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# THE FLUXING OF ASPHALTS

## DISCUSSION BY ONE OF THE WORLD'S LEADING ASPHALT AUTHORITIES, WRITTEN AT THE SPECIAL REQUEST OF THE CANADIAN ENGINEER, ON THE VARIOUS METHODS OF FLUXING ASPHALT AND THEIR RELATIVE MERITS.

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In the early days of the asphalt paving industry, only those asphalts were employed which were found in a hard state in nature. In order to make them available for use it was necessary to soften them, and for this purpose a heavy petroleum oil was used. A light oil would have been dangerous, owing to the giving off of inflammable vapors when heated to approximately 300° F. in the asphalt cement kettles; and, owing to the comparatively rapid loss by volatilization of its lighter constituents, asphalt cements made with light oils would have hardened quickly to an undesirable extent when exposed to atmospheric action in a pavement.

During the period referred to, the bulk of the petroleum refined in the United States was what is known as paraffine base oil; *i.e.*, petroleum in which the paraffine series of hydrocarbons predominated. It was therefore natural that paraffine residuums, as they were termed, should have been used for fluxing purposes. These residuums were obtained by subjecting the crude petroleum to distillation whereby the lighter oils, such as naphthas, kerosenes and light lubricating oils, were removed. What was left in the still was termed a residuum and was largely a waste product, and this was used as a flux. Such residuums were naturally very variable in composition and gravity. Although all of them were made from paraffine base petroleums, the process of distillation varied with the ideas and requirements of the different refiners, and some of them were badly overheated and partially decomposed or "cracked" during the distillation process. Their gravities varied from 21 to 28° Be., and their flash points varied from 175° to 450° F.

As the technology of the paving industry developed, it was recognized that certain features were desirable in a flux, and attempts were made to regulate its production and insure a more or less uniform product, rather than to take at random any refinery waste product from which the lighter oils had been removed. Specifications were then promulgated limiting the gravity to a range of from 20° to 22° Be., and the flash point to not lower than 325° F., and excluding badly cracked residuums and those which lost more than five per cent. when heated for five hours at 325° F. Such residuums contained from seven to thirty per cent. of paraffine scale, and as asphalt cements made from the hard native asphalts usually contained about eighteen per cent. of them, such asphalt cements frequently contained as high as five per cent. and over of paraffine scale. Notwithstanding this, many extremely successful pavements were laid with those cements. This is interesting in view of latter-day claims that asphalts containing over one per cent. of paraffine are very inferior for paving purposes.

When it was found that by careful distillation of asphaltic petroleums, asphalts could be produced which were just as suitable for paving purposes as those occurring in a hard state in nature, the producers of this class of asphalts followed the precedent set and turned out a hard asphalt which required fluxing before use. If they had produced a soft asphalt cement they would have had to ship it in much more expensive packages, and in hot weather it would have been difficult to transfer to the melting kettles the contents of the then almost exclusively used wooden packages without excessive loss and trouble. Sufficient tank car equipment was not available to ship it in the modern way, and flux at that time being relatively much cheaper than asphalt, the expense to the contractors would have been materially increased. With the development of new sources of asphalt came also the development of new sources of flux and it soon came to be recognized that certain fluxes were suitable for use with certain asphalts but did not give good results with others. In view of this, paving specifications began to require, besides certain limitations in character and composition for the fluxes themselves, that the flux and hard asphalt when mixed together should produce an asphalt cement which possessed certain desirable and necessary characteristics.

As a result of still further investigation, it was found that in many instances certain desirable properties could be imparted to an asphalt cement which were not necessarily inherent in the hard asphalt itself, by the use of specially prepared fluxes.

In certain industries it is extremely desirable that the fluxed asphalt should be affected to a minimum extent by variations in temperature. Specially blown fluxes will accomplish this result, but great care must be used to avoid reducing the cementing qualities of the fluxed asphalt to an undesirable extent.

From the foregoing brief review of the situation, we see that the use by the contractor of a ready fluxed asphalt cement is a recent development, and that the value and suitability of sheet asphalt pavements was conclusively demonstrated during a period in which the contractor invariably did his own fluxing. There can therefore be no question but that the fluxing of a hard asphalt by the contractor is an entirely safe and satisfactory method, provided, of course, that the operation is properly conducted, and this proviso applies with the same force to the preparation at the refinery of a ready fluxed asphalt cement.

The relative merits of the two methods is largely an economic one and must be separately considered from the refiner's, the contractor's and the consumer's standpoint.

The refiner who produces his asphalt from asphaltic petroleum may stop the distillation process at the point where the material is of the proper consistency. Provided that the distillation has been properly conducted, he then retains in his product substantially all of the heavy oils originally present in his crude, and all of the various hydrocarbons will be in complete solution. If he desires to reduce the susceptibility of the asphalt cement to temperature changes, he can do this by oxidizing the product (usually by means of air) during the distillation process. Such oxidation is, however, always accompanied by loss in cementing value, and must be very carefully regulated. On the other hand, he may, if he desires, carry the distillation further and produce a harder asphalt and flux this, preferably while still hot, with a suitable flux prepared in a separate operation in another still. By using a flux prepared from a different crude, or by special treatment of a flux prepared from the same crude, it is possible for him to produce an asphalt cement having different properties from that which it would be possible for him to produce from a single crude in a single distillation.

The cost of the asphalt cement prepared from the hard asphalt fluxed back would usually be somewhat higher than that of an asphalt cement prepared from a single distilling operation. Depending upon the characteristics of the crude used, and the purpose for which the asphalt cement was intended, one product or the other might be the more desirable.

The refiner who sells asphalt cement made from a hard native asphalt is, of course, obliged to flux his product. He may either produce or buy his flux, and vary the character of the flux used in accordance with the use to which the asphalt cement is to be put. Assuming that his crude hard asphalt is of constant composition, he must depend upon varying the character of his fluxes in order to produce asphalt cements having different characteristics. If he uses various kinds of crude asphalts, he can, of course, vary his product in this way also.

Both classes of refiners will be affected in the same way by the cost of packages. If it is to be shipped in barrels, these will cost less for a hard asphalt than for a ready fluxed asphalt cement.

Tank cars would not be advisable for use in shipping hard refined asphalts, as they would require too long a period of steaming before the asphalt would be sufficiently softened to permit of being pumped out. They are very useful for shipping asphalt cements, but are quite expensive. Once acquired, however, the necessity for a barrel-making equipment is eliminated, and the freight charges on shipments are considerably reduced by their use. Careful track must be kept of them to insure their prompt return.

From the standpoint of the contractor, much will depend upon local conditions. Some specifications call for certain hard asphalts to be used. If it is necessary for him to procure these from a great distance, and there is available a cheap local supply of suitable flux, it will obviously be much cheaper for him to obtain his flux and asphalt separately. Even where the specifications give him the option of purchasing any of the standard asphalts or asphalt cements, conditions similar to those above described will usually make it to his advantage to buy flux and asphalt separately. Under competitive conditions, the municipality will practically always reap the advantage of cheap buying of raw materials by the contractor.

Where the contractor's plant is small, and the work to be done is limited in area, the cost of paying demurrage on a tank car until he had used up its contents would be a considerable item for him which might more than offset the reduced price of the asphalt in tank cars as compared with the price in barrels. Where the plant is situated at a distance from a railroad, tank car shipments are obviously in many cases impracticable. Under these conditions the frequent advantage in price of buying ready fluxed asphalt cement in tank cars is lost. When municipalities buy their asphalt from refiners situated at a considerable distance, and where cheap local supplies of a suitable flux are available, a ready fluxed asphalt cement will almost always cost them more than if they bought their asphalt and flux separately. Cost of plant operation is also an important factor. Under certain plant conditions a higher priced, ready fluxed asphalt cement might result in an increased output at a lower cost than if hard asphalt and flux were used. This would not apply, however, to a well-equipped stationary plant operating under normal conditions.

From the standpoint of the public and the life of the pavements, there is probably little to choose either way. As already shown, the majority of asphalt pavements have been laid with an asphalt cement made by the contractor at his paving plant by fluxing a hard asphalt. No evidence exists to show that better pavements are laid by obtaining the asphalt cement direct from the refinery.

It may be argued that refiners generally are better equipped, have a more competent staff and do their fluxing on a large scale. Fluxing, however, is not a difficult operation and does not require any high degree of skill, and the handling of the kettles during the fluxing operation is not markedly different from the procedure employed when a ready fluxed asphalt cement is used. With an incompetent contractor, having no supervision, it would perhaps be better to call for a ready fluxed asphalt cement, but this would be only a partial safeguard, as he would be very likely to injure it by overheating. Assuming that the contractor and his workmen are skilled (and unless this is the case it is folly to award him a contract for asphalt paving work), there is no reason why just as good results should not be obtained by permitting him to flux a good hard asphalt at his plant with as suitable a flux as would be obtained if he purchased a ready fluxed asphalt cement from the refiner.

All ready fluxed asphalt cements are not good any more than are all hard asphalts good. Modern specifications describe the fluxing methods to be used, and limit the kinds of flux and asphalt and asphalt cement which may be employed, and if work is properly and intelligently carried out under them, the question of whether the asphalt is to be fluxed at the plant or at the refinery, or to be made into an asphalt cement by a single distillation process, is largely an economic one.

Where the contractor does his own fluxing, the flux used and the method of using it are usually much more under the supervision of the engineer than when fluxing is conducted at the refinery. In all cases the flux used must be of such a character as to completely dissolve the bitumen of the hard asphalt, and the heating must be continued with proper regulation of temperature for a sufficiently long time to effect this result, and sufficient agitation must be used to thoroughly mix together the two ingredients.

Before using, the contents of each kettle or still at the paving plant or refinery must be tested to see that it is of the proper consistency. If too hard, more flux must be added; if too soft, more hard asphalt. It is, of course, assumed that exhaustive previous tests have been made to determine the quality of the asphalt cement produced by the combination of the hard asphalt and flux being used.

The procedure for regulating the quality and consistency is exactly the same whether the asphalt cement is prepared by fluxing a hard asphalt at the paving plant or at the refinery, excepting that at the refinery the operation is usually conducted on a larger scale.

Incomplete solution may, of course, take place if the flux is unsuitable, or if the heating period is too short. This can not occur when the asphalt cement is produced in a single distillation process from an asphaltic petroleum, but such an asphalt cement is subject to the same danger of decomposition, coking, etc., as those prepared from hard asphalts and flux.

Where an asphaltic petroleum is distilled down to a very hard consistency and then fluxed back, there is very considerable danger of decomposition due to overheating, even if the distillation is carried on with care. This is not the case, however, if, as provided in standard specifications, the asphalt be not carried down in the refining process to a penetration which is lower than 30 at 77° F.

Paragraph 9 of the sheet asphalt specifications adopted by the American Society of Municipal Improvements, October 14th, 1915, which describes in general terms the methods to be followed in fluxing a hard asphalt, is quoted below. The note appended thereto is an explanatory note of my own and does not appear in the specifications. It should be borne in mind in connection with this quotation that the specifications also contain clauses to the effect that the refined asphalt and flux must be of such a character that they will combine to form an acceptable and approved asphalt cement complying with the requirements of the specifications, and that these requirements and the methods to be followed during the fluxing operation are the same in the case of asphalt cements prepared at the refinery and asphalt cements prepared at the paving plant.

"**Preparation**:—The asphalt cement shall be composed of refined asphalt, or asphalts and flux, where flux is required, of the character elsewhere herein specified and must be of a suitable degree of penetration.

"The proper proportions of the refined asphalt, or asphalts, and flux, shall be melted together at a temperature between 275 and 400 degrees F., and thoroughly agitated by suitable appliances until they are completely blended into a homogeneous asphalt cement. Thereafter the asphalt cement must not be heated to a temperature exceeding 350 degrees F. If the asphalt cement contains material that will separate by subsidence while it is in a molten condition it must be thoroughly agitated before drawing from storage and while in use in the supply kettles. Excessive agitation with steam or air which will injure the cement must not be used.

"The refined asphalt or asphalts and flux comprising the asphalt cement shall, when required, be weighed separately in the presence of the authorized inspectors or agents of the Engineer."

**Note**:—The provision permitting a maximum temperature of 400 degrees F. during the fluxing operation is intended to cover the use of hard asphalts, such as Grahamite, etc., which require heating to a high temperature in order to effect complete solution of them in the flux. Once this solution is complete, the temperature is then required to be dropped to a maximum of 350 degrees F.

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## THE EXPORTATION OF ELECTRICITY.

When the Parliament of Canada placed upon its statute books the unfortunate act permitting the exportation of electricity, many far-sighted Canadian statesmen and economists protested, fearing that it would be far more awkward to stop the exportation than to start it. Ontario now needs the power that is being exported at Niagara, and the licenses to export may have to be curtailed, and eventually even abolished. The people of Canada are only now realizing the truth of the statement by the Canadian section of the International Waterways Commission that "It is very little advantage, indeed, to this country to develop power which is to be transmitted to the United States."

The mere generation of the power in Canada adds but a trifle to Canadian industry or welfare. Its benefits are negligible. It is the use and application of the power within Canada that adds to the comfort and profit of Canadians. With these facts in mind, and in view of the difficulties that the Ontario Hydro-Electric Power Commission is now experiencing in obtaining sufficient power to supply its requirements, it is interesting to review an article by Arthur V. White, a Toronto consulting engineer, which appeared in The University Magazine as far back as October, 1910. As both the article and the author's note that followed it have a direct bearing upon the present problems that face the Ontario and Dominion governments, they are reprinted here in full:—

Have the people of Ontario, while contemplating the disposal of Canadian water powers, considered fully to what extent their own future power, heat and light may depend upon their retaining control of these water powers?

