PAGES

MISSING

# The Canadian Engineer

*A weekly paper for Canadian civil engineers and contractors*

## High Voltage Transmission Line Has Mile Span

### Overhead Power Cables under 100,000 Volts Pressure to Cross the St. Lawrence River—Two Steel Towers, Rivalling in Height the Main Posts of the Quebec Bridge, Are 5,000 Feet Apart

By ROMEO MORRISSETTE,
Public Works Department, Canada, Three Rivers, P.Q.

FOR some years past, the Shawinigan Water and Power Co. has transmitted power across the St. Lawrence River near Three Rivers by means of a submarine cable, in order to supply its stations on the south shore, viz., Victoriaville, Broughton, Thetford Mines, Black Lake, Windsor Mills, etc.

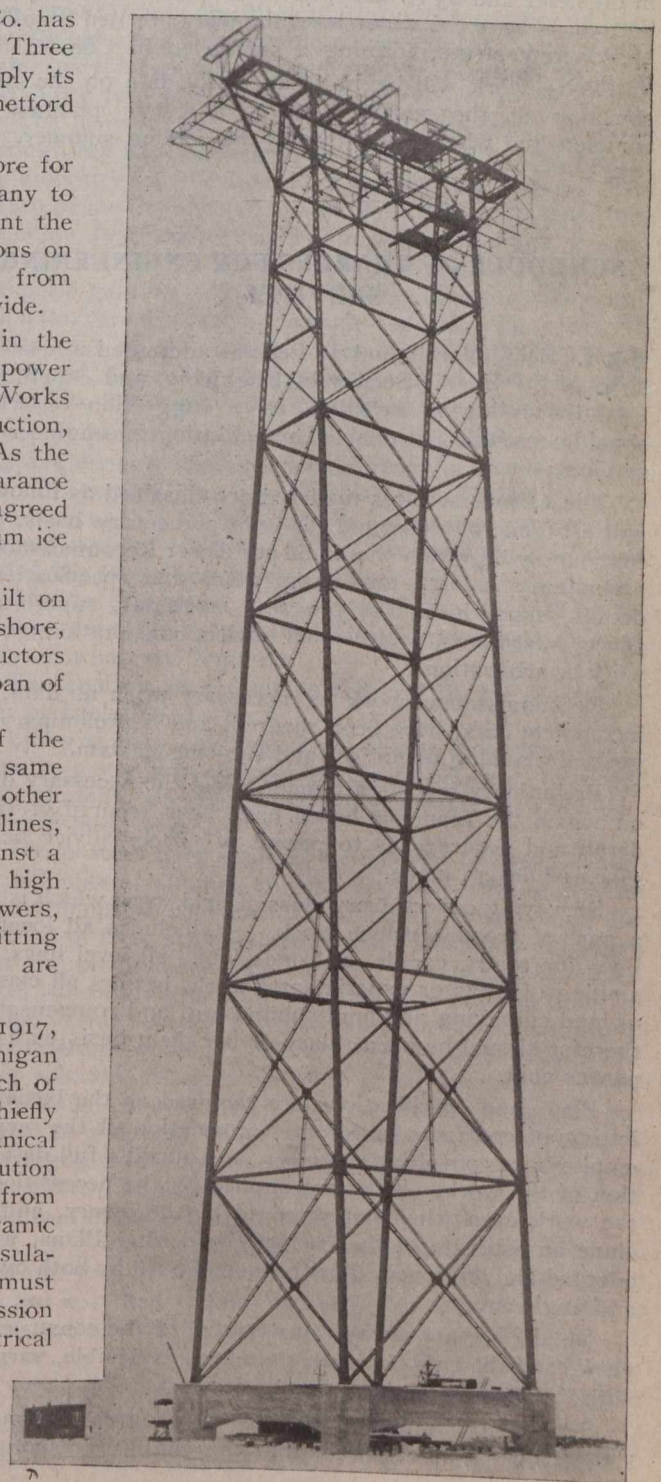
The increasing amounts of power required on the south shore for mining and industrial purposes made it necessary for the company to design an overhead high tension transmission line to supplement the existing submarine cable. The company has transformer stations on each side of the river about one and a quarter miles upstream from Three Rivers, P.Q., and at this point the river is over a mile wide.

Plans were prepared by the company's engineering staff in the winter of 1916-17 for two steel towers to carry the overhead power cables. These plans were presented to the Department of Public Works of Canada for approval. No objection was found to their construction, provided that sufficient clearance be left over the ship channel. As the river is navigable for the largest ocean vessels, a minimum clearance of 160 feet above water level was specified, and the company agreed to keep the power lines 160 feet above water level under maximum ice loading of the conductors in the spring or fall.

The towers weigh approximately 200 tons each and are built on concrete piers. Each pier is built approximately 500 feet from shore, and the distance between the piers is 5,000 feet, so that the conductors have a clear span of that length. This is the longest known span of its kind.

The towers carry three electrical conductors, made up of the highest grade of plough steel, spaced 50 feet apart, all in the same horizontal plane and arranged so as to prevent contact with each other when swinging. In order to connect with existing transmission lines, the conductors have to be insulated from the steel towers against a difference of potential of 100,000 volts. Because of the very high tensile stresses in the cables, they will not be anchored at the towers, but will be supported on the top of the towers by saddles permitting of the necessary movement due to temperature changes, and are anchored to concrete blocks some distance behind each tower.

In an article in *The Canadian Engineer* for May 10th, 1917, Frederick T. Kaelin, E.E., assistant chief engineer of the Shawinigan Water and Power Co., to whom the author is indebted for much of the information presented in this brief description, which is chiefly given to explain the accompanying photograph, said that the mechanical problems of this arrangement of anchoring permit of easier solution than do the problems of the electrical insulation of the conductors from the earth potential of the anchorage. The magnitude of the ceramic and mechanical engineering problems involved in this electrical insulation can be appreciated when it is considered that each conductor must provide mechanical strength of more than 100,000 pounds in compression due to the tension of the cable, besides providing for the electrical stress of the 100,000-volt transmission potential. The arrangement of the insulation also must permit the replacement of any portions showing electrical failure, without hazarding the mechanical safety of the anchorage. An elaborate arrange-



ment of porcelain insulators of new type, held in compression only, has been designed to fulfil the conditions.

The construction of the steel towers was started in May, 1917, as soon as the freshets were over, and the northern tower, of which a photograph is presented herewith, is now completed. The concrete work was done by day labor under the direction of H. G. Huber, superintendent of the Shawinigan Water and Power Co. The structural steel was fabricated and erected by the Canadian Bridge Co., Limited, of Walkerville, Ont.

The towers are 350 ft. high, which is approximately the same height as the main posts of the Quebec Bridge, this great height being necessary in order to get the desired clearance above water level.

Four concrete piers, sunk in caissons, form the footings for each tower. These piers are cylindrical, 11 ft. in diameter and 65 ft. deep, 40 ft. of which is below river bottom. Above the water level the piers are tied together by concrete struts, forming a square 60 ft. x 60 ft.

Active work will begin at an early date on the construction of the southern tower, and it is planned to complete the whole work during the coming summer.

---

## SCHEDULE OF CHARGES FOR ENGINEERING SERVICES

RECENTLY Edmund T. Perkins addressed a meeting of the Illinois Society of Engineers and submitted the following schedule as a suggestion of what should constitute reasonable compensation for engineering services:—

The various services rendered are classified as follows, and are generally charged for on a percentage basis, except surveying which should be per diem: Reconnaissance, preliminary reports, surveying, plans and specifications, details, supervision and progress estimates, superintendence, alterations, professional advice, consultation, court work or arbitration.

Reconnaissance work is necessary when no data, or incomplete data, have been secured, and is preliminary to general planning of project and securing of data.

Preliminary reports are made when the necessary data on which the report is based have been secured of such detail and accuracy as to permit of proper advice being given or design made.

Surveying covers every class of field work which is not a part of reconnaissance work. It includes all location lines for roads, canals, railroads, etc., all level lines, all sinking of wells or experimental work, besides all classes of land surveying and land subdivision, and compensation therefor should be on a salary or per diem basis with expenses paid.

Plans and specifications are required as the basis for letting of contracts or for the information of the owner, employer or consulting engineer, and afford a full description of the work. They are implied by the necessities of the work even when not required by the owner, and include an estimate of the cost of the work. Plans, when adopted and approved, must be so endorsed by both owner and engineer.

Details are not always an essential of the construction work, and the rate charged, therefore, is flexible, varying with the amount of detail work.

Supervision and the making of progress estimates should always be required, that the engineer responsible for the plans and specifications should be satisfied, by personal inspection that the specifications are fully complied with and satisfactory progress made. When superintendence is paid for, as defined in the next section, there is no additional charge for supervision.

Superintendence of construction must be had by a superintendent mutually acceptable to owner and engineer. The schedule rate for superintendence applies when the engineer who has designed and planned the work, or his assistant, superintends construction. All other employees than such assistant or assistants are to be paid by the owner.

Alterations may be required at any time by the owner, or become necessary by reason of unforeseen conditions or changes in the size of projects. The schedule rate applies to such alterations as may be required by the owner —alterations becoming necessary by reason of unforeseen conditions or accidents are covered by percentage charges on the aggregate costs.

Professional advice is always charged for according to interests involved, charges being based on value of services rendered, not on time required in arriving at conclusions or opinions.

Consultation with engineers who have made certain branches of professional work a specialty may be requested by the engineer having general charge of the work, or may be required by the owner. Charges for consultation work being based on value of services rendered, not on time required in arriving at conclusion or opinion.

Court work as an expert or as arbitrator in settlement of controversies, condemnation proceedings, etc., in the interest of the owner, is entitled to additional pay at a rate to be agreed upon.

Schedule rates cover compensation only for engineering services; that is, the services of the engineer and his engineer assistants.

All expenses incurred for materials, blue prints, or for transportation, hire of helpers, rodmen, chainmen, teamsters, conveyances, and living expenses when away from regular place of business, are a separate and additional charge against the owner, as is a reasonable charge for general office expenses.

Time of payment is according to agreement; but usually is arranged on the basis of a preliminary payment, or retainer, and an advance for travelling or other expenses aside from services; and further payments on account, if the commission extends over considerable time.

Final pay for preliminary reports is due upon presentation of report.

Final pay for reconnaissance work is due upon completion of same.

Pay for supervision or superintendence becomes due on progress estimates made for payments to contractors, or, if work is done by day labor, on monthly appraisements of work done.

All percentages are computed on the contract price or actual cost of work.

When construction covered by plans and specifications is not carried out, pay for these plans and specifications is due upon completion of the estimate of cost of work.

The several items of payment on the percentage basis become due from time to time when the class of service has been rendered.

Per diem rates apply to an 8-hour day. Extra time is charged for on a basis of 1½ time on week days, and twice time on Sundays and legal holidays.

### Table of Charges—On Percentage Basis

| | Less than $5,000. | $5,000 to $10,000. | $10,000 to $20 000. | $20,000 to $50,000. | $50,000 to $100,000 | $100,000 to $200,000. | $200,000 to $500,000. | Over $500,000. |
|---|---|---|---|---|---|---|---|---|
| | % | % | % | % | % | % | % | % |
| Reconnaissance . | 2.0 | 1.75 | 1.5 | 1.0 | 0.75 | 0.5 | 0.4 | 0.3 |
| Preliminaries .. | 1.5 | 1.0 | 0.8 | 0.6 | 0.5 | 0.4 | 0.3 | 0.2 |
| Plans and specifications ..... | 4.0 | 3.5 | 3.0 | 2.5 | 2.0 | 1.5 | 1.3 | 1.2 |
| *Supervision ... | 2.0 | 1.8 | 1.5 | 1.3 | 1.1 | 1.0 | 0.8 | 0.6 |
| *Superintendence | 5.0 | 4.5 | 4.0 | 3.5 | 3.5 | 3.0 | 2.8 | 2.4 |
| †Alterations .... | 7.0 | 6.5 | 6.0 | 5.5 | 5.0 | 4.5 | 4.0 | 3.5 |
| Everything from beginning to completion of job ..... | 12.5 | 10.75 | 9.3 | 7.9 | 7.4 | 6.0 | 5.3 | 4.2 |

*Supervision not charged for when superintendence is.

†Alteration relates only to value of work involved in the alteration.

NOTE—Percentages are computed upon the entire cost of the completed work, exclusive of engineering, or upon the estimated cost pending execution or completion of same. "Cost" refers only to such part or parts of the whole work or project as the engineer may deal with.

### Table of Charges—On Per Diem Basis

Chief engineer—$500 retaining fee, $100 a day while absent from office and expenses.

Assistant chief engineer—$50 a day while absent from office and expenses.

Topographers, assistant engineers and chiefs of parties—$15 to $25 a day while absent from office and expenses.

Designers—$12.50 a day while absent from office and expenses.

Instrumentmen, draftsmen, computers—$7.50 a day while absent from office and expenses.

Stenographers, chainmen, axmen—$3.50 a day.

NOTE—Attendance at court or expert testimony for any fraction of a day is considered as a full day.

### Charges on Other Bases

A fixed fee for services rendered may be charged by agreement where a long engagement for professional services is contemplated, the engineer may accept such retainers on a yearly basis, at a compensation not less than that of the permanently employed engineer of the client. Except in cases where the compensation of the engineer is in the form of an annual retainer, the agreement between the engineer and his client should specify the period of time during which the compensation of the engineer, as determined by per diem charges, fixed fee, or agreed percentages, shall apply. If, through no fault of the engineer, the work should not be completed within the time so specified, an additional charge may be made, the basis for which, if practicable, should be agreed upon in advance.

---

Several prospectors have been at work in the Kingston, Ontario, district, and think they have discovered coal deposits, located within a dozen miles of the city. Samples have been submitted for analysis.

Hon. Howard Ferguson, Minister of Lands, Forests and Mines, Province of Ontario, stated at the Provincial Legislature last week, that the price of peat, as compared with coal, is as high as it has ever been, considering its relative fuel value. This is because the cost of manufacturing has advanced so much. The Ontario Government intends to endeavor to secure some labor-saving device for the production of peat in commercial quantities.

## FILTER ALUMS USED IN ONTARIO*

By G. E. Gallinger, A. V. DeLaporte and F. A. Dallyn

THE development of water purification in the province, and more especially the introduction of rapid sand filter plants, has brought new and peculiar duties to the Board of Health. At present an important matter under consideration is the quality of alum or sulphate of alumina offered for sale for water purification purposes. It is extremely necessary that a proper or satisfactory aluminum sulphate should be used in connection with the operation of mechanical filters.

For the past ten years the smaller municipalities in Ontario have been purchasing alum to satisfy their local requirements—amounts ranging from two to twenty tons per annum—through local supply houses or druggists. The importance of the filter alum supply has recently been greatly enhanced through the completion at Toronto of a water purification plant requiring the purchase of from 700 to 900 tons of alum per annum.

The investigation of the various filter alums supplied through the local agencies was undertaken by the staff at the laboratory at the Board's Experimental Station. The return of inquiry sheets showed, with few exceptions, that the alum supplied to smaller municipalities had passed through four or five hands before reaching them, and that the price paid by adjoining municipalities for aluminium sulphate varied widely. During the last two years the prices have varied from 1.9 cents to as high as 7 cents per pound, depending on the amount purchased; the latter represents the prices when purchased in small quantities.

Apart from the economic question of added cost, there is grave danger, when the local agency is unaware of the source of supply, that alum furnished in this way may be found unsuitable for the purpose of water purification. Several striking incidents of this nature were discovered during the laboratory investigation.

The investigation also revealed the fact that the average municipality purchased its alum without a knowledge of what was required.

The analysis of the alums received by the Board appear in Table No. 1.

Lump alum or sulphate of alumina is a combination of bauxite—a southern clay containing 58 per cent. to 60 per cent. alumina, the aluminum being present as $Al_2O_3H_4$, with sulphuric acid.

The process most generally employed for manufacturing sulphate of alumina consists firstly in mixing bauxite with sulphuric acid in lead-lined tanks, then boiling for a period of from six to eight hours. The solution formed after the reaction between bauxite and acid has taken place, is a mixture of $Al_2(SO_4)_3$ and silica; and in order to obtain a clear solution it is necessary to filter the mixture. This filtering process is difficult, tedious and costly. The alum solution is next boiled to expel the excess water. After being concentrated from a density of 25° or 30° Baume to a density of 50° or 60° Baume, the solution is discharged into trays, and on cooling it crystallizes to alum cake. This cake is then crushed or pulverized and is shipped in bulk, barrels or sacks.

A good basic aluminium sulphate should be in lumps from one-half to two inches in diameter. It should contain not less than 17 per cent. of water soluble aluminium calculated as $Al_2O_3$, and should have a basicity ratio of 0.03 or, in other words, should contain one-half of one per cent. of $Al_2O_3$ more than is theoretically required to

*From the 1916-17 annual report of the Provincial Board of Health, issued February, 1918.

combine with the sulphuric acid present. It should not have more than one per cent. as total iron. An excess of bases over the amount required to combine with the total acid present is a necessity and is a point that is overlooked in the purchase of alum by most municipalities.

