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The Canadian Engineer

A weekly paper for Canadian civil engineers and contractors

Elimination of Grade Crossings

Relative Advantages of Cuts and Embankments—Each Crossing Calls for Special Study—Paper Read at Conference of County Road Superintendents

By E. R. BLACKWELL, A.M.Can.Soc.C.E.
County Engineer, Leeds and Grenville Counties, Ontario

GRADE crossings of railways have become such a prolific source of accidents since the advent of automobiles, that their elimination is a problem which must be solved.

The chief difficulty to overcome is the cost, and in a great many cases this is so excessive as to be almost prohibitive.

In Canada, the matter is almost altogether in the hands of the Board of Railway Commissioners, who have the power to order such changes or alterations as they may deem advisable and to assess the cost thereof to the railway and municipality benefited.

A petition from any municipality, or from the residents of a district interested, for the protection of a grade crossing will be considered and passed upon by the Board.

The writer had the privilege of appearing before the commissioners on two occasions; the first was in connection with a grade crossing at Lansdowne, on the Grand Trunk Railway, and in this instance an order was given to place a flagman on the crossing, the cost to be paid by the railway and the local municipality in the ratio of 75 per cent. and 25 per cent. A subway at this point would be very expensive on account of a steep hill paralleling the railway.

On the next occasion, an order was given for a subway on the main line of the Grand Trunk, and for about three-

A Dangerous Subway

quarters of a mile of road diversion, which eliminates two other crossings. This is on a county road about three miles west of the town of Brockville. The cost was assessed to the railway, subway fund, township and county, in the ratio of 50, 20, 15 and 15 per cent.

In the State of Vermont the railways are required to eliminate one grade crossing each year, and as the crossing is not specified, naturally the railways have built the less costly first, irrespective of the conditions of the crossings and the traffic, so that now they are encountering very expensive construction.

As regards the elimination of individual grade crossings, the topography of the location generally decides as

The Sharp Turn Makes This Subway Dangerous

to the method of separation. For instance, if there were a grade crossing in a railway cut at the present time, and it were required to eliminate same, the natural sequence would be to carry the highway over the railway by a bridge; or under the railway by a subway if the railway were built on an embankment.

As to cost, it is impossible to give any definite figure and say that same will apply to all crossings. For instance, the unit prices of the various materials entering into construction of grade separation varies with the locality and the prevailing wages in that district; also transportation for both men and materials. Therefore, each crossing is a special case by itself and should be so studied.

As regards grade separation in the cities and towns, the topographical features still control, but as a rule separation never takes place until some time after the railway has been in operation, and then the entire territory is considered as a whole and the grade line of the railway revised. In the majority of cases the grade line is generally laid so that the railway will be elevated approximately 10 feet above the ground and the streets depressed from 8 to 10 feet, or a sufficient amount so that the excavation from the streets will make up the embankment for the railway between the streets.

This adjustment of grade line is an economic one from the standpoint of cost, and if the grade of ramps does not exceed 3 or 4 per cent. in 100, one can have a clear view under the railway bridge if driving a team or automobile.

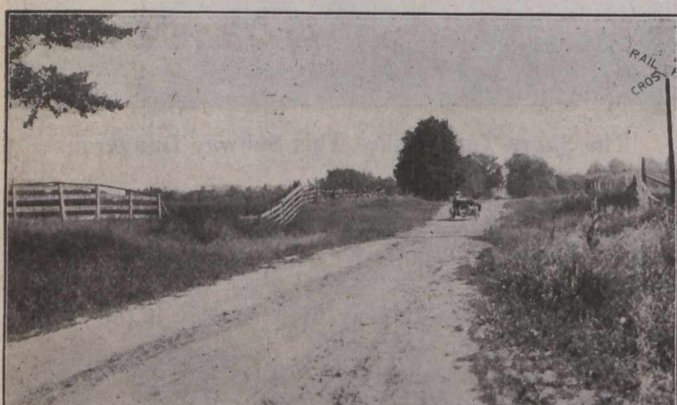
This was the method adopted in the case of the subway built on road No. 49 of the county system of Leeds and Grenville, in the township of Edwardsburg. The railway embankment was raised some nine feet, enabling the roadway to pass under with little or no depression. This method was also adopted by the Grand Trunk Railway in the city of Detroit where grade separation has been going on for the last 15 years.

The Grand Trunk Railway, in making studies for grade separation in the city of Detroit, was able to prove that, if the railway were carried on embankment from Brush Street Station to the top of the bench north of Gratiot Avenue, it would be much cheaper than the plan suggested by the city for depressing the railway tracks and carrying the streets over the tracks.

It has generally been found in considering the question of grade separation that, as a rule, the economic proposition is to place the grade line of the railway on embankment, although, as I have said before, the topographical features will rule.

As regards the minimum clearance of bridges over streets and highways in grade separation in the United States and Canada, the individual States vary in their requirements. For instance, in Buffalo the minimum clearance is 13 feet and on street car lines, 14 feet; in Chicago, 12 feet, and 13.5 feet on car lines; Detroit, 13 feet, and 14 feet on car lines; New York, 14 feet; Philadelphia, 14 feet; Vermont, 13 feet; and Canada, 14 feet.

The maximum grade laid for street ramps in the United States, varies in the different States and cities from 3 to 5 per cent., but there have been exceptions to this in special

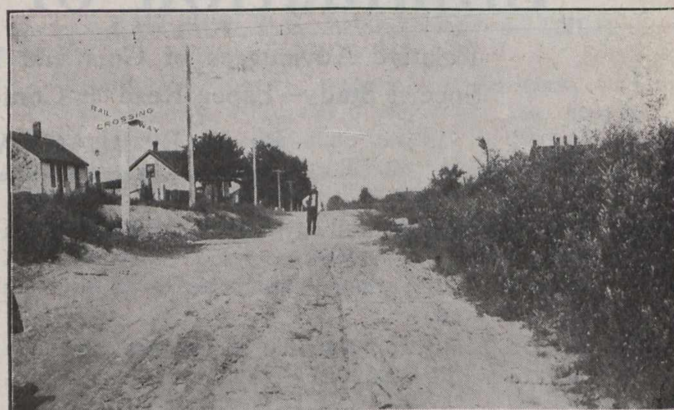


Typical Level Crossing

cases, on account of location, where the grade has been 9 and even 10 per cent. In Canada, the Board of Railway Commissioners have control of grades and location.

In the province of Ontario, where the highway passes over a railway by a bridge, the clear distance between the top of rail and the lowest member of the bridge is specified in chapter 185, section 116, clause 1 of the Revised Statutes of Ontario, which reads: "Every bridge, tunnel or other erection or structure, over, through or under which any railway passes, shall be so constructed and maintained as to afford at all times an open and clear headway of at least seven feet between the top of the highest freight car used on the railway and the lowest beam, member, or portion of that part of such bridge, tunnel, erection or structure, which is directly over the space liable to be traversed by such car in passing thereunder."

Approaches to subways should be laid out so as to get as clear a view as possible and in no case should this be



Unusual Growth on Right of Roadway Makes This Crossing More Dangerous

less than 100 feet, and if the topographical features are such that this cannot be had, then a "slow order by-law" should be passed, and large signs, readily seen, placed on the road.

The drainage of subways is a very important matter and when the roadway is depressed to any extent, may be very difficult and expensive, and in certain cases impossible.

When drainage cannot be had, pumping has to be resorted to, in which case a well is constructed and a pumping system installed.

As an instance of expensive drainage, I might mention the Thompson Road subway at Fort Erie yard, Bridgeburg. This subway is under 15 tracks and cost approximately $90,000. A deep drain had to be excavated to the nearest creek, a distance of about one-quarter of a mile, and rock was encountered which cost about $5 per yard to remove.

WATERPROOFING FOR CONCRETE BOAT

The entire hull of the concrete boat built last fall at Montreal was coated with Toch Bros.' "Liquid Konkerit" waterproof cement coating. All of the hull below the water line was given a second coat, using Toch Bros.' R.I.W. 112, which is especially made for coating hulls of ships below water lines.

BRITISH COLUMBIA ENGINEERS

The Kootenay branch of the Engineering and Technical Institute of British Columbia was formed at a recent meeting in Nelson, B.C., the headquarters of the branch.

The institute, which is applying to the legislature at the forthcoming session for a charter, will be an organization composed of civil and mining engineers, architects and members of allied professions.

The following provisional officers were appointed: Wm. Cunliffe, chairman; A. E. Pickford, secretary-treasurer, and A. E. Thompson, assistant secretary-treasurer.

DISCUSSION OF ENGINEER'S STATUS

At a special meeting of the Ottawa Branch of the Canadian Society of Civil Engineers on February 22nd, the subject of "Ways and Means for Improving and Defining the Status of the Engineer" was discussed. F. H. Peters, commissioner of irrigation, Department of the Interior, Calgary, introduced the discussion, outlining the action with respect to legislation which was contemplated by the Calgary Branch and the events which had led to the drafting of the following resolution of that body:—

"Resolved by the Calgary Branch of the Canadian Society of Civil Engineers, at their annual general meeting, held December 1st, 1917:

"That it is desirable at this time for the membership of the society to discuss the advisability of seeking Dominion legislation which shall define the status of the engineer to the end that the profession and the public may be adequately protected against the practice of the profession by unqualified persons.

"That the secretary of the society be requested to take the necessary steps to procure discussion on this matter within all the branches of the society; to obtain a definite expression of opinion from all the branches; and in due course to report to council and to all the branches, the consensus of opinion expressed.

"That with a view to facilitating discussion within the various branches, a report be attached to this resolution, indicating the evolution of this matter within the Calgary branch and suggesting the lines along which suitable legislation may be framed.

"That copies of this resolution be sent to the council, to all the branches and to *The Canadian Engineer.*"

The speaker said that this action had been contemplated not only that the engineer might be accorded the standing and the recognition in the community which by virtue of his profession he deserved, but also that the public might be protected against the practice of the profession by unqualified persons.

R. deB. Corriveau approved of the resolution of the Calgary branch and suggested that members in each province should be encouraged to secure action from the provincial legislatures to define the status of the engineer. He announced the receipt of a message from A. R. Decary, of Quebec, regretting that matters had prevented him from coming to Ottawa, and read a communication from Mr. Decary explaining the amendments to the Quebec Act defining the status of the practice of engineering, made at a recent meeting of the Quebec Legislature. This communication suggested that definite arrangements be made for holding in Montreal a meeting of representatives of the society from all the provinces with a view to considering ways and means for securing suitable action to define the status of the engineer in the near future.

A. A. Dion referred to the past attempts to secure legislation in Ontario and to the opposition from the Amalgamated Society of Engineers. He pointed out that there is serious objection to Dominion legislation, because the British North America Act places authority in the premises in the provincial legislature. With reference to the measure of control which is necessary to remove the objection that too much power would be given to the society itself, there was the question whether it should be left to the universities, a government board, or some other body. He thought that any action found advisable should not be confined to civil engineers, even if by doing so it would be possible to draw in other branches of the profession.

B. H. Fraser pointed out that, while there is objection to separate laws and regulations, this may be overcome through the society, which is Dominion-wide. Duncan MacPherson agreed with the general proposals of the Calgary branch, but thought that as the society is in a state of flux, it would be well to make haste slowly.

John Murphy favored legislation but recommended that the legislation be made by electing members to the House. A. A. Dion, speaking later, referred to a proposal made by prominent politicians to an engineer, that there should be created a general engineering constituency which would elect one member to every parliament.

Col. Anderson suggested that one important move would be effected if the government were asked to change the Civil Service Act to provide that the government must employ only qualified engineers; that is, members of the Canadian Society of Civil Engineers or graduates of some recognized engineering school.

A. F. Macallum, J. E. N. Cauchon and R. R. Smart also spoke in favor of legislation. W. J. Dick and R. F. Uniacke advised caution and discussion.

James White did not agree with the Calgary branch proposals because of the difficulty of obtaining effective legislation. He told how hard it had been to obtain laws for the protection of game birds in migration, adding that if the Dominion would not legislate for a flock of ducks, there was no hope for the engineers! However, he expressed very warm appreciation of the work of the Calgary branch in developing their ideas in this very important matter and voiced his determination to do everything in his power to help advance the engineering profession.

R. R. Smart thought that it might be possible to obtain Dominion legislation to prohibit the promiscuous use of the degree letters, C.E., M.E., etc.

A resolution commending the action of the Calgary branch was passed unanimously by the meeting, and a committee was appointed to make a further report on the matters brought out in the discussion. The members of the committee are Messrs. Smart, Corriveau, Dick, Gale and Challies.

ONTARIO GOOD ROADS CONVENTION

The sixteenth annual meeting of the Ontario Good Roads Association was held in the York County Buildings at Toronto, on February 27th and 28th and March 1st. About three hundred delegates, representing thirty-five counties, were present.

The morning of the first day was spent in registration and the formation of committees.

In the afternoon, the delegates were welcomed by Mayor Church and addresses were delivered by President C. R. Wheelock and Geo. S. Henry, secretary of the association.

In the course of his address, Mr. Wheelock declared that it is upon good roads that victory depends in the present war and suggested a co-operative system between the railroads and "highway freight trains" as a means of relief in the congestion of traffic which is retarding the movement of men, munitions and materials on this continent.

On the second day Hon. Findlay Macdiarmid, Minister of Public Works and Highways, in reviewing the spread of the movement in the province, stated that all the counties except Peterborough and Northumberland are now co-operating with the association. W. A. McLean, Deputy Minister of Highways, advised caution in borrowing so as not to embarrass the government.

Wimund Huber, Ontario Department of Public Highways; Daniel Quinlan, treasurer of Simcoe County; and E. M. Young, clerk of Prince Edward County, dealt with the matter of finance from the point of view of the association. Mr. Young suggested that the same system of bookkeeping should be adopted in all counties and also that the government might establish a department for purchasing the machinery for road building.

D. M. McIntyre, K.C., chairman of the Ontario Railway and Municipal Board, delivered an interesting address on "Highways of Empire," and F. A. Senecal, clerk of the counties of Prescott and Russell, and J. F. Vance, clerk of the county of Wentworth, spoke on the subject of "Road Organization."