Ontario is dependent for its supply of coal, especially hard or anthracite coal, upon the United States, and few events would prove more disastrous for the people of that province than to be deprived of this necessity. Even if coal were brought from either the Atlantic or Pacific coasts, the costs and difficulties of transportation would add much burden to the Ontario consumer.

It is important that Ontario—as well as other provinces of Canada—should be in a position to command, as far as possible, a continuous supply of coal from the adjacent coal fields of the United States.

If the people of Ontario entertained any apprehension that their supply of hard coal might be greatly increased in cost, interrupted, or entirely cut off, they should yield their best support to any efforts put forth by the governments to keep the assets of that province in such a condition as would establish a working basis upon which a *quid pro quo* could be given in exchange for those commodities which it is necessary to import. The question, then, first to be considered is, What are the possibilities that Canada may at some future time suffer from a cutting off of the United States coal supply; and then, what are the means within our power which may assist us to make it worth while for the States to continue to export some of their coal to Canada?

It has been a policy of many countries to prohibit the exportation of certain natural resources which are essential to their own welfare, and such policies are being more and more adopted. Take, for instance, the phosphate rocks, so valuable as an agricultural fertilizer. Formerly the United States permitted all-comers, so to speak, to avail themselves of its phosphate beds. But suddenly it was forced home to the United States government that in the very near future the people of the United States would require their own phosphate beds. Thus, discussing this subject, President C. R. Van Hise, of the University of Wisconsin, says:—

"During the summer of 1908 the attention of President Roosevelt was called to the fact . . . and it was urged that the Western phosphate lands now owned by the Government should be withdrawn from private entry until such time as legislation could be secured to permit their exploitation upon a lease system, containing a clause preventing the exportation of the phosphate. Later, the matter was again presented to the President, and to James R. Garfield, then Secretary of the Interior. Both the President and Mr. Garfield instantly appreciated the fundamental importance of the matter, and on December 9th, 1908, the phosphate lands of the West were formally withdrawn from private entry, thus retaining these deposits of fundamental importance to the future of the nation as its property."

"Indeed," says President Van Hise, "by the statesmen of foreign civilized nations exportation of phosphates would be regarded as unthinkable folly." And he urges, to use his own words, "that there should be a law which prohibits absolutely the exportation of a single pound of phosphate rock."

From this illustration it may be gathered that where foresight has shown that the people of the United States will need a natural resource, effort has been made to retain such a resource for the people of the United States.

Now as a result of special investigation carried out in the interests of the National Conservation Commission of the United States, it seems clear that the known coal fields of the United States are within measurable distance of exhaustion. Some authorities contend that under existent rates of consumption the hard coal may be exhausted in about another half century.

That the time may come when it may be deemed expedient to reserve to the United States her supply of coal is not an impossibility. Indeed, the subject has already been broached. Mr. George Otis Smith, Director of the United States Geological Survey, and one of the most prominent officials of the United States Government, after commenting upon the supplies of coal, says:—

"This glance at the world's reserves of coal shows plainly not only that the United States leads all other countries in production, our annual output being nearly 40 per cent. of the total, but also that it possesses the greatest reserves. Yet in respect to no mineral is there greater need to emphasize the folly of exporting the raw material. Let us keep our coal at home, and with it manufacture whatever the world needs."

Mr. Smith advises: "Let us keep our coal at home and with it manufacture whatever the world needs." Is it without significance that such a policy should even be suggested?

When Mr. E. B. Borron, in 1891, made his report to the Ontario government on the lakes and rivers, water and water-powers of the Province of Ontario he drew special attention to the fact that Ontario has no true coal. Mr. Borron says:—

"Thus it will be seen that in respect of fuel, and consequently of steam power, Ontario occupies on this continent, a very unfavorable, one might say, 'unenviable,' position, as compared with the Maritime Provinces and British Columbia, and with many, if not most, parts of the United States, and still worse as compared with England, Belgium and other great manufacturing countries in Europe. As was well said in *The Monetary Times* a few days ago, 'Ontario has to import her motive power, and the Dominion commits the folly of taxing it.' To which might have been added—'with the possibility of being denied even that poor privilege should at any time commercial intercourse with our neighbors to the South be suspended or interrupted."

We have not yet had the supply of coal suspended, but the winter of 1902-3 is still fresh in our memories, when the coal supply was interrupted by the coal miners' strike, and the people of Ontario paid up to fifteen dollars and more per ton for their hard coal supply. How would the people of Ontario fare were the United States to carry out any such policy as that suggested by Mr. Smith of keeping their coal at home?

Now, for both power and heat there is a partial substitute for coal to be found in hydro-electric power. I am not here considering the substitutes of wood and peat. Of hydro-electric power Ontario possesses probably sufficient for all needs. Let it be known, however, that the amounts of water-power which may be economically transmuted into electrical energy are much less than are popularly supposed. Ontario and Canada may yet require every unit of electrical energy as much as the United States may yet require "every pound" of phosphate rock.

Certainly the people of Ontario and Canada are in better circumstances to maintain a supply of heat and power if their water-powers, including their full share of international water-powers, are reserved to themselves and not permitted to be exported except upon terms and conditions which will conserve absolutely the present and future interests of the citizens of Canada. Not only would the water-powers of Canada provide, to a certain extent, a substitute for the coal supply of the United States as a means of furnishing light and heat and power, but control of these water powers would secure a basis upon which negotiations for coal could be conducted in a possible day of need. Canada would be in a position to exchange, if need be, part of her electric energy for part of the coal supply of the United States. It is obvious, however, that if United States interests should control both the coal and the water-powers the situation of Canada would become exceedingly grave.

Far-sighted men have realized how dependent the people will yet be upon the hydro-electrical energy, and, backed by great capital, certain syndicates have been acquiring all the possible power sites available. Such monopolizing power syndicates have been denied again and again. Let the following testimony be considered upon this point. Charles Edward Wright, Assistant Attorney to the Secretary of the Interior at Washington, writes:—

"Far-sighted Captains of Industry, realizing what the next generation will bring forth, reduction in the fuel supply with its complement, an enhancement of cost, and anticipating the advancement that will come in the art of utilizing hydro-electric power, have already seized advantageous points, and even now a small group of 'interests' controls the third of the present water power production; that is, produces power the equivalent of that proportionate part. With this portentous concentration of power production, the States, in part, must contend . . . This, and preceding generations, have realized the significance of monopoly in those things which are vital factors in the lives of all consumers, whether it be heat, light, food products, or transportation. Yet all of these united must be multiplied to be tantamount in power to the monopolistic Colossus which is yet but a suckling, nurturing itself at the breast of its foster-parent, the public. For heat, light and transportation, and the power that turns the spindles and grinds the corn, will be the product of transmuted water power within the lifetime of our children."

Commenting on this condition of water-power monopoly, President Roosevelt said:—

"The people of this country are threatened by a monopoly far more powerful, because in far closer touch with their domestic and industrial life, than anything known to our experience. A single generation will see the exhaustion of our natural resources of oil and gas, and such a rise in the price of coal as will make the price of electrically transmitted water power a controlling factor in transportation, in manufacturing, and in household lighting and heating. Our water power alone, if fully developed and wisely used, is probably sufficient for our present transportation, industrial, municipal and domestic needs. Most of it is undeveloped and is still in national or state control. To give away without conditions, this, one of the greatest of our resources, would be an act of folly. If we are guilty of it, our children will be forced to pay an annual return upon a capitalization based upon the highest prices which 'the traffic will bear.' They will find themselves face to face with powerful interests entrenched behind the doctrine of 'vested rights' and strengthened by every defence which money can buy and the ingenuity of able corporation lawyers can devise. Long before that time they may, and very probably will, have become a consolidated interest, dictating the terms upon which the citizen can conduct his business or earn his livelihood, and not amenable to the wholesome check of local opinion."

The testimony of President Roosevelt and of Assistant Attorney Wright clearly indicates the apprehension with which the aggressive conduct of the water-power interests is viewed in the United States. While the United States has witnessed the greatest activity of such interests, their efforts have been directed towards Canada also, and the attempt to obtain corporate control of the available power at the Long Sault rapids on the St. Lawrence River is the latest and most flagrant attempt to make the people of Canada pay a toll in the future for both heat and power.

No one can contemplate what has been taking place in connection with the proposed Long Sault development without seeing the same kind of hand against which the citizens of the United States have been forewarned by the chairman of the National Conservation Commission, Mr. Gifford Pinchot, when he says:—

"There could be no better illustration of the eager, rapid, unwearied absorption by capital of the rights which belong to all the people than the water power trusts, not yet formed but in rapid progress of formation. This statement is true, but not unchallenged. We are met at every turn by the indignant denial of the water power interests. They tell us that there is no community of interests among them, and yet they appear year after year at these Congresses by their paid attorneys, asking for your influence to help them remove the few remaining obstacles to their perpetual and complete absorption of the remaining water powers. They tell us it has no significance that the General Electric interests are acquiring great groups of water powers in various parts of the United States, and dominating the power market in the region of each group. And whoever dominates power, dominates all industry. Have you ever seen a few drops of oil scattered on the water spreading until they formed a continuous film, which put an end at once to all agitation of the surface. The time for us to agitate this question is now, before the separate circles of centralized control spread into the uniform, unbroken, nation-wide, covering of a single gigantic trust. There will be little chance for mere agitation after that. No man at all familiar with the situation can doubt that the time for effective protest is very short. If we do not use it to protect ourselves now we may be very sure that the trust will give hereafter small consideration to the welfare of the average citizen when in conflict with its own."

Mr. Pinchot says the "paid attorneys" appear year after year asking that obstacles be removed which prevent their perpetual and complete absorption of the remaining water powers. We may look for such procedure in Canada as well. The Long Sault, Cedar Rapids, or any other of the water-powers on our international waters are prizes any corporation may well covet.

Let the people of Ontario and Canada inform themselves upon what is taking place by way of effort to control or take away their best and largest water powers and realize what all such deprivation may mean in the future. Then if it appear that men like the late Sir James Whitney, Mr. Clifford Sifton, Mr. Adam Beck and others are endeavoring to conserve the water powers and other natural resources for the people, let it become the duty and privilege of every citizen to yield to such men and those associated with them in the efforts above mentioned every support which can be given. If this is not done, we may expect the day to come when, despoiled of our water power assets and facing the exigencies of the future, we will find that the large power interests, to borrow the words of President Roosevelt, will dictate the terms upon which the citizen can conduct his business or earn his livelihood, and not be amenable to the wholesome check of local opinion. Canadians desire no such conditions.

Note:—It appears to be the intention that the boundary waters between Canada and the United States should be equally divided between each country. Thus under Article VIII. of the International Boundary Waters Treaty of 11th January, 1909, (with rider attached by the U.S. Senate March 3rd, 1909), "The high contracting parties shall have, each on its own side of the boundary, equal and similar rights in the use of the waters hereinbefore defined as boundary waters." Where these waters are used for hydro-electric development it might, in certain instances, be fitting that the various power sites be selected in the very best situation, and if sites so selected resulted in the development in one country of more than half the power, the increment over the half might be inalienably safeguarded as a possession of, and provision made for its free entry into the other country.

The laws at present applicable to the exportation of electric power may be well illustrated with reference to power development upon the Niagara River.

On June 29th, 1906, "A Bill for the Control and Regulation of the Waters of Niagara River, for the Preservation of Niagara Falls, and for Other Purposes," and known as the Burton Bill, was passed and received the approval of the President of the United States (Pub. No. 307, 59th Cong. 1st. Sess. Statutes at Large, Chap 3621). The Burton Act would have expired by limitation on June 29th, 1909, but was extended on 3rd March, 1909, by Joint Resolution of Congress, (H. J. Res. No. 262, 60th Cong. 2nd Sess.) until June 29th, 1911, and is still in force.

Under this Act (exclusive of the 10,000 cubic feet per second diverted for the Chicago Drainage Canal) permission is granted to divert 15,600 cubic feet per second from the Niagara River on the U.S. side. Under the I.B.W. Treaty, however, the United States may make a daily diversion not exceeding in the aggregate at a rate of 20,000 cubic feet per second. The corresponding quantity for Canada is 36,000 cubic feet per second.

Under the Burton Act permits may be granted to transmit electrical energy from Canada to the United States to the aggregate amount of 160,000 horse-power. The jurisdiction in this matter is vested with the U.S. Secretary of War, and in his opinion given 18th January, 1907, the order for *fixed* permits was decided as follows: The International Railway Company may export 1,500 h.p.; the Ontario Power Company, 60,000 h.h.; the Canadian Niagara Falls Power Company, 52,500 h.p., and the Electrical Development Company, 46,000 h.p. (See Annual Report, U.S. Secretary of War, 1907, page 34.) Under the Burton Act *revocable* permits for the transmission of additional electrical energy from Canada into the United States may also be granted, although in no case shall the amount included in such permits with the 160,000 h.p. mentioned above, and the amount generated and used in Canada, exceed 350,000 h.p.