**Table No. 1.—Analysis of Filter Alums Offered for Sale in Ontario and Used 1916-1917**

| Source of Filter Alum (Municipality) | $Al_2O_3$ | $SO_3$ | Basicity ratio | $Fe_2O_3$ | FeO | Insoluble matter | $NH_3$ |
|---|---|---|---|---|---|---|---|
| Toronto, July 13th, 1917 | 19.5 | 38.6 | .138 | 0.375 | 0.34 | trace | ..... |
| Toronto, Aug. 8th, 1917 | 19.5 | 37.6 | .015 | 0.4 | 0.37 | 0.4 | ..... |
| Perth | 19.4 | 40.6 | .06 | 0.275 | 0.23 | 0.079 | ..... |
| St. Thomas | 19.3 | 39.0 | .10 | 0.4 | 0.37 | 0.1 | ..... |
| Toronto, Sept. 12th, 1917 | 19.3 | 32.2 | .3 | 0.46 | 0.41 | 0.056 | .05 |
| Dundas | 18.8 | 43.3 | .02 | 0.3 | 0.25 | trace | .03 |
| Toronto, July 24th, 1917 | 18.7 | 38.9 | .011 | 0.4 | 0.37 | trace | .04 |
| Toronto, July 31st, 1917 | 18.7 | 41.2 | .025 | 0.5 | 0.47 | trace | ..... |
| Haileybury | 18.7 | 38.0 | .01 | 0.3 | 0.28 | 0.1 | .03 |
| Toronto, Aug. 31st, 1917 | 18.64 | 33.7 | .25 | 0.58 | 0.53 | 0.07 | .028 |
| Lindsay (lump) | 18.56 | 38.2 | .128 | 0.47 | ..... | 0.2 | ..... |
| Renfrew | 18.2 | 38.6 | .098 | 0.35 | 0.31 | 0.075 | ..... |
| Cobourg | 18.2 | 36.3 | .16 | 0.3 | 0.27 | 0.05 | ..... |
| Toronto, Sept. 19th, 1917 | 18.1 | 33.0 | .24 | 0.58 | 0.54 | nil | 1.1 |
| New Toronto | 17.9 | 32.7 | .022 | 0.40 | 0.05 | 6.4 | ..... |
| Toronto, Sept. 12th, 1917 | 17.9 | 32.9 | .23 | 0.45 | 0.40 | 0.08 | .028 |
| Iroquois Falls | 17.8 | 32.0 | .286 | 0.58 | 0.57 | 0.24 | .05 |
| Orillia | 17.7 | 37.9 | .094 | 0.35 | 0.345 | trace | ..... |
| Stratford | 17.7 | 38.3 | .08 | 0.3 | 0.26 | trace | ..... |
| Lindsay (ground) | 17.6 | 38.7 | .06 | 0.495 | ..... | 0.25 | ..... |
| Kitchener | 17.5 | 39.8 | .01 | 0.3 | 0.22 | 0.1 | ..... |
| Toronto, Sept. 27th, 1917 | 17.4 | 32.9 | .21 | 0.45 | 0.43 | 0.23 | ..... |
| Toronto, July 10th, 1917 | 17.2 | 38.0 | .059 | 0.3 | 0.27 | trace | ..... |
| Toronto | 17.0 | 38.5 | .035 | 0.3 | 0.21 | 0.1 | ..... |
| Toronto, Aug. 2nd, 1917 | 16.9 | 36.6 | .089 | 0.45 | 0.42 | 0.1 | ..... |
| Weston (ground) | 16.48 | 32.7 | .14 | 0.01 | 0.005 | 0.16 | ..... |
| Niagara-on-the-Lake | 15.8 | 37.2 | .01 free acid | 0.5 | 0.4 | trace | .026 |
| Weston (lump) | 14.0 | 33.2 | 1.1 | 0.04 | 0.03 | 0.12 | ..... |
| Dunnville | 12.8 | 35.5 | 0.1 | trace | trace | trace | 4.5 |
| Maximum of each part | 19.5 | 43.3 | .300 free acid | .58 | .57 | 6.4 | 4.5 |
| Minimum of each part | 12.8 | 32.0 | 1.1 | trace | trace | nil | nil |

NOTE.—Aluminium Sulphate should be judged and purchased on its water soluble aluminium content and on the excess of $Al_2O_3H_4$ over what is required theoretically to combine with sulphuric acid. Estimated on the basis of 17% $Al_2O_3$ at 2 cents per pound, an alum, 19.5% $Al_2O_3$, is worth ⅓ cent more, which is equivalent to a discount of 16½ per cent., and an alum 12.8% $Al_2O_3$ is worth ½ cent less and represents a loss of 25%. The 12.8% $Al_2O_3$ referred to was purchased at 5 cents per pound, and the loss was at least 1¼ cents per pound irrespective of the original high cost.

To insure quality in aluminium sulphate and to make an appreciable saving, the municipalities using chemicals and filtering their water should combine with each other and either manufacture their own aluminium sulphate or purchase it by annual contract according to the proposed specifications from one of several manufacturers. Without introducing the economic aspects of the question, the benefits to be derived from this co-operation are most apparent when the municipalities realize that manufacturers can give them exactly what they require with possibly a reduction in the cost of manufacture, provided the quantities and dates of shipment are reasonably apparent in the annual contracts. Until such action is taken the purchasing agent for each municipality should be instructed, even when buying small quantities of aluminium sulphate, to secure one which fills the following specifications:—

**Table No. 2.—Estimate of the Present Use of Alum for Water Purification in Ontario**

| Municipality | Pounds alum used per annum | Water gallons pumpage per annum | Water pumpage per 24 hours | Pounds alum used per 24 hours | Estimated grains alum per imp. gallon |
|---|---|---|---|---|---|
| Abitibi Pulp and Paper Mills, Iroquois Falls | 14,400 | 94,900,000 | 260,000 | 40 | 1.1 |
| Amherstburg (projected) | ..... | ..... | 750,000 | 106 | 1.0 |
| Arnprior | 300 | 146,000,000 | 400,000 | 52 | 1.5 (not in use) |
| Chatham | 40,000 | 474,300,000 | 1,300,000 | 110 | 0.6 |
| Cobourg | 13,000 | 3,723,000 | 1,002,000 | 36 | 0.26 |
| Dundas | 17,155 | 117,530,000 | 322,000 | 47 | 1.1 |
| Dunnville | 6,000 | 182,500,000 | 500,000 | 15 | 0.2 |
| Haileybury | 45,000 | 73,000,000 | 200,000 | 125 | 4.4 |
| Kitchener | 14,600 | 261,250,000 | 312,000 | 40 | 0.9 |
| Lindsay (under construction) | 58,000 | ..... | 1,152,000 | 160 | 1.0 |
| New Toronto | 64,000 | ..... | 1,250,000 | 175 | 1.0 to 0.75 |
| Niagara-on-the-Lake | 3,400 | 73,000,000 | 200,000 | 9.5 | 0.33 |
| Ojibway (projected) | 50,000 | ..... | 1,000,000 | 140 | 1.0 |
| Orillia | 45,600 | 200,750,000 | 700,000 | 125 | 1.38 |
| Oshawa (in construction) | 22,800 | 159,610,533 | 438,000 | 62 | 1.0 |
| Perth | 18,000 | 200,000,000 | 500,000 | 50 | 0.7 |
| Renfrew | 9,660 | 371,500,000 | 1,017,882 | 26.5 | 0.35 |
| St. Thomas | 5,400 | 622,744,480 | 1,815,820 | 150 | 0.58 |
| Stratford | 25,000 | 372,700,000 | 10,264,640 | 69 | 0.49 |
| Toronto | 1,600,000 | 10,950,000,000 | 30,000,000 | 4,384 | 1.1 |
| Weston | 3,600 | 55,000,000 | 175,000 | 10 | 0.4 |

### Specifications for Filter Aluminium Sulphate

The basic aluminium sulphate shall be in lumps from one-half to two inches in diameter and shall contain not less than 17 per cent. water soluble aluminium calculated as $Al_2O_3$. It shall have one-half to one per cent. of $Al_2O_3$ in excess of the amount theoretically required to combine with the sulphuric acid present. It shall not contain more than seven to ten per cent. insoluble matter in cold water and not more than one per cent. total iron.

Provided that a proper grade of bauxite filling the required specifications for alum-making is used, manufacturers should not find it difficult to supply aluminium sulphate according to the above specifications.

In paper mills, or for other industries where the pure article is needed, it is essential to use a sulphate of alumina containing not more than one-tenth to one per cent. insoluble matter in cold distilled water. For water purification, however, a refined alum is not necessary, and, in fact, it is not nearly so active a coagulant as alum containing a fairly high percentage of insoluble matter.

Table No. 2 is an estimate of the present use of alum and the dosage administered in the several municipalities operating rapid sand filters. It is to be observed that quantities greater than 2.5 grains per gallon and less than 0.5 grains are either excessive and wasteful, promoting corrosion in water service pipes and fittings, or inadequate, permitting insufficiently treated water to pass through filters.

Table No. 3 is a rough forecast of the use of alum in the province, mention being made only of the municipalities using alum at the present time. This table may be of interest to industries in a position to manufacture alum, or capable of supplying an equally satisfactory substance for the use of water purification plants. The number of municipalities employing rapid sand filtration should, in a few years, be considerably increased and the amount of alum used in the province for water treatment will be about 1,500 tons per annum.

**Table No. 3.—Forecast of Use of Filter Alum in Ontario**

| Year. | Estimated pounds of alum used. |
|---|---|
| 1916 | 1,891,115 |
| 1920 | 2,220,725 |
| 1925 | 2,673,610 |
| 1935 | 4,560,381 |

This decided increase in alum consumption, together with the problem of a suitable quantity of alum at a nominal cost, makes it highly desirable to consider the practicability of manufacturing filter alums within the province.

At the present time there is only one firm, to our knowledge, manufacturing alum in Canada. Most of the filter alum used in Ontario is imported either from Great Britain or the United States. A plant for making alum to coagulate water was recently built at the Columbus Water Purification Works, Ohio. According to Charles P. Hoover (Journal of American Waterworks Association,

December, 1915) this plant (1915) is a success both technically and economically, and between 800 and 1,000 tons of alum are manufactured per year. The cost of manufacture in 1915 was about $10.50 per ton. For this process sulphuric acid of not less than 92 per cent. is used and a bauxite containing not less than 52 per cent. $Al_2O_3$, and not more than 3 per cent. $Fe_2O_3$. Bauxite can readily be secured, containing from 58 to 60 per cent. $Al_2O_3$. The filter alum should contain at least 17 per cent. $Al_2O_3$, and one ton of bauxite will serve for at least three tons of alum, $Al_2(SO_4)_3$ 14 $H_2O$. The manufacture of alum in Ontario at the point where it is to be used would be of great economic advantage, especially in that it increases our local market for sulphuric acid wherever large quantities of filter alum are required, and this coincides very well with the points of manufacture of sulphuric acid; also there is a decided advantage in hauling less than one-third the tonnage over railways now known to have very congested traffic conditions. Alum made at some central water purification plant can readily be shipped to adjacent municipalities in a solid form.

The importation of bauxite would probably be from the Southern States of America where it is mined quite extensively. There is no record of any bauxite in Canada. The shales and clays of Ontario seldom give as high as 20 or 21 per cent. $Al_2O_3$ and except the ordinary process is to be changed, are not suitable for the manufacture of alum.

## WATER CONSUMPTION STATISTICS OF SEVERAL CITIES

The following table showing the estimated population, the daily per capita consumption and the percentage of services metered will be of interest. These figures were obtained from the officials of the various cities and are taken from the report of the Chicago Bureau of Public Efficiency.

| City. | Estimated Population. | Average daily consumption per capita (gallons). | Per-centage of services metered. |
|---|---|---|---|
| Des Moines, Iowa ... | 105,000 | 60 | 98.5 |
| Providence, R.I. .... | 284,400 | 66 | 93 |
| Oak Park, Ill. ..... | 33,000 | 70.6 | 100 |
| New Orleans, La. ... | 378,000 | 75 | 100 |
| Madison, Wis. ..... | 32,050 | 77.4 | 99.8 |
| Atlanta, Ga. ..... | 200,000 | 89 | 100 |
| Kansas City, Mo. ... | 380,000 | 89.5 | 80 |
| Columbus, Ohio ..... | 216,687 | 90.5 | 96.1 |
| Omaha, Neb. ..... | 180,000 | 95 | 87.6 |
| New York, N.Y. .... | 5,602,000 | 101 | 26.8 |
| Boston, Mass. ..... | 762,700 | 105 | 66 |
| Springfield, Mass. ... | 106,280 | 106 | 97.7 |
| Cleveland, Ohio ..... | 845,000 | 113.2 | 98.4 |
| Milwaukee, Wis. ... | 440,000 | 118 | 99 |
| Cincinnati, Ohio .... | 415,000 | 126.3 | 69 |
| St. Louis, Mo. ..... | 755,000 | 130 | 7.1 |
| Washington, D.C. .. | 364,088 | 136.5 | 77 |
| Los Angeles, Cal. ... | 533,535 | 140 | 88 |
| Detroit, Mich. ..... | 781,133 | 168.5 | 36 |
| Philadelphia, Pa. .... | 1,700,000 | 176 | 15 |
| Chicago, Ill. ..... | 2,491,933 | 258.9 | 6.9 |
| Buffalo, N.Y. ..... | 486,000 | 329 | 5 |

The following have been nominated as officers of the American Water Works Association for the year 1918-1919:—For president, Chas. R. Henderson; vice-president, Carleton E. Davis; treasurer, James M. Caird; trustees, Allan W. Cuddeback and John J. Hinman, Jr.

## SEWAGE TREATMENT AND DISPOSAL*

By G. Bertram Kershaw, M.Inst.C.E., M.Am.Soc.C.E.
President of the Institute of Sanitary Engineers.

THE first point requiring consideration in sewage treatment is the nature of the sewage to be treated. Sewages differ very widely as regards strength and composition, scarcely two being alike, and it is of vital importance to obtain a thorough knowledge on these points. Sometimes this knowledge can only be tentatively arrived at; usually, however, samples can be taken and analyzed. These samples should be what are known as average samples, or samples drawn according to the rate of flow; otherwise very misleading results may be obtained. A very rough idea of the strength of a domestic sewage may doubtless be obtained by a knowledge of the sewage flow per head of the population sewered; but I would utter a word of caution against placing too much reliance upon this. It by no means follows that a 30-gallons-per-head sewage is necessarily twice the strength of a 60-gallon sewage, even when two domestic sewages are compared. Sewages often differ very considerably as regards oxidizability, even when the water supply per head is similar, and when trade wastes are present the flow of sewage per head may be comparatively little value as an index of strength. The proper way to determine the strength of a sewage is by a series of analyses, and the use of the proper formula for strength.

On the nature of the sewage as shown by the figures of analysis will depend in great measure the nature of the treatment to be adopted; generally speaking, the constructional cost and working charges will vary directly as the strength of the sewage. Even when the treatment works are in active operation, samples should be taken and examined, especially when trade wastes are present; the strength and character of a sewage does not, as a rule, remain constant year after year, and it is well to ascertain from time to time how far and in what way it has altered. One factor alone, *viz.*, the setting up of new manufactories in a town, may entirely alter the composition of the sewage. During the past three years large munition works and huge extensions of existing factories have not only modified but absolutely changed the character of many sewages.

With respect to analyses of sewage liquors (the term "sewage liquors" including effluents), it has always seemed to me that figures taken to four places of decimals are utterly out of place, and tend to give a fictitious appearance of great accuracy, which is seldom justifiable. Again, figures of analysis regarding the water supply itself should, whenever practicable, be given, together with the figures for the sewage. The water forms the bulk of the liquid portion of the sewage; chemically it varies very considerably, and it is often important that its chemical characteristics should be known.

Conjoining with the sampling of sewage liquors, and equally important, is the gauging of sewage flows, and it is often convenient to carry out both operations at the same time. It would be of great assistance in many ways to sewage engineers if greater facilities for gauging were provided at all sewage works, no matter how small, yet it is rarely the case to find such provision. It is no answer to point out that gaugings have been taken for years in the case of a few large works; it is the average works that needs improvement in this respect. Gauging records, when worked up, would give much valuable information.

*Abstracted from Presidential Address.

Passing on to the removal of the larger suspended solids from sewage, the question of screens arises, and I think it will be found that screening in this country is practically confined to what may be termed coarse screening, intended—apart from the protection of pumps, filter presses, etc.—to remove only the larger solids, such as sticks, rags, corks, and the like, which would otherwise be apt to cause trouble by lodging under valves or sluices. Such coarse screening is to be regarded as a mechanical process of abstraction rather than of purification.

Although the amount of material removed by comparatively fine screens (⅛ in. to ¼ in.) may appear large to the eye, it will generally be found when dried to represent on the average considerably less than 10 per cent. of the total suspended matter present in the sewage, while the impurities in solution are practically unaltered, or may even be increased by the screens.

Comparatively recently attention has been directed in America and elsewhere to what is termed fine screening, by which is meant screens having openings not exceeding ½ in., but usually very much smaller, and which are automatically cleaned above the water line. The object of these fine screens is to remove to a certain extent the finer particles of matter, which, if allowed to remain in the sewage liquor, would otherwise be apt to use up rapidly the dissolved oxygen of the stream into which they are discharged, and their use is only recommended when the screened sewage is passed into a comparatively large body of water well supplied with oxygen. Many of the fine screens and the cleaning devices therefore are very elaborate, and the openings in the screens very small; in one screen, for example, they are only 2 mm. wide by 30 mm. long. The use of fine screens has been advised in several cases lately, *viz.*, Jamaica Bay, New York, Cleveland and many other places where it may be desirable to avoid accumulations of sludge or where the body of water into which the sewage liquor is discharged is large enough to deal with the dissolved impurities and finer suspended matter without offence.