Before the close of the meeting, a resolution was adopted asking the government to facilitate the haulage of stone on the highways.

On Friday morning, general discussion and the election of officers took place.

The following officers were elected for the ensuing year: Hon. presidents, J. A. Saunderson and S. L. Squires; president, C. R. Wheelock; vice-presidents, J. J. Parsons, W. H. Pugsley; secretary-treasurer, George S. Henry, M.P.P.; directors, K. W. McKay, Major Kennedy, F. A. Senecal, L. E. Allen, G. Mahoney, M. J. Brown.

PRESIDENT OF CANADIAN SOCIETY OF CIVIL ENGINEERS ADDRESSES TORONTO BRANCH

On Tuesday last, March 5th, H. H. Vaughan, president of the Canadian Society of Civil Engineers, addressed the members of the Toronto branch on "The Possible Activities of the Society Under the New By-laws."

In the course of his address, the speaker explained the reasons for the changes being made and suggested ways and means by which the branches might co-operate in an effort to make the society a still greater factor in the life of the engineer, and enable him in a fuller sense of the term to occupy the place in the community to which his training and capacity entitle him.

Fraser S. Keith, secretary of the society, also addressed the meeting, which was held in the Chemistry and Mining Building, University of Toronto. Prof. Peter S. Gillespie, chairman of the Toronto branch, presided.

CANADIAN ASSOCIATION OF ENGINEERS

Last Thursday, February 28th, a meeting of civil engineers was held at 228 Beverley Street, Toronto, to discuss informally the advisability of organizing a Canadian Association of Engineers along the same lines as the American Association of Engineers.

There seemed to be a decidedly strong feeling among the dozen men present that some concerted effort should be made to improve the financial status of the engineer, especially the younger men in the profession.

The question arose as to whether the organization should take the form of a local chapter affiliated with the American association or operate as a Canadian association conducted along lines similar to those of the American association. This matter was left open.

Another meeting is to be held on March 21st, when the proposed organization will be further discussed and some form of constitution decided upon.

WINDSOR GARBAGE INCINERATOR

THE reconstruction and enlargement of the garbage incinerator at Windsor, Ont., has just been completed by the Canadian Incinerator Co., Limited, of Toronto. The plant is of similar design to those which that company had previously installed at Kitchener, Ont., and Transcona, Man., although some new features have been added which improve the efficiency and reduce the cost of operation still further.

In each cell there are 35 sq. ft. of grate bar area, and it is there that the actual incineration of the garbage is accomplished. Behind this area there is a drying hearth upon which the wet garbage is deposited in such position that the hot gases pass under, through and over it, ensuring rapid drying. A special flue carries all gases into the combustion chamber. In passing on toward the chimneys, they come in direct contact with a separate chamber where the whole carcass of an animal can be cremated within a few minutes.

From this animal chamber the gases pass on through a pre-heater, where hot air is generated. This hot air is conducted under the floor into the air chamber, from which the fireman liberates it into the ash pit at will by means of a special device, using it to create a forced draft. A special design of grate bar makes the forced draft come evenly upwards directly under the fire, thus greatly accelerating the burning.

The feed holes are all water-sealed, eliminating the possibility of any gases escaping onto the dumping floor even if the furnace be filled to its capacity.

The clinkering doors are of the guillotine type, practically the full width of the furnace, giving the fireman full access to the whole furnace for cleaning purposes. These doors are counterbalanced by weights placed inside the channel buckstays and are easily handled.

One oil burner is installed in each cell of the furnace and two in the animal chamber. These, however, are used only for a few minutes when starting the fires or when exceptionally bad garbage is encountered. In two of the plants mentioned above, the oil burners have not been used for more than a year past, as the plants are capable of destroying all ordinary garbage without the help of any fuel.

The appearance of the Windsor furnaces is very neat. Glazed bricks are used in the front and obvious effort made to obtain a presentable plant. Sufficient steel supports or buckstays have been used to obviate heavy repair costs.

A Hydro-electric system has been installed in the Portland cement works at Durham, Ont.

Leclaire and Fils, of Sorel, P.Q., have received a contract for the construction of six steel ships, costing $1,500,000.

Members of the designing and operating staff of the engineering department of the Dominion Iron & Steel Co., Ltd., Sydney, N.S., recently formed an engineering society.

A discovery of bauxite has been reported from Kamloops, B.C., and another from near Vancouver. A discovery of 2 per cent. nickel pyrrhotite is reported from Jervis Inlet. Bauxite in quantity would assure an important new industry.

ERECTION OF KETTLE RAPIDS BRIDGE

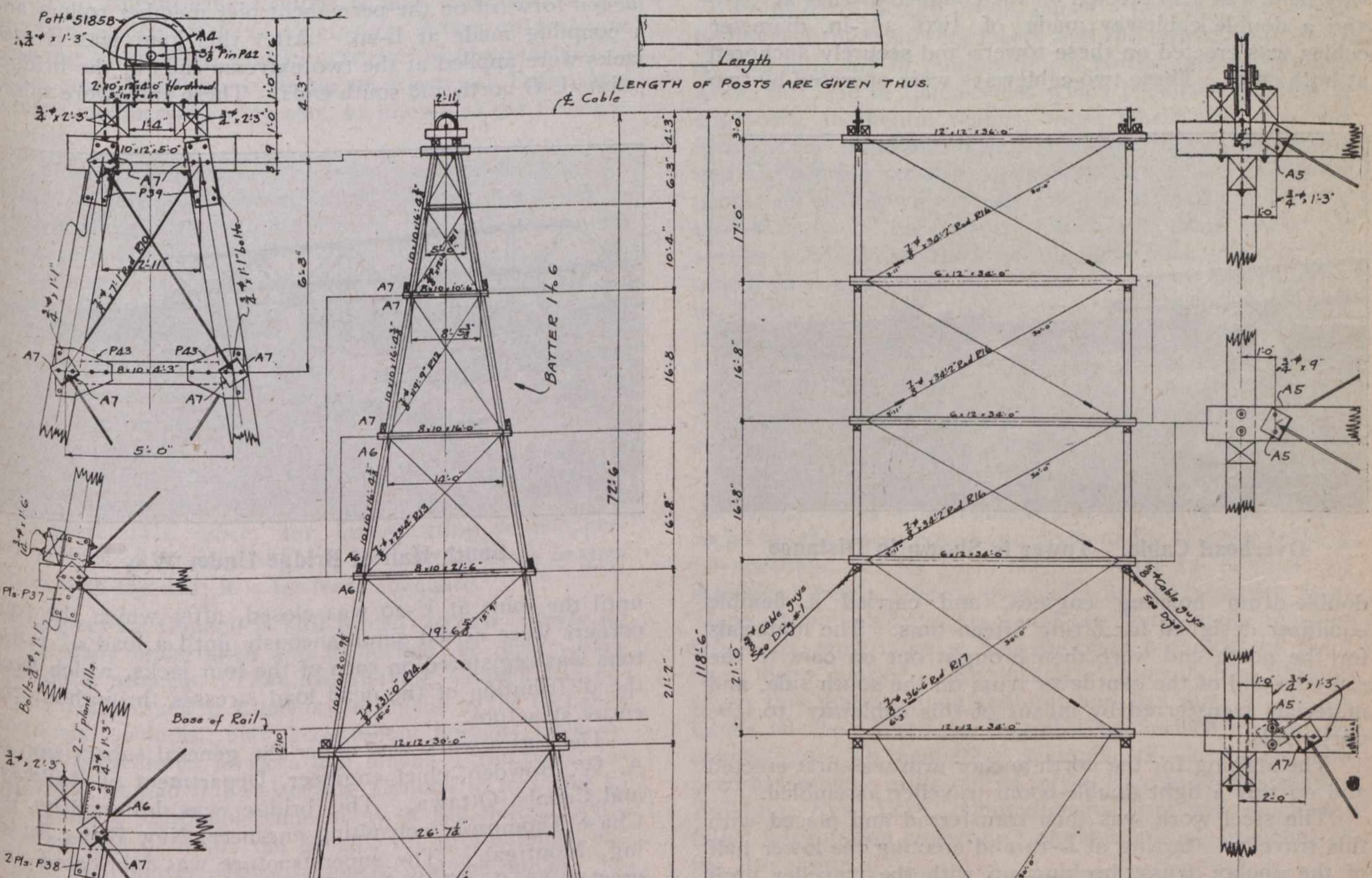
By Sterling Johnston

Assistant Manager of Construction, Canadian Bridge Co.

STAGING of no kind could be used for placing the main channel span of the Kettle Rapids Bridge. This fact, and the remoteness of the site, made the erection of this bridge unusual in character. The site was at the end of a long construction line leading from The Pas, precluding the possibility of bringing in from the north the material required for the north end. The problem of getting the north half of the structure across and in place economically formed one of the chief considerations.

The Kettle Rapids bridge is on the line of the Hudson Bay River and crosses the Nelson River at a point 332 miles north of The Pas, Man. At the point where the bridge is located is a deep, narrow gorge through which flows a swift rapids directly in the way of the site chosen for this crossing. The banks on either side of the river at this point are solid rock for a considerable distance back from the shores and the existence of this rock formation was a determining factor in selecting the continuous-girder type of truss adopted. The design consists of a single track through-truss structure, 1,000 feet long, which is carried continuously over four supports. The channel span is 400 feet long, centre to centre of pier members, while the two flanking arms are each 300 feet long. The trusses are of the Warren type, having 50-foot main panels sub-divided to form two 25-foot stringer panels. These are 50 feet deep, centre to centre of chords and are placed 24 feet apart. All the truss joints are riveted throughout. The floor system is of the ordinary open floor type, having wooden ties carried on two lines of built-up stringers, which in turn frame into the webs of the floor beams. The simplicity of this design greatly facilitated the fabrication and erection of the bridge. The following erection program was adopted:—

The south arm between piers Nos. 1 and 2 was erected on wooden staging with an ordinary derrick car, the only unusual feature being that L-O was erected 10 inches lower than its normal elevation in order to allow for deflection in cantilevering. The truss as a whole was also erected on the permanent pier member rollers about 5 inches closer to the shore than its normal position. The main joints were then completely riveted and the derrick

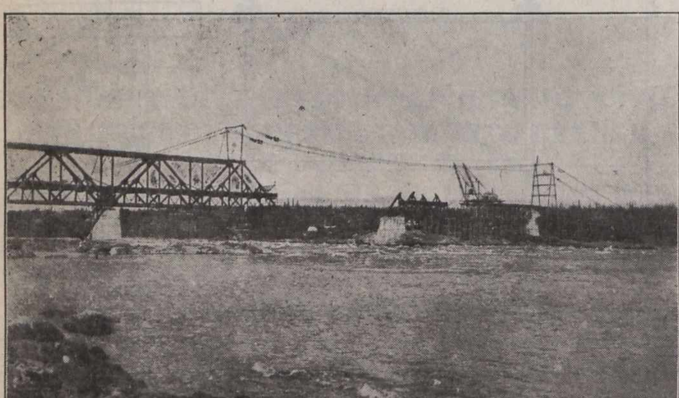


Details of Cableway Tower Placed on North Shore

Portal, Looking North

car erected the balance of the south half of the crossing as a cantilever from L-12 to L-20. The riveting followed the erection very closely so as to take care of the erection stresses.

A cableway tower was then erected on the north shore, materials for same being hauled by team over the ice at a point some distance from the crossing. A short cableway bent was also erected on the completed truss at U-18 and a double cableway made of two 2¼-in. diameter cables was erected on these towers and securely anchored at both ends. These two cableways were operated by two



Overhead Cable. Tower is Shown in Distance

double-drum hoisting engines, and carried a flexible equalizer designed for lifting fifteen tons. The materials for the north end were then brought out on cars to the extreme end of the cantilever truss on the south side, and materials transferred by means of this cableway to the north side.

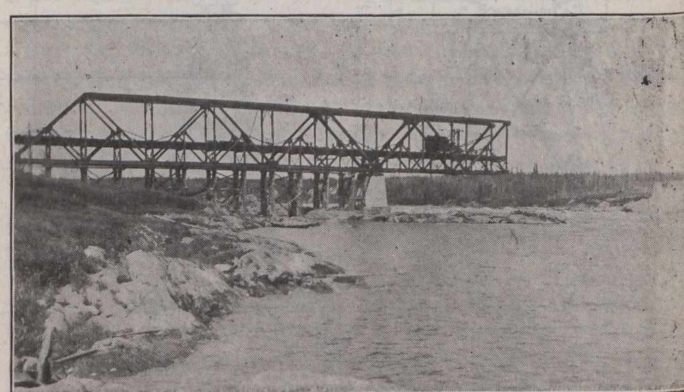
The staging for the north anchor arm was first erected and on this a light double-boom traveller assembled.

The steel work was then transferred and placed with this traveller, starting at L-12 and erecting the lower half of the anchor truss, backing up with the traveller until L-O was reached. The traveller was then jacked up so

South Flanking Arm in Place; Cantilever Erection

as to bring the trucks level with the top chord of the span, and the balance of the steel for the north anchor arm completed, going forward from U-2 to U-12. After riveting this anchor arm the cantilever portion of the truss between panels 12 and 20 was easily completed with the traveller running out on the top chord.