In Canada the Dominion Act 6-7 Edward VII., Chap. 16, entitled "An Act to Regulate the Exportation of Electric Power and Certain Liquids and Gases," provides for the export of electricity to the United States under an export duty not to exceed $10 per horse-power per year. Thus Canada has legislated for the *exportation* of electricity, and the United States has legislated for the *importation* of electricity, but at the second annual meeting of the full Commission of the International Waterways Commission—the Commission that is the executive body dealing with these matters—a fundamental subject laid down for discussion was "The Transmission of Electric Energy Generated in Canada to the United States, and *vice versa.*" Canadians should be interested in the *vice versa.*

# APPLICATION OF NEWTON'S SECOND LAW OF MOTION TO CERTAIN HYDRAULIC PROBLEMS.*

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THE object of this paper is to discuss two phases of the application of Newton's second law of motion to hydraulic problems, the bearing of which is seldom clearly presented in textbooks on the subject. In order to do this it is necessary first to study that law in its most general form. The following statement of it, taken from Watson's "Physics," is a direct translation from Newton's works. "Change of motion is proportional to the impressed force and takes place in the direction of the straight line in which the force acts." As pointed out by Watson, the word "motion" as used by Newton was intended to convey the meaning "quantity of motion" or, as we speak of it, "momentum," *i.e.*, mass times velocity; also that the word "change" as used by Newton was intended to convey the meaning "rate of change." From the law as so interpreted, we may write at once its general differential equation form:

$$\frac{d\,(Mv)}{dt} \propto P, \quad i.e., \frac{(d\,Mv)}{dt} = kP \qquad (1)$$

and by general agreement as to choice of units, the value of the constant "$k$" has been taken as unity.

NOMENCLATURE.

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| $d$ = symbol for differential quantity. | $Q$ = rate of flow of liquid in units of volume per unit of time = $\frac{dV}{dt}$. |
| $M$ = mass. | $c$ = coefficient of contraction. |
| $v$ = velocity. | $r$ = radius of circular orifice. |
| $t$ = time. | $\phi$ = coefficient of velocity, or friction for an orifice. |
| $P$ = force. | $a$ = acceleration = $\frac{dv}{dt}$. |
| $k$ = a constant. | $x$ = a rise in free water surface measured in units of length. |
| $F$ = an area. | $l$ = a length. |
| $s$ = distance. | $C$ = velocity of a wave front, or "bore." |
| $\gamma$ = heaviness of liquid, or weight per unit of volume. | $b$ = inside measurement of the width of an open flume. |
| $g$ = acceleration due to gravity. | |
| $p$ = pressure on unit area. | |
| $p_a$ = atmospheric pressure on unit area. | |
| $h$ = a depth of water measured in units of length. | |
| $V$ = volume. | |

Equation (1) therefore becomes on expanding the left-hand member and putting $k = 1$,

$$v\frac{dM}{dt} + M\frac{dv}{dt} = P \qquad (2)$$

The first phase of the application of this differential equation to problems in hydraulics mentioned at the beginning of this paper involves the interpretation of the term $v\frac{dM}{dt}$. Evidently it represents that momentum which is produced during each unit of time, $dt$, by imparting the finite velocity, $v$, to a small (differential) mass, $dM$; while the term $M\frac{dv}{dt}$, with which we are all so familiar in the mechanics of solids, represents that momentum which is produced during each unit of time, $dt$, by imparting the small (differential) velocity, $dv$, to the finite mass, $M$.

In order to show clearly the application of Equation (2) to a given problem, we will consider the discharge from a re-entrant mouthpiece, such as shown in Fig. 1. The vessel is considered to be very large compared with the mouthpiece, or orifice. We will first apply Equation (2) to the study of the motion of a definite element of the mass $M$, which is a prism of a stream line as indicated in the figure. It is readily seen that $M = \frac{F\,ds\gamma}{g}$ and $P$ = Force in direction of motion = $-\,Fdp$. This force operates to impart a small increment of velocity to the total mass under consideration, during each unit of time $dt$, and we therefore write—

$$M\frac{dv}{dt} = -\,Fdp \text{ or } -\frac{g}{\gamma}\cdot\frac{dp}{ds} = \frac{dv}{dt}$$

$$-\frac{g}{\gamma}\cdot\frac{dp}{dv} = \frac{ds}{at} = v$$

$$\int_0^v vdv = -\frac{g}{\gamma}\int_{h\gamma + p_a}^{p_a} dp$$

$$0 - \frac{v^2}{2} = -\frac{g}{\gamma}\left[h\gamma + p_a - p_a\right]$$

$$v = \sqrt{2\,gh} \qquad (3)$$

We will now apply Equation (2) to a study of the entire mass of water, both in the vessel and in the issuing jet. The re-entrant mouthpiece being of the greatest length which permits the jet to spring clear and not adhere to the sides, the velocity of approach near the points $c$ and $d$ is negligible and the pressure at those points may therefore be taken as hydro-static. The pressure on all sides of the entire mass of water is therefore balanced with the single exception of that area equal to and opposite the opening $A\,B$. If this area be designated by "$F$" and "$h$" be the head of water on the centre of the area under consideration, then the net unbalanced pressure or force is $Fh\gamma$, which becomes our "$P$" in equation (2). This force does not operate to impart a small increment of velocity to the total mass, $M$, during each unit of time, $dt$, but instead is continually imparting the velocity $v$, given by equation (3), to a small mass $dM$ which issues from the vessel during each unit of time, $dt$. Therefore we write

$$v\frac{dM}{dt} = Fh\gamma$$

but

$$\frac{dM}{dt} = \frac{d\left(\frac{V\gamma}{g}\right)}{dt} = \frac{\gamma}{g}\cdot\frac{dV}{dt} = \frac{Q\gamma}{g}.$$

Hence

$$\frac{Qv\gamma}{g} = Fh\gamma \qquad (4)$$

If "$c$" is the coefficient of contraction $Q = cFv$ and we have

$$\frac{cFv^2\gamma}{g} = Fh\gamma \qquad (5)$$

and replacing $v^2$ by $2\,gh$, we obtain the equation

$$c = 0.50$$

That is, we have shown that the coefficient of contraction can be theoretically determined and explained by a general application of Newton's second law of motion to the problem involved.

The foregoing theoretical determination of the coefficient of contraction for a re-entrant mouth piece is given by a number of writers but so far as known, the following theoretical determination of the coefficient of contraction for a thin-edged orifice in the vertical side of a large vessel or tank is new.

In this case, shown in Fig. 2, the velocity near the points $A$ and $B$ is not negligible. It is specified that the orifice is small compared with the dimensions of the tank

*From The Cornell Civil Engineer.

and that it is not close to either the water surface or the bottom of the tank. It may therefore be assumed that the water converges toward the orifice from a hemisphere of infinite radius to one of diameter $A\ B$. On that assumption we will compute the excess of pressure on the left hand over that on the right-hand side of the vessel, due to the opening $A\ B$ of the orifice.

The pressure decrease at any point on the right, outside of the area $A\ B$ of the orifice is equal to the velocity head existing at that point. The summation of these decreases in pressure over the right-hand face is as follows, taking $A\ B = 2r$:—

$$\int_{\infty}^{\pi r^2} p\,dF = \int_{\infty}^{\pi r^2} \frac{v^2\gamma\,dF}{2g} = \int_{\infty}^{r} \frac{Q\gamma}{8\pi^2 r^2 g} \cdot 2\pi v\,dr = \frac{Q^2\gamma}{4\pi g}$$

$$\int_{\infty} \frac{v\,dr}{r^3}\,dr = \frac{Q^2\gamma}{8\pi r^2 g}$$

Then, applying to this problem the same methods used in obtaining Equation (5) in the preceding problem, we have

$$Fh\gamma + \frac{Q^2\gamma}{8\pi r^2 g} = \frac{cF\gamma v^2}{g} \quad . \quad . \quad . \quad (6)$$

Placing $Q = cFv$, $v = \phi\sqrt{2gh}$ where $\phi$ is an *experimental* coefficient of velocity or friction, and $F = \pi r^2$, the equation finally reduces to

$$1 + \frac{c^2\phi^2}{4} = 2c\phi^2$$

from which for $\phi = 0.95$, we find $c = 0.60$, which agrees well with the results of experiments on such orifices.

As the orifice becomes large with respect to the size of the vessel, or is near the bottom or a corner, the mathematical analysis of the problem becomes much more complicated. Newton's law, however, is seen to present a rational theoretical basis for the determination of coefficients of contraction.

The second phase of the application of Newton's second law is found chiefly in hydraulic problems involving a sudden change in the conditions of flow, such as sudden enlargement in a pipe flowing full of water, the standing wave, or the "bore" created by the sudden stoppage of flow in an open flume. It is somewhat the the same as the problem of "direct central impact" in the mechanics of solids. Such problems can be attacked either by the method of "work and energy" or by the "momentum" or "impact" method. It will be shown that the method of "work and energy" seems to lead to erroneous conclusions and that apparently the "impact" method should be used in such cases.

Before proceeding it is well to recall that the method of "work and energy" is based upon the following differential equations:—

$$v\,dv = a\,ds \quad . \quad . \quad . \quad (7),$$

a purely mathematical equation, and

$$\frac{dv}{dt} = a = \frac{P}{M} \quad . \quad . \quad . \quad (8),$$

an incomplete form of Newton's second law, the differential equation through elimination of "$a$", becoming

$$Mv\,dv = P\,ds \quad . \quad . \quad . \quad (9);$$

which equation, when integrated between the limits of $v_1$ and $v_2$ for velocity and $s_1$ and $s_2$ for distance which correspond to the limits $O$ and $t$ for time, becomes for constant values of $M$ and $P$,

$$\frac{M\,(v_2^2 - v_1^2)}{2} = P\,(s_2 - s_1) \quad . \quad (9a)$$

On the other hand, in the case of a sudden change in the conditions of flow, the change of momentum occurs *not* as a small change in the velocity for the finite mass, $M$, *but* as a large change in the velocity, $v = (v_2 - v_1)$ for a small amount of mass, $dM$, in the time, $dt$. Hence the method of work and energy which is based upon the first mentioned type of change of momentum cannot correctly apply to a problem where the conditions are such that a change of momentum of the second type exists. The "momentum" or "impact" equation, which should be used, is

$$v\frac{dM}{dt} = P \quad . \quad . \quad . \quad (10)$$

or, since $v = v_2 - v_1$ and $\frac{dM}{dt} = \frac{Q\gamma}{g}$

$$\frac{Q\gamma\,(v_2 - v_1)}{g} = P \quad . \quad . \quad . \quad (10a)$$

We will first consider the problem of an abrupt enlargement in cross-section of a pipe flowing full of water,

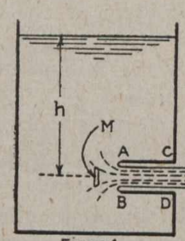
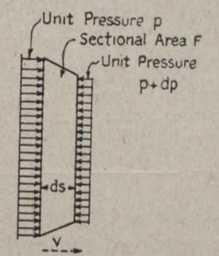


Figure 1
Re-entrant Mouthpiece



Enlarged View of Elementary Mass

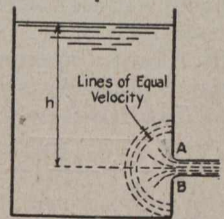


Figure 2
Sharp Edged Circular Orifice

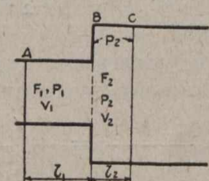


Figure 3
Sudden Enlargement in Pipe

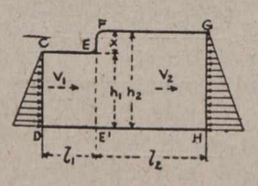


Figure 4
Standing Wave

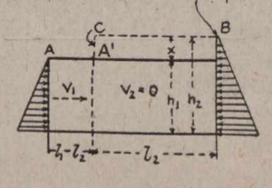


Figure 5
Closure of Gate in Flume

the notation being as shown in Fig. 3. The basic assumption made in order to make the problem possible of solution is that the pressure over the entire sectional area of the stream immediately beyond the enlargement is uniform and equal to $p_2$. Using the equation of work and energy as expressed by (9a) and considering the prism of water $AB$, of sectional area $F_1$ and length $l_1$ during the time it takes for the prism to come into position $BC$, where its sectional area is $F_2$ and length $l_2 = \frac{F_1}{F_2} l_1$, we obtain the following result:—

$$\frac{F_1 l_1 \gamma\,(v_2^2 - v_1^2)}{2g} = F_1 p_1 l_1 - F_2 p_2 l_2$$

or

$$\frac{p_1 - p_2}{\gamma} = \frac{v_2^2 - v_1^2}{2g} \quad . \quad . \quad (11)$$

This equation indicates no loss of head at the abrupt enlargement due to shock or impact and is shown by experiment to be incorrect.

Applying the equation of "momentum" or "impact" as expressed by (10a) and considering the same prism of water as before, we obtain the following result:—

$$\frac{Q\gamma(v_2 - v_1)}{g} = \frac{F_1 v_1 \gamma (v_2 - v_1)}{g} = F_1 p_1 + (F_2 - F_1) p_2 - F_2 p_2$$

where $F_1p_1$ is the total pressure on the small end of the prism, $(F_2 - F_1)p_2$ is the total pressure on the annular surface of the prism at the enlargement in section and $F_2p_2$ is the opposing pressure on the large end of the prism. This equation reduces to

$$\frac{p_1 - p_2}{\gamma} = \frac{v_1 (v_2 - v_1)}{g} \quad . \quad . \quad (12)$$

which is the universally accepted formula for this case, which is a case of true "direct central impact" since the centre of gravity of the prism moves continuously forward in the direction of motion of the prism, or looked at in another way, the line, joining the centres of gravity of the prisms impinging at the change of section, is in the direction of motion of the prisms.

We will next consider the problem of the standing wave. Here we do not have a case of true "direct central impact" and hence the analysis by the impact method is not exactly rigorous. By the method of "work and energy," (Equation 9a), we have, referring to Fig. 4,

$$\frac{bh_1^2\gamma l_1}{2} - \frac{b(h_1 + x)^2 \gamma l_2}{2} - \frac{bh_1\gamma l_1 x}{2} = \frac{bh_1 l_1 \gamma}{g} \cdot \frac{(v_2^2 - v_1^2)}{2}$$

where the first two terms of the left-hand member represent the work of the end pressures on the prism and the third, the work of raising the centre of gravity of the entire prism an amount $\frac{x}{2}$.