There would seem to be an opening for fine screening under certain conditions in this country, as in the case of large rivers, where the volume and velocity are such as to admit of the discharge of fine suspended matter without injury; it would also appear to be adapted to seaside resorts where bathing is carried on, and where the presence of floating solids would be extremely objectionable. In any case, if fine screening is to be effective, it is essential that the sewage shall be as fresh as possible, and it must be fully recognized that the brunt of the purification will be thrown upon the body of water receiving the screened sewage, while turbidity and putrescibility will be but little affected; moerover, the efficiency of the screening will probably vary seasonably in the case of an extensive sewerage system, according to the temperature. In the case of a very large screening plant abroad, the seasonal percentage removal of solids was as follows: Spring, 18.7 per cent.; summer, 17.3 per cent.; autumn, 27.6 per cent.; winter, 48.3 per cent.

Concerning the removal of solids by gravity. Scant information is available about detritus tanks, both as regards most suitable design and also with reference to means of cleaning them, most designs having a good deal to be desired in this respect. Theoretically, the velocity through these tanks should be such as to permit settlement of the heavy mineral matter, while the lighter organic and mineral matter is carried forward; sewage flows, however, vary very considerably even in dry weather, and it therefore follows that, given a certain optimum rate of "flow through" for a particular sewage, there must of necessity be times, even in dry weather, when the rate of flow through may be either in excess of or below this optimum rate. With small or medium-sized works, by sacrificing a certain amount of fall, these variations could be controlled by a movable weir, enabling the capacity of the tank to be varied at will, and, as a sequence, the rate of flow through. In times of storm a duplicate tank would usually need to be brought into use, and detritus tanks should never be constructed in fewer than two units.

In the case of large treatment works it is advantageous to have ample tank capacity, subdivided into several units, which can be drawn upon as desired. Particular stress should be laid upon so designing detritus tanks as to ensure ample facilities for frequent and thorough cleansing; if drawing down the top water and removing the contents of detritus tanks is not rendered reasonably easy of accomplishment, and a filthy hand ladle process substituted, trouble will follow.

It is during the preliminary stages of sewage treatment that recovery of grease from ordinary domestic sewage appears feasible. Various processes have been placed on the market for the extraction of fatty substance from sewage sludge, but, so far as I am aware, few serious attempts have been made in this country to recover grease from the scum on sewage as it arrives at the works. It is not a question of whether, as frequently stated, recovery of grease is "commercially practicable"; the point is that sewage and sludge from which the bulk of the grease has been removed are rendered far easier of treatment, and better results are consequently obtained at less cost than would otherwise be the case. If something is obtained for the grease, so much the better. Grease renders sewage sludge very reluctant to part with its moisture; when the sludge is used as a manure it hinders sowing and subsequent decomposition; further, when grease reaches land, contact beds or percolating filters, it clogs up the pores of the soil, contact or filtering medium. Much has been said and written about the value of glycerine wasted in fats, but it must be remembered that if the fat is to be utilized for glycerine recovery, acid treatment is inadmissible, an alkali, such as caustic soda, being necessitated.

With reference to continuous flow settlement and precipitation tanks generally, there is a wide field of investigation open, especially in the direction of securing uniform rates of "flow through," and also in working out some means by which the efficiency of tanks can be more accurately determined. The method commonly in use, of expressing efficiency by percentage removal, is open to objection; it is the actual condition of the finished tank liquor which is the real criterion. Particular attention should be focussed upon the vital necessity for handling sludge as little as possible—any saving in this direction saves money—and also on the means to be adopted for drawing off the sludge from the tanks with a minimum of top water, and this can rarely be satisfactorily done without proper "draw-offs" discharging to a line of pipes distinct from the sludge pipes. Unless the sludging arrangements are good, the tanks will be run for two long periods, and it may be observed that unless continuous flow settlement tanks are frequently cleaned out, fifteen hours' flow through is, in most cases, too long, and partial septic action is almost certain to arise in hot weather.

It is quite possible for a portion of the sewage in a continuous flow settling tank to be septic, while the bulk of the liquid is fresh, and sometimes nuisance from smell arises from this cause, the sludge and overlying stratum of liquor becoming quite septic, and stinking when removed from a tank.

In any experimental work connected with settling tanks it is well to bear in mind the fact that the temperature of the liquid plays a considerable part, especially as regards the finer particles. For example, with a temperature of 74 deg. Fahr. it has been found that a fine particle will settle twice as fast as with a temperature of 32 deg. Fahr. Another point of importance is that with most sewages the lighter and more putrescible suspended solids are apt to be carried some distance down the ordinary rectangular tank before settling—*i.e.*, to a position where means for frequently drawing off these fine solids is rarely present.

Closely connected with tankage of sewage is the use of precipitants. One of the results of the war has been to restrict the use of certain precipitants involving the use of sulphuric acid, such as abumino-ferric—made by treating bauxite with sulphuric acid. In place of this precipitant, and also in lieu of sulphuric acid, what is known as "nitre-cake" (acid sulphate of sodium) has been somewhat largely used, this by-product resulting from the manufacture of nitric acid. Unfortunately, nitre-cake is a heavy and bulky precipitant, and its application to sewage liquors by no means so easy as alumino-ferric, although for certain purposes, where large quantities are not required, it can be obtained in powder form.

The day of precipitants is by no means over; they will probably be employed more frequently in the future, especially in cases where the effective removal of the finer putrescible solids is called for, and also where trade wastes are to be considered, either separately or in conjunction with sewage.

There is little doubt that, given efficient organization, sewage sludge could have been used for agricultural purposes far more freely than hitherto, even admitting that the percentage of actual manurial constituents in it is generally low judged by chemical analysis, and that it usually contains more or less grease, which makes it difficult to manipulate. It is quite possible that in the near future there may be a considerably increased demand for sewage sludge by farmers, and as the price of nitrogen increases, sewage sludge will probably become more valuable. In the case of a large sewage farm which I visited somewhat recently large quantities of air-dried sludge have been disposed of to farmers for years past at 3s. per load.

It is very usual to arrive at the value of sewage sludge by comparing it with sulphate of ammonia as a standard. The nitrogen in sulphate of ammonia, however, is in a readily available form, and its effects are practically limited to the year of application. The nitrogen in ordinary sludge sewage, on the other hand, is not as a rule readily yielded up to plant life, and in assessing the value of a manure, ease of decomposition is the chief point to be considered. There is nitrogen, for example, in leather, but it is only rendered available very slowly under natural conditions. The stimulating effects of an artificial manure are admittedly evanescent, and it possesses no "staple," whereas with sewage sludge the manurial effect is spread over a considerable period, while its cheapness renders possible the application of heavy dressings in order to compensate for comparatively low fertilizing value. I would direct the attention of all interested in sewage sludge to an order issued last October by the Ministry of Munitions concerning compound fertilizers and regulating the sale of these on a new basis. This should have the effect of stimulating the use of ordinary air-dried sewage sludge in compound manures, the unit rate for nitrogen in sewage sludge being 7s. 6d., as against 17s. 6d. in the case of nitrogen derived from sulphate of ammonia, nitrate of soda, etc. The word "unit" is defined to mean 1 per cent. by weight in one ton of compound fertilizer. It follows that a sewage sludge containing one unit of nitrogen would have a value of 7s. 6d., and in most cases it would be easy to air-dry sludge down to a point where the contained nitrogen reached 2 per cent.

With regard to the use of wet sludge, I may refer to the plan adopted at the Wolverhampton sewage farm by William Clifford, A.M.Inst.C.E., the engineer and manager. The method has now been in use for some four years, during the months of September to April. Briefly, the wet precipitation sludge is forced by compressed air through 4-in. diameter light iron pipes, provided with flexible joints, and irrigated upon farm lands in the neighborhood of the works. The farmer provides the horses and ridge plough, and the sewage works staff the labor. A nominal charge of 10s. per acre is made, but instead of payment in money an equivalent in horse hire is taken. On grass land the liquid sludge is brushed over the surface with bass brooms. From May to August the sludge is irrigated over some 6 to 7 acres of land adjoining the works. After each dressing a cultivator is passed over the land, and deodorization is found to be satisfactory. A good dressing serves for a root crop and a straw crop, or, alternatively, two grass crops. Given sufficient storage, it is considered that it would be practicable to dispose of the whole year's make of sludge in eight months.

## LETTER TO THE EDITOR

### Garbage and Refuse Disposal

Sir,—We read with much interest the article by Dr. Rudolph Hering in *The Canadian Engineer* of March 14th, and only wish the same article would be reprinted in all the engineering magazines throughout the whole of this continent. The writer has been interested in the question of incineration for many years, in Europe and America, and has developed a plant with many of the features about which Dr. Hering writes.

If only it were possible to get all municipalities to study every word in that article, much of the money now spent on experimenting would be used in erecting plants which would destroy their refuse and garbage, and give them a clean town or city.

Then the question of cost arises. We find that some of our competitors are erecting plants where the cost for burning is as high as $1.50 per ton of garbage burned, while we have plants that are doing it for as low as 28 cents. This, of course, is low, but it can be done, particularly if there be sufficient garbage and refuse to keep the plant in continual operation. This is, however, impossible in any of the towns or cities where we have built incinerator plants.

We have just completed a five-cell plant at Windsor, Ont. This plant is burning all the city's garbage, etc., without the use of any fuel, but, just as Dr. Hering says, the fireman needs to be intelligent, for they will use up any amount of fuel if one allows them to have it. We put in an oil burner to each cell, for use only when starting the fires or when the garbage is exceptionally wet, but most of the firemen seem to delight in seeing the oil burned, and it takes a little time to teach them that they do not need it. We have succeeded in making our plants destroy all ordinary garbage and refuse without using any fuel except that found in the garbage itself.

J. G. PICKARD,
Canadian Incinerator Co., Limited.

Windsor, Ont., March 16th, 1918.

## BOARD OF ENERGY COMMISSIONERS RECOMMENDED

A FEW weeks ago, before the Ottawa Branch of the Canadian Society of Civil Engineers, John Blizard, B.Sc., read a paper on the "Availability of Energy for Heat and Power," which was published in full in *The Canadian Engineer* for March 7th.

At that same meeting Edgar Stanfield, M.Sc., chief engineering chemist, Mines Branch, was invited to be present and spoke as follows:—

I have greatly valued the privilege of attending this meeting and listening to Mr. Blizard's excellent paper, the more so because for the past eleven years I have been closely associated with him in work on fuel problems.

There are two points to which I desire to call attention. The first is that Mr. Blizard has made it evident that the question of how best to utilize our sources of energy involves both engineering and chemical problems. There was a tendency to relegate the chemist to the attic, as it were, and to submit to him only specific questions; this is, fortunately, now passing, or passed. We must realize that only by full co-operation between engineer and chemist can we make satisfactory progress towards our goal.

A full treatment of the fuel problem cannot neglect the chemical possibilities of fuels. It is needless to enumerate the chemical compounds, dyes, fertilizers, antiseptics, etc., obtained from coal; their great number and their importance are too well known. They are all derived, as was stated in the paper, from the primary products of the carbonization or coking of coal. The coking of coal and the exploitation of its by-products constitutes a very large industry, notably in Germany, but also in England and elsewhere. The paper points out some of the limitations of this method of utilizing fuels. In Canada our difficulties in this respect, as in others, are greatly increased by the distance between centres of population and the geographic distribution of our fuels. Nevertheless, I am more optimistic than Mr. Blizard as to the future of the carbonization industry. It does not appear to me impossible that even in Ottawa we may have in the not very distant future a large coke oven plant which will operate on water-borne soft coal from Nova Scotia, coking it in ovens rather than in retorts on account of the economies of the larger scale process, and which will distribute gas and coke for domestic and factory use throughout the cities of Ottawa and Hull.

Mr. Blizard referred to oven coke as "metallurgical coke," and described it as too hard for convenient domestic use; such coke is made by what is called high temperature carbonization. Low temperature carbonization gives a softer coke and has many apparent advantages. Its commercial development with respect to bituminous coal so far, however, has been very disappointing, although I still hope for a future for the method.

Carbonization is not confined to bituminous coal. The commercial development of low-grade lignite will probably involve low temperature carbonization. Some of us have been engaged for the past year in studying in the laboratory the possibilities of this process, and, as has been stated in the daily papers, there is a project under consideration for the establishment of a commercial carbonizing and briquetting plant in the West. I am of the opinion, moreover, that the carbonization of peat may prove a commercial possibility. The carbonizaton of wood to form charcoal, wood alcohol, acetic acid, etc., is already a well-established industry. In every case carbonization gives solid, liquid and gaseous products with great economic possibilities. The solid products of the lower grade fuels—lignite, peat and wood—have comparatively high calorific value, and can, therefore, stand transportation charges to far greater distances than can the original fuel.

The second point to which I desire to call attention is the way in which private individuals and corporations wastefully exploit our resources of fuel for their own immediate gain.

Coal is wasted in many ways in the winning, and Mr. Dick has stated that the percentage of available coal brought to the surface from our mines is often very low. Thus, where a thick and a thin seam occur together, quick profits can be made by working the thick seam only, but the thin seam is lost to us, probably for ever. Is this right?

Under present conditions, in some districts remote from centres of population, immediate profits might be made by extracting gasoline from natural gas and allowing the gas to go to waste for lack of a convenient market. Can this be permitted?

Fuels are wasted in utilization, as Mr. Blizard has shown. Our railways burn nine million tons of coal a year with an efficiency of only three per cent. Out-of-date and inefficient power plants are wasting our fuel resources, and the wasteful use as well as the wrongful use of power on all sides add to this orgy of extravagance. These methods may give immediate dividends to individuals, but we must consider the present and the future welfare of the whole country. Can we afford to let these methods continue?

Again and again arise the questions: Is it right wastefully to exploit our resources for immediate gain? Can we afford to allow this waste to continue?

Mr. Blizard's paper not only calls attention to these points, but is also suggestive as to methods of remedy. May I recommend the following for consideration:—

That a Dominion Board of Energy Commissioners be established, somewhat on the lines of the Board of Railway Commissioners, and that this board be given wide powers.

That the board consist of mechanical engineers, electrical engineers and chemists; the best men available in their respective spheres, having not only high scientific and technical ability, but imagination.

That the board be given investigative, advisory and restrictive powers—investigative power to carry out such laboratory and large-scale investigations as are necessary for the efficient utilization of our resources; the scope of the investigations to include the winning and marketing of fuels and their by-products, as well as the development and employment of power and heat; advisory power to furnish the best advice and most up-to-date information, including recommendations as to new developments, improvements of old plants, consolidation of power plants, and the co-operative establishment of allied industries; restrictive power to prohibit the inception of needlessly wasteful schemes, and to compel the improvement within a term of years, where such improvement can be shown to be commercially practicable, of all established, needlessly wasteful processes.

The recommendation as outlined above was considered by the Ottawa Branch of the society and later submitted to the council of the society at Montreal.

---

Col. R. W. Leonard, M.Can.Soc.C.E., will address the Ottawa branch of the Canadian Society of Civil Engineers this evening on "The Manufacture of Nicu Steel."

# TRAFFIC REGULATIONS IN RELATION TO ROAD CONSTRUCTION AND MAINTENANCE*

By W. A. McLean, C.E.
Deputy Minister of Highways, Ontario.

TRAFFIC regulation in its relation to road construction and maintenance is a matter in which highway engineers and those held responsible for road conditions have been unduly patient. Traffic regulation there is, it is true, but for the greater part with a view only to questions of public safety and convenience.

The durability of a road is, by the average citizen, regarded as independent of traffic; and it seldom occurs to him that the use and the abuse of roads are closely related. The road, it is assumed, must be able to sustain any form of traffic and any load to which it can be subjected, and if the road fails, or shows sign of wear, the fault is that of the builder, regardless of impossible and extraordinary traffic conditions to which the road may have been subjected, and for which it was not, perhaps could not, have been designed and built.

When traffic regulation in relation to road construction is mentioned, we are apt to be told that restriction would tend to retard the good roads movement; that unless "good roads" can carry any load at any speed, we lose a chief argument in their favor, *viz.*, greater speed, heavier loads.

With unlimited funds the engineer can build roads which will sustain unrestricted traffic. But is the engineer justified in asking the public to pay for such construction? Will the public continue to pay for such roads, even if they are asked to do so? Or is it preferable that the traffic should be restricted within reasonable limits to effect a great saving in cost? Consideration will indicate that the latter is a sound, economic course. And it is, therefore, desirable that the public should be informed in the matter; that reasonable traffic standards be fixed and enforced, and that roads be then designed for these conditions.

It should be emphasized that reasonable standards should be fixed. Undue limitation should not be placed on the weight and speed of vehicles, otherwise the value of the common road and vehicles in transportation, and their future development, will be retarded. The question largely resolves itself, therefore, into the problem: What are the limits which should be adopted? Can these limits be varied for different roads? Or for different seasons of the year? Or in minor details which may affect construction?

It is desirable that the engineer should know, approximately, the number of vehicles for which a road is to be built. In this there is necessarily much uncertainty, as traffic tributary to a road is subject to many vagaries and much fluctuation. Assumptions must be made in this respect. But it is enough that assumptions should be made where uncertainty is unavoidable. Traffic regulation will fix some factors which can reasonably be definite.

## Weight of Vehicles

The maximum weight of vehicles (apart from the well-recognized influence on bridges) largely determines the depth of foundation necessary on a given road, the depth of foundation varying also according to the nature of the subsoil, and particularly in northern climates, the season of the year during which heavy vehicles may use the road. The constant passing of many light vehicles will, it is true, influence the foundation, and to meet this condition, a certain "mass" is required; but a very few heavy vehicles may shatter an insufficient foundation and thus destroy the entire construction. It is material, therefore, that the engineer should know whether the maximum load is to be six tons, ten tons, twelve tons, fifteen tons, twenty tons; particularly the maximum load concentrated on one axle or one wheel, and also the width of tire on which the maximum load is concentrated.