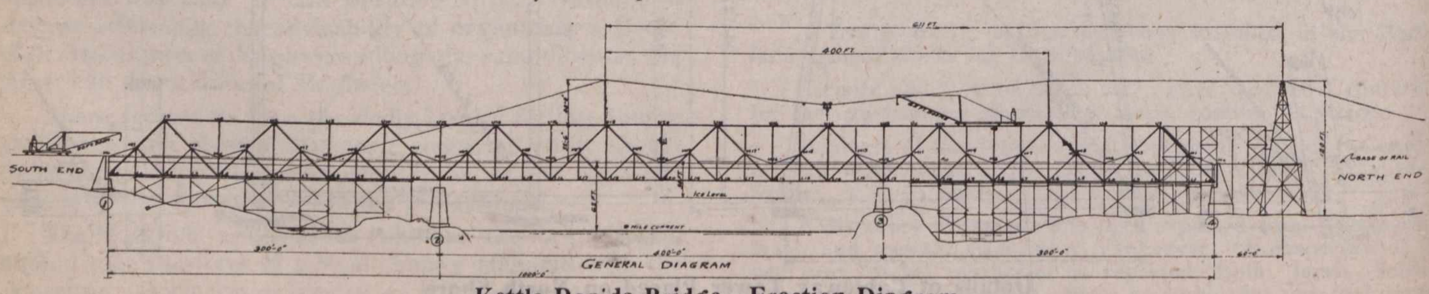
The whole of the south half of the bridge was then jacked forward on the permanent pier member rollers and a coupling made at L-20. After this joint was riveted jacks were applied at the two extreme ends of the bridge, points L-O north and south ends. These ends were raised



South Half of Bridge Under Way

until the joint at U-20 was closed, after which the four corners were raised simultaneously until a load of 118½ tons was registered on each of the four jacks, which fixed the distribution of the dead load stresses throughout the entire structure.

The entire work was under the general supervision of A. W. Bowden, chief engineer, Department of Railways and Canals, Ottawa. The bridge was designed by W. Chase Thompson, consulting engineer, New Birks Building, Montreal. The superstructure was fabricated and erected by the Canadian Bridge Co., Limited, Walkerville, Ont.



Kettle Rapids Bridge—Erection Diagram

United States Engineering Council

Official Outline of the Aims, Field and Progress of the Joint Organization of American Civil, Mechanical, Mining and Electrical Engineering Societies

By ALFRED DOUGLAS FLINN, M.Am.Soc.C.E.
Secretary, Engineering Council

ENGINEERING COUNCIL held its first meeting June 27th, 1917. In the months which have elapsed, useful services have been rendered to the government, to engineering societies and to individuals, and progress has been made in perfecting Council's organization. Offices have been secured in the Engineering Societies Building, New York City, the focus of engineering activities in America. A permanent secretary has been engaged and several important committees have been created.

Engineering Council is an organization of national technical societies of America created to provide for consideration of matters of common concern to engineers, as well as those of public welfare in which the profession is interested, in order that united action may be made possible. Engineering Council is now composed of the American Society of Civil Engineers, American Institute of Mining Engineers, American Society of Mechanical Engineers and American Institute of Electrical Engineers, having a membership of 33,000 and known as the Founder Societies.

A patents committee, to investigate reforms in the United States patent system and in the use of experts in litigation wherein the validity of patents or other technical matters are involved, was also created. The committee was instructed to co-operate with any committee of the National Research Council, and with committees of other technical societies organized for a kindred purpose.

Limitation of financial resources has been and still is one of the greatest handicaps. At the beginning of this year, an appropriation of $16,000 by United Engineering Society, contributed equally by the four Founder Societies, became available for the period ending October 31st, 1918. Although this sum provides for the usual expenses of the secretary's office, for inaugurating several permanent lines of service and for a few special items in connection with the war, it is far from adequate.

Engineering Council is still forced to go slowly on work already undertaken and to decline or defer other meritorious projects. That Engineering Council has accomplished as much as it has is due chiefly to the fact that individuals, societies and government bureaus have informally contributed services and means. Additional income must be had if Engineering Council is to bring to pass within a reasonable time many of the things rightfully expected of it for the benefit of professional engineers, the country, the government and the public.

Restriction of membership in Engineering Council to the four societies just mentioned is not intended. Quite to the contrary, it is planned and earnestly desired that other national engineering and national technical societies shall become affiliated, thus making Engineering Council truly representative of the hundred thousand engineers in all branches of the profession throughout the United States. Conditions and methods for the admission of additional societies have been developed. Henceforth, a chief aim of Engineering Council will be to increase the number of member societies and thus gain not only an enlargement of its capacity for usefulness along its chosen lines, but also greater technical and financial support.

So extensive is the field of possible activity for Engineering Council that even yet it is unwise to set its bounds. Nevertheless, some of the proposed activities may now be outlined. Foremost among these is the fostering of a sense of solidarity throughout all divisions of the profession in all parts of the country—the increasing of a sense of common interest and of the strength that results from unification. To this end, subordination to the general welfare of the preferences and pride of organizations and of persons may be necessary; but it is confidently expected that even through difficult places the right paths will be found. Patience and good sense will win full and effective co-operation.

Publicity of a high order, but of a practical sort, must be devised that both engineers and the public may be informed not only of engineering achievements in physical work, but also of the services which peculiarly pertain to engineers, in mental realms, those which they are performing and those which they should perform. Engineers and engineering must be made more comprehensible to the people up and down the land, and kept instructively and interestingly in the public prints. A most important service is the standardization of definitions, methods, requirements and tests for all varieties of engineering materials and work. Others are the improvement of the methods and requirements of engineering colleges, the standardizing of the meanings and values of the degrees given to graduates, and the broadening of the engineer through knowledge of humanitarian subjects, in which other professional men take interest.

Mutual helpfulness in getting the right engineer for the empty niche of usefulness and in finding an empty niche for the unemployed engineer, or for the one seeking advancement has for years been a need of engineering societies, widely voiced, especially by the younger men. Many endeavors have been and are being made to meet this need, with more or less success; but most of them have been limited. Engineering Council has already given this matter much thought and has put it in the hands of the American Engineering Service, one of its committees. To meet these demands, this committee has been assembling in its offices in the Engineering Societies Building, New York, comprehensive lists and much detailed information concerning engineers in all branches of the profession.

During the past few months, there have been supplied to government departments and bureaus several thousand names of engineers, from which men were selected to fill a great variety of positions in uniformed and civilian service for the army, the navy and other branches of the government's activities in connection with the war, as well as for manufacturers and contractors engaged upon government war work. Hitherto, these war demands have absorbed most of the energies of this committee and its staff, but incidentally there have been accumulated great masses of live material which can in the near future be re-cast into a suitable mold of classification and indexed for permanent use.

On methods of classifying and indexing, the committee has already done not a little work. It is the intention to discover what has been done by others and so to combine and strengthen all useful systems as to secure the greatest benefits for engineers, for employers and for local, state and national governments. It is the aim ultimately to create a complete, skilfully classified catalog of all American professional engineers. This body of information will have many obvious uses, as well as others that will be discovered.

It has become evident that although numerous engineering societies are occupying limited fields efficiently, and although some of these fields are extensive, there are large sectors of the domain of the engineer which are either but weakly held, or else are usurped by others. This condition has arisen partly from specializing tendencies among societies as well as among individuals. Until the present time, there has been no central agency capable of entering these sectors and competent to speak for the profession at large; no duly constituted representative to learn of the share in local civic and governmental enterprises which should be the engineer's, to claim it for him, and to see that he gets it; no organization to harmonize the action of the profession on similar questions in different localities; no interpreter to the public of the engineer, his work, his ideals and his methods; no body to develop meritorious projects for the general good of the profession or for the benefit of the public; no one constantly on guard to detect and oppose objectionable schemes and tendencies. To fill these gaps is the great aim of Engineering Council—not by demolishing any useful existing agencies, but by building these into a well-proportioned and thoroughly furnished structure. Time will, of course, be required for erecting and perfecting such an organization with its necessary local branches covering all the United States.

Engineers are organizers and should be directing their abilities as such to the greater service of the nation. No better demonstration of the need of such a centralizing body as Engineering Council could be had than the multiplicity of existing engineering organizations, and especially the manifestation during recent months of this tendency to segregation exhibited in efforts to serve the government in connection with the war. Order is slowly being brought into this confusion, but if Engineering Council could have been well established before the beginning of the war, it would have become at once the connecting link between the government and engineers, securing results quickly, directly, economically and in an orderly manner. While contributing its best endeavors to the winning of an early and complete victory, Engineering Council must be shaping its organization so as to be prepared to aid engineers in taking the leading part which must be theirs in the years following the conclusion of peace.

Unselfish service and mutual helpfulness must be the test requirements for all the undertakings of Engineering Council. Offensive political or business activities must be avoided and the selfish aims of groups or individuals must not be fostered. If the work roughly outlined be carried forward in this spirit, no fear need be entertained for the profession's ethics, its honor, or the standing of the engineer in the community.

The Carnegie Corporation, New York, has given McGill University a million dollars in recognition of war services.

SEWER PIPE JOINTS*

LESLIE WOODFALL, C.E., Boston, Mass.: Joints in sewer pipe, until recent years, has been made mostly with cement. I have been informed that in England well-puddled clay was used to a considerable extent; also the so-called Stanford joint. This latter joint, I believe, was patented and was never extensively used in this country. It was made by filling the inside of the bell with a hot mixture similar to asphalt. The outside of the spigot was then chipped so as to allow it to be covered for a short distance with this same mixture. Molds, made so as to give a beveled surface, were used for pouring the material, and the pipes were forced together, thus making a tight joint. I understand some pipe was manufactured with the spigot end made so as to avoid the chipping.

Cement Mortar Joints

Different methods of making cement joints are: First, by the use of cement mortar alone; second, by caulking a gasket, either dry or soaked in liquid cement, into the bell and then filling the bell with cement; third, by placing the cement in the joint and then caulking the gasket in, thus forcing the cement into the bell; and fourth, by the use of cement alone, forcing it thoroughly into the joint with a caulking iron and covering the joint with cheese-cloth for the purpose of holding the cement in place. In this latter joint small wooden blocks are imbedded in the cement of the bell for the purpose of centering the pipe.

An additional precaution to make the joints tight was used at Malden. This consisted in the use of a small wooden box having the sides cut to the radius of the outside of the pipe, which was placed at the joint and filled with cement mortar up to the middle of the sewer pipe. I used this method a number of years ago, but it did not prove entirely satisfactory.

Poured Joints

Under this head may be included all of the methods of pouring the joints with hot mixtures. These mixtures are of two distinct classes, *viz.*, that known variously as G-K, Jointite, etc., and that composed of sulphur and sand.

For making any of these joints, deep and wide socket pipe should be used. A gasket is first caulked into the bell in a thorough manner, to prevent the material from running into the pipe. A gasket is then clamped around the pipe and the hot material poured in the same manner as in making water pipe joints.

Water must be kept out of the bell while the sulphur and sand is being poured. It is claimed that with G-K, or Jointite, this is not necessary, but from such information as I have obtained I judge it is difficult to make a good joint under water. The sulphur and sand joint becomes hard at once, but it is so rigid that the pipe will break if any settlement takes place. The G-K or Jointite compounds do not harden so quickly and have enough elasticity to take care of any slight settlement of the pipe.

In my experience covering thirty years, I have seen three small cases of broken sewer pipe. In one case the joint was made with cement while in the other cases sulphur and sand was used.

Careful levels indicated that the breaks were not caused by a settlement of the pipe.

*Abstracted from discussion in Journal of Boston Society of Civil Engineers.

Among the reasons for building sewers as nearly water-tight as possible are the following:—

First, to avoid increasing the size of the sewers to provide for an extreme leakage; second, to prevent the pumping of an unnecessary amount of ground water; third, to prevent the treatment of an increased amount of sewage caused by the leakage of ground water into the sewers; and fourth, to prevent the entrance of tree roots in the sewers through imperfectly made joints.

Taking everything into consideration, my conclusions are that a nearer water-tight joint can be secured by pouring.

EDWIN H. ROGERS, City Engineer, Newton, Mass.: The city of Newton, Mass., has a separate sewerage system, and for the past eleven and one-half years a sulphur and sand compound has been used exclusively as a jointing material for its vitrified pipe, sanitary sewers, and house connections, and for a limited amount of surface drains.

The method of making the joints in the pipes is similar to the pouring of lead joints in water mains.

The quantities of material per joint required for 8-in. pipe are about as follows: Sulphur, 1½ lbs.; sand, 1½ lbs.; jute, ½ lb.; pitch, 0.4 lb. For 5-in. pipe the quantity of sulphur is about nine-tenths pound, and other materials in proportion. On the basis of present-day prices, the cost of materials for an 8-in. joint would be from 11 cents to 12 cents, but until recently the cost has been considerably less.

HENRY A. VARNEY, Town Engineer, Brookline, Mass.: Brookline has tried many different materials for sewer pipe joints, but as yet has found nothing that is entirely satisfactory.

For many years Roslindale cement mortar was used, and no great care taken in forming the joint, which resulted in much trouble from tree roots, and a large amount of leakage in wet ground.

Later on, Portland cement was substituted for the natural cement, and the pipe centered with a jute gasket. But with every precaution we were able to enforce, such as the use of rubber gloves in applying the mortar and deferring the heavy backfilling until the cement had thoroughly set, the results were not at all satisfactory. In one case where there was a large amount of ground water, we constructed wooden boxes to fit the lower half of the pipe and long enough to extend each side of the bell. These were set to the proper grade, then filled with rich mortar, so there could be no question but that each joint was thoroughly bedded and protected. With all these precautions, there was considerable leakage. In another instance we encased the entire pipe in 6 ins. of concrete, but with no better results.

We then tried the sulphur and sand joint similar to that used in Newton. By this method we greatly reduced the amount of leakage, but we were apprehensive that such a rigid joint as this material makes from the moment it is poured would result in cracks in the bells or the pipe itself, for it is difficult to bed several lengths of pipe so as to prevent all possibility of movement when the backfilling and puddling is completed.

