employed at the Gunnison tunnel with a drill-repair cost per machine of 13 cts. per foot of hole drilled; but when piston drills were substituted the repairs were reduced to 3 cts. per foot. In addition to the cost of materials these figures include also a charge for the labor of the machinist making the repairs, which is not embraced in any of the values which follow. This fact must be considered in making comparisons. Two years later (September, 1907, to August, 1908), in driving the last 3,000 ft. of the Yak Tunnel, the cost of materials only for re-

Table I.—Cost of Repairs for Hammer Air Drills, Little Lake Division, Los Angeles Aqueduct, July, 1909, to May, 1911.

Name of tunnel.	Distance excavated. Lin. ft.	Total cost of drill repairs.	Cost of drill repairs per foot of tunnel.
1B, south	1,030	$160.39	$0.156
2, north	926	180.72	.195
2, south	419	64.75	.154
2A, north	460	46.28	.100
2A, south	375	55.50	.148
3, north	864	113.60	.131
3, south	2,149	505.01	.235
4, north	448	67.03	.149
4, south	725	215.48	.297
7, north	1,911	399.70	.209
7, south	1,024	493.46	.482
8, north	225	146.56	.651
8, south	1,334	530.52	.398
9, north	777	230.51	.297
9, south	2,479	404.94	.163
10, north	2,626	585.78	.223
10, south	1,776	577.24	.325
10A, north	1,373	303.06	.221
10A, south	1,756	359.27	.204
Average			$0.24

pairs to the hammer drills employed was only 1¾ cts., approximately, per foot of hole. At the Marshall-Russell tunnel, where hammer drills were employed, the average cost of drill repairs from June, 1908, to June, 1911, was 1½ cts. per foot drilled. Piston machines were used at the Strawberry tunnel from January, 1909, to September, 1911, the cost for repairs being nearly 2½ cts. per foot drilled. On the Little Lake division of the Los Angeles aqueduct, where hammer drills were employed, the average cost of drill-repair materials from July, 1909, to May, 1911, as shown by Table I., was only 24 cts. per foot of tunnel excavated. As each of the two machines in the heading drills approximately 8 ft. of hole for every foot of tunnel excavated, the cost per machine per foot of hole is 1½ cts.

For 1910 and the first half of 1911 the repair cost of hammer drills at the Carter tunnel was 2 cts. per foot drilled. At the Lucania tunnel the repairs cost ½ ct. per foot drilled, but the hammer drills had been in use only one month at the time the tunnel was visited. The hammer drills at the Rawley tunnel were new also, the repairs for June and July, 1911, averaging 1 ct. per foot of hole.

ECONOMICAL STREET SPRINKLING IN CALGARY.

The city of Calgary has about 1,300,000 square yards of street pavements covering in the neighborhood of 54 miles of streets. The equipment for street sprinkling and flushing consists of four horse flushers, four rotary brooms, two squeegees, five horse sprinkling tanks and two 5-ton electric motor trucks.

The total motor vehicle equipment consists of eight electric trucks. Besides the two just mentioned, there are two 3-ton trucks for the waterworks and stores department, one 5-ton truck for the sanitary department and three 1-ton trucks for the electric light and street railway department. These were all supplied by the General Motors Company.

With respect to the electric sprinklers and flushers, it is stated that during the season of 1914 they saved the city $24 a day in the cost of watering streets. They were operated nine hours in the daytime for sprinkling and eight hours at night for flushing. They averaged 38 miles each per day and 17 miles each per night. They used $1.30 worth of electric power per truck during the 17 hours. In addition to this saving, the other six motor vehicles showed similar economy and it is the intention of the city to replace horse-drawn equipment with motor trucks for all municipal work.

The following are the specifications for the 5-ton electric sprinkler noted above:—

Water capacity of tank, 1,200 U.S. gal.; total length of tank, 160 in.; inside diameter, 51 in.; air compartment in forward end of tank, 36 in. long—25 per cent. of tank volume; pressure in air tank, 65 lb.; total weight of tank, 3,600 lb.; tank provided with air and water pressure, gauge and pop safety valve in by-pass connecting water space with air chamber. The tank is filled by means of a 2½-in. water intake valve located in the centre of the rear drum-head. The water discharge is controlled through lever gate valves operated by hand at the driver's seat. The two flusher nozzles may be worked together or independently. The main outlet connection is a 4½-in. standard pipe; the flushing nozzle connections, 2½-in. pipe.