Motor and steam trucks are coming into extensive use on the country highways. Commonly a motor truck, itself weighing five tons, can carry a load of seven tons, making twelve tons in all. Two-thirds, or eight tons, is on the rear axle, one-half of that load, or four tons, is on each rear wheel. The disruptive effect of this load on roads of light construction is very great, particularly in wet seasons.

Steam trucks, with steel tires, in some cases corrugated, are now in occasional use. As an instance, a five-ton steam wagon in running order with fuel and water, weighs about six tons ten cwt., with about two tons fifteen cwt., on the front axle and three tons fifteen cwt. on the back axle. Practically all the load would come on the back wheels so that when loaded with five tons, the actual weight on the back axles would be eight tons fifteen cwt., or over four tons seven cwt. on each rear wheel. Motor trucks carrying fifteen tons and weighing in all about thirty tons, are being manufactured.

Self-propelled gasoline motor and steam trucks, in addition to their heavy concentrated load, have the further disadvantage of exerting a strong driving force (referred to more fully in discussing motor car speed) so that their use demands not only a heavy and expensive foundation, but an especially durable surface as well. Legislation limiting extraordinary traffic of this description would appear justifiable, in order that a large increase in the cost of roads may not be necessary to serve the requirements of a few vehicles. Such limitation at the present time would forestall the introduction of unnecessarily heavy vehicles and would avoid cases of individual hardship. Width of tire alone will not solve the difficulty, as, owing to the necessary camber of the road surface, excessive width places the load on the edge of the tire. Should investigation justify it, a less weight would be most desirable in the interest of road maintenance.

The following schedule is drawn up with a view to the traffic law of Ontario, which permits a maximum load of twelve tons, or four and one-half tons on one wheel; and a maximum pressure of six hundred and fifty pounds per inch in width of tire. The general assumptions are, that two-thirds of the weight of the vehicle and its load will be carried on the rear axles; that wheel pressure is transmitted downward at an angle of thirty degrees from the vertical; that the various types of subsoil will safely carry the pressure indicated at the head of each column; that the road crust is solely of broken stone or macadam construction.

From the schedule it is evident that twelve tons is the maximum load which can be carried without producing an excessive tire pressure; that there is little difficulty in providing for a twelve-ton load on gravel, compact sand or firm clay; that clay only moderately dry requires a crust approximately ten inches in thickness; that twelve inches will take care of a six-ton load on wet clay, but that sixteen inches would be required for a load of twelve tons (a condition which could probably be taken care of by a Telford base and broken stone surface having a total depth of twelve inches). In the case of quicksand and wet, yielding soil, it is evident that special drainage

*Address to the American Road Builders' Association.

**Table Showing Required Thickness of Road Crust to Transmit at an Angle of 30° from the Vertical Safe Bearing Pressures to Subgrades of Various Soils**

650 pounds per inch width of tire up to 12-inch tire

| Weight on Vehicle, tons | Weight on Rear Wheel, tons | Width of Tire, inches | Weight per inch width of Tire, pounds | DEPTH OF STONE IN INCHES | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Gravel, 8 tons per square foot | Compact Sand or firm Clay, 4 tons per square foot | Clay moderately dry, 2 tons per square foot | Wet Clay, 1 ton per square foot | Quick Sand or Wet Yielding Soil, ½ ton per square foot |
| 3 | 1 | 3.07 | 650 | 2.33 | 3.74 | 5.98 | 9.05 | 13.40 |
| 6 | 2 | 6.15 | 650 | 2.63 | 4.87 | 7.92 | 12.25 | 18.30 |
| 9 | 3 | 9.21 | 650 | 3.16 | 5.65 | 9.20 | 14.40 | 21.80 |
| 12 | 4 | 12.00 | 666 | 3.46 | 6.10 | 9.60 | 16.20 | 24.80 |
| 15 | 5 | 12.00 | 833 | 4.20 | 7.26 | 12.00 | 18.60 | 28.20 |
| 18 | 6 | 12.00 | 1,000 | 4.90 | 8.26 | 13.50 | 20.82 | 31.50 |
| 21 | 7 | 12.00 | 1,166 | 5.48 | 9.20 | 14.65 | 22.50 | 34.60 |

or other special construction is necessary to meet the needs of any but a light load.

As clay is a soil which has very largely to be considered, its drainage and climatic conditions are evidently important factors, as indicated by the difference in depth of crust required by a moderately dry clay and one that is wet.

Military experience will probably indicate the most desirable type and weight of truck for future industrial purposes. The great majority of trucks now used by the French armies weigh three and one-half tons empty and seven to eight tons loaded. This standard, applied to road construction generally would effect a great saving in cost as compared with the maximum of fifteen or twenty tons which unrestricted loading will involve. If military preparedness demands provision for heavy artillery loadings of twenty tons (and the tendency is still upward) a more moderate standard should be enforced with respect to the great network of purely agricultural and industrial roads which cannot be so built without imposing an unnecessary financial burden.

### Climatic Regulation

The State of Michigan has adopted a very useful regulation which provides that "it shall be unlawful to move any traction engine or similar heavy machinery over the public highways, by its own power or otherwise, during the months of March, April and May, or at any other time, if by reason of the thawing of frost, or rains, or any other cause, the roads are in soft condition rendering them unfit for the passage over them of such heavy machinery without damage to the highways, or if the engines are equipped with lugs which seriously damage the highways, except by written permission from the commissioners having jurisdiction over said highway or highways." With respect to tires, the Michigan law also provides that: "Whenever by reason of the thawing of frost, or rains the roads are in soft condition, the maximum carrying capacity of tires on all vehicles shall be limited to one-half the carrying capacity of tires as provided in this Act."

### Width of Tires

Having determined the foundation which a given subsoil and load of vehicle will require, the influence of traffic on the surface remains to be considered.

The crushing effect of steel tires is an important factor, and is one of the features which, in the days of horse-drawn traffic only, was covered by "wide-tire" laws. Wide-tire laws are still necessary, although their relative importance has diminished through the growing preponderance of rubber-tired vehicles. Local considerations will necessarily control to a certain extent, but the crushing strength of local material available will necessarily be a factor. In a district where trap rock is freely available for the road surface, the concentrated loads may be greater than where soft limestone is the only material obtainable.

In Ontario a maximum load of 650 pounds per inch in width of the tire is permitted. In Great Britain, the width of hard-tired trucks may vary, according to axle weight and diameter of wheel, from five inches to fifteen inches. In Michigan, a carefully regulated schedule of widths has recently been imposed.

### Extraordinary Traffic

The traffic law of Great Britain recognizes the relationship between traffic and liability for maintenance, in a statute respecting extraordinary traffic, which proceeds in part as follows:—

"Where, by a certificate of their surveyor, it appears to the authority which is liable or has undertaken to repair any highway, whether a main road or not, that having regard to the average expense of repairing highways in the neighborhood, extraordinary expenses have been incurred by such authority in repairing such highway by reason of the damage caused by excessive weight passing along the same, or extraordinary traffic thereon, such authority may recover from any person by or in consequence of whose order such weight or traffic has been conducted, the amount of such expenses as may be proved to the satisfaction of the court having recognizance of the case to have been incurred by such authority by reason of the damage arising from such weight or traffic as aforesaid.

"Provided that any person against whom expenses are or may be recoverable under this section, may enter into an agreement with such authority as is mentioned in this section, for the payment to them of a compensation in respect of such weight or traffic, and thereupon the persons so paying the same shall not be subject to any proceedings under this section."

### Speed Regulation

In the case of rubber-tired vehicles, speed is an important factor. It is the general experience that light motor vehicles travelling at a speed of 18 to 20 miles an hour are not difficult to cope with. That much injury to macadam road surfaces results from heavy touring cars travelling at speeds of 40 and 50 miles an hour is common knowledge to the highway engineer; where it exists to any great extent, demanding the proportionate cost of bituminous treatment, or the selection of a strongly resistent paving material.

The propelling power of a horse-drawn vehicle is communicated to the road through the feet of the horses. Speed is limited and makes little difference. The abrading effect of the steel tires comes solely from a downward pressure varying with the weight of load, diameter and width of tire. Self-propelled vehicles, on the other hand, communicate their driving force to the road at the rim of the wheel. While the downward pressure due to weight of load does little injury, the driving force is very great. It is nearly horizontal, tending to tear away the surface of the road, throwing out the binding material and loosening stones. This shearing force increases with the speed, not in direct proportion, but probably in proportion to the square of the speed. Thus, taking ten miles as a unit of speed and comparing with speeds of twenty, thirty and forty miles, the shearing force is not merely twice as great at twenty, three times at thirty and four times at forty, but instead is four times as great at twenty as at ten miles, nine times as great at thirty and sixteen times as great at forty miles. At fifty miles an hour, the shearing force on this basis would be twenty-five times as great as at ten miles.

Excessive speed is thus exceedingly destructive to improved roads. Motor cars of moderate weight travelling at a speed of twenty miles an hour, do comparatively little injury to a well-built road. Heavy cars travelling at a rate of forty or fifty miles an hour do excessive injury which can be provided for only by expensive types of construction. While these types can be adopted for main highways, as in the case of foundations, the greater network of minor roads require speed limitation, in order that heavy construction and maintenance costs may not be unnecessarily imposed. This is the more important at the present stage of road development on this continent, when a large mileage must be maintained at low cost while main routes are in course of construction.

### Relation of Highway Department

In view of the close relationship between traffic regulation and the design of roads, their cost of construction and maintenance, it is desirable that governmental highway departments and motor vehicle registration and control should be under the one management. Responsibility is more definitely fixed, as a highway department is more likely to secure a proper observance of traffic laws to the advantage of the roads and those who pay for them, the factors to be met in construction and maintenance are under more definite observation and control, the development of traffic laws is under more logical guidance, and payment of motor car fees is more agreeable to the car owner if he sees the money going directly to the department which builds and maintains roads. When this policy was adopted in Ontario, the schedule of fees was concurrently doubled with little complaint from our car owners. Ontario is the only province of Canada in which the highway department administers traffic laws and collects revenue. In the United States, Massachusetts, Pennsylvania, Rhode Island, Arkansas, Idaho and Oklahoma appear to be the States in which this policy is followed.

### Conclusion

Highways and the vehicles using them should be considered together. This is as logical as that railroads and rolling stock should be so related.

A rule for definitely fixing standards of loads, widths of vehicles, widths of tires and speeds of self-propelled vehicles, is necessary to the intelligent design of roads. The control of traffic by the department responsible for road construction and maintenance is of advantage.

## THAWING WATER PIPES BY ELECTRICITY*

By H. D. Rothwell
Hydro-Electric Power Commission, North Bay, Ont.

THE difficulties which present themselves in the operation of waterworks in the northern climates are many, and not the least of these is the thawing of frozen service pipes.

These are due to the prolonged cold weather, or because there is insufficient earth covering to protect the pipes. In many cases even the mains themselves will freeze, where the flow of water is inclined to be sluggish, thereby rendering part of the system ineffective for domestic use and crippling it entirely in case of fire.

The thawing of frozen water pipes by means of an electric current is quite simple, and undoubtedly the most effective of any of the methods in use to-day. Pipes up to three inches in diameter may be thawed in a few minutes by passing a heavy electric current at low voltage through the pipes. In most cases, pipes will be frozen only for a few feet, where they are exposed the most, and in such cases, the time required is usually measured in seconds, and even where pipes are frozen for fifteen or twenty feet, the time required is not usually over eight minutes, and in practically no cases would be sufficiently long to affect the municipality's twenty-minute sustained peak. From the records of over 75 conservative cases where service pipes were frozen, the maximum time required to thaw any one service was not over five minutes, and the majority were not over thirty seconds. One case was noted, however, where the current was left on for twenty minutes, and, on further examination, it was found that the valve on the street was closed. Thawing operations are not usually carried on past the point where the water begins to flow, as it is found cheaper to let the flowing water thaw the core of ice which remains in the pipe.

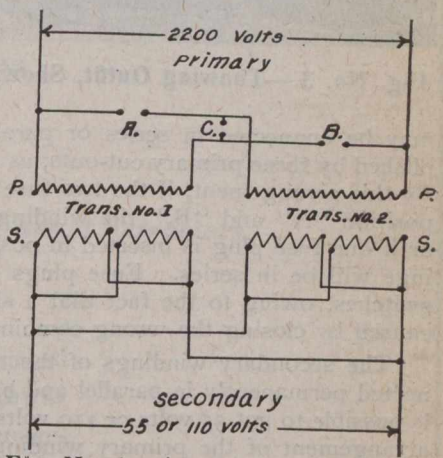



**Fig. No. 1.—Arrangement of Transformers to Obtain 55 Volts**

The apparatus required for thawing water pipes consists of two 15 k.v.a. (2,200-volt, 110-volt) single-phase transformers, with the primary windings arranged in such manner that they

**Fig. No. 2—Connecting the Primary Leads to the 2,200-Volt Circuit**

*From the Bulletin of the Hydro-Electric Power Commission of Ontario.

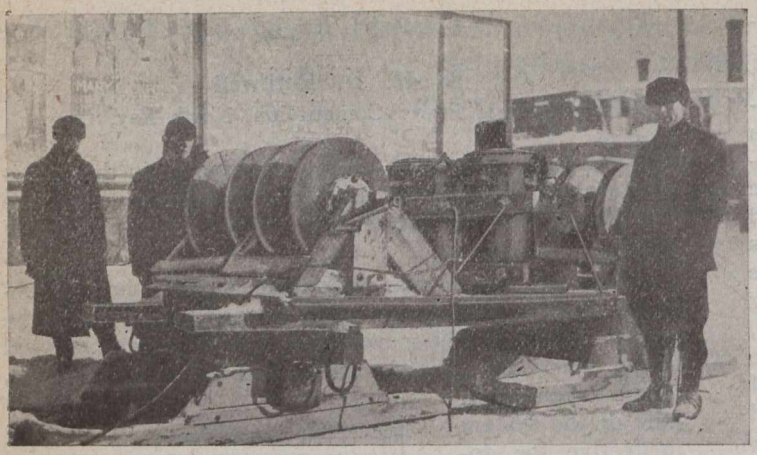


**Fig. No. 3.—Thawing Outfit, Showing Secondary Reels, Etc.**

may be connected in series or parallel. This is accomplished by three primary cut-outs, as shown in Fig. No. 1. By this arrangement, if the two fuse plugs are inserted in position "A" and "B," the windings will be in parallel, or if one fuse plug is inserted in position "C," the windings will be in series. Fuse plugs are used instead of switches, owing to the fact that a short circuit might be caused by closing the wrong combination of switches.

The secondary windings of the transformers are connected permanently in parallel and by this arrangement it is possible to get 55 volts or 110 volts, depending upon the arrangement of the primary windings—whether they are connected in series or in parallel.

The transformers, which are mounted on the centre of a sleigh, are clamped together by four cross-arms and six through bolts. The cross-arms serve as a support for the cut-out and also an ammeter, which is connected in the primary side, to indicate the current taken.

Four reels of wire are carried as a part of the outfit. The two mounted on the rear of the sleigh are No. 6, B. and S. gauge, stranded, double-braid, rubber-covered, and are used for making connections to the 2,200-volt primary.

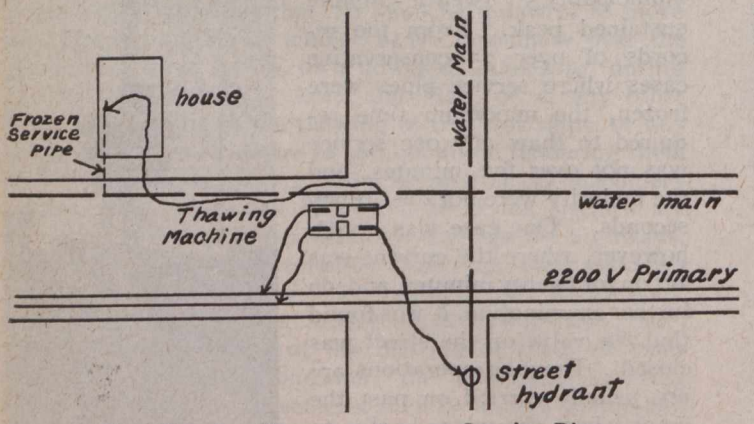



**Fig. No. 4.—Thawing Frozen Service Pipe**

The two forward reels are bare No. 210, extra flexible, copper cable. Primary reels carry about 800 feet on each, whereas the secondary reels contain about 250 feet on each.

The ends of the wires nearest the centre of the reels are brought out through a hole made in the side, and a suitable connector is soldered on, which facilitates the making of connections to both the primary and the secondary transformers, after sufficient wire has been payed out.

The usual method of thawing an ordinary house service is to connect one of the secondary cables to the nearest street hydrant and to attach the other to the cold-water tap on the service to be thawed. Having already connected the primary leads to the nearest 2,200-volt circuit, all that remains to be done is to insert the fuse plug in position "C", and the thawing will commence immediately. By watching the ammeter, the operator can usually tell if sufficient current is flowing to complete the thawing. In a few cases, were the street hydrant a considerable distance away, it would be necessary to use 110 volts, but such instances would not be many on the ordinary waterworks system.