Data Relating to Sewer Pipe Joints

City or Town.	Material Used.	How Long Used.	Why Is This Material Used.	Work Done by City or Contract	Other Material Used.	Have You Had Trouble From Tree Roots?	Does Present Type Prevent Roots?	Does it Make Water-Tight Joints?	What Material Used in House Connections	Remarks
Boston	Cement mortar	30 yrs.	No better for all purposes	Both	None	Yes	No	No, except with extreme care	Cement mortar	Experiment under way with special material.
Brockton	Portland cement	25 yrs.	Think it the best	City	G-K compound	Yes	No	Yes	Portland cement	Iron pipe with lead joints used where roots give trouble.
Brookline	Asphaltic compound	10 yrs.	Gives best results	Contract	Cement, sulphur and sand G-K compound	Yes	Yes	When carefully used	No regulations	House connections laid by private contractors.
Cambridge	Cement mortar	28 yrs.	Considered practical	City	Bituminous filler	Some	Yes, if carefully made	Yes	Cement mortar	
Concord, N. H.	Cement mortar	25 yrs.	Makes effective joint	City	Roman cement	Yes	Yes	Yes, when well made	Cement mortar	
Haverhill	Cement mortar	Many yrs.	To prevent entrance ground water and tree roots	City	None	Yes	Yes, if done properly	Yes	Cement mortar	
Lawrence	Cement mortar	Always		City	None	Yes	No	No		Combined system of drainage.
Lynn	Cement mortar	40 yrs.	Most convenient	City	None	Yes	No	Nearly	Cement mortar	Iron pipe with lead joint used where tree roots give trouble.
Malden	Cement mortar	26 yrs.	Considered best	Both	G-K compound	Yes	Yes, if made properly	Yes, if made properly	Cement mortar	
Melrose	Cement and G-K compound	G-K past 2 yrs.	On account of wet trenches and tree roots	City		Yes	Yes	Yes	Any	Trouble with tree roots in house connections and some main sewers.
New Bedford	Cement mortar	Many yrs.	For convenience and economy	City	G-K compound	No		No	Cement mortar	
Newton	Sulphur and sand	11 yrs.	Permanent water-tight and resistant to roots	Both	Cement mortar and bituminous compound	No	Yes	Yes	Sulphur and sand	
Pawtucket	Cement mortar	20 yrs.	Most satisfactory	Both	None	Very little	Not entirely	Not entirely	Cement mortar	Quality of work depends upon inspectors.
Worcester	Cement mortar cloth wrapped	20 yrs.	Because it has given good results	City	None	No	Yes	Fairly	Cement mortar	
Metcalf & Eddy	G-K compound	5 yrs.	A poured joint considered best	Contract	Sulphur and sand	No	Yes	Fairly so	G-K compound	

We next experimented with various bituminous compounds, and in 1909 used a mixture of asphalt and sand in laying a 30-in. sewer. This gave so much better results than anything we had previously tried that we continued its use, and up to the present time have found nothing that is more satisfactory, considering the ease of manipulation, cost, etc. The method of making a joint with this material is similar to that used for lead joints, except that the material does not have to be caulked. It also required very little heat to bring the compound to the proper consistency, a small wood fire being all that is necessary. We take the precaution to fill the angle between the bell and the barrel of the adjacent pipe with cement mortar, but do not think this is absolutely necessary, especially in the smaller sizes of pipe.

We have recently inspected some of the first work done with this material and have found the joints in perfect condition, and could see no change in the consistency of the compound itself.

In the accompanying table are tabulated the results of an inquiry as to methods used in other communities.

COUNTY ROAD SUPERINTENDENTS CONFER

The fourth annual conference on road construction for county road superintendents and engineers was held under the auspices of the Ontario Department of Public Highways, February 25th to 28th.

The papers which were read provoked an unusual amount of discussion. The discussion was led this year by the superintendents and county engineers themselves instead of, as in former years, by engineers of the department.

The attendance was larger than had been anticipated and the enthusiasm of all who were present would indicate that the conference fills a want in the experience of the men who are responsible for the construction and maintenance of highways in Ontario.

The following county road superintendents and engineers were in attendance: Thos. R. Allison, Wentworth; Wm. Watters, Lanark; John M. Young, Wellington; Peter Robertson, Lincoln; Wm. Forbes, Oxford; H. G. Bleecker, Hastings; C. R. Wheelock, Peel; Chas. Talbot, C.E., Middlesex; T. V. Anderson, Lennox and Addington; H. D. Cleminson, Prince Edward; J. G. Wilson, Halton; John Roger, C.E., Perth; R. H. Fair, Frontenac; M. D. Hallman, Waterloo; Samuel McClure, Carleton; E. R. Blackwell, Leeds and Grenville; E. A. James, C.E., York; D. W. McBurney, Haldimand; W. W. Brookfield, Welland; F. A. Senecal, Prescott and Russell; J. G. Cameron, Dundas, Stormont and Glengarry; A. R. McVicar, Brant; D. J. Izzard, Bruce; G. R. Marston, Norfolk; L. A. Pardo; Kent; Frank Pineo, Elgin; Robert McQuigge, Renfrew.

HONOR ROLL FOR TORONTO BRANCH

The Toronto Branch of the Canadian Society of Civil Engineers is preparing an Honor Roll. Members are requested to send the names of men who are now serving in the Imperial or Canadian armies to George Hogarth, secretary, Parliament Buildings, Toronto, or J. R. W. Ambrose, Toronto Terminals Railway Co., 36 King Street East, Toronto.

LIGNITE COAL IN MODERN STEAM PLANTS*

By T. L. Roberts, A.M.Can.Soc.C.E.
Consulting Engineer, Winnipeg.

THERE has been a great deal written about lignite coal and a great many tests of this coal have been made, and a conclusion has been drawn that this coal cannot be utilized economically unless it has been put through a certain process of manufacture, such as briquetting, gas or powered fuel. More recent experiments have found that the coal can be handled in its natural state, without special preparation, and that economical results can be obtained as well from this coal as from other coals which have a greater percentage of heat value, and less ash.

In making an analysis of any coal, there are two ways in which it may be done, each of which furnishes information of considerable interest and value to the engineer. Of these analyses, one, called an ultimate analysis, determines the percentage of the various chemical elements of which the coal is composed, but does not necessarily show in what manner these elements are combined. It shows that, if a sample of the coal is separated into its elements, these will be certain proportions of oxygen, hydrogen, carbon, etc. These proportions are generally expressed in percentages of the weight of the original sample, the weight of which is considered as a unit, or 100 per cent. From the ultimate analysis, the heating value of coal may be estimated.

Although the ultimate analysis of a fuel presents difficulties that render it impracticable for any but a skilled chemist, there is a method by means of which a careful engineer can acquire an amount of skill that will enable him to determine the percentage of water, volatile matter, fixed carbon, and ash, with a fair degree of accuracy. This method is called a proximate analysis, and is described in any engineers' handbook.

Another method commonly used among old firemen is to take a few lumps of coal at random from the pile, pound them up with a hammer till very fine, then fill a clay pipe, place the pipe in a position to be able to watch the effect, care to be taken that the bowl is set firmly among pieces of red-hot coal in the fire-box or on the floor of the boiler-room on a shovel. When the powdered coal in the pipe bowl is burned to ashes, from this ash is determined the quality of the coal. The impression so gained is very hard to change. When the chemist takes samples at random he later places all of them together, subdividing them many times, each time reducing a section and subdividing it, till at last his final sample is a good average of the whole.

Analysis of a Few Coals Used in Winnipeg

	Moisture.	Volatile.	Fixed carbon.	Ash.	B.t.u.
Anthracite	3.46	3.86	83.77	6.6	14,000
Semi-anthracite ..	.65	9.40	83.69	5.34	15,500
Semi-bituminous .	1.0	21.0	74.39	3.03	15,700
Bituminous	1.03	36.50	59.05	2.61	15,000
Sub-bituminous ..	2.8	40.7	50.85	5.65	12,500
Manitoba lignite..	23.49	35.01	31.50	9.99	8,128

A good steam coal is the semi-bituminous of these pochontas and the standard of this part of Canada. The price of this coal is naturally the basis on which all coals

*Abstracted from paper read before the Manitoba Branch of the Canadian Society of Civil Engineers.

are sold. Seventy per cent. of the heat units is practically all that can be used to make steam. It will be found that a pound of coal requires practically the same amount of air whether it be anthracite or bituminous. Roughly speaking, it requires 160 cubic feet of free air, but with forced draft it has been found that a fan must be supplied which will give 260 cubic feet for each pound of coal to be burned, on account of leaks, etc. By the use of a hand gas analysis machine the air required will be quickly determined and by adjusting the dampers to suit these readings draft gauges will show how much air is required according to the depth of fire needed for the work the boiler has to do or is made to do. Chimney draft is generally read by gauges which are inserted in the breeching. It will be noticed that when the dampers are changed the chimney draft will vary. Kent's table of chimney capacities is ample and safe, and the full capacity can, as a rule, be found without heating the stack. In the writer's opinion, chimneys should be used only to take the burned gases away from the power house, and draft to burn coal should be supplied by a fan under the grates. Fires require fresh super-heated air to bring the supply up to the fire-box temperature, fresh, not burned. As an experiment, hot air from the combustion chamber was used with the result that the fan drawing the air out of the combustion chamber nearly put the fire out, and the steam pressure dropped. The fan connection was changed as before and the fire burned up again quite brightly. Dampers play a very important part in boiler settings and, as it has been said, the firemen's throttle is the damper. They should be arranged so that perfect control can be maintained at all times and they should not be made too large in section. If the breeching is 1/5 larger than the flue area it will answer and when this area calls for dampers of any size that may cause warping from the hot gases, they should be made in several sections and rigging arranged, connecting them altogether to a common control point with proper adjustable notches for fine adjustment.

When firemen have the draft gauges of each boiler set and they are instructed to keep the draft at the economical point, which point has been previously determined by the CO_2 recorder, these dampers will require to be changed frequently. It appears that forced draft is the only means by which the coal can be burned with economy on account of boiler load changes and the demand for better draft regulation. The fireman depends on the draft in the chimney, but this varies according to the weather; with forced draft his breeching dampers may be partly closed when his fire is getting heavier and he can give the fire more air, get more out of the boilers and keep up his CO_2 requirements.

Fire-box design for stationary boilers has changed a great deal in the last few years. The dimensions were formerly determined by the width of the boiler, by the length of the first plate in return tubular boilers and by the grate surface for others. One square foot grate surface to 40 square feet of heating surface was a common rule, and when the grate length exceeded 6 feet the sides were never made wider than the boiler. Some years ago the engineer who designed the Bank Head Mines for the Canadian Pacific Railway set up eight 150-h.p. return tubular boilers with a grate surface of 1 to 20 and explained that this was on account of the low heating value of the buckwheat coal they intended to burn. These boilers were set very close to the grates. Now settings of 1 to 27.5 are used for low-grade coal. The bridge walls were always made close to the boiler and also made to follow the curve of the boiler and the seam of the return boiler was always placed near the bridge wall to keep the extra thickness of plate out of the fire. Now that CO_2 records have been watched, all these high-speed gases at points like this have shown that the boiler only requires to be suspended in a bath of heat and the flow of gases reduced to slowest speed while they have any heat left, so that the sides of the fire-box are made straight and the boiler is lifted out of the fire and the bridge wall is only a place on which to rest the end of the grates, and ample room is left so that the gases can pass by with less velocity. Slow-burning coal and lots of coal in the fire-box gives the desired results and the fire-box volume is the thing that counts. A grate surface of 1 to 20 with 1 square foot of grate to 8 cubic feet of fire-box volume, which is made up mostly by raising the boiler from the grates, gives such a setting that with forced draft an almost unlimited horse-power can be taken out of the same boiler.

A paper written many years ago by Lawford Fry on tests made by the Baldwin Locomotive Co., stated that fire-box volume would prove to be the governing factor, not grate surface. All this has come into modern practice. Take the case of a locomotive. These boilers, when used for stationary boilers, develop under natural draft 150 h.p., and when pulling up hills or on fast trains develop 1,200 to 1,400 h.p.

The development of modern steam boiler plants to keep pace with the prime movers has caused engineers to push the development of the stoker to a surprising extent. Although the prime movers have been doubled and trebled, the same boilers now handle the load by forced draft and settings that keep the boiler far away from the fierce force of the fire on the grates. Boilers on bank can now, with lignite, be put on the line in a few minutes. Tests made by one of our leading power plant equipment companies who make three kinds of stokers, have developed their forced draft stoker till they can now give a guarantee that they will place the boiler plant in shape to give 300 per cent. to 400 per cent. rating with lignite coal at 70 per cent. efficiency, 65 per cent. on lower ratings. This means, with lignite coal, 6 pounds per horse-power-hour, while to-day most plants in the West are only getting one horse-power with 5 pounds of the best coal money can buy, in place of 3 to 2½ with stokers.

These large modern plants, when burning coal at the rates referred to, find that the ash in lignite coal is far less than is the common impression and, in fact, there is less ash than in eastern coals. One of the points in favor of burning lignite coal with forced draft is that the ash is so light a great deal goes up with the stack draft, and soot-blowers are used to remove the deposit to the stack and the combustion chamber, so that very little remains in the ash pit.

Clinkers, though, are quite a problem. Double-dump grates are among the latest and most successful methods of disposing of the clinkers. When coal is properly burned and all the value taken out of it, the refuse should be clinker alone.

ENGINEERS TO DISCUSS FUEL SITUATION

A general meeting of the Canadian Society of Civil Engineers will be held in Toronto, March 26th and 27th. Means will be discussed whereby engineers may assist in solving the national fuel and power problems that confront the Dominion.

SUPERVISION OF PUBLIC WATER SUPPLIES BY THE HEALTH OFFICER*

By Jack J. Hinman, Jr., M.Sc.
Water Bacteriologist and Chemist, Laboratories for the State Board of Health, State University of Iowa.

FROM the health officer's standpoint the two essentials for a public water supply are, first, that it shall be safe water for drinking and all domestic purposes as it comes from the mains; second, that there shall be an adequate quantity for the ordinary uses of the community with a sufficient reserve to take care of emergencies. Another matter of importance to the health officer is the attractive quality of the water, an agreeable taste, a suitably low temperature, freedom from odor, color and suspended matters.