Coast to Coast

Winnipeg, Man.—The city quarries made a profit of nearly $16,000 in 1914. Plant No. 1 disposed of 77,770 cu. yards of stone. Plants No. 2, 3 and 4, while not so extensively operated, record very favorable production.

Basque, B.C.—The Canadian Northern Railway completed the laying of steel on its main line between Lake Superior and the Pacific Coast at this point on January 23rd, 1915. Ballasting is being proceeded with and will probably be completed in April.

Quebec, Que.—It is stated that legislation will be introduced at the present parliamentary session for another loan of $10,000,000, to be spent on good roads under similar conditions to those which governed the expenditure of the $10,000,000 borrowed in 1912.

Ottawa, Ont.—The sinking of the foundations of the Victoria Memorial Museum, discovered a few years ago, continues, and extensive repairs are necessary, as considerable danger exists. The Department of Public Works has called in experts to make an examination.

Calgary, Alta.—The city gas committee has decided to put in a number of experimental gas installations to test out various kinds of burners and to secure accurate information regarding mixtures of air and gas, etc., including also the testing of a coal furnace converted to gas burning. Mr. Geo. W. Craig, city engineer, is a member of the committee.

Toronto, Ont.—It is stated that the provincial government has under consideration a patrol system for supervising and maintaining the highways of the province. If this scheme is carried out, it will provide employment for over 200 men. For some time the Ontario Government has been considering the problem of maintenance, and it is thought that when instrumental legislation pertaining to the $30,000,000 scheme is brought down in the legislature provision will be made for the satisfactory up-keep of roads.

Prince Rupert, B.C.—Of the twelve large reinforced concrete pontoons required in connection with the construction of the new floating drydock, described a short time ago in this journal, six of them have already been launched, and it is expected that the pontoon work will be completed by next June. The shipbuilding plant is in an advanced stage of construction. The shops have been practically completed, and machinery is being installed. The Prince Rupert dock is being built in three sections.

Calgary, Alta.—About $87,000 worth of bridge work is under consideration at the present time. Mr. Geo. W. Craig, city engineer, states that to complete the abutments and piers of the Mission bridge it would take $5,500; to complete the abutments and piers of the Louise Bridge it would require $3,500, and for the same work on the Center street bridge it would take $55,000, and to do the necessary grading for the approaches to the Center street bridge it will take $23,000, bringing the total amount required up to $87,000.

Winnipeg, Man.—Local improvements in Winnipeg are valued at $12,654,216.18. Sewers, $3,282,872.88; asphalt pavements, $6,588,305.51; macadam pavements, $225,226.01; cedar block pavements, $260,942.29; sandstone block pavements, $4,902.26; westrumite pavements, $20,012.08; gravel pavements, $5,486.68; granolithic sidewalks, $976,871.17; plank sidewalks, $288,485.67; sanitary improvements, $34,567.49; street and lane openings, $637,520.31; boulevards, $70,715.74; ornamental gateways, $9,527.70, and ornamental street lights, $248,780.39.

PERSONAL.

J. A. D. McCURDY, B.A.Sc., is making arrangements in Toronto for the construction of aeroplanes.

WILLS MACLACHLAN, B.A.Sc., until recently with the Electric Power Co., Toronto, has accepted a position with the Electrical Employers' Association of Ontario as inspector.

J. H. O'BRIEN, engineer in charge of the Erie Railway Tunnel, New York, gave an illustrated lecture last week to a literary society in Montreal on tunnel and subway construction.

CHESTER HUGHES, B.A.Sc., who for several years has been assistant engineer on the St. John and Quebec Railway, has been appointed provisional lieutenant in the Second Field Company, Royal Canadian Engineers.

J. C. MURRAY, B.A., B.Sc., is the editor of a new fortnightly magazine entitled "Mine, Quarry and Derrick," published at Calgary. It is devoted to the development of mining, quarrying and oil production in Western Canada.

GEORGE W. TILLSON, consulting engineer to the president of the Borough of Brooklyn, New York, N.Y., was elected president of the American Road Builders' Association, which held its regular annual meeting at the Hotel Astor on Friday, February 5th. Mr. W. A. McLean, provincial highway engineer of Ontario, was the retiring president.