## CO-OPERATION IN ROAD BUILDING*

**By John G. D. Mack**
Chief Engineer, State of Wisconsin.

BUT a few years have passed since it was difficult to convince more than a small fraction of the people of the necessity of good highways and of the requisite expenditure of money for this purpose.

Now, however, the demand for good roads is greater than the capacity of the road builders to supply the immediate wants of the public. The good roads movement seems firmly established, so that plans may be made for years ahead, looking toward the final and complete development and not merely a season's patchwork, with the patches often widely scattered.

Continuous and permanent results can be obtained only by complete co-operation on the part of every organization and individual interested in better highways.

A portion of a highway is no more a local affair only than is a part of a railway, telephone or telegraph system or a part of the postal service to be so considered.

This growth in highway interest is shown by the change from a town matter to county, then to state, and now to federal interest in the projects. The co-operation has spread to be nation-wide.

Everyone cannot live alongside a main trunk railway, nor can everyone live adjacent to a trunk highway.

It is co-operation in the road work which in time will give those who live at a distance from the trunk highway a good route to the trunk line, just as the branch railway carries us and our freight to the main line for the long haul.

To carry this work to its best development, the public must be kept in touch with the plans so that everyone may be able to see and understand just what is being done, and what connection the roads in front of his place or in the next neighborhood has with the general scheme.

Many unnecessary and unjust criticisms are made, not only of highway, but of other construction projects, because the complete plan is not understood.

This is the co-operation, based on the information of the public, which we must have. Such information is given at public meetings, by individual effort, in magazines and in newspapers.

In addition to these most excellent methods, I wish to note another possibility of great promise—the schools.

Make opportunities, in which I am sure the teachers will aid, to give talks on your section in the schools of

*Paper read before the Wisconsin Highway Commission.

SUBSCRIPTION RATE: $3 a year; $1.75, six months; $1, three months; postpaid anywhere.

# The Canadian Engineer

Published Weekly. Established 1893.

*Issued in the Interests of Canadian Civil Engineers and Contractors*

This field includes chiefly the men who are engaged in municipal, railroad, hydraulic, structural, highway and consulting engineering; surveying; mine management; contracting; and water works superintendence.

## Index to Volume 33

**July 1 to December 31, 1917**

Published every Thursday by THE MONETARY TIMES PRINTING CO. OF CANADA, LIMITED
HEAD OFFICE: CORNER CHURCH AND COURT STREETS, TORONTO, ONTARIO
*JAMES J. SALMOND, President and General Manager. ALBERT E. JENNINGS, Assistant General Manager.*
**Telephone Main 7404; Branch Exchange connecting all Departments.**
**Cable Address: "Engineer, Toronto."**
WESTERN CANADA OFFICE: 1208 McArthur Building, Winnipeg. G. W. GOODALL, Western Manager.

# The Canadian Engineer

## INDEX TO VOLUME 33

### July 1 to December 31, 1917



*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

## D



## E



## F



*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

## T



## U



## V



## W



## Y



*Illustrated. **Letter to the Editor. †Editorial. ‡Author of Book Review. §Obituary.

your district. Illustrate these talks with maps and describe why the road is located as shown, how it is to be constructed, how it is to be financed, its cost, its relation to other parts of the system, and other points of general interest.

There is no better lesson in local geography, with some economics, arithmetic and other subjects thrown in. Furthermore, anyone who has children in school knows that the points given in school rather lead the home conversation. One other point we sometimes overlook, and a very important one it is in this connection, is that before we "grown-ups" realize it, the present-day school children are also grown up, and we should therefore give them an early and correct start on the principles of good road development.

All that we of this age have, and all that we are, is the result of co-operation and the division of labor among specialists.

In the museum of the State Historical Society of Wisconsin is an exhibit which never fails to stop me for a moment at least, although I have seen it a great many times, as it illustrates this point so well. It is a model of a Wisconsin pioneer's log cabin home, which was made under the specification that the only tool available in building the original was an axe.

The co-operation and co-ordination of innumerable specialized industries are joined in the building of even a small residence to-day, and so it is with every work which we undertake and with everything which surrounds us.

To illustrate: Just think where that simple axe of the pioneer came from, and of the co-ordinated mining, metallurgical and transportation industries which made it possible.

It is the same with good highway progress. The work must continue to be planned and the construction carried out by those who are specially qualified by study and experience for the tasks.

In addition to this, we must never lose a single opportunity in any direction in which it may appear to work for complete co-operation.

## W. J. FRANCIS HEADS MONTREAL BRANCH

Walter J. Francis, consulting engineer, was elected last Thursday as the chairman of the newly formed Montreal Branch of the Canadian Society of Civil Engineers, Arthur Surveyer, consulting engineer, was elected vice-chairman, and Frederick B. Brown, a partner in the firm of Walter J. Francis & Co., was elected secretary-treasurer. An executive committee was elected as follows:—

F. P. Shearwood, designing engineer of the Dominion Bridge Co.; W. Chase Thomson, consulting engineer; H. G. Hunter, resident engineer for the New York Continental Jewell Filtration Co.; L. G. Papineau, consulting engineer; O. O. Lefebvre, chief engineer, Quebec Streams Commission; and K. B. Thornton, chief engineer, Montreal Public Service Corporation.

The meeting held last Thursday evening in Montreal was the last meeting there of the parent society under the old by-laws. All future Montreal meetings will be Montreal Branch meetings—not meetings of the society as a whole—excepting when general professional meetings or annual meetings are held there, as provided for in the new by-laws recently adopted by the society. Brief addresses were delivered by H. H. Vaughan, the president, and by Chairman-elect Francis, and Commander J. W. Skentelbury, R.N., described the work of the Great Silent Fleet.

## POPULAR OBJECTIONS TO WATER METERING AND HOW TO OVERCOME THEM*

THE opposition to metering is due largely to prejudice and to a misapprehension as to the results which follow the installation of meters. There is a generally prevalent belief that meters are intended to restrict the "use" of water and that, unless the consumer cuts down the quantity of water which he requires or is accustomed to use, his water bills will be increased. The problem, therefore, is to overcome this prejudice and misapprehension by demonstrating that meters do not restrict the "use" of water; that they produce results by preventing waste and leakage; and that they result in an equitable apportionment of water charges, and in the reduction rather than in the increase of bills in the vast majority of cases. If consumers and owners can be convinced of these facts, opposition to metering will disappear. The same arguments that are advanced against meters to-day have been used for years not only in Chicago but in practically every other city where metering has been proposed. Yet wherever it has been introduced experience has demonstrated that there was and is no basis for the objections raised.

Metering is not proposed as a means of restricting the "use" of water. "Use," we repeat, is meant to include every legitimate use to which water can be put for domestic, industrial, and municipal purposes, including water for sprinkling streets and lawns, extinguishing fires, flushing sewers, and every other purpose for which water is necessary or has any real value. The abundant use of water should be encouraged and every inducement should be held out, particularly to domestic consumers to insure their using all the water which can possibly be of value in improving health and sanitary conditions. To this end, rates should be fixed so as to guarantee every consumer an ample supply at a reasonable price which he should be required to pay even though he fail to use his full allowance. A minimum charge of this kind would remove any inducement to "skimp" or save on water at the expense of health or comfort and, as hereafter pointed out, would serve other important purposes.

One reason why metering is advocated is because it is the most effective means for insuring an abundant supply of water under sufficient pressure to enable all consumers, including those living in sections remote from pumping stations and upon the upper floors of apartment buildings, to obtain promptly and at all times the water which they require and are entitled to for their legitimate uses. This would be accomplished by curtailing waste and leakage and not by restricting "use." Such a condition has never existed in Chicago and in the opinion of the Bureau never will be brought about until metering is introduced on a comprehensive scale.

Meters are not intended to operate as a restriction upon the "use" of water and they do not in fact produce that result. This is well illustrated by the situation in Cleveland, Ohio, and in Oak Park, Ill., both of which are under complete meter control. Both Cleveland and Oak Park charge on the basis of a certain rate per 1,000 gals. but fix a minimum charge which must be paid whether or not the quantity of water to which the consumer is entitled for that charge is used.

In Cleveland, the minimum charge applicable to the large majority of consumers is $2.50 or $5 a year, depending upon the size of the building, the number of fixtures,

*Abstracted from "The Water Works System of Chicago," a recent report by the Chicago Bureau of Public Efficiency.

etc. For these amounts consumers are entitled to 46,875 and 93,750 gallons, respectively. For the 6 months period ended September 30th, 1915, there were 27,374 consumers liable to pay at the $2.50 rate and 60,393 liable to pay at the $5 rate regardless of whether or not they used the full amount of water to which they were entitled under those rates. Of the 27,374 subject to the $2.50 rate, 18,141, or 66 per cent., used less water than they were entitled to and paid for; of the 60,393 subject to the $5 rate, 35,481, or 58 per cent., used less water than they were entitled to and paid for, and 12,814 used less than half that amount. These figures cover the summer period when the consumption was heaviest on account of the use of water for sprinkling purposes and on account of such use as may have been made of it for cooling purposes. During the winter period even a large number of consumers failed to use the amount to which they were entitled for the minimum charge. The Bureau does not mean to be understood as expressing any opinion as to the reasonableness of the charges here cited. The purpose in citing them is merely to show that when consumers are required to pay a relatively small minimum charge—one smaller than the flat rate charge made in thousands of cases in Chicago—they are unable to "use" all the water that such a minimum charge will buy.

In Oak Park the minimum charge is $7 per year, for which the consumer is entitled to 36,000 gallons. The accounts for a recent year show that of 4,546 residential consumers subject to this minimum charge 941, or 21 per cent., used less water than they were entitled to and paid for.

At the minimum rates above mentioned there could be no possible incentive for anyone to restrict his use of water, and certainly it is not to be inferred that the people of either Cleveland or Oak Park have lower standards of cleanliness than the people of other communities or that they require less water for their legitimate uses.

Metering produces results not by restricting usage, but by preventing waste and leakage. When a consumer knows that he will have to pay for the water that he wastes, he is careful to avoid wastage. He no longer installs fixtures of a cheap and wasteful type, such as hopper closets, or permits minor leaks, which can be readily repaired at trifling expense, to continue indefinitely; he protects his pipes from freezing so that there is no occasion to let the water run continuously during cold weather and he shuts off the hose when he is through using it for sprinkling purposes; he avoids leaving the faucet open when not using water; and in countless other ways is careful to prevent waste. With practically every other consumer exercising this care to eliminate waste, water can be furnished so cheaply that no one need think of restricting the amount which he can make any use of.

Keeping plumbing tight and shutting off the water when it is not in use are the important factors in effecting waste control, and there is nothing unfair or harsh in the suggestion that water users be required either to observe these precautions or to pay the penalty of their own shiftlessness and carelessness. Experience shows that about half the people who use water are not wasteful or shiftless. The exercise of reasonable care in matters related to the water supply, as in other things, becomes a habit with them and imposes no hardship. It is manifestly unfair, therefore, to permit the other half who are wasteful to saddle the expense of their carelessness and shiftlessness upon their more careful neighbors. If consumers insist upon wasting water, either wilfully or by permitting their plumbing to remain continuously out of repair or by installing cheap and wasteful fixtures, they should be required to pay for what they waste. Under metering they do pay for it. The result is that they soon find it profitable to stop the waste.

The problem growing out of the use of water for cooling purposes is not so easily disposed of, however, since there is considerable public sentiment against restricting the practice, which prevails largely in those sections of the city tenanted by families too poor to provide themselves with ice. Lake water is not really effective as a means of refrigeration, and from the standpoint of the city, its wasteful use for such purpose is expensive. Probably it would be cheaper for the city to furnish the poor with ice than to permit a continuance of the waste which at present exists in this connection. Assuming, however, that in the absence of some better arrangement these poor families can make some legitimate use of water for cooling purposes, it may be safely asserted that they now waste more than they use in the process. Only a moderate quantity is required. A wide-open faucet is no more effective than one permitting the continuous flow of a small stream. If proper care were taken to regulate the size of the stream, all the water which a family could use by letting it run continuously four months of the year would not cost to exceed $2. Moreover, in many cases the minimum charge which a consumer should be required to pay would entitle him to all the water used in this way, in addition to that used for other purposes. In such cases, of course, the use of water for cooling purposes would not impose any additional financial burden upon the user.

It is sometimes urged that the excessive amount of waste and leakage in Chicago tends to help in the matter of sanitation. This is due entirely to a misunderstanding of the facts. Waste reduction measures do not aim to curtail the abundance of water which is essential to cleanliness and proper sanitary conditions. Their purpose is to cut down the enormous quantity of water which runs away through sewers and the ground without serving any useful purpose whatever.

Another reason why meters are opposed is the belief that they operate to increase water bills. This belief prevails quite generally where meters have not been introduced. The consumer who pays his own bill feels that in order to avoid increased cost he will have to cut down the amount of water which he needs or has been accustomed to use. The landlord who pays the charges for the water used by his tenants fears that he will be robbed by the wastefulness of the latter, who will have no incentive to avoid waste. Each therefore is opposed to meters. Moreover, the landlord, in addition to exerting his own influence against them, by threats of increasing rents or otherwise, often persuades his tenant to oppose them. The opposition to meters accordingly becomes general. Opposition to metering on this ground is due entirely to misapprehension as to the effect of meters upon charges.

---

At the recent conference between members of the government and representatives of transportation companies and harbor commissions, it was suggested that the three necessary factors to increase overseas transportation are:— 1, Ships; 2, improved terminal facilities at the various Canadian ports; 3, better railway facilities for the delivery of goods at the ports.

The occupations of the 235 members composing the new House of Commons, according to figures compiled by W. F. O'Connor, general returning officer, are: Barristers, 73; notaries, 3; conveyancer, 1; physicians, 23; veterinaries, 2; dentist, 1; farmers, 39; rancher, 1; publishers and journalists, 11; educationalists, 2; manufacturers, 23; lumber operators, 7; contractors, 2; merchants, 22; brokers and agents, 17; plumber, 1; railway conductor, 1; land surveyor, 1; military officers, 4; **engineers, none.**

## ARMSTRONG-WHITWORTH PLANT

WHEN the tentative program was prepared for the last annual meeting of the Canadian Society of Civil Engineers, an inspection trip was arranged to permit the members to visit the steel manufacturing plant of Armstrong-Whitworth of Canada, Limited, at Longueuil, a suburb of Montreal. At that time *The Canadian Engineer* secured a brief description of the plant from Charles F. Bristol, B.Sc., construction engineer of the Armstrong-Whitworth firm, to be published with the detailed story of the proceedings at the annual meeting. Later, the council of the society decided to make no inspection trips this year, so that part of the program was cancelled, but Mr. Bristol's article, which follows, will nevertheless interest many engineers.

The plant is divided into nine manufacturing departments, *viz.*, crucible pots, crucible melting furnaces, electric furnaces, open hearth, rolling mills, hammers and hydraulic presses, annealing furnaces, small tools, wheels and tires.

With but one or two exceptions, the building is subdivided into bays, served by overhead travelling cranes. A special feature is an alley-way between each pair of bays. These alley-ways contain the numerous heating and annealing furnaces, and permit of individual smoke-stacks on each furnace without in any way interfering with the cranes.

The side and front walls are of reinforced concrete. About 70 per cent. of their area is glass. The columns and trusses are of steel construction. The back wall is wood studding covered with expanded metal on both sides and plastered with a strong cement mortar. This type of wall is easily removed when additions are required, and, as originally planned, any department may be increased over 1,000 feet in length.

The crucible pot manufacturing department is situated in the first bay, 50 ft. x 100 ft. long, served by means of a hand-operated overhead travelling crane. This department manufactures both clay and graphite crucibles.

The crucible steel melting furnaces are situated in the second bay, 50 ft. wide by 100 ft. long, served by means of a 5-ton electrically operated overhead travelling crane. The crucible furnaces are both coke and oil-fired types, and have a total capacity of 48 pots to a heat. The crucible pot and ingot annealing furnaces are situated in the alley-way in front of the crucible furnaces.

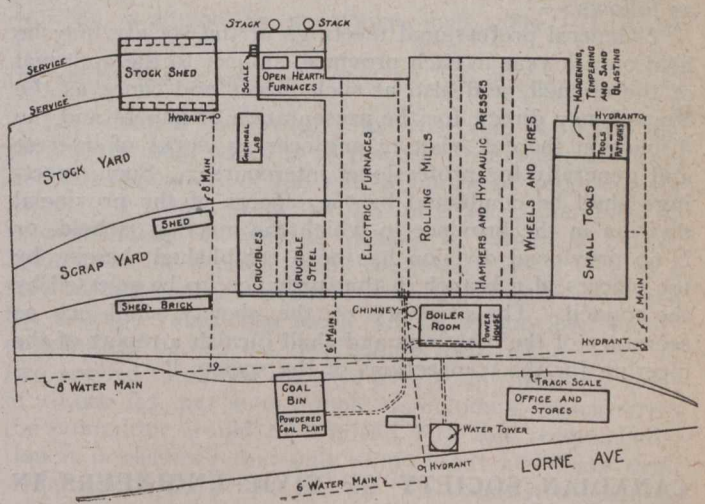
The electric furnace bay is 75 ft. wide by 275 ft. long. It is served by two 15-ton electrically operated overhead travelling cranes, and contains one 3-ton Heroult electric arc furnace for making all kinds and grades of alloy steel, and three 6-ton Heroult electric arc furnaces for making wheel and tire steel. The transformers and various electrical equipment for operating each individual furnace are placed in totally closed-in compartments in the alley-way adjoining, and very close to the furnaces. The electric current is 3-phase, 63 cycles and is transformed at the furnaces from 22,500 to 110 volts.