We should first consider the quantity factor and then take up the question of the quality of the water, because the quality of the water is more nearly under our control. In this country the daily per capita consumption of water from public supplies varies between 40 and 300 gallons. In Iowa City during the past few years the consumption has run from 97 to 167.5 gallons per person per day. The local installation of meters has reduced the waste of water, but the daily pumpage approximates 100 gallons per person. In installing a plant, the probable increase in population for a determined period is calculated by ordinary statistical methods and this is taken as a basis on which to figure the probable amount of water required. Fire protection requires that a sufficient reserve of water be maintained. On one occasion, on account of a fire, it was necessary for the local plant to pump nearly a million gallons of water more than the usual daily pumpage. This represented an approximate doubling of the quantity of water treated. If the quantity of safe water available is too small, it becomes necessary to turn to a polluted stream or pond for water. In consequence this foul water may lie in the mains and dead ends for a week or more before it is replaced by a safe supply. Naturally, the use of the polluted water is dangerous, and when an emergency has required such a measure, the public should be warned by posters and newspaper notices. Such measures, however, are not usually efficient. Competent engineering advice is needed in deciding if a water supply will be sufficient. If the town is very small, wells may probably be assumed to yield the required amount. If their water contains too much iron or is polluted, simple measures may be resorted to to remove the difficulty. As the town increases in size, the number of wells and the necessary plant rapidly increase. Deeper wells may yield more and safer water, but water which is often so heavily laden with solid matters as to be almost useless for ordinary industrial purposes. Infiltration galleries may be laid in stream valleys. Their waters take on most of the characteristics of shallow well supplies. Creeks or larger streams may be held back by dams and considerable quantities stored for use. If the water sheds of the streams are prepared and then patrolled to keep away polluting agencies, the impounded water may be of quite good quality. If no provision is made for protection, the water approaches ordinary stream or river water. Impounded supplies are troubled by algae, which often gives rise to odors and tastes. The water of almost any stream may be made safe for drinking purposes, but I do not know of any stream in Iowa which furnishes water which is safe for use in its raw condition.

*Abstracted from paper read before the School for Health Officers, Iowa City, Ia.

Common Methods of Purification

I want to make a brief mention of the limitations and advantages of the common methods. Storage of impounded water effects a certain amount of purification. In London, for example, storage for a period often exceeding a month is depended upon as one of the chief factors in the purification of the heavily polluted Thames water. This purification consists chiefly in the settling of the suspended matters, a bleaching of the color and a reduction of the bacteria due to sedimentation, food conditions, sunlight, etc. London then filters the stored water. Stored water is often troubled by growths of algae and lower animal forms when stored in the open air. Odors and tastes sufficient in amount to cause complaint by the consumers sometimes results. The usual preventive measures are storage in the absence of light in covered reservoirs and the treatment of the surface water, particularly at the shore line, with copper sulphate. It is applied as a spray or by rowing about the reservoir a boat to the stern of which a bag of copper sulphate crystals has been tied. The copper rapidly precipitates from the water and it is usually copper-free in twenty-four hours or less. Coagulation of a water is usually brought about by the addition of filter alum (more accurately known as sulphate of alumina, since it is not a double salt) or lime and sulphate of iron. The advantage of the latter process lies in the cheapness of the iron sulphate, which is a by-product of the steel industry. In order to remove all of the iron, however, it is necessary to add somewhat more lime than is needed to use up all of the free carbon dioxide which exists in the water. Our local raw water contains about forty parts per million of free carbon dioxide and this requires about 560 pounds of lime [$Ca(OH)_2$] per million gallons. If the free carbon dioxide is not all removed, part of the iron may be retained in solution as the bicarbonate and later be precipitated. With alum, the use of lime is not necessary when treating our hard waters since the presence of free carbon dioxide does not tend to retain the alum in solution. A little lime is helpful, at times, however, in speeding up the reaction.

Filtration as Applied to Water Plants

Filtration as applied to water plants may be divided into two heads, *viz.*, the slow sand or English type and the rapid sand or American type, also known as the mechanical type. The slow sand filter may be dismissed from the discussion as far as Iowa is concerned. The rapid sand plant uses coarser sand than the other type and depends for its success on the coagulum from the iron and lime or alum process depositing on the surface of the sand. A rapid sand filter may be readily cleared by reversing the flow of water and agitating the sand by rakes, air or by high velocity of wash water alone. Rapid sand filters are usually cleaned from one to three times a day. They should yield a clear water and should reduce the number of bacteria very considerably. Some color is also taken out. A late tendency has been to slight the operation of the filters and place most dependence on the treatment of the water after filtration by calcium hypochlorite or liquid chlorine. These two substances are efficient germicides and their use is universally recommended. They are not entirely satisfactory when used on turbid water containing considerable coloring matter, since the chemical is unable to reach bacteria imbedded in masses of suspended material. The use of more coagulant and more attention to the filtration of turbid waters is worth while. Chlorination alone should not be advised for a water which is even slightly turbid, except in emergencies when nothing better is offered.

Iron Objectionable

Iron is objectionable in a water supply because it precipitates on standing, stains bath-room fixtures and white clothes, and tends to favor the growth of the iron-secreting organism crenothrix. This organism may grow so luxuriantly in the mains as to clog them. Iron is usually removed by filtration after precipitation by aeration or treatment with lime. Manganese, which sometimes accompanies iron, gives rise to similar difficulties. It is more difficult of removal. There is nothing definitely known which would lead us to believe that the mineral substances ordinarily found in our streams and wells are not healthful. A soft water may be preferred for drinking by many people; it is certainly more pleasant for washing purposes and more economical for industrial purposes, but there is no good reason to believe that it is necessarily more healthful for the normal individual than our ordinarily hard waters. It is the bacterial condition of the public water supply which is of the greatest importance from the health officer's viewpoint. He should know what the bacterial condition of the water really is. In cities and towns depending on the untreated water of wells for their supplies, changes in the quality of a water should be very slow. At times of unusually low water, or at times when a change in the character of the supply is apparent, examination of the water should be made, even though the water is examined at regular intervals once or twice a year. Where treated water supplies are used, it should be remembered that there may be considerable variation in the output of the plant from day to day. The operation is most likely to be unsatisfactory in the winter or in the very early spring. A turbid water coming from a water plant is usually a sign of improper operation, although it may be due to an after precipitation of iron. The chlorination process will not properly act on such water and the bacterial count is usually high. The cause will often be found to be cracks in a packed sand bed, insufficient chemicals or too little sedimentation.

Examination of Water Supplies

And now a few words with regard to the examination of water supplies as conducted by the Iowa State Board of Health Laboratories: All our work is directed toward an attempt to determine whether the water is contaminated or not, and if contaminated, whether or not the contamination is from sewage or sewage-like material. Of course, sewage is very likely to contain at any time the specific organisms of typhoid fever and similar diseases. If the bacteria of the disease are deposited in the water by a carrier or in the excreta from a case of the disease, the disease may be reproduced and an epidemic follow. We do not look for the typhoid organism itself, because it has not been found practical to do so. The organisms might die out before we received the sample of water, for one thing. Instead of looking for the typhoid bacillus we look for the colon bacillus, which is constantly present in the excreta of man and the warm-blooded animals.

Our chemical work we regard as subordinate to our bacteriological findings. The chemical substances determined are none of them important for their toxic actions in the quantities ordinarily present in contaminated waters. They aid us in forming an opinion of the history of the water, the density of the contamination and its source. In the chemical examination, most of the emphasis is put upon the determination of nitrogen in its various forms, because it happens that nitrogen is one of the substances most commonly present in organic matter. The albuminoid ammonia determination is intended to give us some notion of the amount of undecomposed organic matter present. Chlorine—by which we mean the combined chlorine of common salt and calcium and magnesium chlorides—may come from the soil or it may come from urine, and other wastes. If the nitrogen forms are high and chlorine is low, it may be said that in all probability the organic matter is the product of vegetable decay, while if chlorine is also high, the presence of decaying animal matter is indicated. In all cases where the collection of the sample is not made by a member of the staff, we must assume that the sample was collected and forwarded to us in the manner directed. We have carefully prepared a set of instructions which appear on our data sheet, but we know that sometimes they are neglected or not even read. Any contamination which is introduced will be to the disadvantage of the supply. In extreme cases it might even be erroneously condemned. Whenever we are led to believe that the sample has been accidentally contaminated, we explain this matter and request another sample for a re-examination. In a few States the ideal method of collection of samples by agents of the laboratory and sometimes plating in the field is practiced. The expense involved has prevented us from adopting this procedure, since the cost of collecting a single sample is considerable. Most of our communities were originally supplied with water by means of private wells, many of which remain in use at the present time or have been replaced by new wells, usually of the bored and driven types. Quite often an owner or a new tenant will have doubt as to the safety of one of these private wells. When convenient, the health officer can make a personal inspection of the well and its surroundings, and, if found advisable, an analysis may be recommended. Most board of health laboratories are glad to make examinations of private water supplies on the same basis as those for public use. It is recognized that an epidemic involving the neighborhood or even the entire community might have its origin in one of these private wells.

STREET CLEANING IN MONTREAL

"Far from satisfactory," says the Bureau of Municipal Research in its report to the Board of Control of Montreal, in commenting upon the results obtained by the street cleaning methods in vogue in that city. "This is due," claims the Bureau, "to the unpaved condition of many lanes and streets in the city, to the deplorable condition of a large part of the paved thoroughfares, and to the inadequate forces and equipment provided for street cleaning work.

"It is recognized that, during the period of the war, it may be advisable for the city to get along without spending more for street cleaning, but the following suggestions, if adopted, would promote cleaner streets without additional cost:

"Motor equipment, including flushers and the machine brooms recently purchased by the city, have developed certain defects that must be corrected. In particular, the larger machine brooms are ill-adapted for conditions in Montreal. These difficulties would indicate an error in judgment on the part of those ordering the above equipment, together with inadequate specifications that should be guarded against in the future. The more extensive use is advised of flushing methods in street cleaning and suitable equipment provided. The corporation of the tramways company should be ordered to extend the use of flushers."

CHAIN FENDERS IN THE LOCKS OF THE PANAMA CANAL*

By Henry Goldmark
Consulting Engineer, New York City.

WHEN the alternative plans for the Panama Canal were under discussion, advocates of the sea-level type laid great stress on the dangers to navigation inherent in a lock canal. Such dangers undoubtedly exist, although experience has shown that the risk of serious accident is very small in locks that are properly designed and carefully operated. Even at the Soo where the traffic, for many years, has been extremely heavy, only one serious accident is on record since the first lock was opened in 1855.

In comparing the two types in the case of Panama, it should be borne in mind that the broad and deep channels provided by Lake Gatun possess elements of safety which would have been absent in the smaller cross-sections of a sea-level canal.

On the other hand, the accidental destruction of certain of the lockgates would not only involve the risk of injury to vessels but might also set free the water impounded in Lake Gatun and lower its level so much as to stop navigation for a long period of time.

In working out the detailed plans of the locks, it was thought wise to take all possible precautions against injury to the gates and to provide special safeguards against further damage in case, after all, one or more gates were accidentally destroyed.

The safeguards adopted with these ends in view are the following:—

(1) Electric locomotives for towing all vessels through the locks. These travel on a rack railroad close to the edge of the lock walls and have, so far, proved entirely satisfactory in controlling vessels and keeping them centered in the lock chambers.

(2) Chain fenders for protecting the most important gates.

(3) Duplicate gates in certain parts of the locks. There are the usual "guard gates" at both ends of each lock flight and besides these a second pair of lower operating gates is provided in Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

(4) Emergency dams of the drawbridge type at the upper end of each lock for shutting off the flow of water in case of serious injury to the gates.

The first of these devices forms a part of the machinery used in normal locking. As long as it functions properly no further safety mechanism comes into operation.

The second device, the chain fender, protects the gates when, for any reason, a vessel is not under the control of the towing system.

The third safeguard, the duplicate gate, in its turn, does not come into play until the fender protecting it has failed to fulfil its proper function, and finally,

The emergency dam is needed only after all the preceding safety appliances have failed so that it becomes necessary to check the current of water flowing through the locks.

A full description of the various safety appliances is given in a series of papers on the Panama Canal written by the members of the engineering staff responsible for the different parts of the work and presented to the International Engineering Congress at San Francisco in 1915. (Transactions of the International Engineering Congress, 1915. The Panama Canal Vol. II. Also published separately by the McGraw-Hill Publishing Co., New York, 1916.)

They are also described in a concise but readable and comprehensive article published in Engineering and Contracting, January 7th, 1914, which is the best general account of the Panama Canal known to the writer. Reference should also be made to an excellent paper ("First Year's Operation of the Locks of the Panama Canal," F. C. Clark and R. H. Whitehead. Journal of the Western Society of Engineers, Vol. xxi., No. 4, April, 1916), which records the experiences obtained in the actual operation of the locks since the opening of the canal.

The chain fenders, the second of the safeguards mentioned above, were adopted at the suggestion of the writer who was in immediate charge of their design and construction. While similar fenders have been used in English locks for a number of years, they are believed to be inferior in strength and reliability to the Panama design.

The fenders were placed in the upper and lower approaches to the lock flights, thus protecting the upper and lower guard gates, and also just above the intermediate and lower gates in the Pedro Miguel lock and the upper chamber at Gatun and Miraflores.

Description of Fender Machinery

The fenders consist of heavy chains, which normally span the lock chambers near the top, being lowered to the lock floor when a vessel is about to pass. Each gate and its protecting fender are interlocked electrically, so that the chain cannot be lowered until the gate is opened, and hence is no longer in danger from collision.

The chain is arranged to pay out under stress when it is struck by a vessel, so that the energy of the vessel is absorbed and it is brought to rest without damage. The machinery must, therefore, not only make provision for lowering and raising the chain in daily operation but must also include some reliable means of putting the chain under stress when it is stopping a vessel. Evidently the success of the entire fender depends upon the mechanism for producing a suitable resistance to the travel of the chain in its emergency action.

In the English fenders, mentioned above, the friction of the chain about a horizontal cast-iron cylinder placed on one of the lock walls, is depended upon to give the necessary resistance. A small hoisting engine on the other wall raises and lowers the chain.

The writer examined one of these fenders at Avonmouth, near Bristol, in 1908, and discussed their details with the designers and builders, Messrs. Brown, Lenox & Co., of Pontypridd, Wales. They are simple in construction but the frictional resistance is likely to be variable in amount. It is also believed that lowering the chain from one end only is undesirable, as it often forms a loop at the bottom which may foul vessels in the lock. As far as could be learned, no tests in actually stopping vessels have ever been made with these fenders.

It is proper to add that the Panama designs were well in hand before the writer had heard of the English fenders, although their inspection proved of much interest. He would also like to record here his indebtedness to his friend, E. H. McHenry, M.Can.Soc.C.E., for most valuable suggestions in connection with the first inception of the Panama chains.