ARTHUR H. BLANCHARD, M.Am.Soc.C.E., consulting highway engineer and professor in charge of the graduate course in highway engineering at Columbia University, on February 11th, delivered an address on the subject, "The Highway Engineer in Public Life," at the annual meeting of the Engineers' Society of Northeastern Pennsylvania.

G. L. WETMORE, who has been in the employ of the Canadian Pacific Railway Company as divisional engineer at St. John, N.B., for the past seven years, retires on March 1st. Mr. Wetmore commenced engineering work on a survey of the north shore of Lake Superior in 1872, and was engaged on the construction and maintenance until the line was taken over by the C.P.R. ten years later. He was appointed divisional engineer and placed in charge of maintenance of way, which position he held until transferred in 1908 to St. John. He is the only person now in the employ of the C.P.R. who was engaged on the survey of the original road.

ANNUAL DINNER, UNIVERSITY OF TORONTO ENGINEERING SOCIETY.

The 26th annual dinner of the Engineering Society of the Faculty of Applied Science and Engineering, University of Toronto, was held at the Prince George Hotel, on the evening of February 12th, Mr. E. D. Gray presiding. About 300 members and guests were in attendance.

Hon. W. H. Hearst, Premier of Ontario, addressed the gathering on the subject of Canada's natural resources. Particular attention was drawn to Ontario in this respect, and many eulogistic things were said of the northern section of the province, and of the opportunities which it presented for young engineers and business men. President Falconer made some very apt remarks respecting the lamentable situation which had its paralyzing effect on the University as well as on engineering. Hon. W. H. Taft, ex-president of the United States, made a very pleasing address upon the development of the Panama canal from an engineering point of view, and upon the sanitary features of the situation, the betterment of which made the canal construction possible. Ex-Mayor T. R. Deacon, of Winnipeg, president and general manager of the Manitoba Bridge and Iron Works, made an excellent speech, in which he referred to the future of the young engineer. Mr. Deacon strongly emphasized the cultivation of a business training and the participation in industrial and productive lines. He recommended against a future which only comprised service similar to that demanded by municipalities, as municipal engineers, and of such a nature that the participant has periodically to look for some new employment and virtually begin over again. He was firmly of the opinion that the graduates of the institution should look forward to connection with business and manufacturing concerns. Acting Dean Ellis gave an interesting talk on the establishment of the School and the events which lead thereto. Dean Goodwin, of the School of Mines, Queen's University, reflected upon the departure of so many young engineers for the front. Mayor Church of Toronto displayed an intimate knowledge of the progress and successes of graduates of the institution, and expressed a desire to see the city of Toronto and the University of Toronto co-operate at an early date toward the establishment of a fitting monument to the late Dean Galbraith. These and other speakers made the occasion one of the most remarkable and most successful in the history of this, the oldest engineering society in the Dominion.

VANCOUVER BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The regular meeting of the Vancouver Branch, Canadian Society of Civil Engineers, was held on Thursday, February 4th, 1915. An illustrated paper on "Ancient and Modern Gas Manufacture" was presented by R. W. Ford, M.I.G.E., manager of the Vancouver Gas Company.

MOTION PICTURES OF RAILWAY CONSTRUCTION.

The Toronto Branch of the Canadian Society of Civil Engineers has acquired the use of a large lecture room in the Chemistry and Mining Building of the University of Toronto for Thursday evening, February 25th, when Mr. William McNab, Mem. Can. Soc. C.E., principal assistant engineer of the Grand Trunk Railway Company, Montreal, will give an illustrated talk on the construction of the Grand Trunk Pacific. The illustrating will be effected not only by lantern slides, but by a series of motion pictures. The meeting will be commenced at 8 p.m., Mr. J. R. W. Ambrose, chairman of the Branch, presiding.

Another important paper will be presented late in March by Dr. John A. Amyot, director of the Provincial Laboratories. The subject will relate to the work of the International Joint Commission in connection with the investigation into the pollution of boundary waters between Canada and the United States.

Arrangements are being made also for a luncheon and another paper to be presented in April.

An important business matter that will be brought before the meeting by Mr. C. H. R. Fuller, secretary of the Branch, next Thursday evening, will be a communication from Hon. W. J. Hanna, secretary and registrar of the province of Ontario, requesting the Toronto Branch of the Canadian Society of Civil Engineers to pass upon the question of how far the cost of farm bridges should be included in drainage, under the Drainage Act. The subject will be brought under discussion, and it is probable that a recommendation will be made to the Government.