The open hearth building, at right angles to the electric furnace department, contains two 18-ton basic open-hearth furnaces. These furnaces are primarily intended for melting only, while the refining is done in the 6-ton electric furnaces, as a steel superior to either basic or acid open-hearth steel is required. Owing to the relative positions of the open-hearth and electric furnace departments, each may be added to as occasion may arise. A 25-ton electric overhead travelling crane serves the ladles, and a Wellman-Seaver-Morgan ground-type charging machine is installed on the charging platform.

The rolling mill bay contains one 12-inch two-high, 5-stand hand-mill, driven by a 300-h.p. variable speed d.c. motor; one 9-inch, three-high, 5-stand hand-mill, driven by a Porter-Allen engine; and one 20-inch, three-high, 2-stand hand-mill, driven by a William Todd engine. The bay is 50 ft. wide by 300 ft. deep and is served by one 5-ton electric overhead travelling crane.

The steam hammers and hydraulic presses are in a similar bay, parallel to the rolling mills and containing one 4-cwt., one 8-cwt. and one 12-cwt. Massey tilting hammer; one 1-ton Massey hammer; one 3-ton Bertram hammer; and one 500-ton, one 600-ton, one 1,000-ton and one 2,000-ton steam intensifier hydraulic press. The lower end of this bay is served by a 5-ton electric overhead travelling crane, while the upper end has an electric overhead ingot server. The 2,000-ton and 600-ton presses are for the various forging operations necessary for the manufacture of wheels and tires, while the other presses and the hammers are for forgings and for cogging, billetting and tilting tool steel.

The last bay, 50 ft. wide by 300 ft. long, contains the tool steel annealing furnaces, the repair shop, wheel and




**General Plan, Armstrong-Whitworth Plant**

tire rolling mills, wheel and tire marking press, and tire-centering press. This bay is served by two 5-ton cranes.

The tool manufacturing shop is separated from the previously mentioned shops by a reinforced concrete wall and contains the very latest automatics, milling machines, relieving lathes and grinders of all descriptions required for the numerous operations pertaining to the various tools manufactured.

The hardening department is a continuation of the tool room, separated therefrom by a concrete wall, and contains a variety of semi-muffle furnaces for heating the various tools for hardening.

The boiler room contains two 500-h.p. B. & W. water-tube boilers and two 500-h.p. Goldie & McCulloch water-tube boilers equipped with superheaters. Separated from the boiler room by a wall is the motor-generator room, containing two synchronous motor generator sets with control switches for all shop lines, also a Goldie & McCulloch steam engine direct connected to a 2,200-volt a.c. generator. The direct current generators are of the three-wire type, supplying 500 and 250 volts. The synchronous motors are wired for 2,200 volts, but differ from the ordinary synchronous motor inasmuch as they start up as induction motors. The sub-station is equipped with lightning arresters, oil switches and transformers, stepping 22,500 volts down to 2,200 volts.

The powdered-coal system was installed by the Bonnot Company. It weighs, drys and crushes the coal, mixes air in definite proportions with the pulverized coal, and blows same through pipes to the boilers and furnaces scattered throughout the plant.

Three of the reheating furnaces are equipped with waste-heat boilers; one with a 125-h.p. horizontal return tubular boiler, and each of the other two with a Goldie & McCulloch 250-h.p. water-tube boiler, with superheater. In the event of there being insufficient waste heat to fire the larger boilers, arrangement has been made to supplement same with powdered-coal jets.

## FIRST GENERAL PROFESSIONAL MEETING OF CANADIAN SOCIETY OF CIVIL ENGINEERS

The first general professional meeting of the Canadian Society of Civil Engineers, which is to be held next Tuesday and Wednesday at Toronto, has been called under section 44 of the new by-laws of the society, which reads as follows:—

"General professional meetings of the society may be held once a year in each province, subject to the approval of the council, and also at such places and times as the council may direct, for the presentation of papers and the discussion thereof, visiting engineering works of interest and generally for professional intercourse. Such meetings shall be conducted by the officers of the provincial division in the province in which the meeting is held, or if no provincial division has been established therein, by the officers of a branch in that province, to be selected by the council. The secretary of the society shall act as secretary of the meetings and shall furnish a report of the meeting for the transactions of the society."

## CANADIAN SOCIETY OF CIVIL ENGINEERS IN THE MARITIME PROVINCES

Fraser S. Keith, secretary of the Canadian Society of Civil Engineers, was in Halifax recently in connection with society affairs and met as many of the local members as could conveniently get together on short notice, at an informal supper on Friday evening, March 8th.

As a result of a meeting with a committee of the Nova Scotia Society of Engineers, a resolution was adopted, subject to ratification by both societies, approving of an amalgamation of the Nova Scotia Society with the Canadian Society of Civil Engineers. Mr. Keith at the same time discussed with local members the affairs of the Canadian Society in general, with special reference to recent changes in the by-laws and the change in name.

It was unanimously decided to make application to the council of the Canadian Society of Civil Engineers for the formation of a branch in Halifax. This application will be dealt with this week by the council of the Canadian Society, as will also an application for the establishment of a branch in St. John, N.B.

It is expected that the Hudson's Bay Railway will be completed by the Dominion Government within the next three months. Only 80 miles of steel remain to be laid, and the last bridge has been completed. In the near future, a new route will be open from Great Britain to Japan and the Far East by way of Hudson's Bay and Prince Rupert.

## TESTS OF STEEL COLUMNS

AFTER a very extensive series of tests, the special committee on tests of steel columns, appointed by the American Society of Civil Engineers in 1909, has submitted its final report.

The report covers column sections designed to avoid the necessity of latticing or battens and tested with square ends. It covers one grade of structural steel—the ordinary structural grade—with a desired ultimate tensile strength of 60,000 pounds per square inch.

The earlier tests showed a decrease in unit ultimate strength of the heavy columns when compared with the light ones. In seeking to account for the falling off in strength of the heavy material, the committee learned that it was necessary to look beyond the differences in the ratios of widths to thicknesses of outstanding legs, and variations of cross-section. The only remaining element which could be charged with responsibility appeared to be the metal itself, and though the intention had been to secure material of a uniform grade, a more careful and thorough investigation disclosed the fact that the attempt had not been successful.

Not finding an explanation of the falling off in strength of the heavy material in the record of mill specimen tests, the Bureau of Standards then took some of the long columns, which had already been tested, and cut them into lengths to give a slenderness ratio of $\frac{l}{r} = 20$.

These short columns showed that the unit ultimate strength of the heavy columns was considerably more than that of the light ones. Both series indicated a fairly definite point at which permanent set occurred, and showed that this point was lower for the heavy columns than for the light ones, indicating that the increased ultimate strength of the heavy ones came about from the block action of the short, heavy material, and that the elastic limits or yield points are the true indicators of the strength of the two different thicknesses of material.

Tests of short columns having a slenderness ratio of $\frac{l}{r} = 20$, made of material which had not been previously stressed, confirmed these results and the belief that the strength of columns is governed, not by the ultimate tensile strength of the material but by the point at which there is marked departure from an elastic condition.

To investigate the question of this critical point, the Bureau of Standards proposed some supplementary specimen tension and compression tests, to be made from pieces, 5 ft. in length, which had been provided from each melt at the time the material was rolled. These 5-ft. pieces were in the nature of coupon material from the columns, and had not been subjected to stresses in the testing of the columns. Table I. is a summary of the averages for these supplementary specimen tests and of the averages of the mill specimen tests.

The ultimate strengths shown on the supplementary specimen tests were very close to the ultimate strengths given for the specimen mill tests, and neither the ultimate strengths from the supplementary tests nor from the mill tests indicates the falling off in strength of the thicker material. It also was evident that the yield point, as recorded by the ordinary commercial tensile specimen tests, even when the machine is run at comparatively slow speeds, as was done in the Pittsburgh Laboratory of the Bureau of Standards, did not give the correct index of the strength of the material. The committee concludes that "it appeared necessary, therefore, in order to predict the

strength of a column, to determine the nature of the metal by some other means than those generally used."

For the purpose of studying the column tests, the committee gave careful consideration to the discussion held by the American Society for Testing Materials at its annual meeting, June, 1916, on the relation between proportional limit, elastic limit, and yield point, to find whether it was possible to determine some point which, for practical purposes, might be easily located, clearly defined, and at the same time represent the limit where the metal ceases to have structural value. None of the terms defined by the discussions of the American Society for Testing Materials appealed to the committee as having these qualities. In searching for a more satisfactory definition, the committee considered a modification of the suggestion made some years ago by the late J. B. Johnson, M.Am.Soc.C.E. The committee has defined the critical point as the point which is determined graphically by drawing a line tangent to the envelope of the stress-strain curve, having a slope

**Table I.—Summary of Results of Mill Tests and Bureau of Standard Tests**

| Type. | Mill Specimen Tests made at Pittsburgh. | | | Bureau of Standards Specimen Tests. | | | Average U.L.P. of full-size columns $\frac{l}{r}$ = 50 and 85 | Average ultimate strength of full-size columns $\frac{l}{r}$ = 50 and 85 |
|---|---|---|---|---|---|---|---|---|
| | Average drop of beam. | Average ultimate strength | Number of tests. | Average U.L.P. | Average ultimate strength | Number of tests. | | |
| 1 | 34 000 | 58 900 | 7 | 33 100 | 59 000 | 8 | 28 300 | 32 000 |
| 1A | 38 300 | 59 500 | 7 | 29 800 | 56 200 | 2 | 25 000 | 28 600 |
| 1B | 36 400 | 59 600 | 4 | 31 100 | 57 000 | 1 | 26 200 | 27 700 |
| 2 | 36 500 | 57 700 | 5 | 32 500 | 58 800 | 8 | 28 100 | 32 900 |
| 2A | 36 900 | 59 700 | 4 | 30 200 | 58 400 | 6 | 26 800 | 31 400 |
| 3 | 39 800 | 55 600 | 5 | 34 100 | 55 400 | 4 | 28 200 | 33 300 |
| 3A | 37 900 | 59 200 | 2 | ..... | ..... | ..... | 25 500 | 28 800 |
| 4 | 36 500 | 58 100 | 5 | 33 800 | 58 000 | 13 | 31 600 | 35 400 |
| 4A | 37 700 | 59 400 | 4 | 27 100 | 59 700 | 13 | 22 900 | 27 900 |
| 5 | ..... | ..... | ..... | 37 500 | 61 500 | 2 | 33 800 | 36 200 |
| 5A | ..... | ..... | ..... | 33 300 | 57 900 | 3 | 30 900 | 33 800 |
| 5B | ..... | ..... | ..... | 22 600 | 56 400 | 12 | 20 000 | 24 400 |
| 6 | 34 600 | 57 600 | 9 | ..... | ..... | ..... | 24 500 | 30 400 |
| 6A | 38 300 | 60 400 | 3 | ..... | ..... | ..... | 22 600 | 29 500 |
| 7 | 34 600 | 59 400 | 5 | 33 500 | 61 600 | 3 | 30 000 | 32 500 |
| 8 | 39 200 | 56 300 | 6 | ..... | ..... | ..... | 31 200 | 34 200 |
| 8A | 37 600 | 58 700 | 3 | ..... | ..... | ..... | 29 400 | 32 300 |
| 10 | 37 600 | 58 100 | 16 | ..... | ..... | ..... | 26 800 | 34 000 |
| 10A | 37 600 | 61 700 | 3 | ..... | ..... | ..... | 25 200 | 30 100 |

of one-half of the last run-up line for its straight, or nearly straight, portion. So as not to confuse this with former definitions of yield point or elastic limit, the committee has adopted a new term, and calls this the Useful Limit Point, or U. L. P.

In straining a column, there is a point beyond which its structural value is uncertain, and consequently unsafe to rely upon. This point lies somewhere above the region of perfect elasticity and well below the place where manifest yielding occurs. For the study of column tests, the U.L.P. as above defined, states the committee, seems to fulfill these conditions satisfactorily. Careful observations and plotting of the stress-strain curve locate it without chance for controversy. The method is applicable to both tension and compression tests.

In the early days of the iron and steel industry, it was the custom of engineers to adopt a working unit stress for tension members of one-quarter of the unit ultimate specimen tensile strength, and they spoke of a factor of safety of four. When we consider the distortions produced by the stretching of tension members after being strained above the yield point, and that manifest yielding and failure occur in columns when the stress reaches about one-half of the specimen ultimate strength in tension, it is evident that the factor of safety obtained by this older method was nearer two than four.

In a structure having both tension and compression members, the desideratum in determining a factor of safety is to obtain a working stress so that all parts of the structure have an equal capacity to resist the applied loadings.

The committee made no original investigations of the strength of full-sized riveted tension members, and, therefore, could not make as definite a comparison with full-size riveted columns as would be desirable. It may be stated, however, that the usual working stress in tension is approximately one-half the elastic value of the metal, and the committee assumes that, in view of all the factors mentioned above, columns should have a safety factor of at least two, based on the U.L.P., in order to be on a parity with tension members.

The average U.L.P. of all the column tests in the committee's program for slenderness ratios, $\frac{l}{r}$ = 50 and $\frac{l}{r}$ = 85, is 27,200 lbs. per square inch. The U.L.P. for the extra heavy section, Type 5B, slenderness ratio, $\frac{l}{r}$ = 50, which is the lowest value observed, is 19,700 lbs. per square inch, which is 28 per cent. below the average, and this appears to be too wide a margin of under-run for safety. It would seem to be necessary, therefore, in recommending a working stress, to assume a U.L.P. lower than the average of all the tests. If we take as a safe assumption the mean between the lowest value and the average value, this mean will be 23,500 lbs., or approximately 24,000 lbs. per square inch. The factor of two applied to 24,000 lbs. will give a safe working value of 12,000 lbs. per square inch for columns, which stress the committee would recommend. In this recommendation it is assumed that only static loads are being dealt with, and that a percentage of the static stress will be added to cover the impact due to moving loads.

Lacking further experimental data, the committee regards it as unwise to assume a higher working stress than 12,000 lbs. per square inch for columns in which the ordinary grade of structural steel (60,000 lbs. ultimate tensile strength desired), is specified. It is, of course, impracticable to know in advance the precise U.L.P., or any other factor of strength, which the metal used may develop. It would be possible to specify the desired value, and, in important structures, to inspect the material with sufficient care to insure the rejection of all which failed to come up to the specification.

The committee would recommend that this working stress of 12,000 lbs. be used for columns up to a slenderness ratio of $\frac{l}{r}$ = 80, and, above this slenderness ratio, the committee would reduce the working stress to allow for uncertainties. The committee realizes that the results as given in its program show that the slenderness ratio has a comparatively small effect, up to values of $\frac{l}{r}$ = 120. It must be remembered, however, that the tests were made by the Bureau of Standards under extremely favorable conditions, the ends of the column being scraped so as to give a bearing precisely perpendicular to the axis of the column. The committee would recommend a working stress of 8,000 lbs. per square inch for slenderness ratio of $\frac{l}{r}$ = 120, and that the working stresses for

slenderness ratios between 80 and 120 be determined by interpolation.

The committee realizes that the working value recommended for short columns is lower than that given by the American Railway Engineering Association formula, which has been in use for a number of years. Originally this formula was $\frac{P}{A} = 16{,}000 - 70\frac{l}{r}$ and, later, the upper section was truncated to a maximum working stress of 14,000 lbs. The committee feels, in view of its studies in regard to the U.L.P., that there is no warrant for high working stresses in short columns.

## SASKATCHEWAN LAND SURVEYORS MEET

The eighth annual meeting of the Saskatchewan Land Surveyors' Association was held in the Parliament Buildings at Regina, Sask., on Monday and Tuesday, March 4th and 5th.

The meeting was well attended, many members being present from various parts of the province, and a keen interest was displayed throughout all the sessions in the work of the association. A number of visiting engineers from the Department of Highways were in attendance.

The meeting was devoted mainly to a study of rural roads. A number of valuable papers dealing with the various phases of the location, construction and maintenance of roads were presented by W. M. Stewart, S.L.S., of Saskatoon, Sask., which brought forth a lively discussion.

The series of papers dealing with roads consisted of: "Rural Road Development—Legislation and Control," "The Planning of a System of Highways," "Financing Rural Road Work," "General Features of Construction and Principles of Design Applicable to All Road Types," "Earth Roads," "Sand, Clay and Top Soil Roads," "Types of Road Surfaces Within the Means of the Average Saskatchewan Rural Municipality," "Gravel Roads."

In addition to the above, papers were also read and discussed on the following subjects: "Principles of Drainage Assessment," by H. G. Phillips, S.L.S.; "The Railroad Spiral in Relation to Land Surveys," by E. C. Brown, S.L.S.

On Monday evening a banquet was held at the Assiniboia Club, at which the retiring president, R. W. E. Loucks, acted as chairman. The guests included the Hon. S. J. Latta, Minister of Highways for Saskatchewan, and H. R. Mackenzie, as official representative of the Saskatchewan Branch of the Canadian Society of Civil Engineers. At this dinner W. T. Thompson, one of the pioneer surveyors of the province, read a very interesting paper describing a canoe trip "Down the Saskatchewan from Prince Albert to The Pas." The Hon. Mr. Latta addressed the meeting, pointing out the policy of the Department of Highways towards road building.

A spirited discussion then followed dealing with various aspects of rural roads, in which the majority of those present participated.

The following officers were elected for the ensuing year: President, W. T. Thompson, Regina, Sask.; vice-president, E. C. Brown, Winnipeg, Man.; secretary-treasurer, H. G. Phillips, Regina, Sask; executive council, W. M. Stewart, Saskatoon, Sask.; R. W. E. Loucks, W. A. Begg, and S. Young, Regina, Sask.; auditors, W. R. Reilly, C. S. Cameron, Regina, Sask.