Since $bh_1l_1 = bh_2l_2 = b(h_1 + x)l_2$ (inasmuch as we have under consideration the prism $CDE^1E$ during the time it takes it to come into position $FEE^1GH$), we easily find

$$x = \frac{v_1^2 - v_2^2}{2g} = \frac{v_1^2}{2g}\left(\frac{1}{2} + \sqrt{\frac{1}{4} + \frac{2gh}{v_1^2}}\right) - h_1, \quad (13)$$

which, just as in the previous case, indicates no loss due to shock and is therefore incorrect. If we apply the impact method (Equation 10a) to the same prism of water over the same period of time, we have

$$\frac{bh_1^2\gamma}{2} - \frac{b(h_1 + x)^2\gamma}{2} = \frac{bh_1\gamma v_1 (v_2 - v_1)}{g}$$

Putting $h_1 + x = h_2$ and remembering that $bh_1v_1 = bh_2v_2$, we find

$$h_2 - h_1 = x = \frac{2 v_1 v_2 (v_1 - v_2)}{g (v_1 + v_2)} \quad (14)$$

Except for the error in assuming this to be a case of direct central impact, this is the correct formula for the standing wave. This error can be expressed in another way, by saying that the end pressures $\frac{bh_1^2\gamma}{2}$ and $\frac{b(h_1 + x)^2\gamma}{2}$ do not act in the same straight line and hence cannot strictly be used in the equation derived from Newton's second law. A more convenient and useful form of this equation for the standing wave is

$$x = -\frac{3}{2}h_1 + \sqrt{\frac{h_1^2}{4} + \frac{2h_1v_1^2}{g}} = h_1\left(-\frac{3}{2} + \sqrt{\frac{1}{4} + \frac{2v_1^2}{gh_1}}\right), \quad (14a)$$

which is the form given by Gibson and others. Despite its acknowledged defect, it seems to be the most rational formula yet derived for this problem and certainly is based upon sounder reasoning than the formula given in Merriman's "Hydraulics" and in the American Civil Engineer's Handbook.

There still remains for solution the problem of the rise in the water surface in the flume due to instantaneous closure of a gate or valve at its lower end. Referring to Fig. 5, we will consider a prism of water of original length $l_1$ and depth $h_1$. Then, after the expiration of some length of time "$t$", we assume the prism will have taken the position shown by the dotted lines and that the section at $A$ has just reached $A^1$ and stopped. We further assume that the upper surface of the water already raised remains practically horizontal and in a fixed position.

Evidently from the equation of continuity

$$xl_2 = h_1 (l_1 - l_2)$$

$$\text{or } l_1 - l_2 = \frac{xl_1}{h_1 + x} = \frac{xl_1}{h_2}$$

and hence we may write $t = \frac{l_1 - l_2}{v_1} = \frac{xl_1}{h_2v_1}$.

If we apply the equation of work and energy (Equation 9a) to the mass under consideration for the time "$t$" and neglect the loss due to sudden change or shock, we have

$$\frac{bh_1^2\gamma (l_1 - l_2)}{2} - \frac{bh_1l_1\gamma x}{2} = \frac{bh_1l_1\gamma}{g} \cdot \frac{(-v_1^2)}{2}$$

Solving for $x$, the rise in height, we find

$$x = \frac{v_1^2}{2g}\left(1 + \sqrt{1 + \frac{4gh_1}{v_1^2}}\right). \quad . \quad (15)$$

If we call the velocity of propagation of the "bore" or wave front "$C$", then since it travels the distance $l_2$ while the water travels the distance $(l_1 - l_2)$,

$$\frac{C}{v_1} = \frac{l_2}{l_1 - l_2} = \frac{h_1}{x}$$

and

$$C = \frac{h_1v_1}{x} \quad . \quad . \quad . \quad . \quad (16)$$

We will now apply the equation of impact (Equation 10a) to this problem although, as in the case of the standing wave, it is not a case of true direct central impact,

$$\frac{bh_1^2\gamma}{2} - \frac{b(h_1 + x)^2\gamma}{2} = -\frac{bh_1v_1\gamma(-v_1)}{g}$$

Putting $h_1 + x = h_2$ and solving for $x = h_2 - h_1$, we find

$$x = h_1\left(-1 + \sqrt{1 + \frac{2v_1^2}{gh_1}}\right). \quad . \quad (17)$$

This would seem to be the most rational formula for this case.

For the reasons stated, the writer believes the formulas for the standing wave and "bore" derived by the "momentum" or "impact" method to be the most rational yet proposed. It seems quite probable that they can be revised to take account of the fact that the impact is not "central" and thus be made entirely rigorous.

The question of the "bore" in a flume arose several years ago in connection with a certain hydro-electric development where the nature of the load was such that it was liable to be thrown off almost instantaneously. Nothing could be found on the subject in English, but after making independent studies in collaboration with Mr. W. E. Germer and arriving at the formulas here given, a number of experiments on the subject undertaken by Darcy and Bazin were called to our attention by Prof. I. P. Church. A study of this data led us to the conclusion that for all practical purposes the impact formula for this case is sufficiently accurate.

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The six-mile Selkirk tunnel will be completed in the fall, according to the C.P.R. officials. The cost will be about \$12,000,000. That is about the only really big work in which the C.P.R. has been engaged lately, but it is interesting to recall that in the years before the war the company spent between \$25,000,000 and \$35,000,000 per annum in the development of the West, and since its inception, has spent over \$200,000,000 for that purpose.

## SNOW REMOVAL IN MONTREAL.*

By P. E. Mercier, Chief Engineer, City of Montreal.

THE city of Montreal has a total area of 26,226 acres. The length of the streets aggregate 485 miles, 104 miles of which have tramways tracks. The sidewalks form a total length of 622 miles.

**The Snow Fall.**—The snow fall varies each year, but has averaged, for the last 41 years: 119.3 inches.

The number of days on which snow fell in 1915, was 79. Out of these 79 days, it rained and snowed on 28 days.

The snow-fall period covers five months: November to March. The heaviest snow fall we have had this winter was on the 14th of December, and was of 7.4 inches. The previous day we had a snow fall of 2.1 inches. On the 14th the temperature was 9.7 degrees, and the wind had a velocity of 23.7 miles per hour. The following day the temperature went down to 5.4, and the wind went up to 32.6 miles per hour.

**Administration.**—The affairs of the city are administered by a Board of Commissioners. The different departments report to and receive their instructions from the board through the heads of the departments.

The chief engineer, known in the charter as the city surveyor, is the head of the public works.

The public works are divided into roads, waterworks and sewers, each under a superintending engineer.

The roads have charge of the construction and maintenance of the roadways and sidewalks; the cleaning, watering and oiling of streets; the snow removal.

The snow removal is done entirely by the city, by day work. The cost of removal of snow from the sidewalks, is paid by the proprietors at the rate of five (5) cents per running foot. The cost of the snow removal from streets with tramway tracks is paid half by the Montreal Tramways Co., half by the city.

The cost of the snow removal in any other streets is paid by the city.

As the country surrounding Montreal has winter roads, the city does not entirely remove the snow from its streets, but keeps, during the winter months, a thickness of 6 to 12 inches of snow.

**Organization of Labor.**—The Road Department is divided in three divisions under the charge of a superintendent, and in sections under a section foreman.

We have, therefore, the following organization:

BOARD OF CONTROL.

**Chief Engineer.**

| Supt. Eng. **Waterworks Dept.** | Supt. Eng. **Road Dept.** | Supt. Eng. **Sewer Dept.** |
|---|---|---|

**General Superintendent.**

| **East Division.** Superintendent. | **North Division.** Superintendent. | **West Division.** Superintendent. |
|---|---|---|

| | East Division. | | North Division. | | West Division. | |
|---|---|---|---|---|---|---|
| | Streets. | S'dw'ks. | Streets. | S'dw'ks. | Streets. | S'dw'ks. |
| Timekeepers | 2 | 4 | 2 | 4 | 2 | 2 |
| Foremen .. | 21 | 18 | 23 | 19 | 20 | 23 |

The snow plow, walkaways, etc., are kept in city yards as near as possible to the centre of each section.

*Paper read at the Canadian and International Good Roads Congress.

Each section foreman keeps a list of laborers and owners of horses within his section.

The division superintendent keeps a list of owners of sleighs, single and double, in his division. Each sleigh is numbered and measured. A single sleigh must contain 65 cubic feet, and a double 210 cubic feet.

The superintendents keep at their offices reliable barometers.

At the beginning of a storm, word is sent to all section foremen to gather their forces.

Long before the snow season starts, routes are defined and each plow is detailed to a certain route, so that each man knows where to go and what he has to do.

The Montreal Tramways Company, to keep its tracks clear during a snow storm, has a wonderful organization. Regular routes are mapped out for the sweepers, before the beginning of the winter. Routes that can be handled to best advantage from it are given to each depot. These routes are arranged so that each can be covered by its sweeper in from forty-five minutes to one hour and also arranged so as to have one central conveying point for three or four sweepers. In case of need, it is therefore easy to direct a sweeper from another route, when it reaches this spot.

In each car, a blue print is posted, giving the detailed route of that particular car.

The necessary men are appointed to each car at the beginning of the winter, and they are kept during the entire winter. The superintendent meets all of these men before the winter season and discusses with them proposed improvements on actual conditions.

Their organization is so well thought of, that, as Mr. Gaboury, the Montreal Tramways superintendent, said: "Each man knows where to go and what he has to do, and it seems that he simply goes and does it."

**Machinery Used.**—The Montreal Tramways Co. has 39 sweepers and 12 levellers or wing cars. Most of the sweepers are of the two-broom type, having on the right side a large iron wing to clear the snow from the outside of the track, and on the left side a smaller wing to clear the devil strip.

Single truck sweeper: Two 50-h.p. motors (G.E. 80), and one K10 controller at each end, one K10 controller for broom, length 28 ft., width 8 ft., height 11 ft., weight, 31,000 lbs., wing 8 ft. by 2 ft. Used to brush off the snow from the track and push it towards the sidewalk.

Double truck: Two 50-h.p. motors (G.E. 80), and two K35 controllers for motors, two 101-h.p. motors and one K10 controller for broom, length 39 ft. 6 ins., width 7 ft. 6 ins., height 11 ft., weight 44,500 lbs., wing 11 ft. Does the same work as the first one.

Leveller or wing car: Flat freight car fitted up with iron shaped wing 12 ft. long and 2 ft. high. The wing is pushed out by reinforced wooden bar operated by chains and drum—four 50-h.p. motors (G.E. 80), weight of car 43,400 lbs. Used to push the snow towards the sidewalks.

Single truck leveller or wing car: Made from old box car; length, 26 ft. 7 ins.; height, 11 ft. 1 in.; width, 8 ft. 6 ins.; two G.E. 80 motors; wing, 16 ft. long; weighted down by double floor filled in with rails and cement; total weight, 30,640 lbs.

Walkaways to move snow from the road towards the sidewalk: Ordinary automobile truck, fitted up with a side plow. The plow can be raised and put to any angle.

Snow scarifier used to lower or level the roadway: Hauled with four horses or by a truck. Cost $165 to $200. Built by the city.

Two-horse plow: The plow can be placed at any elevation or any angle. Bought at $150 and built by the city for $85.

One-horse plow: Same as the former one, but lighter. Cost $35, built by the city.

One-horse iron scraper "Jumper," built by the city for $35.

One-horse wooden scraper, used also as a plow: for sidewalks. Built by the city for $18. The bottom of this plow is protected by a flat iron bar, one edge of which is toothed. When necessary, the toothed edge is used on the sidewalk to make a rugose surface.

The machineries are divided as follows:

| | East. | North. | West. | Total. |
|---|---|---|---|---|
| Truck levellers | 4 | 2 | 4 | 10 |
| Walkaways | 11 | 12 | 15 | 38 |
| Snow scarifiers, streets | 4 | 2 | 5 | 11 |
| Snow scarifiers, sidewalks | 20 | 29 | 35 | 84 |
| Plows, double | 6 | 18 | 10 | 34 |
| Plows, single | 96 | 84 | 109 | 289 |
| Jumpers | 35 | .. | .. | 35 |
| Wooden scrapers | 124 | 208 | 99 | 431 |

At the beginning of the storm, all hands are called. The Tramways sweepers are sent out on the route; the city plows are sent out to remove the snow from the roadways and from the sidewalks. The heavier the snow storm, the shorter the routes are made, so that each plow can be back at the starting point before the snow accumulates. Snow shovellers are sent out to keep the street corners clear of snow. Whenever a section foreman feels that his section will be snowbound, he calls the division by telephone for more help.

In case of emergency, section or division lines are wiped out, and everybody works with one ambition—beat all the others in results.

Working hours are the usual hours in a ten-hour day; but, if necessary, the work lasts as long as the snow.

We are now at another phase of the work. The snow has been brushed away from the tramway tracks, from the sidewalks and from part of the roadways. However strong the snow storm and however cold the wind may have been, the tramways have never ceased carrying the laboring class to their work, the office people to their offices, the ladies to the stores; the sidewalks were always kept in such a good state that even "my lady" could not find fault with the city employees; the roadway was clear enough to let the tradespeople deliver their goods.

The work of the sweepers and of the levellers is done, the Tramways crew may now rest and the cars are sent back to the yards.

A new phase now appears. This force is composed of 3,000 men and horses. They attack the snow banks from all sides and cart it away.