The adopted design was the result of an extended investigation. Frictional resistance of different kinds were studied, also the use of heavy weights for stopping the

*Abstracted from paper on tests of these fenders, presented to the Canadian Society of Civil Engineers.

vessels, but the hydraulic apparatus finally selected was considered to have advantages over all other forms.

In each of the twenty-four fenders built at Panama, there are three cylinders of the plunger type, the upper of which is suspended from beams spanning the machine pit while the bottom plunger rests directly on the concrete. The intermediate cylinder is movable, and slides on the inner surface of the upper and the outer surface of the lower cylinder. The chain passes through a hawse-pipe casting of steel, secured to a heavy anchorage, and is connected to the moving cylinder by a system of grooved sheaves. The pull of the chain when stopping a vessel is transferred to the anchors embedded in the concrete.

The lowering and raising of the chain is brought about by pumping water under pressure into the bottom and top cylinders respectively. The maximum stroke is 21 ft. 3 ins. and the multiplication given by the sheaves is four-fold, so that the chain pays out 85 ft. from each wall, a length which is sufficient for the deepest lock and also provides ample stopping power in emergency operation.

The chains were made from wrought iron bars 3 ins. in diameter and have links 10 ins. wide and 17 ins. long. The sections spanning the lock chamber have standard Navy stud links, while open links are used for the part that passes around the sheaves. Considerable difficulty was met with in obtaining chains of proper strength, especially the open links which have rarely been made of so large a size. The specified breaking strength was 500,000 lbs. for the studded and 450,000 lbs. for the open links, but all shots of chain were subjected to proof tests of 300,000 lbs. and 250,000 lbs. respectively.

In order to start the cylinder on either the upward or downward stroke, it is necessary to start the centrifugal pump and also to reverse the position of the operating valve which controls the direction of the flow. The latter is of the double piston type and operated by a small electric motor. Both the pump and valve motors are normally started from the central control house, from which all the gate and valve machines in the lock flight are controlled, but local control is also provided for.

The cylinder is brought to rest at each end of the stroke by a limit switch which stops the pump automatically, and it also starts the same whenever leakage has caused the cylinder to move up or down a predetermined distance from its end position.

The maximum pressure in the cylinders is from 100 to 150 lbs. per square inch, the higher pressure being required in lowering the chain as the heavy intermediate cylinder has to be lifted in this case. The high pressure prevails in the upper cylinder when raising and the lower cylinder when lowering the chain.

The pump has two stages, the first being of the volute, the second of the turbine type, a somewhat novel arrangement, which has proved entirely satisfactory. The pump has a 6-in. suction and 5-in. discharge pipe and is operated at 460 r.p.m. by a 70-h.p., 250-volt, 25-cycle induction motor. The lowering or raising of the chain is done in about one minute in a perfectly satisfactory manner, the chain dropping into a pit in the floor so as to offer no obstruction to the passage of vessels.

Emergency Operation

As the sole function of the fender is the checking of vessels, the device for maintaining a heavy tension on the chain, as it pays out, after being struck, is the most vital part of the entire apparatus.

It consists of a pair of resistance or relief valves. When the chain is struck by a vessel, there is a tendency for the moving cylinder to rise, so that the water pressure in the piping increases rapidly. The resistance valves must permit the water to escape, as soon as the pressure reaches a point corresponding to a suitable working tension in the chain links and then keep the pressure as nearly constant as possible. As a rule it will be necessary, in order to accomplish this result, for the opening in the valves to vary slightly as the chain pays out. Their movement must, of course, be reliable and they must close promptly when the strain on the chain is entirely relieved.

It should be noted that the travel of the chain is resisted not only by the hydraulic resistance to the motion of the cylinder but also by the weight of the cylinder and other moving parts, by the friction of the chain at the hawse-pipe casting, as well as by frictional resistance in the machinery itself. It proved entirely feasible to measure these supplemental forces accurately. They proved about equal in amount to the internal hydraulic resistance, making it necessary to set the valves which control the pressure in the cylinder for a much lower pressure than originally contemplated.

With the chain in its normal operating condition across the top of the lock, all gate and check valves are closed, so that the resistance valves provide the only means by which the pressure can be relieved.

In view of the importance of the subject, various types of valves that seemed suitable for the purpose were carefully studied and three different designs were finally selected for detailed tests. The tests were very carefully made, with delicate apparatus, so that they may be called laboratory experiments on a large scale. There were three series of tests:—

(1) Preliminary tests on the three valves at a large pumping plant in the United States, which provided water under high pressure.

(2) Tests made on the first fender machine erected in Gatun Lock, the chain being put into tension by a large winding engine.

(3) Actual working tests of one of the Gatun fenders in stopping large vessels.

Tests in Stopping Vessels

The first two tests gave a reasonable assurance that the fenders would function properly in stopping vessels. Twenty-two of the fenders were therefore built, practically identical in plan, while two others (in the lower approach to Miraflores Lock) differ only in having two chains stretched across the lock at different levels, to provide for the great difference (22 ft.) between high and low tides in the Pacific. Their machinery is absolutely identical with that in the other fenders, the high and low level chains being alternately connected and detached, as the tide changes.

It was, of course, desirable to make an actual test of the fenders in checking a vessel in the lock. In October and November, 1915, after the writer had left the Isthmus, a number of such tests were therefore made by a board appointed by the governor of the canal. They proved of great interest and value especially as the vessels were of considerable size. Two ships were used, the "Allianca," having at the time a displacement of 4,221 tons, and moving at speeds varying from 1.23 to 3.38 miles per hour, and the "Cristobal," with a displacement of 18,000 tons and speeds as high as 2.45 miles per hour.

The resistance valves were set to open at 360 lbs. per square inch in most of the tests, and the propellers of the vessels were stopped in every case before the chain was struck. Indicators were connected to the piping system in the machinery rooms and the pressures and also the travel of the moving cylinder of the machines were automatically recorded.

A rope mat was woven around the central portion of the chain and a similar protection given to the stem of the ship. No damage to the ships occurred as a result of the tests, and the chain was marred only very slightly. Twelve runs were made with the "Allianca" and ten with the "Cristobal," and the vessel was brought to a stop in every case before the chain had paid out to its extreme limit.

The tests with the "Allianca" were not entirely satisfactory, as the resistance valves had not been cleaned for a long time, and there was a slight sticking of the valves which prevented them from closing promptly when the pressure was reduced. All the valves were, therefore, thoroughly cleaned, a new leather placed in one valve, and the other leathers softened up. The tests with the "Cristobal" were made after these changes were made, and proved entirely satisfactory.

The pressure curves have a decided peak at the beginning, which is in every case decidedly above the setting of the resistance valve. Beyond this point, and throughout the greater part of the stroke the pressure remains remarkably uniform, with very few oscillations. The vessel was brought to rest from 51.5 to 62.0 ft. beyond the centre of the fender machines, its speed when striking the chain being from 2.06 to 2.45 miles per hour.

There was little difference between the pressures in the machines on the two lockwalls or in the length of chain paid out from each side. The travel of the cylinders was hardly over 6 ft. out of a total possible stroke of 21.5 ft.

The distance travelled by the ship before being stopped was less than the shortest distance from any of the fenders to the gate it is intended to safeguard, so that there seems to be every assurance that the fenders, if ever called upon, would fulfil their purpose, even in the case of a ship as large as the "Cristobal" and moving at a speed of over 2 miles per hour. As this vessel is about 500 ft. long, and 58 ft. wide, few larger ships are likely to use the canal, nor is the speed of two miles likely to be exceeded in the approaches or the locks.

The distance in which the "Cristobal" was stopped agrees very closely with the theoretical curves which were computed before the designs were completed, but after the working stress of 220,000 lbs. had been adopted for the chain in stopping vessels. These curves are shown in the Annual Report of the Isthmian Canal Commission for 1911. This close agreement with theory is, of course, very satisfactory. Accounts of the various tests are given in the Annual Reports for 1913, 1914 and 1916.

CORRECTION

On page 150 in our issue of February 21st, in the article on "Water Supply and Sewer System for Cap de la Madeleine," by Romeo Morrissette, of Three Rivers, P.Q., it was stated that the sides and bottom of the reservoir were constructed of 1:2:4 concrete, 2 ft. thick, covered by a 3-inch layer of waterproofing grout of the same proportions, "to which," said Mr. Morrissette, "was added 10 per cent. of Toch cement." This should have read "2 per cent. of Toxement," as Toxement is the trade name of the concrete waterproofing made by Toch Bros., and it was found necessary to add only 2 per cent. of it, not 10 per cent., to obtain the desired results.

AVAILABILITY OF ENERGY FOR POWER AND HEAT*

By John Blizard, A.M.Can.Soc.C.E.
Division of Fuels and Fuel Testing, Mines Branch, Ottawa.

THE source of all our useful energy is the sun, which continues to supply us with food, fuel, rain, wind, and radiant heat, and has stored up for us in the past vast quantities of vegetable matter since converted into valuable fuels. The forms of energy available for conversion into power and heat are: Water power, wind power, sun power, natural gas, oil, wood, peat, lignite and coal. The cost of converting any one of them as found in nature into a specific quantity of the form of required energy at the particular place required is a measure of its availability. It will depend upon the cost of winning and transportation or harnessing, the cost of conversion, and the cost of transmission.

The cost of winning and transportation applies to the fuels, and is summed up by their price as delivered at the place of conversion. The cost of harnessing refers to expenses, such as those involved in developing a water-power site. The cost of conversion applies to all, and its consideration involves an inquiry into the law of conversion. In its simplest form, this law states that any of the forms of energy may be converted into heat; but that the conversion of heat into work is never the sole result of a natural process. Thus, since the production of work by fuel involves the generation of heat, the best overall efficiencies of coal steam electric generating stations are of the order of only 18 per cent. But the overall efficiency of a hydro-electric station may reach 80 per cent. If, however, a fuel be used to generate thermal energy, as in a steam boiler, it is possible to recover 80 per cent. of its energy. Thus the development of water powers for heating processes which the combustion of fuel will perform with equal efficiency is a degradation of energy. For special electro-thermal processes it is economical to use water power for heating; but they are exceptional, and practically all thermal processes should make use of fuels. For the same reason, wind and water power should not develop heat energy. Unfortunately, wind power is available only for small powers, while the cost of development and situation of water powers make it necessary to use fuels for the generation of most of the world's power supply.

The actual efficiency of conversion of the energy in fuels into mechanical or electrical energy varies considerably. It depends upon the class of fuel and the heat engine. Thus, the best thermal efficiency to be obtained with a steam turbine is about 26 per cent., and with the gas engine about 35 per cent. But the thermal efficiency is not the sole criterion of the cost of conversion, for the costs of the installation are an important factor. And the steam turbine, with its higher heat consumption, is able to compete with and outdistance its competitors for large stations, because of the much lower investment costs.

The energy of a fuel is invariably released eventually in the form of heat. But it is frequently converted into other modifications of fuel. A most important example of this type of conversion is the carbonization of coal, by which not only gaseous liquid and solid fuels are produced but numerous and valuable by-products.

The cost of transmission of energy will depend upon the class of energy transmitted, its price per unit, and the

*Paper read before the Ottawa Branch of the Canadian Society of Civil Engineers, February 28th, 1918.

distance transmitted. Thus, it is economically possible to transmit electrical energy to great distances, gas of high calorific value to comparatively long distances, low calorific value gas to shorter distances, and steam or hot water only in the vicinity of the plant.

It is obviously of great importance to the community as a whole to see that all forms of energy serve in the best way the purpose for which they are most available. To choose energy and means of using it for a particular purpose is not simple. Thus, energy for road transportation may involve a comparison between oats and gasoline; and horses and heat engines. For a mill with a high load factor the issue may be between the Diesel engine and water power; while for a poor load-factor the steam turbine plant alone may be worth considering.

It may appear at first sight that, since sellers and users of energy sell, generate, or buy to the best advantage to themselves, things will be adjusted so that energy is used in the most economical manner. This is true for the most part. But they are compelled to use only the available forms of energy, and to convert them into the required form in the apparatus which manufacturers supply. To better these conditions, three things are necessary: First, it is necessary to examine the whole community's requirements; secondly, to take stock of the sources of energy, and thirdly, to see how they may meet the requirements to the best advantage.

An inquiry into these three subjects would be of great breadth, depth, and variety. Once completed, it would be of very great value. Constant change in a country's development and its methods of generating heat and power would necessitate its frequent revision. But until such an inquiry is being prosecuted continuously with great vigor, both in the field of commercial use and development, and in laboratories independent of private interests, a country will be at a disadvantage.

It is proposed here to outline the sources whence we in Canada receive our supplies of energy, and the requirements they meet.

Coal is of first importance. In the course of a year we burn 30 million tons, of which 60 per cent. comes from the United States. The remainder is mined in Canada.

Practically no coal supplies exist between the provinces of New Brunswick and Saskatchewan, and the combined output of these two provinces amounts to only 4 per cent. of the country's production. One-half of the remaining 96 per cent. is mined in Nova Scotia, and the other half is mined in the provinces of Alberta and British Columbia. The coal reserves of Canada are enormous, and we may rely on a continuance of native supply for a very long period of years. Whether we may place equal reliance on our supply from the United States or not is uncertain. The present shortage seems to be due to abnormal difficulties of transportation rather than those of production. It is certain, however, that the supply of anthracite from that country will decrease, and that the time is not far distant when they will come to us for their supply of coke or coking coals.

A part of the annual coal consumption is accounted for as follows:—

Manufacture of coke	2,000,000	tons
Railway locomotives	9,000,000	"
Collieries	1,000,000	"
Bunkering ships	1,000,000	"

The remaining 17 million tons are used for domestic and general manufacturing purposes. An approximate estimate of its subdivision is: 5 million tons for domestic heating, 6 million for industrial heating, and 6 million for industrial power.

Assuming that the colliery consumption is for power purposes only, and that 7 pounds of coal generates a horse-power hour, the total mean continuous applied horse-power in Canada derived from coal is 500,000, of which locomotives develop 300,000.