## PROBLEMS OF MODERN INDUSTRY*

By W. L. Hichens

UNLESS industry is recognized as primarily a national service in which each individual is fulfilling his function to the best of his ability for the sake of the community, in which private gain is subordinated to public good, in which, in a word, we carry out our duty towards our neighbor—unless we build on this foundation there is no hope of creating the House Beautiful. If each man thinks of making his pile by all the means that economic individualism allows, if class bands itself against class, trade union against employers' federation, firm against firm, to secure the greatest share of the world's goods in unrestricted competition, social life must inevitably break down and anarchy reign supreme. Some of the practical steps that this principle seems to suggest in relation to certain of the problems that confront industry to-day are briefly indicated below:—

(1) I think it follows that no business is entitled to make unlimited profits. The present theory is that the residuum, however large it may be, after defraying the costs of production, should go to capital. This, I submit, is unsound. Labor, the entrepreneur class, capital, and the consumer, are all partners in the business of the community, and no one class is entitled to benefit unduly at the expense of another. The principle of the Profits Tax should therefore be retained after the war. The present tax, of course, was intended as a temporary measure, and a standard of profits based on pre-war earnings is quite unsuited to permanent conditions. It would be necessary to fix a standard rate of interest for the capital invested in each class of trade or industry, and a proportion (I suggest a substantial one) of any excess profits over that standard should accrue to the State. In any such scheme it would be necessary to provide that adequate allowances are made for depreciation and for reserves to secure the stability and development of business. The wholly inadequate provision for depreciation allowed under the Income Tax Regulations to-day has done serious injury to the industries of this country. It has encouraged overcapitalization; it has hampered the scrapping of old and the substitution of modern machinery; it has given us a retrograde in place of a progressive standard. Effect must somehow be given to the principle that no section of society is entitled to an unlimited share of the wealth of the community, that free competition has proved an impossible solution, and that profit-sharing with the State, which is, in the effect, an excess profits tax, is more equitable and more expedient than other forms of profit-sharing.

(2) It follows secondly that, just as capital is not entitled to an unlimited reward but must be checked by State action, so also the reward of labor must in the last resort be determined by the State as representing the community. Labor has no more right than capital to make a corner in its own commodity and hold the community up to ransom, and it, too, must bow to the will of the State. In practice it is clear that the tendency will develop for wages to be settled by joint industrial boards representing employers' and workers' organizations, but in the event of disagreement, or collusion to exploit the community, the State must have the right of intervention. It is not fitting that any party should be the final judge in its own cause, and any such claim, if successful, will inevitably lead to the disintegration of society. For the community will be

*Abstract of James Watt Lecture, delivered before the Greenock (Scotland) Society, January 18.

divided into a number of groups each fighting for its own hand, private gain will rise superior to the public good, the fundamental law of social life will be broken, and the eternal truth will be verified that a kingdom divided against itself cannot stand. I recognize that a large section of the community is not to-day prepared to accept the principle of State intervention, and I recognize also that unless it appeals to the moral judgment of the great majority of the nation it cannot be enforced and ought not to be enforced. The important thing to-day is that the verdict of public opinion should be sought.

(3) The principle of national service requires, thirdly, that the status of labor as a whole should be raised. The workers are clearly entitled to have an effective voice in regard to the general conditions under which their work is carried on. They are vitally interested in all questions, for example, affecting wages, hours of labor, apprenticeship, demarcation of work, decasualization, and they have an equal right with employers to assist in the determination of these problems. The general acceptance of the proposals for Joint Industrial Councils contained in the Whitley report is good evidence that public opinion will support the demand of labor for an improved status. If its voice is to be at all effective it follows that, as suggested in the Whitley report, district councils and works committees must be established to deal with local questions and to ensure that whatever is agreed to by the central councils is carried out locally. The more highly organized employers' associations and trade unions have already advanced far along the lines of the Whitley report, but much has yet to be done in determining precisely the powers and functions of these joint central and district bodies.

There are two points in particular which, it seems to me, deserve careful consideration. The first is the interpretation of decisions in regard to wages. At present all general increases in time rates are determined by the government, and, incidentally, I may say that it is a grave defect in organization that so many government departments meddle in labor matters. There should be one government department only—the labor department—to deal with labor questions, not half a dozen, and this salutary reform would save great confusion and waste of money. There is, in fact, a serious lack of co-ordination between the government departments. New departments have been thrown down as from a pepper pot, without a clear definition of their functions or their relations to the older departments and each other, with the result that, as in the game of "Snap," when identical cards are turned up by two or more players, a discordant noise ensues for the appropriation of the spoils, and all are as intent on the game as the boy in Theocritus, who pays no heed to the wily fox that designs to rob him of his breakfast. The solution, I submit, is a Cabinet for internal affairs, distinct from, though subordinate to, the War Cabinet, with a president of its own whose business it should be to co-ordinate the administration of domestic policy. This would give relief to the over-burdened War Cabinet, and allow serious and orderly consideration to be given to the vast internal problems with which we are faced.

But this is a digression, and I return to my point, which is that, while general increases in time rates are to-day settled by the government, individual firms still determine time rates in particular instances and all piece rates, which, in theory, should bear some definite relation to time rates. Thus the door is left open for one firm to pilfer from another, and, since leaving certificates have been abolished, the temptation has not always been resisted. It is obvious that the firms whose piece rates are highest will attract most labor, with the result that other firms will be obliged to follow suit, and this will eventually react on the time rates. Similarly in periods of depression, when labor is plentiful, individual firms can cut their piece rates and compel others to follow suit, or lose their trade. The strongest justification for restriction of output is that individual firms have it in their power to cut down piece-work rates, and in the past they have often done so when they found that under them the workers were earning very high wages. Consequently the workers have felt that in the end the result of increasing output and speeding-up has been to reduce the piece-work rates and restore the normal balance of their earnings; but, unnaturally therefore, they have concluded in favor of maintaining a normal output of work. It is quite clear that a mistaken piece rate must be open to revision downwards as well as upwards, and the pledge given by the government at the beginning of the war that no piece rates would be reduced was a benevolent blunder. What they should have done was to ensure that piece rates were not arbitrarily altered, and that due care was exercised in the fixing of all rates. The responsibility for fixing piece rates and special time rates—in other words, the detailed interpretation of wages agreements—should rest, not on individual firms, but on the joint district councils, which are to be linked up with the joint industrial councils. This would mean that these councils would require a competent staff of rate-fixers to deal with each case promptly, but a more than corresponding reduction could probably be made in the rate-fixing staffs of individual firms, and the gain that would result from placing the settlement of piece rates on a basis that would establish confidence is incalculable.

It is sometimes claimed that labor should have an effective voice not merely in regard to the general policy and conditions of industry, but in the management of each individual business. This claim is vaguely put forward and has never been clearly thought out; it makes its appearance usually under the guise of a demand for the democratization of industry. The political analogy implied in this phrase is attractive, but misleading. For whereas a State cannot at one and the same time be an autocracy, an aristocracy, and a democracy, it is possible for every variety of organization to co-exist in industry. The general policy and conditions of industry should, it is true, apply to each firm in an industry, and therefore it is right that labor should have an effective voice in determining them and seeing that they are carried out, through joint industrial councils and district committees. But every degree of variation is possible in the detailed organization of individual businesses. There is ample scope in industry for everyone to select or develop the type of organization that suits him best, and it seems to me that each man is entitled to choose for himself. Unrestricted competition is an evil, but its complete elimination spells stagnation; for a healthy rivalry between one type of organization and another and between one firm and another is the life-blood of efficiency. Hence, subject to the observance of the general policy and conditions of industry, each business should be organized on whatever lines seem best to those who are responsible for its direction. I do not agree, for example, with the suggestion so often made that the power of dismissal is too big a responsibility to be exercised by any single employer, and that there should be a right of appeal to some outside body. Given an adequate system of unemployment benefit, it is vital to the success of industry that those responsible for the management of a business should be entitled to select their own employees. The secret of success in business lies very largely in the wise selection of men, and if that re-

sponsibility is taken away from the management a blow will be struck at the very roots of our industrial supremacy.

(4) The fourth point in the application of the general principle of national service is, strictly speaking, rather a necessary preliminary to, than a consequence of, the principle. I refer to the question of the reduction of hours of labor, which is one of the most important problems awaiting solution. The first step on the return of peace should be the establishment of an eight-hour day as a first instalment towards still farther reductions, if experience shows that this is possible consistently with the material requirements of civilized existence. Moreover, it should be arranged that each worker who has been with a firm a whole year and has kept good time should be given a holiday on full pay. The distinction between a strike and a holiday should be more marked than it is now, and the same absence of pay should not characterize both.

(5) But the reforms indicated above will require large sums of money, and there are many others, such as housing and education, the cost of which will be formidable. Moreover, these reforms will be of little or no avail unless a high standard of wages is established. Seeing that we are so largely dependent on our foreign trade, in which prices are regulated by international competition, it is quite clear that we shall not be able to meet the bill unless we can effect drastic economies in production and largely increase our output. If all strikes can be prevented, and regarded, as they should be, as the unhealthy excrescence of a semi-civilized age, the addition to our national wealth will be very great. An average of 18 million working days per annum was lost owing to trade disputes in the four years before the war, to which must be added the indirect losses involved by the dislocation of industries not primarily affected. But an even greater gain will be made if the policy of restricting output is abandoned. Disastrous though the policy is to the workers themselves, as well as to the rest of the community, we shall be indulging a vain hope if we think it will be abandoned so long as the theory holds the field that capital is entitled to the residuum of profit after the costs of production have been defrayed. Unless it is made unmistakably clear that industry is run for the benefit of the whole community and not for the enrichment of certain classes, restriction of output will continue, and the reforms that are so urgently needed will be sadly hampered. A third important factor in improved production is the substitution of up-to-date machinery for old and the extension of labor-saving devices. It is clearly in the general interest that machinery should be substituted for hand labor wherever practicable, just as it is a social duty to secure that no one is paid a wage below what will support a civilized existence. In fact, the latter cannot be secured without the former. It would be a mistake to suppose that the opposition to the reforms involved in the introduction of improved mechanical devices and improved organization comes from the workers alone. Vested interests play an even more powerful part in thwarting progress, and ingrained habits present a formidable obstacle to far-reaching schemes of reform.

One instance of wasted effort I should like to refer to briefly because of its far-reaching importance. I mean the waste involved in unrestricted competition. Certain forms of competition are healthy and cheapen production, but others are sadly wasteful. The rivalry in economical production—so long as wages, hours, and general conditions of work are safeguarded—seems to me healthy, and I believe it is better for a country to have a large number of small manufacturers than a few big trusts; this also accords more with the genius of our race, whose sturdy independence and self-reliance have built up an Empire containing a quarter of mankind. Nor do I believe that the economies resulting from manufacture on a gigantic scale are very great.

But big selling organizations are undoubtedly more economical than small ones. What is wanted, therefore, is big selling combinations, which should also promote research work, and a variety of manufacturing units. The money that is wasted every year in travellers, in touting for orders by means which are often degrading, in overproduction, runs into enormous figures. But the remedy of syndicating the produce of each industry is full of difficulty; it tends to stagnation, to the exclusion of newcomers and to inflation of prices, for the evil of rings in the past has been that they have thought more of keeping prices up than of cutting costs down. These evils are not insuperable, and attention should be concentrated on the establishment of big selling organizations. The principle is not, of course, immediately applicable in all industries, but it might be applied at once with great advantage to many of the standardized trades, and it might be encouraged where it already exists.

## TORONTO MAY ESTABLISH PIGGERY

Street Commissioner George B. Wilson and Property Commissioner D. Chisholm, of the city of Toronto, have presented a joint report to the aldermanic sub-committee on waste disposal, recommending the establishment of a municipal piggery, to commence with 500 hogs. They state that the initial expense involved is $15,250, made up as follows:—

One 5-ton motor truck, $8,000; annual operation and maintenance of truck, $3,600; one sterilizing apparatus, $2,000; one foreman at farm, $1,000; 200 cans, $450; incidentals, $200.

The proposal involves the separation by the citizens of the class of material required, and it is intended to collect this in a limited section of the city, beginning with the residential section known as Rosedale. Householders from whom collections are to be made, are urged for patriotic reasons to assist the city by carefully conserving all edible wastes and retaining the same in separate receptacles for collection twice a week during the winter months and three times a week during the summer months.

At the start it is the intention to make provision on the present collection equipment of the department to enable the drivers to keep the hog-feeding material entirely separate from the other collections made by the same vehicle. The material will be transferred to the motor truck at the incinerator. Separate collections may be instituted at a later date. The food value of the edible garbage laid down at the Industrial Farm, where the piggery will be established, is said to be approximately $15 per ton. As it is expected to deliver five tons a day, the delivery is estimated to be worth $22,500 per annum. From this amount, however, must be deducted the expenses of the enterprise. The city council are asked by the report to include $15,250 in the current year's estimates of the property department, to cover the expenses outlined above.

The sterilizer is required by the regulations enforced under the direction of the Veterinary Director-General of Canada. A man who keeps one pig is not hampered by any feeding regulations. More than one pig, but not more than twelve pigs, may be fed with pot-boiled garbage. If more than twelve are kept, a sterilizing plant must be installed to heat the garbage to 200 degrees.

## PROVINCIAL CONTROL OF FORESTS

The recent proposal of Hon. Edward Brown, provincial treasurer of Manitoba, to retire the provincial debt by realizing on the natural resources of the province, was noted in these columns two weeks ago. A circular, just issued by the Canadian Forestry Association, takes issue with Mr. Brown and with the other Western political leaders who have brought forward the contention that Manitoba, Saskatchewan and Alberta should be placed upon the same basis as the older provinces in respect to ownership of their natural resources. This Association is a non-government, non-commercial body of 5,500 Canadian citizens, 1,200 of whom reside in the prairie provinces.

With the political side of the long-standing dispute over control of natural resources in the prairie provinces the Canadian Forestry Association states it is not concerned. So peculiarly, however, is the question related to proper management of the Western forests that some reference to it at this time, it thinks, is essential in the public interest.

The Association states that the bulk of the citizens of the Western provinces have an impression that the forests would constitute an immediate source of revenue to the provincial treasury and that in demanding control of the forest resources they are asking the Dominion to enhance their cash income. The ownership of the Western forests, however, is an immediate financial liability to the Dominion government, and the total income from Western forests does not equal the total outlay for protection and improvement. The Dominion Forestry Branch spends $445,000 annually on forest protection in Manitoba, Saskatchewan and Alberta, while the total revenues are approximately $39,000.

"If the forests are handed over to the Western provinces, they must accept the situation as it actually is," says the Association. "Instead of adding to their revenues, they would then have to find at least $200,000 from some fresh source with which to pay the cash deficit on one year's handling of their new forest possessions. More than that, they would, in all likelihood, automatically forfeit the provincial subsidies paid by the Dominion government amounting to: Manitoba, $409,007; Saskatchewan, $562,500, and Alberta, $562,500, as a Dominion allowance in lieu of public lands. These subsidies are paid as compensation for Dominion control of the natural resources, and would lapse with any transfer of title to the lands. What proportion of the subsidies is represented by the forest resources is not ascertainable, but assuredly it would represent a large sum for each province." These are important considerations and should have the attention of the provincial authorities during their discussions.

## STEEL PLANTS EXPECT CONTRACTS

That all steel plants in Canada will probably be operating at full capacity throughout the year under heavy demand, and that large new munitions contracts are expected from the United States and Great Britain, are opinions expressed by Colonel Thomas Cantley, chairman of the board of directors, Nova Scotia Steel and Coal Company.

The production of steel ingots and direct castings in Canada in 1917 was approximately 1,700,000 tons, creating a new record, the previous banner year being 1916, when about 1,300,000 tons were produced. The production of pig iron likewise advanced in 1917 to 1,200,000 tons. About 13,000 tons of this came from electric furnaces The electric furnaces accounted for 45,000 tons of steel last year, as against 19,000 tons in 1916.

## TRADE RETURNS

The transportation difficulties, rail and ocean, are reflected in the trade figures. Our exports of agricultural products in January were valued at only $26,000,000 compared with $91,000,000 in the previous month, despite the urgent demand of the United Kingdom for our products. A better record was made in regard to manufactures. In December, the total volume of exports under that head was the smallest during the past year. A considerable improvement occurred in January when exports of manufactures were valued at $41,383,115, an increase of nearly $8,000,000, representing more than 40 per cent. of the total exports of all classes. Another satisfactory gain was $4,500,000 in "animals and their produce," while increases were shown under the heads of "the mine" and "the fisheries." How our export totals during January and December last were made up, is shown in the following table:—

| Exports of— | January, 1918. | December, 1917. |
|---|---|---|
| Mine | $ 5,528,992 | $ 5,026,041 |
| Fisheries | 3,390,587 | 3,016,059 |
| Forest | 3,110,324 | 3,836,909 |
| Animals | 15,918,079 | 11,433,910 |
| Agricultural | 26,390,294 | 91,216,447 |
| Manufactures | 41,383,115 | 33,635,790 |
| Miscellaneous | 494,893 | 246,763 |
| Total | $96,216,284 | $148,411,919 |

Our imports in January were valued at $60,000,000 compared with $61,000,000 in December and $107,000,000 in May. Imports, which have been decreasing steadily since the summer of 1917, largely because of the difficulty of securing raw materials in the United States, were the smallest reported in any month in more than a year. Because of a decrease of $13,000,000 in the import figures the net trade balance in favor of Canada was in January last nearly $9,000,000 higher than in January a year ago, and a new record for the month. If our imports continue to decline and our exports increase, the trade balance will rapidly improve. At the same time, as a large part of our imports are raw materials from the United States and as much of the product is finished here for export, a decrease of imports will to some extent affect the volume of our export trade also. Our trade balance may possibly be improved by a compulsory reduction of the importation of articles which may properly be considered luxuries. This matter is having the consideration of the War Trade Board.