The city is, as you are probably aware, built on an island seven miles wide.

The snow used to be dumped in the river from the wharves, or on vacant lots. The larger the city got, the further the northwest boundary was, and the greater the hauling distance became.

The residents facing the dumping grounds objected, with reason, to the snow being left there. There was, therefore, only one place left—the river. But, in places, the distance was so great that the cost was prohibitive.

In 1913, the chief engineer of the city, the late Mr. Janin, thought that the cheapest way to send the snow to the river was by the sewers. Special manholes were built and the snow was dumped in the sewers.

The sewers were not designed for this purpose, and nobody knew what would be the result of throwing such a large quantity of snow and ice in the sewers. The Department of Sewers, responsible for the maintenance and the cleaning of sewers, took the matter in hand and studied the results.

The sewers used were collectors of a diameter varying from 3 ft. to 7 ft. 6 ins. Some were 10 ft. below the roadway, some 42 ft. The length of the collectors varies from 1 to 4 miles; they are mostly built of brick and cement. The "snow manholes," as they are called in Montreal, were made of steel, with a 3-ft. 5-in. by 7 ft. cover.

To prevent large pieces of ice from falling through, a grating having openings of 4 ins. is employed.

After three years of operation, the results were satisfactory. The sewers were, of course, found dirtier, and in some places the invert was crushed by solid ice falling 40 ft.

We have, therefore, designed a new snow manhole covered with galvanized iron ⅛ in. thick, and the sewer was also lined with galvanized iron ⅛ in. thick for a length of 12 ft. We think that this new manhole will answer this purpose, and withstand the shock of the falling ice.

The distance between the manholes varies very much, but the longest haul is approximately 2,000 ft.

**Cost of Work.**—The cleaning of sidewalks, including the spreading of sand, scraping, etc., costs 7½ cents per running foot.

The cost of removing snow from streets is $2,500 per mile.

## WINNIPEG AQUEDUCT REPORT DELAYED.

At least five or six weeks more will elapse before the board of engineers who are conducting the inquiry concerning the Winnipeg-Shoal Lake Aqueduct will be able to report finally.

At the usual fortnightly meeting of the board of the Greater Winnipeg Water District, on July 14th, a letter was read from the engineers to the effect that certain important experiments and tests had yet to be carried out and the results of these were necessary to enable the commission to answer the questions submitted.

The result of these tests will, the letter stated, enable the commission to determine whether or not a more economical system of strengthening the inverts may be adopted. Also some of the flooded portions have yet to be examined when the water recedes.

Reeve McColl, of Assiniboia, asked the chairman, Mayor Waugh, whether the new work now being done is along the lines recommended by Mr. Cantell. The chairman replied that the new work is being done upon the recommendation of seven good engineers, and that that should be enough.

Letters were read from several municipalities endorsing the board's action in devoting $5,000 to the colonization of the water district. The only exception was Assiniboia, whose council objected to the outlay.

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The following is a list of Canadian patents recently issued through the agency of Messrs. Ridout and Maybee, 59 Yonge Street, Toronto, from whom further particulars may be obtained:—Samuel Glover and John West, gas producers; Charles O. Bastian, electric incandescent bodies for glow-lamps; Edward B. Killen, pneumatic shock-absorbing devices; Alfred Bailey, packings for stuffing boxes; Joseph L. Dixon, electric furnace; Bricknell Bros., rotary internal combustion engine; Frank Iliff, heating and ventilating apparatus; Chas. W. Tozer, construction of retorts for the distillation of carbonaceous materials; T. B. Grierson, safety slings for lifting packing cases, bales, barrels, etc.

## LETTER TO THE EDITOR.

### Proposal to Dam Niagara Rapids.

Sir,—The writer is in receipt of your communication enclosing a clipping of your editorial of July 6th, and wishes to thank you for the courtesy extended in your invitation to comment upon the question of the proposed dam across the Niagara River at Queenston.

It is difficult to consider this matter in a serious vein, because the problems involved are so stupendous that the probable consequences following the construction of such a structure as you describe are impossible to conjecture except through the medium of a very lively imagination. There are a few obvious facts, however, which may be of assistance in directing flights of fancy toward a more or less rational conclusion.

In this connection, it might be instructive to point out the manner in which ice is periodically discharged through the gorge during a part of the ordinary winter season. The surface velocity of the water in the upper gorge is so slow that the ice, as it rises after its submergence in the vortex of the cataract, finds itself crowded by ice already lying nearer the surface, and the result is a so-called ice bridge, or jam of ice, arching itself between the abutting banks of the gorge. It is quite clear that the chief contributing cause of this condition is the sluggishness of the surface velocity. Under favorable weather conditions the bridge remains a more or less stable structure; but, in mild winters, when a high wind is able to break up the ice on the surface of Lake Erie and start it down the river, a new set of phenomena is observable. The jam then begins to thicken by the application of new layers of ice underneath, and at the same time extends its surface, in some cases even to the narrowing neck just above the cantilever bridge. This thickening process continues, heaving the surface by flotation, higher and higher, and incidentally gradually stopping off the discharge of the river underneath the jam. The restriction of the flow causes the water to back up until sufficient pressure is developed against the ice-pack to move it *as a glacier* and shove its nose into the swift water at the head of the rapids, where the mass is continually churned into small bits and usually gets away as fast as it is being fed by the glacier. The water has been known to rise in the upper gorge, some forty feet, due to this cause, and the writer has observed the ice surface opposite the Hydraulic Power Co.'s plant, to be just about even with the eaves of the building, although the discharge from the tail-races kept the floe free from the building.

The construction of a dam rising ninety feet above the water level at Queenston would render sluggish the surface velocity for a good part of the five miles from the cantilever bridge to Queenston, so that the relief point for the nose of the glacier would be *gone*, unless the dam crest, five miles further down stream, might be imagined to serve the purpose.

The question is, how high would the water need to rise to develop sufficient pressure to move this new glacier, including in its course, a sharp right-angle bend at the Whirlpool site? Of course, the answer must be only problematical, but how can it be conclusively shown that this artificial condition would not result in a filling of the upper gorge with ice—even to the top? This presumption is naturally partly contingent upon whether the dam remained in place, or took the easier course down stream.

The writer would not like to have it understood that he regards any obstacle in connection with this dam project as absolutely insurmountable, for he believes that with unlimited capital and engineering talent of the highest order, almost anything rationally conceivable may be accomplished, if there is a strong enough public sentiment demanding it. But it is safe to say that a number of the problems to be encountered in the construction of a power plant as described, would need to be solved by the trial and error method, somewhat as is frequently done in laboratories, and such experiments as outlined in your editorial, which would have to be conducted on a full grand scale to be at all instructive, would not tend to promote faith in any estimate of cost.

R. D. JOHNSON, Consulting Engineer.
(Formerly Chief Hydraulic Engineer of the Ontario Power Co., Ltd.)

New York City, July 18th, 1916.

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## AN EXPENSIVE PAVING "ECONOMY."

Andrew F. Macallum, works commissioner of Ottawa, Ont., who was until very recently city engineer of Hamilton, Ont., made some interesting remarks while presiding at the last annual meeting of the American Society of Municipal Improvements, which show that some "economies" in engineering work are expensive in the long run.

"About four years ago," said Mr. Macallum, "some bright mind suggested the idea of doing without a binder in asphalt paving, and in a moment of weakness I accepted the suggestion, and unfortunately tried it on two streets. Both of these streets developed the handsomest waves that I have ever seen on any streets in the country. The streets ran east and west, and peculiarly enough the waves were formed on the south side of the street almost to the centre line in the second year, and about the fourth year on the other side of the street; that is, they formed continuously across. The idea at the time, I think, was to roughen the base and do away with the binder, and save about thirty-five cents, but as a matter of fact it was a great failure."

The official report of the meeting also contains other interesting comments on Hamilton paving work, as follows:—

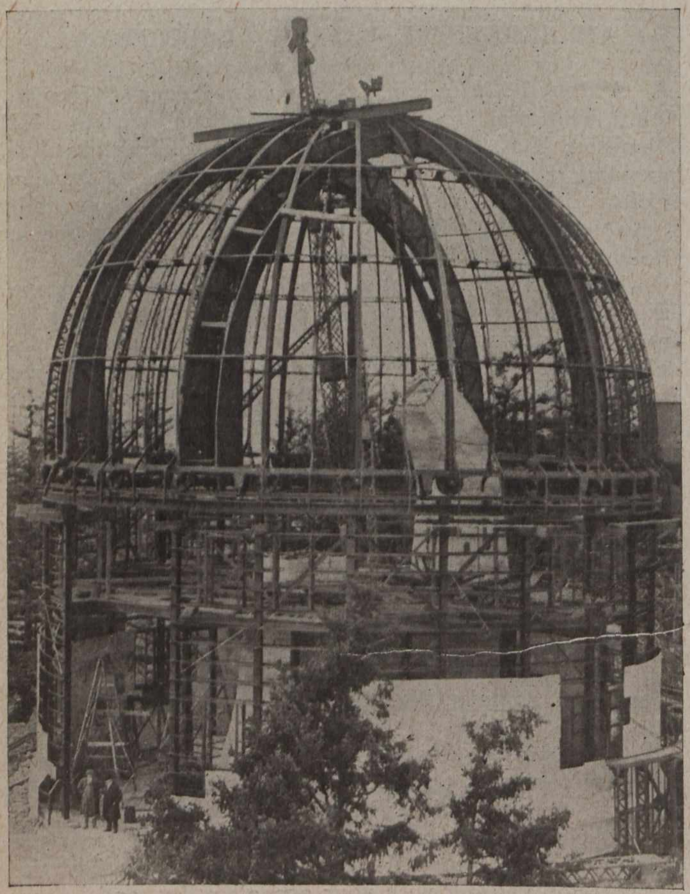
"Recently we found in some streets where there is heavy motor truck traffic, that the compression which is given to sheet asphalt with the ordinary asphalt roller is not sufficient. The great compression you get from the wheels of these motor trucks is much greater than the compression you get with your asphalt roller, and I have found it necessary in streets of heavy traffic to put on a road roller also.

"On one street in Hamilton, called John Street, we had a six or seven per cent. grade, and we used a pavement called asphalt concrete. That is what we called it at the city hall, but the people who use the pavement call it other things. It is different from the ordinary asphalt, and being on a seven per cent. grade, our own teamsters in hauling stone down there developed the faculty of going down with the rear wheels going along in the gutter at right angles and scraping the curb, but those living outside the city did not realize the possibilities of such a pavement, and they generally came down with the wagon first and the horses after. I found that this pavement, which is supposed to have a rougher face than the sheet asphalt, developed a surface that was much smoother than an asphalt pavement; in fact, it was polished. I just want to point out the fact that on a grade of that nature, almost any kind of bituminous pavement will get to such a state that it is just as smooth as an asphalt."

## THE GREAT DOMINION TELESCOPE.

UNDER the above heading, *The Canadian Engineer* published, last week, a brief description of the 72-inch reflecting telescope installation at Victoria, B.C. In an article prepared for the July 20th issue of Canadian Machinery, through whose courtesy we reproduce the four accompanying illustrations, Prof. J. S. Plaskett, of the Dominion Astronomical Branch, who will be in charge of the Victoria Observatory, gives some further interesting details from which the following notes have been abstracted:—

**The New Observatory.**—The road to the summit of Saamih Hill, the site of the new observatory, which is about seven miles north of Victoria, B.C., was completed

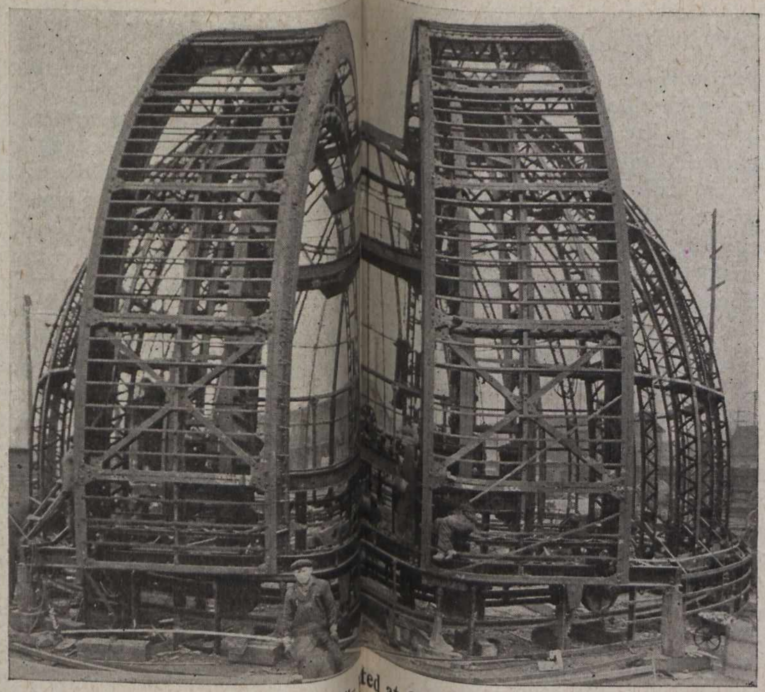


Dome of Telescope Building, May 5th, 1916.

early in the spring of 1915, by the government of British Columbia, who contributed $10,000 towards the purchase of the site and had agreed to build a road from the present main road to the summit of the hill where the observatory building was to be located. Although the first source of water supply was a failure, this important question is now satisfactorily solved.

The concrete pier for carrying the telescope and the surrounding circular steel building whose wall serves to support the dome, was commenced last summer and is now completed except for some minor details which were delayed awaiting arrival of the telescope. One of the essential features about the building and dome is that they are entirely of steel construction, which allows them to rapidly assume the air temperature. They are provided with double walls and a system of louvres at the top of the dome, ensuring a thorough circulation of the air and the maintenance of the interior at the shade temperature.