Water power is used for the most part to supply mechanical and electrical energy. About 2 million horse-power has, so far, been developed. The total available horse-power is estimated at about 18 millions, of which 8 million is estimated to be available within the present range of markets. An additional development of 6 million horse-power, assuming an efficiency of conversion of 60 per cent., and a plant factor of 40 per cent., would supply about 1½ million horse-power continuously. This is much more than sufficient to supply that generated yearly by our 16 million tons of coal.

Wood is a very important Canadian fuel. The estimated value of firewood used during 1916 was 62 million dollars, or more than the value of our coal imports. Although, to some extent, its use may be for power generation, principally in log-product factories, it is probable that most of it is used for domestic purposes. It is not likely that it will, to any extent, be able to take the place of other forms of energy, except spasmodically, as in times of an acute scarcity; nor is it likely that other forms of energy will take its place.

Oil and natural gas occupy an inconspicuous position compared with wood, coal and water power.

The annual oil consumption is about 250 million gallons, and practically all of it is imported. It is in a more available form for the generation of power and heat than any other fuel. While not impossible to replace it with other forms of energy for small gasoline and kerosene engines, such a change could be effected only with great inconvenience. In addition to its use for these purposes, crude oil in large quantities is used, particularly in the West, for railways, ships, and industries. Altogether, at least 100 million gallons are burned under steam boilers.

Van H. Manning, director of the United States Bureau of Mines, in reviewing the oil situation of that country, estimates that its supply at the present rate of usage will last only 25 years. He further remarks that petroleum should be used neither for gas manufacture nor for fuel under boilers, nor in any way to compete with coal. It would appear, then, that we must soon find another source of supply. This may come from the known shale deposits of Canada or the United States, or, possibly, from the vast unexplored areas in the west of Canada. The distillation of oil shales would not be a new venture, since, in Scotland, 3 million tons are produced annually, giving about 20 gallons of oil to the ton. Another source of oil is tar obtained from the distillation of coal and lignite. Benzol, another coal distillation product, is an excellent motor spirit, though, to counteract its tendency to freeze at only fairly low temperatures, it is necessary to mix it with alcohol or gasoline. Still another coal by-product, naphthalene, may be used for explosion motors.

There is no doubt that alcohol is destined eventually to become prominent as a motor spirit. It is of particular importance, since it may be obtained from vegetation, and is thus independent of the stored sources of energy.

Natural gas is used in particular districts adjacent to the gas fields. Its high calorific value, nearly twice that of coal gas, renders its distribution over a large area economically possible. The annual consumption in Canada is about 20 million thousand cubic feet. It is used for industrial and domestic purposes. Since it is in a form more available for the generation of power than any solid fuel, it is advantageous to use it for this purpose whenever possible instead of coal.

Peat contributes practically nothing to our energy requirement. Yet it exists in large quantities throughout the Dominion, and in view of its success as a fuel in other countries, and the information obtained from its manufacture and use here, its availability for the generation of power and heat is known. It is impossible to believe that there is no field for its exploitation and it must be expected soon to find a position as a source of heat and power.

This faint outline of our requirements and sources of energy does not afford information sufficient for proceeding with an inquiry which will lead to the connection of the user of power and heat with the most available form of energy. Here the possibilities of increasing the availability of our supplies of energy will be considered with reference to special methods. They will refer only to the establishment of central stations for the use of the solid fuels, and to the possibility of using hydro-electric energy for house heating.

Central Stations

The central station may be designed to supply electrical energy, gas, steam, liquid fuel, solid fuel, and various by-products, many of which have no connection with the generation of energy. The economy of operation depends upon many factors; one of the most important of which is a large system in which there is more complete utilization of the full capacity of the plant. This is due to non-coincidence of the maximum loads of the various consumers, better thermal efficiency of conversion due to the use of larger units, more complete and intelligent supervision and design, and to the possibility of operating for longer periods at the more economical rated load. The limit of the central station's sphere is reached, when it is cheaper to haul the fuel to the consumer than to deliver energy through pipes or along a wire. It varies with local conditions and the type and price of the fuel. It will be greater for low-grade than high-grade raw fuel, since costs of transportation vary with quantity and are independent of energy content.

The largest field for the central station will be in the generation and distribution of electrical energy. The rough estimate of the mean present power load now met by coal showed the very large requirement of locomotives. To replace the uneconomical steam locomotive with the electric locomotive seems at first sight a rational project. Where the substitution has taken place the coal consumption in the central steam electric stations is one-half of the former consumption on the locomotive. There could be no objection to its substitution for oil in forest areas, and the present damage from locomotive soot and sparks would cease. An examination of the roads electrified shows that they are confined for the most part to suburban and mountain traffic. But the electrically equipped mileage is increasing, and the continuous increase in the price of coal brings the day of general electrification nearer.

The remaining power, which is used for general industrial purposes, is in itself of magnitude sufficient to warrant the consideration of central station supply. Whenever external electric supply takes the place of energy generated at the plant itself, economy results. In many districts this change has resulted in reducing the coal consumption to one-quarter of its previous magnitude.

Central stations distributing gas have not so promising a field as those distributing electrical energy. The costs of transmission, and the relatively high efficiency of conversion of coal into heat energy in the plant itself reduces the possible gain to the buyer. Nor is it likely that the substitution of this type of plant would save fuel. Nevertheless, the cleanliness and improved availability of gas as compared with coal would frequently lead to its preference by consumers.

Types of Central Stations

Central stations may be of the following four types:—

(*a*) Those in which the fuel is completely gasified by partial combustion, and the energy distributed either as gas or electrical power.

(*b*) Those in which the fuel is carbonized and energy distributed in the form of solid fuel, and gas or electricity.

(*c*) Those in which the fuel is completely burned and electrical energy and steam distributed.

(*d*) Those in which fuel is completely burned and electrical energy only distributed.

A consideration of these stations follows:—

(*a*) The by-product recovery producer plant is the most promising means of totally converting solid fuel into gas. Its economic importance lies largely in the high returns possible by the recovery of from 60 to 70 per cent. of the nitrogen in the fuel in the form of sulphate of ammonia. It is of great value for the exploitation of low-grade fuels, particularly peat, whose nitrogen content is high compared with its calorific value. The gas produced has a heat content of about one-fourth that of coal gas. It may be distributed to consumers, or partially converted into electrical energy by use of gas engines or boilers and steam turbines.

In south Staffordshire, a plant has been in operation for some years, and supplies gas over an area of 123 square miles. The price paid for the gas varies from 3 to 5½ cents per thousand cubic feet. The fuel used is slack coal of a fairly low calorific value. This is the only plant which distributes producer gas on a large scale, and it is noteworthy as a possible reason for its unique position, that no dividends have been paid for some years.

In Italy two by-product plants, using peat, are in operation. The energy is distributed electrically.

(*b*) The two outstanding objects of carbonizing coal are to obtain a maximum yield of either coke suitable for metallurgical purposes or of gas suitable for domestic purposes.

The first method of carbonizing is carried out in coke ovens, wherein the long time of carbonization, large size of charge and compression give a coke of the requisite great density and hardness. It is possible with modern coke ovens to obtain a yield of gas more than sufficient for heating the charge, about 20 per cent. of the nitrogen in the coal as ammonia in addition to light oils and tar. The surplus gas is usually of only slightly lower calorific value than town gas, and is eminently suited for distribution for general use, or may be used as a fuel at the plant for the generation of electrical energy.

The second method of carbonization differs from the first in that smaller charges are used in order to obtain the necessary quality and quantity of gas, none of which is used for heating the retorts. As with coke ovens, coke, ammonia, benzol, and tar are recovered as by-products from retorting coal. The yield of coke, however, is less and some of it is used for heating the retorts, while the ammonia yield is greater, due to the smaller contact with the smaller charge.

The coke obtained from retorting the gas is soft and loose in structure, and may be used in domestic furnaces; its disadvantages for this purpose are its bulk—which necessitates more frequent firing than with coal and larger storage space—and its tendency to clinker.

The choice of installing coke ovens or gas-making retorts, both of which require much the same class of coal, obviously depends upon the possible market for the products. The development of a domestic fuel trade in the soft coke is possible, if a suitable market can be found for the gas. Metallurgical coke, on the other hand, is not so suitable for domestic purposes, since it is very hard, difficult to ignite, and requires a strong draft to burn it. Nevertheless, it may prove a valuable and economical substitute for anthracite coal, if sold at a reasonable price.

(*c*) The third type of station represents the most economical means of generating power where coal is reasonably cheap and all the exhaust steam may be used for heating. The prime mover may be either a steam engine or steam turbine of a comparatively cheap type, and no condenser is required since the power may be looked upon as the by-product and the steam as the most valuable product. It is not possible frequently, however, to find useful employment within a small area for the exhaust steam, and heat losses prevent the transmission of thermal energy in the form of steam or hot water over a large area. On the other hand, it may prove feasible to generate power in plants where a heating load exists and transmit electrical energy to customers in the neighborhood.

(*d*) This is the most popular type of power plant, and in large sizes consists of boilers, turbo generators and condensers. It is too well known to need description; but it is interesting to note that steam turbines are made of 70,000 kilowatt capacity, and operate with steam pressures and temperatures as high as 350 pounds per square inch and 690° F.

Each of these stations has a field of use. To say what field, without more information, would be mere speculation.

Hydro-Electric Energy for House Heating

There is a prevalent notion in the public mind that the country should settle once for all the difficulties and inconvenience of securing and burning coal for heating houses by developing and using water-powers for this purpose.

At first sight it seems reasonable to reduce the consumption of our transitory possessions, the fuels, by using a continuous source of energy, which is at present going to waste. It is pleasant to contemplate the substitution of the cheerful electric radiator and switch for the complications of the present system. But the substitution by this method is based on a wrong principle.

Recurrence to the previous remarks on the laws of conversion of energy will show that the conversion of electrical energy into heat, as when a current flows along a conductor, is a degradation of energy. To use this highly available form of energy for a simple thermal process can only be taken as a confession of lack of resourcefulness to provide a more suitable load.

To emphasize the misuse of electrical energy by direct degradation into thermal energy, it is proposed to see how its availability may be put to proper use for the purpose served by the direct radiator. The result, which follows from a suggestion of Lord Kelvin in 1852, will be surprising; for it will show that it is possible to render more kilowatt hours available for heating the house than would be registered by the wattmeter. The method is to use the electrical energy to drive a heat pump. That is to say, the energy delivered to the house is the sum of the electrical energy and the energy obtained from a cold source. Supposing a reversible engine, the supply of heat from the freezing of water, and the temperature of delivery as 155° F.; for every kilowatt hour paid for, 5 kilowatt hours would be delivered to the system. Since no actual engine is absolutely reversible the efficiency would be less than that shown, but even supposing only 2 kilowatt hours per kilowatt hour to be possible, it is clear that use of the thermodynamically irreversible radiator, when the partially reversible heat pump is much more efficient, would be a waste of energy.

Were the domestic heating load constant or nearly so throughout the year, it might be profitable to examine the practicability of this scheme. But the ratio of maximum to minimum load is higher than would allow of a rational diversion of hydro-electric energy for this purpose.

Conclusion

In conclusion it is pertinent to point out that an engineer introduced the present age of energy. It came with Watt's invention of a steam engine, and with it began the slow and sure depletion of our stores of energy. It is for the engineer to prolong this age. He must not fail to draw energy from the right source, through the best channels and use it with a minimum loss. And there is ever before him an immeasurably greater question. It is the consideration of the availability of the natural continuous supply of energy for the generation of the world's requirements of heat and power.

MONTREAL BRANCH, CAN. SOC. C.E.

Following is a list of nominees for office in the Montreal Branch of the Canadian Society of Civil Engineers:—

For chairman—Sir Alexander Bertram, Walter J. Francis, R. M. Hannaford; one to be elected.

For vice-chairman—J. A. M. Duchastel, Arthur Surveyer, R. M. Wilson; one to be elected.

For secretary-treasurer—Frederick B. Brown, Harry M. Lamb; one to be elected.

For committee—M. B. Atkinson, John S. Bates, J. A. Burnett, A. Crumpton, A. Frigon, H. G. Hunter, A. E. Johnson, W. D. Lawrence, O. Lefebvre, J. W. Orrock, L. G. Papineau, P. L. Pratley, Stewart Rutherford, J. A. Shaw, F. P. Shearwood, A. D. Swan, W. Chase Thomson, K. B. Thornton; six to be elected.

These nominations were presented by the nominating committee at a meeting of the branch held on February 28th, and have been sent out to members in the form of a letter ballot.

WILL ORGANIZE HALIFAX BRANCH

The establishment of a Halifax Branch of the Canadian Society of Civil Engineers has been approved by the Council of the society and it is expected that arrangements will be completed at an early date. The secretary of the society has been delegated by the council to go to Halifax for that purpose.

The Engineers' Section of the Ontario Municipal Electrical Association will hold its semi-annual meeting March 13th and 14th. The meeting will be held in Room C. 26, Chemistry and Mining Building, University of Toronto.

INCREASED CANADIAN STEEL PRODUCTION

In a recent issue of The Wall Street Journal is contained a quotation from a business man of excellent judgment, who says that those in the United States reckoning upon a large sale of steel and iron products to Great Britain and to other European countries after the war is ended are in error. For it is asserted that Great Britain, Canada and Germany have greatly enlarged their steel-producing capacity; they have, in addition learned economy and efficiency. Furthermore, the Wall Street Journal says that the prevailing opinion that after the war is ended we shall be found leading the world in our exports of steel and iron products, is not taken seriously by steel men, who have watched the development of the steel industry since the beginning of the war.

Will Not Buy Heavily

One of the reasons given by the authority which the newspaper quotes for his belief that European countries will not buy heavily of steel and iron from the United States after the war, is to be found in the fact that these countries will then be debtor nations, possibly by as much as $100,000,000,000. They certainly will owe the United States many billions—in fact they do now. Therefore, they will not be disposed to increase their indebtedness by making heavy purchases of steel and iron in the United States. Instead of that the manufacturers will strain themselves to the utmost to command the greater part of the steel and iron trade of the world. For in that way they will be able to secure some part of the funds by which they may meet their obligations. They will make a great drive against the United States; they will attempt successfully to compete in our own markets with American iron and steel manufacturers They will rely to some extent for success upon high cost of production of steel and iron in the United States, due chiefly to the wages and salaries which are paid to the artisans.