## CONCERNING STEEL SHIPBUILDING

In answer to the enquiry of the St. John board of trade as to whether the government would furnish the builders with steel plates in the event of a steel shipbuilding yard being established in St. John by private capital, the deputy minister of marine advises that it is the intention of his department in connection with the proposed programme of shipbuilding to enter into contracts only with such firms as are now equipped with the necessary machinery and labor for the delivery of steel steamers complete.

The suggestion that St. John is favorably situated for the establishment of a steel shipbuilding plant has brought an enquiry as to whether there is available here a water lot with deep water frontage of 5,000 feet and a depth of 1,500 feet that would be suitable for a comprehensive shipbuilding plant. The size of the plant contemplated would involve an expenditure of between eight and ten million dollars and would employ from five to seven thousand men all the year round.

The British Aluminium Company, Limited, whose head office for Canada is at 60 West Front Street, Toronto, has distributed a most useful article in the shape of a perpetual calendar combined with paper weight. Those who are fortunate enough to secure one of these desk friends will, no doubt, find it very handy.

## CANADA'S SHIPBUILDING ACTIVITIES

Shipbuilding contracts placed in Canada by the Imperial Munitions Board since March 1st, 1917, constitute the biggest year in shipbuilding this country has ever seen. Contracts have been let in the last twelve months for 46 wooden ships with a total tonnage of 128,000, representing $24,500,000, and for 43 steel ships, totalling 211,300 tons, worth $40,000,000, or a total value of $64,500,000. Four steel ships aggregating 13,900 tons, the individual boats having a tonnage of 4,200, 3,400, 4,500 and 1,800, have been completed. Four wooden ships have already been launched and several others are ready to take the water. New yards were opened during the year at Welland, Vancouver, and Toronto. All yards for the construction of wooden ships are new or have been added to.

The value of the contracts let in the different provinces is as follows:—Nova Scotia, $1,340,000; New Brunswick, $1,000,000; Quebec, $11,600,000; Ontario, $19,240,000; British Columbia, $31,434,000.

### Contracts in Provinces

In British Columbia nine steel ships, each of 8,800 tons, worth $14,750,000; two of 4,600 tons, worth $1,679,000, and one of 4,500 tons, worth $905,651, or a total of $17,334,651, have been contracted for, along with 27 wooden ships, worth $14,100,000.

In Ontario 25 steel ships were contracted for. These comprise 13 of 3,500 tons, nine of 3,400 tons, one of 4,300 tons, and two of 2,900 tons, a total tonnage of 86,200 tons, representing $17,240,000. In addition to this four wooden ships, totalling 11,200 tons, worth $2,000,000, have been contracted for.

In Quebec four steel ships of 7,000 tons each, valued at $5,600,000, and twelve wooden ships of 2,800 tons worth $6,000,000, representing a total value of $11,600,000, have been contracted for.

In New Brunswick two wooden ships, each of 2,800 tons, worth $1,000,000, are contracted for.

In Nova Scotia two steel ships of 1,800 and 2,400 tons, worth $840,000, and one wooden ship at $500,000, are contracted for.

### In 1918 Tonnage Will Be 400,000

According to a report of the Imperial Munitions Board it is reasonable to suppose that the approximate total tonnage for 1918 will be about 400,000. The approximate tonnage of wooden vessels being built by the Imperial Board on the two coasts, the Great Lakes and the St. Lawrence River is about 146,000. Figures as to the exact number of men employed in this programme are not available, but assuming an average labor cost per ton it is stated it will not be far from the equivalent of 25,000 men continuously employed.

In view of the foregoing, the figures with respect to the tonnage constructed in Canada in past years is of interest. For instance, 190,756 tons were constructed in 1874 when wooden ship construction was at its height, and each year since then has shown less activity until the war years. In 1880 the tonnage constructed was 65,441; in 1885, 41,179; in 1890, 52,378; in 1895, 16,270; in 1900, 22,326; in 1905, 19,781; in 1910, 22,283, and in 1914, 43,346.

### For Imperial Munitions Board

At present practically every shipbuilding plant in Canada that is equipped for building steel ships is making ships for the Imperial Munitions Board. Just as soon as each berth becomes vacant it is being taken up by the Dominion government in connection with the large shipbuilding programme announced by Hon. C. C. Ballantyne, minister of marine and fisheries, early in the year. Following are the details of conditions in the different shipbuilding plants of Canada:—

Two berths are vacant at Canadian Vickers, Limited, Montreal, with whom the government has entered into contract to fill the berths at once. Arrangements have also been made to fill berths becoming vacant in May, August and September with 8,200-ton ships.

Arrangements have been made with the Collingwood Shipbuilding Company to fill one berth now vacant with a 3,800-ton ship as rapidly as men can be found. It is also expected two 3,000-ton ships will be started, one in April and one in May.

The Wallace Ship Yard, Vancouver, will commence building a 4,350-ton ship early in May. They also propose building a 5,000-ton standard ship at an early date.

The government has made arrangements with the Port Arthur Shipbuilding Company to fill two berths vacant before July with two 3,000-ton ships, canal size boats.

The Polson Iron Works, Toronto, will fill four berths vacant in October with four 3,000-ton ships.

### Get Steel from United States

The Canadian Allis-Chalmers, Toronto, say they can build six ships before June, 1919, and will start as soon as berths become vacant.

Messrs. Coughlan & Sons, Vancouver, find it impossible to commence further work this year. They are building ships for the Imperial Munitions Board.

The Davie Shipbuilding Company, Quebec, will fill a berth as soon as vacant with a 5,000-ton ship.

In the meantime the department of marine and fisheries has made arrangements with the United States to secure the necessary steel to take care of shipbuilding, and at the same price as the plants across the border are paying. This steel is to be delivered to the various factories as required up to June, 1919.

It is pointed out that the establishment of new yards would only draw off men from the other yards because there are only a certain number of men available for this work. Therefore, the more the men were spread the fewer ships would be got into the water. Under existing conditions it is more important to get a few ships into service than have a large number under construction and none available.

## CANADIAN NORTHERN ARBITRATION

Testifying before the Canadian Northern Railway board of arbitrators recently at Osgoode Hall, Toronto, Mr. Samuel Bertron, of the banking firm of Bertron and Briscom, New York, declared that the stock of the Canadian Northern Railway at present was worth from 50 to 60 cents on the dollar. His estimate was based on the future prospects of the railway, the growing territory through which it operated, its small grades, economical operation, and its small bonded indebtedness, which had been placed on a very low interest return. These features of the Canadian Northern Railway had attracted a group of New York financiers, who, up to the entrance of the United States into the war, had virtually consummated a proposition to finance the railway on the representations of Sir William Mackenzie. It was at the instigation of these financiers that the Loomis-Platten report on the Canadian Northern Railway was prepared.

## CANADA'S TRADE HAS INCREASED

Canada's trade for the ten months of the fiscal year ending on January 31st reached a total of $2,229,493,276, according to the monthly statement issued from the customs department. This constitutes an increase of $351,208,579 over the same period last year, when the total trade amounted to $1,878,284,697. Domestic merchandise exported reached a total of $1,353,811,184 during the ten months of this year as against $960,736,072 during 1916. The exports of domestic merchandise during the month of January, this year, however, were lower than a year ago. They totalled $96,216,284 as against $99,106,259 a year ago.

Merchandise entered for consumption during the ten months this year reached a total of $823,059,701 as compared with $674,964,548 a year ago. During the month of January the total of this class was $60,677,414, which was lower than in January, 1917, when it reached $72,323,074. Foreign merchandise exported during the ten months of the fiscal year totalled $38,874,724 as against $20,470,769 for a similar period in 1917, and coin and bullion exported was $2,972,822 as compared with $196,190,607 a year ago.

The total of dutiable goods entered for consumption during the ten months ending January 31st was $460,976,255. Last year this class of goods totalled $370,646,468. Free goods during the ten months amounted to $362,082,846 as against $304,318,080 in 1917. Duty collected during the ten months of 1917 totalled $136,339,474, which was a substantial increase over the same period a year ago, when it reached $119,141,351.

# The Canadian Engineer

Established 1893

*A Weekly Paper for Canadian Civil Engineers and Contractors*

**Terms of Subscription, postpaid to any address:**

| One Year | Six Months | Three Months | Single Copies |
|---|---|---|---|
| $3.00 | $1.75 | $1.00 | 10c. |

**Published every Thursday by**
**The Monetary Times Printing Co. of Canada, Limited**

*JAMES J. SALMOND*, President and General Manager — *ALBERT E. JENNINGS*, Assistant General Manager

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


## Principal Contents of this Issue



## USE FUEL EFFICIENTLY!

FUEL is a subject which is engaging the minds of thousands of people in each of many countries. It is the fundamental basis of industrial development and social amenity. Hydro-electricity has changed our requirements to some extent, but—considering Canada as a whole—fuel is the prime necessary of the hour. Fuel is the metaphorical reef upon which Canada could possibly be wrecked more easily than many other countries; therefore it is highly essential to develop the conservation of the various classes of fuel, especially that which is imported.

If each consumer of fuel were to make an intensive study of the present efficiency—or, more correctly sometimes, the inefficiency—of his plant, it might be found that thousands of tons of fuel could be saved. Apart from the patriotism that is displayed by economizing in the consumption of fuel, such economy is good business. It enhances the credit of the country. It is not by the amount that we spend, but by the amount we save that our credit is measured.

Fuel has been obtained previously without much difficulty, but this winter and the war have caused engineers to consider how they could meet even more aggravated conditions such as might materialize another winter. Steps taken now to improve the methods of consumption, might help to prevent a worse plight than any we have so far experienced—and every little bit helps! Even a quarter ton of coal saved the situation at times for thousands of Canadian families this winter.

Not only the conservation of fuel, but also the problem of how to eliminate waste of the article produced, should be carefully considered. For example, some municipalities complacently allow the waterworks pumps to deliver water in quantities far exceeding the legitimate requirements of the community, thus using fuel or power which must be bought and which should be available for other and more justifiable purposes.

Conservation of fuel and power should be the fixed policy of all public authorities; because, if they are wasteful, how can the private citizen be consistently urged to economize?

## "SCIENTIFIC" AND "PRACTICAL"

THE terms "scientific" and "practical" are often considered to be diametrically opposed, and there is too great a tendency on the part of individuals in either category to depreciate the other. It must be realized that the two terms are complementary, not opposed, and that both in many instances seek the same end by diverse roads.

Professor Marshall, in his "Economics of Industry," thus states the essential divergence between practical and scientific method: "It would indeed be a mistake to be always thinking of the practical purposes of our work, and planning it out with direct reference to them. For, by so doing we are tempted to break off each line of thought as soon as it ceases to have immediate bearing on that particular aim which we have in view at the time: the direct pursuit of practical aims leads us to group together bits of all sorts of knowledge, which have no connection with one another except for the immediate purposes of the moment, and throw but little light on one another. Our mental energy is spent in going from one to another; nothing is thoroughly thought out; no real purpose is made. The grouping, therefore, which is best for the purposes of science is that which collects together all those facts and reasonings which are similar to one another in nature: so that the study of each may throw light on its neighbor."

In other words, as one great thinker has said, "Superior mentality consists in a large development of the faculty of association by similarity."

The meaning of the word "practical," as applied to engineering affairs, has yet another alternative rendering. Essentially, it means experienced. The main difference between the scientific and the practical mind is that the first is concerned with fact and theory while the interest of the latter is confined to useful application of knowledge. Technicality stands, perhaps, midway between the two extremes since it is science in a more practical dress applied to industrial issues.

The scientific mind desires to enlarge the boundaries of human knowledge without reference to practical ends, the practical mind desires to achieve results in a particular and limited direction only.

The past separation between science and practice is to be deplored,—the scientist despising commercial gain, the practical man having experience is not overfond of abstruse theory unless directly applicable to a practical end. It is, however, certain that a more practical spirit in scientific research, together with more science in practice, would better serve industrial ends.

Despite Professor Marshall's dictum, practical knowledge is not altogether a hotch-potch of unrelated items of knowledge. It has taken a lot of first-class reasoning to elucidate why certain processes and methods have given practical results. Practice as often leads science as the reverse. A freer spirit of exchange and closer association which is now happily visible, is going to benefit industry in a marked manner. There is more understanding both sides than was previously the case.

## PERSONALS

Capt. E. R. TAYLOR, R.E., '14 graduate of McGill, of Victoria, B.C., formerly engaged in civil engineering under the government, has been awarded the Military Cross.

JOHN HOLE, Sr., who for the past two years has been assistant superintendent of construction for the Toronto Harbor Commission, is leaving the commission to enter private practice as a general engineer and contractor.

WALTER BAKER CHAMP, who for many years has been secretary-treasurer of the Hamilton Bridge Works Co., Limited, and who was last week elected managing director and secretary of the company, was born in Hamilton, March 23rd, 1874. His entire business career has been with the Hamilton Bridge Works Co., having joined that firm when he was 17 years old. He was appointed treasurer of the company when only 24 years of age and seven years later he was made secretary-treasurer. Mr. Champ has been a director of the company since 1910. He is a member of the Hamilton Board of Trade and was president of that organization for the year 1909. He is a member of the Canadian Manufacturers' Association and served on the executive council of that association from 1909 to 1912. As managing-director of the Hamilton Bridge Works Co., Mr. Champ succeeds the late R. Maitland Roy, M.Can. Soc.C.E. Mr. Champ has been acting manager of the company since Mr. Roy's death in July, 1916.

*British and Colonial Press Photo.*

R. A. SARA addressed the Manitoba Branch of the Canadian Society of Civil Engineers last Tuesday evening on "The Statistical Methods and Equipment of the City of Winnipeg Light and Power Department." The meeting was held in the office of the City Light and Power Department and was followed by an inspection of the equipment in operation. The lecture was illustrated by lantern slides.

EDWARD S. COLE, president and treasurer of the Pitometer Co., was at a recent meeting of the New York Section of the American Water Works Association selected as a governor to take the place of Allan Hazen, who is retiring.

M. A. BLACK, C.E., a graduate of McGill University, recently with the Grand Trunk Railway at Windsor, Ont., has accepted a position as manager of the new concrete manufactures plant of J. J. McCaffrey, at South Devon, New Brunswick.

HOWARD TAYLOR, who for some years has been chief electrical and mechanical engineer of the Spanish River Pulp and Paper Co.'s plants, with headquarters at the Soo, has resigned to become consulting engineer with the Dayton-Wright Aeroplane Co., at Dayton, Ohio.

GAVIN N. HOUSTON, M.Can.Soc.C.E., formerly with the irrigation office, Department of Interior, at Calgary, has been appointed supervising engineer on the construction of the fifty-million-dollar explosives plant which the United States government is building at Charleston, West Virginia.

Lieut. RONALD DARE GILLESPIE, of the Imperial Gordon Highlanders, who was taken prisoner at La Bassee, January, 1915, has been exchanged and is in Holland. Lieut. Gillespie is a native of Victoria, B.C. He received his training in Edinburgh, Scotland, but returned to British Columbia to practise engineering and surveying.

## ANNUAL MEETING OF JOINT COMMITTEE OF TECHNICAL ORGANIZATIONS

The second annual meeting of the joint committee of technical organizations will be held in the Chemistry and Mining Building, University of Toronto, March 25th, at 8 p.m.

The chairman's annual report will be presented, and Colonel David Carnegie will address the meeting on an important industrial problem.

Other speakers will be M. J. Butler, managing director of Armstrong-Whitworth, of Canada, Limited, and W. E. Segsworth, Administrator of the Vocational Branch, Military Hospitals Commission.

## ASSOCIATION OF MUNICIPAL ELECTRICAL ENGINEERS

About one hundred of the managers, superintendents and engineers in charge of municipal electrical plants in Ontario met in Toronto March 13th and 14th.

For some time past it had been felt that in the best interests of all concerned it would be more desirable that instead of the organization remaining as an engineering section of the Ontario Municipal Electrical Association that a reorganization take place and a new association be formed of the managers, superintendents and engineers of the different municipal electric utilities free from the Ontario Municipal Electrical Association and financially independent.

E. V. Buchanan, of London, Ont., occupied the chair and after much discussion it was finally decided to go forward. It was moved by P. B. Yates, of St. Catharines, and seconded by O. M. Perry, Windsor, that the resolution looking to the new association be adopted. This was carried. The name of the new association is the Association of Municipal Electrical Engineers.

After a few minor amendments to the suggested constitution and by-laws the following officers were elected for the ensuing year: President, E. V. Buchanan, London; vice-president, E. I. Sifton, Hamilton; secretary, S. R. A. Clement, Hydro-Electric Power Commission, Toronto; treasurer, R. C. McCollum, Hydro-Electric Power Commission.

The following committees were also appointed: Membership and Credentials Committee, O. F. Scott, Belleville, chairman; Papers Committee, E. S. McIntyre, Kitchener, chairman; Convention Committee, W. J. Stapleton, Collingwood, chairman; Rules and Regulations Committee, R. H. Martindale, Sudbury, chairman.