A contract for the 66-foot revolving dome, which, in the case of a large reflecting telescope, is a most important part of the equipment, as it has to be provided with many accessories required in the handling of and observation with the telescope, was awarded in May, 1915, to the Warner & Swasey Co., so that dome and telescope were designed together, and should work in proper relation to one another. This dome is now being erected on its building at the observatory site, and although it has not yet been operated, its temporary erection at Cleveland sufficed to show that it will be the most complete and convenient in every operating detail of any ever built.



Dome Temporarily Erected at Cleveland, Ohio.

One of the observer's houses is completed, but none of the other buildings required have yet been begun.

**The Telescope.**—The telescope, whose general form follows the English type of equatorial mounting, has a long polar axis supported at its north and south ends by bearings, in a direction parallel to the earth's axis. The declination axis, to which the tube is attached at right angles, passes rectangularly through the central cubical portion of the polar axis, the weight of the tube on one side being counterpoised by the declination gearing and housing on the other.

The polar axis is composed of three sections, all of the best steel castings, firmly bolted together, namely, the central cubical section above mentioned and north and south conical tubular sections. It is nearly 23 feet long and weighs about 10 tons. The declination axis is a steel forging, $5\frac{1}{4}$ tons in weight, $14\frac{1}{2}$ ft. long by $15\frac{1}{2}$ ins. in diameter, with a flange 41 ins. in diameter by 4 ins. thick, to which the tube is bolted. The tube is also in three sections, the central cylindrical steel castings, about $7\frac{1}{2}$ ft. in diameter by 6 ft. long, weighing 7 tons, being attached to the flange of declination axis; to the bottom flange of this central section is bolted the steel mirror cell, weighing with mirror counterpoises and mirror, 6 tons; while to its upper end is firmly attached the skeleton tube, a beautifully designed and extremely rigid piece of structural work, upwards of 23 ft. long by $7\frac{1}{2}$ ft. in diameter, and weighing, with attachments, about two tons.

Structural Steel Work of Telescope Building.



**Spectograph and Visual Appliances.**—Below the mirror cell the spectograph and visual appliances for use at the Cassegrain focus are attached. At the upper end of the skeleton tube an exceedingly ingenious arrangement, avoiding the use of several heavy and awkward extensions of the skeleton tube, which were necessary with all previous reflectors, enables either the prime focus, Newtonian or Cassegrain attachments to be used at will and with the minimum of trouble and delay in changing from one to the other.

The driving clock, similar in design to that which has been so successful in the Lick and Yerkes telescopes, moves the telescope in right ascension by means of an accurately cut worm-wheel 9 feet in diameter, mounted on the polar axis by ball and ball thrust bearings and clamped to it when required by an electric motor.

**Telescope Electrically Operated.**—The telescope is moved from one position to another and set and guided wholly by electric power, no less than seven motors besides several solenoids and magnetic clutches being required for these motions. The quick-motion motors move the telescope at the rate of 45 degrees per minute, one revolution in 8 minutes, in both co-ordinates. The slow motions have two speeds, a fast one for fine setting at the rate of one revolution in 36 hours, and a slow one for guiding, one revolution in 720 hours or 30 days. With the Cassegrain focal length of 108 ft., the guiding speed of the star image at the focal plane is 1/300th in. per sec. or 1/5th in. per min.

The electric wiring and control systems have been carefully worked out, all sliding brush contacts avoided, and the whole system installed in a permanent and yet easily accessible form, giving the maximum of convenience in operation with the minimum of attention and repair. The method of operation will be as follows: An operator on the observing floor controls the quick motion and clamps of the telescope and the rotation of the dome from the most convenient of the switchboards, one on the east and the other on the west side of the south pier, the telescope being quickly set approximately to the tabular position of the desired object by the sideral and declination setting circles. The observer at either the upper or lower ends of the tube can clamp or unclamp the telescope, make the fine settings and guide by means of push buttons located on a small keyboard which he can carry around with him or attach to any convenient place.

**High-grade Workmanship.**—The mechanical workmanship throughout is of the very highest grade, such indeed being necessary for the proper performance of the required operations. The principal mechanical feature wherein it differs from other telescope mountings is in the main bearings, in the skeleton tube, in the accurate cutting of the driving worm wheel and in the extensive use of steel castings for the principal parts.

It has always been considered necessary hitherto by astronomers to have the alignment or collimation of the polar and declination axes determined by cylindrical journals and bearings and to reduce the friction on these

Telescope Pier and Telescope Building Foundation.

sliding contacts by ball or roller relieving devices. The perfection of modern ball bearings has rendered this arrangement unnecessary and the main bearings are wholly of the self-aligning ball form, the S.K.F. Swedish bearing. The friction is thus much reduced and a very slight pressure on the tube is sufficient to set it in motion. The amount of current consumed in moving the telescope in quick motion would only be sufficient to light one 16-c.p. incandescent lamp.

**The Skeleton Tube.**—The essential features about the skeleton tube are its lightness, its great stiffness and the new method of interchanging the attachments at the upper end. It is built up of ordinary structural members, the stiffness being given by diagonal steel tension rods which are screwed up sufficiently tight so that they are always under tension, even the lower set when the tube is horizontal. The interchanging of the Newtonian & Cassegrain mirrors at the upper end of this tube, previously accomplished by fitting each into a separate extension of the tube, thus entailing the handling of awkward and heavy pieces, has been much simplified in this telescope by leaving the tube full length and devising a simple means of interchanging the mirrors only. Less than one-quarter the weight has to be handled, it can be done in one-tenth the time, and with no danger of accident.

The worm wheel, which is 9 ft. in diameter with 720 teeth cut in its bronze rim, was mounted on a rigid stand on its own ball and ball thrust bearings and each tooth cut by a cutter set at the proper angle. The spacing was done by means of a circle 42 ins. diameter graduated on silver to half degrees by the Warner & Swasey circular dividing engine whose greatest error is six-tenths of a second of arc. This was concentrically mounted on the worm wheel and the settings made by two micrometer microscopes. The teeth were cut around three times to remove any error due to springing and the previously lapped worm and the worm wheel were finally polished together by running them for several days with rottenstone and oil.

The three sections of the polar axis, the declination sleeve, the central section of the tube and the mirror cell are all steel castings heat treated. They were cast and machined at the Bethlehem Steel Works and are striking examples of the perfection to which the process has attained. They are entirely free from blow holes or other defects and as tough and homogeneous as forgings.

**The Mirror.**—The 72-in. mirror, which is 12 inches thick at the edge, has a hole 10⅛ inches in diameter through the centre, and weighs some 4,340 lbs.; is finished on edges and back, and its front surface is now practically spherical. Before it can be made a paraboloid of revolution, the surface necessary to bring the parallel pencil of light from any celestial object accurately to a focus, it is necessary to prepare a large flat surface for the purpose of testing the paraboloid. It is hoped that this will be finished and the mirror completed as soon as the mounting is ready to receive it.

The mounting was practically completed and it was temporarily erected in the factory of the makers, the Warner & Swasey Co., of Cleveland, Ohio, about the end of March last. Some finishing touches to one or two details, the holding of a formal reception and exhibition of the telescope, delayed by the absence of members of the firm until March 25th, and the fact that the dome was not sufficiently advanced to offer protection from the weather, caused the postponement of the shipment to Victoria until the middle of June.

The erection of the mounting will occupy some three months, hence occurring during the most favorable season, and should be completed by the early autumn.

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## INDUSTRIAL USES OF HYDRO-ELECTRIC POWER.*

By J. B. Challies,

Superintendent, Dominion Water Power Branch.

AT the present time the great steel mills of this continent are absolutely dependent upon the electric furnace for the production of alloys. The automobile manufacturer is dependent upon another electric furnace production, aluminium, for car bodies. The manufacturer of steel products needs these materials for making tools, and countless factories require abrasives which cannot now be imported, and which are now being produced in the United States, at any rate, only by electric processes. Without acetylene gas and graphite, and other electric products, many existing industries would be absolutely crippled.

So far as the products of electro-chemistry are concerned, it is found that the surgeon and the doctor look to electric plants for chloroform and disinfectants; the cotton and the paper manufacturer need the bleaches produced by electricity; the user of soap patronizes the electro-chemical establishment, as does every user of matches. Gold and silver mining of the west requires electric products to assure a profit, and it is only lately that the United States, cut off from its supply of German dyes, has found itself dependent upon electric products to supply the deficiency, in part at any rate.

These are but a few of the industries dependent upon cheap electric power. The further development in either Canada or the United States, or the inauguration of such processes in Canada, is very largely, if not altogether dependent upon cheap available, dependable power. The source of such power is admittedly, for a very large portion of our country, water-power. The development of water-power in making available a supply of cheap hydro-electric energy in various parts of the Dominion, would probably result in the reduction of the cost to the consumers of countless articles of every-day use, which, to the man on the street, are in no way associated with hydro-electric development.

To be more specific, the manufacture of steel is one of the greatest of the United States industries, and is fast becoming a very important one for Canada. To-day, electrically produced ferro-silicon is used as an alloy by most steel manufacturers, with the result that the Bessemer process is fast becoming obsolete. The essential element in the manufacture of armour plate and armour-piercing projectiles, is introduced into steel by the alloy, ferro-chromium, strictly an electric furnace product.

Ferro-chrome, another product of the electric furnace, has made possible the manufacture of high-speed tools, which in turn have tripled the capacity of our machine shops and enhanced the efficiency of our mechanics. It has cut to one-third the capital invested in tools to accomplish a given volume of work.

In the absence of chromium, tungsten, vanadium and molybdenum, all alloys made by electrical processes, the builders of American battleships and other weapons of national defence, and a large portion of our Canadian steel and metal-working industries and other industries, would be in the condition of twenty years ago. The electrical industry itself is largely dependent upon silicon steel, a product that does not age and does not wear.

The development of aeroplanes also calls for aluminum, and only with the abundant production of cheap electric energy from water-power will the price of aluminum kitchen utensils come within the reach of every housewife.

At the outbreak of the war, we were cut off from the supply of Greek and Turkish emery. To-day the metal-

*(Continued on page 82.)*

*From the weekly bulletin of the Department of Trade and Commerce.

# The Engineer's Library

**Any book reviewed in these columns may be obtained through the Book Department of The Canadian Engineer, 62 Church Street, Toronto.**

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## BOOK REVIEWS.

**Military Preparedness and the Engineer.** By Ernest F. Robinson, A.M.Am.Soc.C.E. Published by the Clark Book Co., Inc., New York. First edition, 1916. 224 pages, 75 illustrations, 4¼ x 6¾ ins., flexible leather. Price, $1.50. (Reviewed by F. A. Snyder, M.Can.Soc.C.E., M.Am.Soc.C.E., Lieut.-Col. National Guard of Pennsylvania—retired.)

This book, while primarily written to encourage military preparedness by the engineers of the United States, can be read with interest and profit by the engineers of any country, especially those engineers or line officers and N.C.O.'s who in peace or war times desire to perfect themselves in the rudiments of military field engineering so as to give their government the best use of their services. The author explains the different work of the engineer in war, how best to obtain a military training, the National Guard or Organized Militia, Military Organization and Administration, the duties, organization, equipment and special services of engineer troops in the field.

Rifle and artillery fire is fully explained, and their effects shown.

Field fortifications are shown in detail and embody practically the latest types used in Belgium and France. The different types of obstacles are shown.

Siege works are described in detail. In the chapter on Demolitions is an excellent article on "High Explosives," by Professor M. C. Whitaker, of Columbia University.

Military bridges, knots and lashings, pile, spar, trestle and floating bridges of all kinds are fully described.

In the chapter on Topographical Sketching the different methods in use by the military topographers of the U.S. Army are described. These differ quite a lot from the methods in use in the British Army, as the preference is given to the plane table methods, either with or without a compass set in the board.

With these methods it is possible to teach men who had no previous knowledge of surveying, how to make good sketches in two or three lessons, and the prismatic compass is only used for running traverses for control.

These methods should be used more by engineers in civil life for rough reconnaissance surveys for railroads, drainage projects, etc.

The book closes with a brief description of the needs of the engineers in war, and in an appendix is shown a list of references of books that are recommended for reading by civilian engineers and a list of property carried by an engineer company in the field.

While this book does not attempt to cover the whole field of military engineering, it does give the preliminary details in a readable form that should interest civilian engineers and line officers in this branch of the service.

**Concrete Construction for Rural Communities.** By Roy A. Seaton, M.S., Professor of Applied Mechanics and Machine Design, Kansas State Agricultural College. Published by the McGraw-Hill Book Co., Inc., New York. First edition, 1916. 223 pages, 96 illustrations, 5 x 8¼ ins., cloth. Price, $2 net. (Reviewed by J. F. Rhodes, Canada Cement Co., Montreal.)

This book in Part 1 covers very thoroughly all those points in regard to materials which are used in making concrete and also the methods used in the field and in the laboratory to test these materials.

In Part 2, "Plain Concrete," the problem of proportioning concrete is well covered and a good explanation is made in regard to the advisability of correctly apportioning concrete. A rule is given which, while it is not new, is made in very plain terms, so that it can be used by any man not well acquainted with engineering formulas. This rule is adapted from Mr. Fuller's rule as to the proportioning of concrete.

In the Part "Reinforced Concrete," he has given in very plain language the necessity of reinforcing and a general discussion of the different materials that are used for reinforcement. He also gives some problems and solutions in this section of the book which are very simple and can be understood and applied by anyone accustomed to doing small building operations.