Discussing these statements, "Holland," in an article in the Wall Street Journal, says that undoubtedly the view set forth by this authority is the one taken by the leaders of the steel and iron industry, yet with a mental reservation. These leaders believe that we can hold and increase our world trade in steel and iron products, notwithstanding the high cost of labor, if there be satisfactory legislation, part of it so enacted as to prevent the dumping into the United States of steel and iron products and part of it so enacted as to enable us with facility and at reasonably low cost to approach the markets of the world.

On the office wall of one of the high executive officers of the United States Steel Corporation is conspicuously placed a legend reading as follows: "In time of war, we should prepare for peace." Undoubtedly, the managers of the Steel Corporation and, in fact, the managers of all the independent steel and iron industries of the United States, are now, as far as possible, preparing for conditions which will arise immediately after the war is ended They hope to secure the passage of an act which will enable steel and iron manufacturers who are exporters, to act in co-operation and in combination, so far as foreign markets are concerned. Action of that kind was one of the reasons why Germany was able to secure rapidly a considerable share of the world's trade in the iron and steel products. Then, again, these industrial leaders hope that after the war is ended they will have available a large amount of ships. Lack of shipping facilities was one of the reasons why the iron and steel makers of the United States were not able always to compete with the Germans and the English manufacturers of iron and steel.

Furthermore, it is hoped that legislation, which will modify the existing anti-trust laws, will be enacted. For if, for instance, the United States Steel Corporation should be dissolved through the judgment of the Supreme Court upon the action now pending, then it is inevitable that the United States will lose a large part of her exports of iron and steel products.

France and Belgium

Apparently the managers of the United States iron and steel industries do not now contemplate entering the markets of Great Britain or of Germany with their products after the war. They do believe that France and Belgium, if Belgium is quickened, will become heavy purchasers of American iron and steel products, provided conditions as well as legislation are favorable They look for great markets in South America and in the Far East, and if they are not handicapped by unfavorable conditions or by stringent legislation they believe that they will be able to meet whatever competition Great Britain or Germany, should Germany try to compete, may offer in the South American and Far Eastern markets. They are not concerned about the high cost of labor, for they believe this is offset by the greater productive capacity of highly-paid labor, by the utilization of the best labor-saving machinery, by the employment of highly competent men of science, and also by our favorable situation with regard to coal and iron deposits.

This is the contingency which the industrial leaders, whose achievements since the war began in iron and steel commodities, have been noteworthy, hold in reserve while they are disposed to admit that Great Britain and the European nations will not only refrain from purchasing American iron and steel, but will also attempt to dump enormous amounts of these commodities into the United States. The British manufacturers may be able to do this unless the United States manufacturers are favored by legislation and are aided by such facilities as, for instance, the proposed foreign commerce bank would offer. Given fairly even conditions the American manufacturers believe that they can not only hold the trade they have already secured but can increase it, no matter what competition Great Britain and Germany may offer.

C.N.R. EQUIPMENT WOULD YIELD PROFITS

The proceedings of the board of arbitration, sitting at Osgoode Hall to hear evidence as to the value of the Canadian Northern Railway stock, on February 14th were enlivened by a debate between members of the board as to the feasibility of W. H. Coverdale's plan for extensions to the Canadian Northern Railway system in mileage and equipment, which, he declared, if put into execution, would result in practically doubling the earning capacity of the railway. Mr. Coverdale is the New York consulting engineer who examined the Canadian Northern Railway system and finances for the purpose of the Loomis-Platten report, and his programme of betterments involves the expenditure, before 1923, of a sum approximating $80,000,000. With this expenditure allocated as he suggests, he estimates that gross earnings standing at $35,476,000, as on June 30th, 1916, would be increased to $80,320,000, with a surplus over expenses of $4,615,000 by 1923. Mr. Coverdale declared that his estimate of increases in earnings was conservative, and pointed to the fact that for the 1917 period the railway had actually exceeded the amount estimated by $2,000,000.

The point of contention between members of the board was as to the possibility of finding the funds to pay for the betterments. Mr. Justice Harris expressed an opinion that no sane man would attempt such a programme of expenditures under present conditions, as he believed it would be impossible to get the money. Counsel for Mackenzie and Mann contended that the expenditures were vital and must be made if the railway is to continue its existence as a going concern. Sir William Meredith then broke into the argument in support of Justice Harris, and declared that the minister of finance had intimated that he would not put a dollar into additional expenditures on capital account. Wallace Nesbitt, K.C., disagreed with the chairman, and declared that the money would be available if the proposals proved to be sound.

The Brantford, Ont., city council has approved the purchase of the toll roads of Brant for $28,000.

One feature of the coming annual general meeting of the Institute of Metals will be the display of cinema films of the Canadian water powers.

A deputation from the Lincoln County Council has asked that the Provincial Government take over the Queenston-Grimsby road as part of the provincial highway system.

To-day at a luncheon meeting of the Ottawa Branch of the Canadian Society of Civil Engineers, Hon. F. B. Carvell, Minister of Public Works, is to speak on "Some Phases of the Relation of the Engineer to National Life."

"It is hardly likely that I would be guilty of making such a silly proposition," was the comment of Lord Shaughnessy, president of the Canadian Pacific Railway, when his attention was directed to rumors which announced that the company would dispose of the railroad to the government. The rumors intimated that the shareholders would retain the hotels, steamships and land of the company and expect a guaranteed dividend of 7 per cent.

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HEAD OFFICE: 62 CHURCH STREET, TORONTO, ONT.
Telephone, Main 7404. Cable Address, "Engineer, Toronto."
Western Canada Office: 1208 McArthur Bldg., Winnipeg. G. W. GOODALL, Mgr.

Principal Contents of this Issue

GUARANTEE BONDS

A treasury board regulation prevents the acceptance of anything but a cash security in connection with contracts for the Public Works Department of Canada. This department cannot accept a guarantee bond, an instrument which has become an important factor in modern business. Considerable inconvenience is caused to contractors and others by the requirement of substantial cash security for the performance of certain work. Large sums of cash deposits lie idle when they might be employed profitably. The majority of public bodies in Canada are satisfied with the guarantee bond, furnished by reputable companies which make a specialty of the business, and which bond provides security for performance of contract. What is the reason for the treasury board's regulation?

WAR TRADE BOARD

The appointment by the Dominion government of a War Trade Board is a commendable step. One of the few criticisms that might reasonably be offered is that the creation of the organization was delayed too long. The personnel of the board combines many qualities and experiences which will be of great value in the important work ahead. The board is representative not only of departmental experience, but also of practical industrial, financial, labor, and executive experience. It might perhaps be strengthened by the addition of engineering advisers.

The powers and duties of the board, which were outlined in the February 14th issue of this paper, are very wide. The organization will have direction of licenses for export and import. They may supervise when necessary, industrial and commercial enterprises with a view to preventing waste of labor, raw materials, and products. They will make recommendations for the maintenance of the more essential industries and will also investigate the country's stock of raw materials, partly finished and finished products and, when necessary, direct their distribution. In addition, they will co-operate with the Canadian War Mission at Washington which, by the way, might profitably have been appointed many months ago, instead of in the early part of 1918. The board naturally will co-operate with the several departments of the government.

Our War Trade Board has been constituted, as the prime minister has stated, "following very careful consideration of more effective organization for the purpose of the war, and having regard to the necessity of more effective measures for maintenance of industries essential for that purpose."

ARE ENGINEERS NARROW-MINDED?

Not so much for any valuable ideas which it contains but more as an example of the glittering generalities which many magazines are to-day printing about engineers and their work, we reproduce the following from the December issue of Industrial Management, New York:

"Engineers are steadily moving into the forefront of the professions. This enviable position was once held by the clergy, then by the law, and then by medicine. Engineers now are having their turn—or soon will be having it. It is a responsible place in society. To lead, to guide—that is it. Therefore, bearing this tremendous responsibility, engineers should live cheek to jowl and elbow to elbow with society. Engineers should understand humanity—its foibles, its weaknesses, its governing sciences. Men in the profession should know something besides laws which have nothing to do with society as such. Mathematics never bred cats, for instance—though mathematics might at times be strained to keep count of the kittens; nor has chemistry or physics ever accounted for John's red hair, when John's father and mother both have raven locks.

"Something is wrong with the profession—has been wrong from the first. Engineering courses are not quite what they should be—not quite complete. If they were, engineers would be different. They would think in channels somewhat broader than they do; they would see with clearer and more generous vision. Engineers must think in broader channels—must see with more generous vision—if, having once moved into the forefront, as they will, they would remain there—would not go back—as the clergy has gone back, as the law has gone back, as medicine is going back. Once to the front, engineers could stay there. They could stay there if only they would profit by the mistakes of their brethren in the older professions, and study the New Management. Which means that engineers have got to forget some things and learn some other things. Forgetting, and learning, they will have attained to mastery over the world. . . .

"The human element, after all, despite mechanical perfection, despite the laws governing the sum of two figures, is the vital element, the element that makes or breaks—the one science above all sciences deserving of consideration and study on the part of the engineering fraternity.

"Engineers as a race have not studied it. They have considered it, of course, as in the designing of apparatus;

but this consideration for the most part may be summed up and dismissed—as it is summed up and dismissed in all drawing-rooms—in a single compound word, 'fool-proof.' Making a thing fool-proof, and the engineer, as he sees it, has done his bit. In this direction a few engineers have done a great big bit—automatic machinery in some fields creates wonder and amazement in the on-looker. But these instances have been rare—few and far between—and the work of a very small group of engineering minds. And while the word 'fool-proof'—itself symbolic of the mental attitude of the engineering world toward humanity at large—is a word well understood in engineering circles, yet the human element as a factor in the operating of machinery is not taken into consideration as much as it could be, should be, and will be, in time. . . .

"Out of all this emerges a broad general conviction. It is that the engineering mind, taken collectively, is a narrow mind. If it is a narrow mind—and, personally, I believe it is—it is so by reason of the specialized intensive training given engineers in preparation to pursue their profession. Of all the students in any university, 'engineers' are seen least on the campus, least in the gymnasium, least on the track and field. They haven't the time. It would be better for the profession if this were otherwise. Campus and gymnasium are places where the human side is brought out, and it is the human side that is lacking in development in the average engineer. Anything that would tend to develop this in the man would likewise tend to develop it in his profession. Recognition and knowledge of the foibles of humanity would broaden and soften."

As Francis Bacon, Lord Verulam, said in his essays, grant a false premise and a wonderful argument and new labor can be created. Charles M. Horton, the author of the above-quoted article, writes from a false assumption of the mental balance and intelligence of engineers. Dispute the premise, says Bacon, and the elaborate argument falls apart for lack of actual proof.

SHAWINIGAN WATER AND POWER CO.

The annual report of the Shawinigan Water & Power Co., Montreal, for the year 1917, says that water conditions throughout the year were above normal. The late spring, heavy rainfalls throughout the summer and general conditions throughout the watershed of the St. Maurice River resulted in a river flow considerably in excess of former years.

A continuance of this satisfactory condition is guaranteed for the coming year by the putting into operation of the La Loutre storage dam. This dam has been completed by the company for the Quebec provincial government. Although the amount of work involved was considerably in excess of that anticipated at the outset, the dam was completed some weeks ahead of the contract date, which was January 1st, 1918. The storage lake should be substantially full at the end of the flood period in June, 1918, and from that date the full benefit of the storage water will be available to the company and its allied interests.

The company also constructed a plant for the Canadian Electro Products Company, and increased the capacities of two other subsidiary companies, the Electrode Company and the Canada Carbide Company. A certain amount of new construction work was also occasioned by the development of the company's power business. The new work constructed at Shawinigan Falls by the Canadian Aloxite Company, a subsidiary of the Carborundum Co. of America, will require about 12,000 h.p. The work is now practically completed and the equipment is being installed. The plant will be in full operation at an early date.

The new business written by the company has exceeded that of the previous year, which was the record up to that time, and should increase the demand on the company's plants, says the annual report, by 35,000 h.p. The general industrial situation throughout that part of the province of Quebec served by the company, has been one of intensive operation of existing industries, says the report.

Referring to the coal shortage and its effect on some power plants, the report states that "in general it may be said, as regards hydro-electric development, that time is on its side and the future cannot fail to be advantageous to it."

PERSONALS

S. V. Kendall, managing director of William Cowlin & Son (Canada), Limited, contractors, has moved his office to 154 Simcoe Street, Toronto.

A. M. Morton, B.A.Sc. (University of Toronto) and lately with British Forgings, Limited, is in charge of the new chemical laboratory of the Alloy Steel Works, Limited, Toronto.

B. F. Haanel, B.Sc., chief of the Division of Fuels and Testing, Mines Department, Ottawa, addressed the Royal Canadian Institute, Toronto, last Saturday evening on "The Fuels of Canada."

H. I. Armstrong has been elected managing-director of the Alloy Steel Works Company, Toronto, a new corporation which has been formed to take over and operate the Moffatt-Irving Steel Works, Limited.

A. V. DeLaporte, B.A.Sc., chemist in charge of the experimental station of the Provincial Board of Health of Ontario, has joined the overseas forces and is now in England qualifying as an officer in the Royal Engineers. He had been attached to the Hydrological Corps with the rank of captain and served at the Toronto Exhibition Camp last winter.

Hon. W. J. Hanna, K.C., formerly Ontario provincial secretary and more recently Dominion food controller, has been elected president of the Imperial Oil Company to succeed Walter C. Teagle, president-elect of the Standard Oil Company of New Jersey. Mr. Hanna has been the legal adviser of the Imperial Oil Company since the earliest days of the company's existence and latterly has been one of its directors and vice-president, although his chief activities for several years past have been of a public nature.

OBITUARIES

Flight-Lieut. Ross Harrison, of Kingston, who was for some time inspector on the construction of the Canadian Northern Ontario Railway, and later employed on munitions by the Canada Locomotive Co., Kingston, was instantly killed in a flying accident at Fort Worth, Texas, on December 23rd, 1917.