Part 4 covers miscellaneous matters and goes very much into detail in the production of good surface finishes in concrete, in the use of cement for stucco and plaster work and also in the theory and methods of obtaining waterproof concrete. In this section the methods of constructing building blocks, bricks, drain tile and pipe are covered fairly well and enough information is given to instruct the ordinary builder how to make these products of concrete.

The book as a whole is one which covers the use of concrete in smaller structures completely and is written in a language which can be readily understood by farmers and small contractors. While there is really nothing new in this book of any consequence which has not already appeared in print, it is one of the first books which has appeared on the market which has covered the subject as completely as it is given within its covers.

**A Treatise on Hand Lettering.** By Wilfred J. Lineham, B.Sc., M.Inst.C.E., M.I.Mech.E., M.I.E.E. Published by Chapman & Hall, London. First edition, 1915. 282 pages, 117 plates, 8 x 12 inches, cloth. Price, $2.50. (Reviewed by J. H. Parkin, B.A.Sc., Lecturer in Hydraulics, University of Toronto.)

While good lettering is recognized as being essential in drafting practice, lettering has not been developed nor applied in America to the extent that it has in Europe, due to the difference in the drawing office methods employed. Because of its importance, many books have been published devoted entirely to lettering, and it is dealt with more or less briefly in works on drafting, machine design, etc. The present treatise, however, while written from the standpoint of European practice, is a distinct departure from the usual lettering text, in the clearness of the explanations of the methods, and the number, arrangement and character of the copyplates.

The author treats the drawing of the letters in several stages, namely, pencil outline, inking, complete and properly spaced alphabets, continuous sentences, centralized titles, and applications to drawings. The drawing of each style of letter, commencing with those most commonly used, is shown in these successive stages by a series of plates accompanied by explanatory notes, outlining the method clearly and drawing attention to the difficult points. The letters and figures are arranged on the plates, first in order of difficulty, then alphabetically and numerically, followed by the plates of sentences and titles, the examples chosen for the latter being those likely to occur in the practice of engineers and architects. In addition to the usual types of letters, the familiar American (Reinhardt) and the European "Engrossing" styles are illustrated. Several varieties of letters are shown suitable for architects, together with typical titles, samples of mottoes for friezes and examples of Greek letters, rubber stamp and stencil letters. Short explanations are also included of shading, zincography, photo printing processes, patent office drawing requirements, and the making of scales. An important section of the book is that devoted to the figuring of dimensions showing the proper placing of dimensions, arrowheads, figures, and so on. The book is completed by a series of folding plates showing examples of good practice in various types of drawings, mechanical, civil and architectural.

Summing up, the subject of lettering is dealt with in a comprehensive and practical way, the extreme and seldom used styles having been avoided and the drawing of those in everyday use fully and clearly illustrated. The methods used make the book equally useful for self-instruction or school use. The book will undoubtedly prove of great assistance to all those desiring to become proficient letterers and should make a desirable text for engineering and technical schools.

**Irrigation Structures, Vol. III.** By B. A. Etcheverry, Head of the Department of Irrigation, University of California. Published by McGraw-Hill Book Co., New York. First edition. 421 pages of text, 186 cuts, 20 plate inserts, 6 x 9 ins., cloth. Price, $4 net. (Reviewed by H. G. Acres, Hydraulic Engineer, Ontario Hydro-Electric Power Commission.)

This volume is the third and last of a series having the general title "Irrigation Practice and Engineering," the specific titles of the first and second volumes being respectively, "Use of Irrigation Water and Irrigation Practice" and "Conveyance of Water."

The scope of the work as a whole is clearly set forth by the author in his preface to the third volume, from which the following is quoted:

"This treatise on irrigation engineering, as presented in Volumes II. and III., is largely confined to canals and other works which pertain to the usual types of irrigation systems. No attempt has been made to discuss the subject of dams used for the development of storage, and of high masonry dams used for the diversion of water. On the other hand, much space has been devoted to a rather complete consideration of low dams used for diversion weirs.

"The division of this work into two volumes has been made primarily to avoid an excessively bulky book in one volume. The division has had to be made more or less arbitrarily. These two volumes are not entirely separate from Volume I., which has been presented as an introductory volume, and to which reference is made in Volumes II. and III."

It appears, therefore, that as a complete treatise on the subject of irrigation, the three volumes must be regarded as one.

The subject matter of Volume III. is divided into thirteen chapters, having the following headings:—

Diversion Works, Scouring Sluices, Fish Ladders, Logways, Main Headgates or Regulation for Canal System, Canal Spillways, Escapes and Wasteways, Sand Gates and Sand Boxes, Crossings with Drainage Channels, Drops and Chutes, Distribution System, Check Gates, Lateral Headgates and Delivery Gates, Road and Railroad Crossings with Canals, Culverts, Inverted Syphons and Bridges, Special Types of Distribution Systems, Measuring Devices.

To each of the above chapters is appended a copious and valuable list of references. Also throughout the text are distributed a considerable variety of cost data so analyzed and sub-divided as to be most useful for estimating purposes, if used with judgment.

As the author himself indicates in his preface, the volume under discussion cannot be considered as complete in itself, nor, with the possible exception of the first four chapters, is the subject matter susceptible of general application. Chapter 1, which contains an interesting and suggestive discussion on weirs on pervious foundations, is worthy of study by any engineer having to do with hydraulic problems, as is also Chapter 4, which contains an especially valuable theoretic and descriptive treatment of syphon spillways and automatic flashboards.

The evident function of this volume, with its predecessors, is to serve as a text and reference book for the practicing irrigation specialist and the student of irrigation engineering. Judging from Volume III., the author would seem to have produced a work which, as a whole, covers the subject in greater detail than the works of earlier authors, and which, in view of its recent publication, has the additional merit of being quite up to date.

**Ford Methods and the Ford Shops.** By H. L. Arnold and F. L. Faurote. Published by the Engineering Magazine Co. 440 pages, illustrated, cloth, 7¼ x 10¼ ins. Price, $5 net. (Reviewed by J. E. Burns.)

This book is a rearrangement of a series of articles that appeared in the Engineering Magazine, and originated at the suggestion of the editor of that paper. It is wholly descriptive of the men, methods and machinery of the Ford Automobile Co., of Detroit. We are told in the preface that "To the manufacturer, manager or engineer confronted by the problems of mechanical production, this exposition will excel in interest and value anything of the kind heretofore attempted, not only by the intrinsic quality of the text and illustrations, but by their exposition of what up to now is the final word in efficient, standardized, repetitive production." If we discount the above statement sufficiently it gives a good idea of the book.

For the man who wants to know just how things are done at the Ford plant, it leaves nothing to be desired. Certainly the Ford shops hold no secrets, and in this case, are literally an open book. Much of the matter is of special interest; but on the whole, the work holds a deal of valuable description and suggestion for the manufacturer and engineer.

The text is marred to some extent by the introduction of matter more or less superfluous, and by a tendency to verbosity. As a case in point, we are admonished thus: "Let not the reader hasten to conclusions based on meagre information. All economists are agreed that the only reason why any one man works for another man is because the hired man does not know enough to be the director of his own labor. And, incontrovertibly, the employer being wiser than the employed, the wisdom of the employer should be applied to the benefit of the employed, to some extent at least."

Chapter I., entitled "The Genius of the Plant," is an essay in hero-worship, and a trifle overdone. The remainder of the book, with the exceptions noted, is timely and readable.

**English and American Tool Builders.** By Joseph Wickham Roe, Assistant Professor of Machine Design, Sheffield Scientific School, Yale University. Published by Yale University Press, New Haven, Conn. 315 pages, 57 illustrations, 6½ x 9½ ins., cloth. Price, $3.00 net.

The main purpose of this book is to emphasize the importance of the work and influence of the leading machine tool builders with a view to pointing out the important part they have always played and must continue to play in the development of the modern industrial arts. The book will be welcomed as a very valuable addition to the bibliography of the machine tool industry. Chapter 1 is devoted to a discussion of the influences of the early tool builders. Chapters 2, 3 and 4 deal with the work of Messrs. Wilkinson and Bramah, Bentham, Brunel and Henry Maudslay, respectively. Chapters 5 and 6 deal with the men who are connected with the invention of the planing machine, and Chapter 11 is devoted to the subject of the growth of the interchangeable system of manufacturing.

**Poor's Manual of Public Utilities.** Published by Poor's Manual Co., New York. 2,500 pages, 5¾ x 8¾ ins., bound in cloth.

Complete and up-to-date financial statements, practically of every public utility company in the United States and Canada in which there is public interest, are presented in this manual, just issued. The book is one of the largest and most comprehensive works of its kind.

A new feature of the Manual is the "Margin of Safety" over interest or dividend requirements of individual stocks and bonds. This margin is a practical rating of securities based only on facts. It answers the first question before making an investment: "What is the risk involved?"

The Manual gives general information revised to June 15, 1916; income accounts and balance sheets are given as of December 31, 1915, and some as late as April 30, 1916. It is in every respect up to the high standard of other years.

The completeness of the Manual is well shown by the fact that it devotes 39 pages to the American Waterworks and Electric Co.; 34 pages to the United Gas and Electric System; 67 pages to the United Light and Railways System; etc.

**Canadian Mining Manual, 1915.** Edited by Reginald E. Hore, Editor of The Canadian Mining Journal, and published by the Mines Publishing Co., 263 Adelaide Street West, Toronto. 432 pages, illustrated, 7¼ x 9½ ins., cloth.

This well-known handbook of information concerning the minerals and mines of Canada has again made its appearance, and is filled with valuable data that is of special advantage and interest to those who have to do with the Canadian mining industry. A great deal of valuable statistical information is given concerning the mining interests, gleaned from government reports, company reports and other sources. It is well illustrated. A very useful list which the book contains is that of the mining companies, this being arranged according to the product.

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## PUBLICATIONS RECEIVED.

**Highways Department, Nova Scotia.**—Annual report of the Highways Division of the Department of Public Works and Mines of Nova Scotia. Hiram Donkin, C.E., chief engineer.

**Forest Branch, B.C. Department of Lands.**—The report of the Forest Branch of the Department of Lands, Province of British Columbia, for the year ending December 31, 1915. Includes discussion of market extension, forest records, land classification, forest reconnaissance, forest branch organization, forest protection, etc.

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## CATALOGUES RECEIVED.

**Vulcan Soot Cleaners.**—Ninety-page catalogue published by the Vulcan Soot Cleaner Co., Du Bois, Pa., specializing on cleaning apparatus for boilers, superheaters, economizers, etc.

**Engineering in Foreign Fields.**—A thirty-page publication issued by the J. G. White Companies, New York and London, showing photographs of bridges, tramways, railroads, power plants, etc., constructed in countries other than the United States.

**Little David Pneumatic Tools.**—A very interesting circular published by the Canadian Ingersoll-Rand Co., Limited, Sherbrooke, P.Q., illustrating their range of pneumatic tools and showing views of the many different classes of work upon which they can be used.

**Meco Conveyers.**—A new catalogue issued by the Mining Engineering Co., Limited, Moorefields, Sheffield, England. Illustrations show installations both underground and upon the surface.

**Coal and Ash Gates.**—New catalogue issued by C. W. Hunt Co., Inc., West New Brighton, N.Y., dealing with coal and ash gates or valves for controlling the flow of bulk materials. Well illustrated.

**Duplex Exciter.**—Booklet issued by the Terry Steam Turbine Co., Hartford, Conn., describing duplex exciter sets for large steam generating stations.

**Graphite Lubrication.**—Booklet giving facts about lubricators that are made for use of graphite alone or with oil. Issued by the Joseph Dixon Crucible Co., Jersey City, N.J.

# Editorial

## NIAGARA EXPORT POWER SITUATION.

Statements recently made to the daily newspapers by Sir Adam Beck, have brought home to the public in a forcible and dramatic manner, a realization not only of the marvellous growth of "the Hydro," but of the very real dependence of Ontario's industry upon the policy pursued by the Federal authorities in regard to the export power at Niagara Falls.

In September, 1910, the Hydro-Electric Power Commission's Niagara system began operations with a load of 600 h.p. That system is now carrying a load of 110,000 h.p. When the commission executed a contract with the Ontario Power Co. for the supply of 100,000 h.p., it was confidently expected that this amount of power would meet all the requirements of the Niagara system for at least 30 years. The commission has actually more than exhausted this contract in less than 6 years' operation, hence the urgent necessity of negotiating the 50,000 h.p. contract with the Canadian Niagara Power Co., concerning which much discussion has recently appeared in the daily newspapers.

Even upon the basis of the past rate of increase and demand, the commission will certainly require 200,000 h.p. or more to supply Niagara system alone in 1918. If this estimate is correct, the extra 50,000 h.p. will be absorbed within a year, and at least two years more will probably elapse before the commission's Queenston plant will be in shape to deliver power. If, as would seem to be the case, the existing plants at Niagara Falls have not sufficient ultimate capacity, in view of their other contract obligations, to meet the increasing demand of this two-year interim, what is to happen?

It would inevitably result that the present power shortage, serious as it is, would increase during the next three years in spite of any preventative means which could reasonably be taken. This shortage would be especially serious, in that it would probably obtain during the critical period of reconstruction following the declaration of peace, when every available natural resource of this country must of necessity be used to the limit of its economic value. This view leads naturally to a query as to whether the "contract obligations" of the power companies are really of such a nature as to make it impossible for them to meet the increasing demand for power in Ontario during the next three or four years.

Under the Federal law, Canadian power companies are permitted to export certain quantities of power to United States through the granting by the Dominion government of licenses, renewable annually and revocable at will. Information is not available as to the precise amount of power permitted to be exported under licenses, the issue of which is now understood to be pending, but licenses in force as recently as 1915 permitted the power companies at Niagara Falls to export an aggregate of about 210,000 h.p. to the United States.

In issuing these licenses it is understood that the Dominion government specifically cautioned the Niagara power companies against making binding contracts for the permanent supply of exported power to their American customers, in view of the revocable nature of their licenses and the possibility of the power being later required in Canada. Furthermore, the purchasers of this exported power were officially warned through the State Department at Washington that the Dominion authorities reserved the right to exercise to the fullest extent the provisions of the federal statute governing the export, and of the terms of the licenses therefor. In view of the clear-cut stand it has taken, it would seem that from an international standpoint, the Dominion government could not be justifiably accused of committing an unfriendly act if it should see fit to exercise its well-defined rights in the matter of reclaiming the power now being exported.

In this latter expedient appears to lie the answer to the query propounded above, as to how the power shortage can be met. It appears to be the only possible means of supplying the ever-increasing demand in Ontario pending the delivery of power from the commission's projected plant.

The carrying out of such a policy as this might fairly be discussed from a standpoint of possible injury to the present users of this imported power in New York State, and also with a view of proposing a remedy for the injury, if such there be.

While the position of the Dominion government is undeniably strong from a legal standpoint, there is nevertheless the fact to be faced that notwithstanding the clearly defined limitation as to export, a large vested interest has been created in New York State, apparently based upon the assumption that the imported power would be permanently available. The attitude taken by those interests is clearly set forth by the New York State Public Service Commission, which states in a recent decision:—

> "Without going into details, it seems sufficient to say that the prohibition of exportation from Canada of this present electric power which now comes into this country would paralyze business and industry of many kinds, and would deprive numerous localities of electricity for light. American-produced Niagara power is so far from supplying the vital needs of the sections of the state above described, that the immediate results of such prohibition would plainly amount to a great public calamity.
>
> "We have nothing before us but the suggestion that the Dominion of Canada may at some future time forbid this exportation. This commission must assume that international relations affecting so important a subject as the means of continuing great industries which have grown up in reliance upon the use of this important power, and as well the interests of the Canadian producing companies themselves, HAVE BECOME FIXED, and subject only to such changes as will fully protect the great commercial and industrial interests and rights now served by this power brought from Canada.* The time has long since passed when governments proceed ruthlessly from pure national rashness or anger, to destroy the settled accepted commercial relations and formal vested rights of persons and corporations.
>
> "There is a large shortage of electric power in Western New York, with a strong demand for greater supply which is not being met by existing companies. We are using all the power made on the New York side, and all that has been brought from Canada, and the demand for more power in Western New York is insistent, and being urged with great force."

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*The Dominion Government replied to this statement. Through the proper channel, Washington was informed that Albany's interpretation of Canadian laws was incorrect. A member of the Albany committee later made partial retraction, "in view of the war"—or words to that effect.

Here we have a succinct statement of the other side of the case, which serves at least to indicate that the longer we permit interests in the United States to use the power of which we stand so urgently in need ourselves, the more insistent will become their alleged claim as regards its permanent possession, on the ground that the conditions of supply and use have become "fixed."

The point arises as to whether, in the event of the Dominion government prohibiting the export of power from Canada, any resulting shortage of power in New York State can be effectively compensated for.

It is possible that the curtailment or absolute prohibition of export will place the State of New York in a position very similar to that in which Ontario finds herself at the present time as regards an adequate supply. While the reclaiming of exported power will alleviate conditions for the time being, Ontario's true remedy lies in the projected power development at Queenston. And the State of New York has precisely the same remedy available, provided that public interest in that State can be sufficiently stimulated to enforce its application.

The United States government still holds in reserve 4,400 c.f.s. of the treaty water at Niagara. Between 7,000 and 8,000 c.f.s. of Niagara water is being diverted through the Chicago Drainage Canal, of which more than 3,000 c.f.s. is being taken in direct defiance of the Federal authorities at Washington, and which is being wasted to all intents and purposes in a low-head development at Lockport, Ill.

The State of New York should, therefore, have 7,400 c.f.s. of water available for development at Niagara. It is understood, furthermore, that topographical conditions would permit the use of this water under an effective head of 300 feet. In other words, here lies nearly 225,000 h.p. of dormant capacity, the utilization of which would more than offset any curtailment in the supply of Canadian-generated power.

It seems evident, therefore, that any injury to vested interests in New York State which might result from the non-supply of Canadian power, should not be charged to any action of the Canadian government in this regard, but rather to the failure of the State of New York to emulate Ontario in developing the available resources of Niagara in the public interest.

## GREAT BRITAIN'S BLACKLIST.

All Canadians will undoubtedly wish to familiarize themselves with the list of individuals and business concerns in the United States who have been blacklisted by Great Britain as being "German firms controlled from Germany though operating in the United States, German firms which are incorporated in the United States but assist England's enemies, either by loans, or other means, individuals or concerns which assist England's enemies by cabling code messages." The phrase in quotation marks is the official description given in the British Act of the firms at which the act is directed, according to a Canadian press despatch from London, England, which was printed last week in daily newspapers.

The act, which forbids residents of the United Kingdom to trade with a certain list of United States firms, is known as the "Trading with the Enemy Blacklist Act." Among the firms mentioned in the press dispatches were a considerable number having German names, and also the following firms whose names are not all Teutonic:—

THE ELECTRO-BLEACHING GAS CO., Niagara Falls, N.Y., and 25 Madison Avenue, New York City.

EUGENE DIETZGEN CO., 166 W. Monroe Street, Chicago.

ORENSTEIN & KOPPEL, Koppel, Pa.

GOLDSCHMIDT-THERMIT CO., 90 West Street, New York City.

THE TEXAS EXPORT & IMPORT CO., Galveston, Texas.

THE INTERNATIONAL IMPORT & EXPORT CO., 136 South Fourth Street, Philadelphia, Pa.

GEO. W. McNEAR, 433 California Street, San Francisco, Cal.

PETROLEUM PRODUCTS CO. OF CALIFORNIA, San Francisco, Cal.

CHAS. HARDY, 50 Church Street, New York City.

INTERNATIONAL HIDE AND SKIN CO., 59 Frankfort Street, New York City.

SOUTHERN PRODUCTS TRADING CO., 15 William Street, New York City.

SUPERIOR EXPORT CO., 90 West Street, New York City.

The first four firms mentioned above are those which are of the greatest interest to the engineering community in Canada.

The Electro-Bleaching Gas Co. manufacture liquid chlorine and chlorinators. They have sold not a little "bleach" in Canada for water and sewage disinfection purposes, together with the chlorinating outfits for feeding same. The firm is fairly well known through extensive advertising in United States trade and technical papers.

The Eugene Dietzgen Co. are manufacturers of engineering and surveying instruments and draughting room supplies and equipment. A firm by the name of Eugene Dietzgen Co., Limited, is operating a store in Toronto, its capital stock being owned by J. P. Neumann, R. H. Cunnington and Harry Riley, all of Toronto, R. F. Allin of New York, and W. E. Cook of Chicago. When interviewed by *The Canadian Engineer*, Mr. Neumann, the manager, of the Canadian company, stated that he did not know how the blacklist would affect them, but that the Canadian concern might be wound up, as it is controlled by Messrs. Cook and Allin, who direct the Eugene Dietzgen Co. of Chicago and New York. Mr. Neumann cannot understand why the firm should have been blacklisted, and thinks that the publication of their name in the list is a mistake.

Orenstein & Koppel are well-known makers of industrial railway equipment, but they have done little or nothing in Canada of late, as their former agents, the Canadian Fairbanks-Morse Co., Limited, patriotically discontinued their agency relations at the outbreak of the war, probably feeling satisfied that that concern was pro-German.

Goldschmidt-Thermit Co., of New York, manufacturers of welding apparatus, have a branch at 103 Richmond Street W., Toronto. Admission was made to *The Canadian Engineer* by the person in charge, that the Toronto factory is a direct branch of the New York firm.

*The Canadian Engineer* regrets the existence of these facts, of which it must, through a sense of duty, warn its readers,—it regrets that these four concerns have done anything to cause them to be blacklisted,—it regrets that *any* United States firm has given cause to be blacklisted,—but despite any and all former pleasant relations with any of these firms, Canadians should now regard them as out of bounds until such time as Great Britain is convinced of the propriety of removing their names from the blacklist.

The names of the exporting or commission firms that are blacklisted—other than those having distinctive German names—are reprinted here because it is believed that some of them may have had certain dealings in Canada in the past.

Serious and weighty reasons must obtain for these firms having been placed on Great Britain's blacklist. While the British act may possibly be not legally binding upon Canadian citizens until the names are gazetted officially in Canada, there is surely no doubt but that the names will be so gazetted,—and this may have been done by the time this issue is printed,—but, in any event, whether they are so gazetted in Canada or not, no Canadian engineer or municipality cares to deal with any firm while reasons exist for that firm's name being upon Great Britain's blacklist.

## PERSONAL.

N. D. PAINE, of the staff of Price Bros. & Co., Limited, Kenogami, P.Q., has been elected an associate member of the American Institute of Electrical Engineers.

Dr. J. A. BANCROFT, of McGill University, has left to make a reconnaissance survey of that portion of the Transcontinental Railway between La Tuque and Bell River.

D. O. LESPERANCE, ex-M.P.; D. H. PENNINGTON, and ALFRED S. GRAVEL have been appointed harbor commissioners of Quebec City. Mr. Lesperance will be the chairman.

F. K. BRUNTON, formerly assistant superintendent of the British Columbia Copper Co.'s smelter at Greenwood, B.C., is now on the staff of the A. S. & R. Co.'s smelting works at Garfield, Utah.

JAMES WHITE, deputy head and assistant to the chairman of the Commission of Conservation, Ottawa, is attending the western Canada irrigation convention that is being held this week at Kamloops, B.C.

L. R. TALBOT was recently appointed construction engineer for the Shawinigan Water & Power Company, at Shawinigan Falls, Que. Mr. Talbot will work on the storage dam on the upper St. Lawrence River and on the construction of a transmission line.

THOS. GEOFFREY LEITH, manager of the Canadian head office of the British Aluminium Co., recently sailed for England and has become attached to the aeronautical branch. Mr. Leith was trained for the Army, and for some years held a commission in the Gordon Highlanders. He came to Canada about ten years ago, and was associated with the engineering department of the Canadian Northern Railway. Later the firm of Parke & Leith was established, handling the products of the British Aluminium Co. and, after the retirement of the late Mr. Parke, Mr. Leith was appointed manager.

## OBITUARY.

JOHN HENDRY, prominent in timber, railway and mine interests in British Columbia, died recently at Victoria, B.C., at the age of 73.

GEORGE RENNIE, building contractor, died at his home in Toronto on July 20th. Mr. Rennie was in his 61st year, and was born in County Tyrone, Ireland, coming to Canada over thirty years ago.

ERNEST G. BARROW, for many years city engineer of Hamilton, Ont., died in Toronto on July 21st. For a number of years Mr. Barrow was engaged as assistant consulting engineer, and afterwards succeeded E. B. Wingate as city engineer, retiring in 1909. During his regime the waterworks system was remodelled, the third main and James Street reservoir constructed. He was considered one of the best hydraulic engineers on the continent. Before entering the employ of the city Mr. Barrow was a member of the firm of Barrow & Hunting, contractors, who constructed the Mimico waterworks.

## INDUSTRIAL USES OF HYDRO-ELECTRIC POWER.

(*Continued from page 76.*)

working industries of this country are dependent almost entirely upon electric furnace abrasives, carborundum and alundum. The manufacturer of agricultural machinery, locomotives, firearms, milling machinery, automobiles, and countless other metal products must have these abrasives, and they can now be made only where water-power is developed cheaply.

The electric furnace also turns out calcium carbide, the only source of acetylene, which is being so extensively used in Canada. The oxy-acetylene flame has become of intense value in the welding of metals and the cutting of steel. This same calcium carbide is the important factor in the fixation of atmospheric nitrogen, and is the source of supply upon which we may have to rely for nitric acid and nitrates employed in making munitions of war and fertilizers.

All the artificial graphite used in the world to-day is produced at Niagara Falls, by cheap waterpower. Its uses are manifold. Practically the whole supply of abrasives on this continent is from Niagara.

Considering the products of electro-chemistry alone, chlorine stands out as of first importance. The sterilization of water supplies of countless cities has been made possible by the use of bleaching powder or hypochlorite, and in communities where this is used extensively, typhoid has been largely eliminated. The armies of Europe use chlorine to avert typhoid, and other chlorine products, including chloroform, are used surgically, both as anesthetics and antiseptics. This same chlorine, or bleach, makes possible the manufacture of white cotton goods and white writing paper. Other products of chlorine, produced electrically, enter into the manufacture of soaps. Even into fire extinguishers goes this product of cheap electricity.

To meet the shortage in coal-tar dyes, by the combination of chlorine with coal-tar benzon and tuluol, there is now beginning to be produced quantities of those necessary intermediates formerly made and exported from Germany.

Metallic sodium, also a product of electricity, is the basis for sodium peroxide, which is used in generating oxygen for hospitals, for laboratories, and for submarines and mine-rescue apparatus. It also enters into the manufacture of hydrogen peroxide. Without sodium cyanide, many gold and silver mines could not possibly operate at a profit.

These are but a few of the products of every-day use which will largely depend upon water-power. Many of these, a few years ago, had no known value. What other products remain to be developed with the growth of electricity, no one can predict.

There can be no question regarding the fundamental and essential relation of water-power to the economic and industrial situation in Canada.