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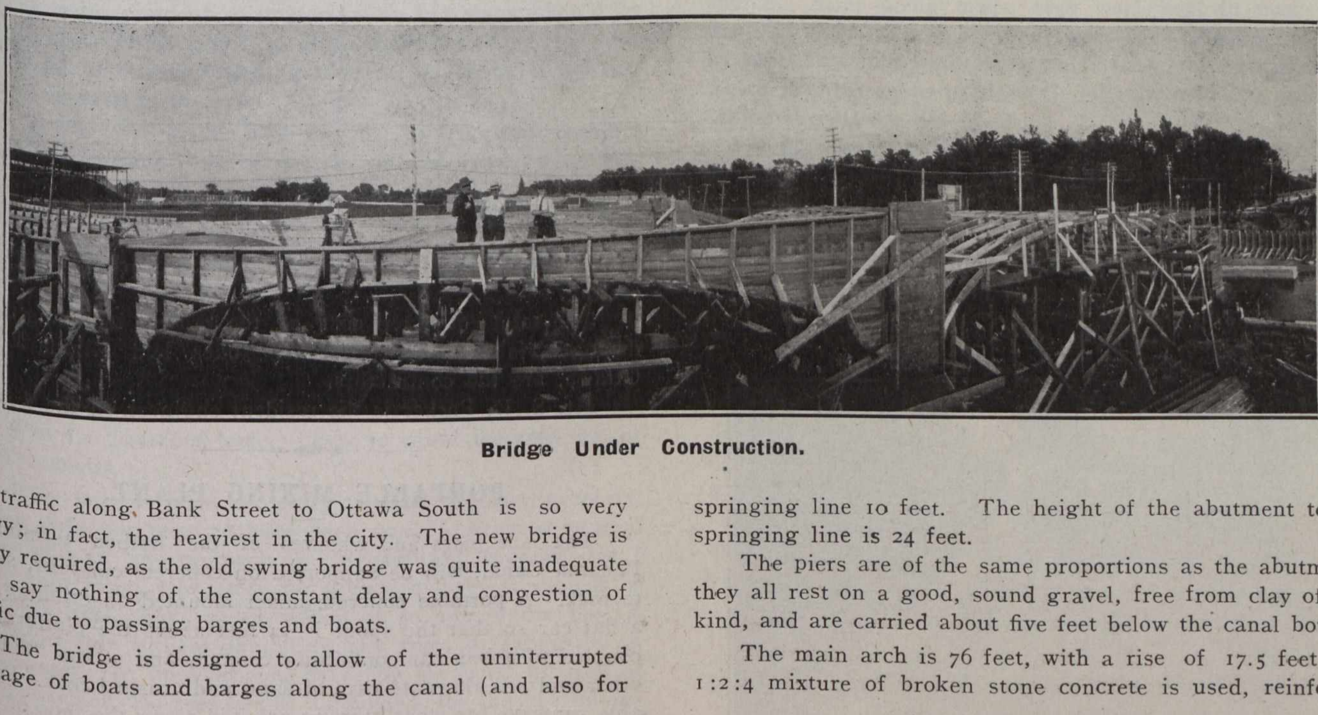
The Canadian Engineer

An Engineering Weekly

BANK STREET HIGH LEVEL BRIDGE, OTTAWA

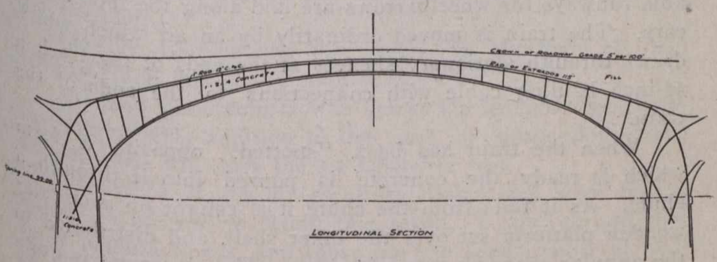
BY L. McLAREN HUNTER*

The Bank Street high level bridge, which is being constructed over the Rideau Canal by the city of Ottawa, is more than two-thirds completed. This new crossing will considerably help the development of Ottawa South, as it will enable the electric railway to cross the canal at this point. This they have been wanting to do for some time, as the traffic along Bank Street to Ottawa South is so very heavy; in fact, the heaviest in the city. The new bridge is badly required, as the old swing bridge was quite inadequate —to say nothing of the constant delay and congestion of traffic due to passing barges and boats.



Bridge Under Construction.

The bridge is designed to allow of the uninterrupted passage of boats and barges along the canal (and also for heavy highway traffic) having a clearance of twenty-nine feet above water level.



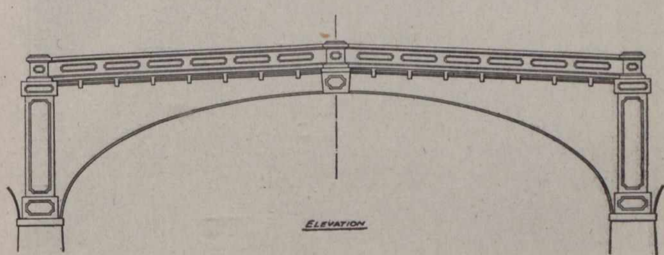
Longitudinal Section.

The main channel is spanned by a seventy-six-foot arch with a rise of 17.5 feet. The south approach consists of one arch span 62 feet, rise 14 feet; one arch span 50 feet, rise 11.5 feet, and about 30 feet of retaining wall, which completes the approach to the north side of Echo Drive. The north approach consists of three arches with spans 62 feet, 50 feet, and 40 feet, and rises of 14 feet, 11.5 feet and 8.7 feet respectively, and 230 feet of retaining wall.

The south abutment of the bridge (a section of which is reproduced) is of a 1:3:6 gravel mixture up to the springing line. At the base it is 25 feet 6 inches, and at the springing line 10 feet. The height of the abutment to the springing line is 24 feet.

The piers are of the same proportions as the abutment; they all rest on a good, sound gravel, free from clay of any kind, and are carried about five feet below the canal bottom.

The main arch is 76 feet, with a rise of 17.5 feet. A 1:2:4 mixture of broken stone concrete is used, reinforced top and bottom with ⅞-inch square steel bars placed 12-inch centre to centre, and tied together both vertically and horizontally with ½-inch square steel bars at 3 feet centres.



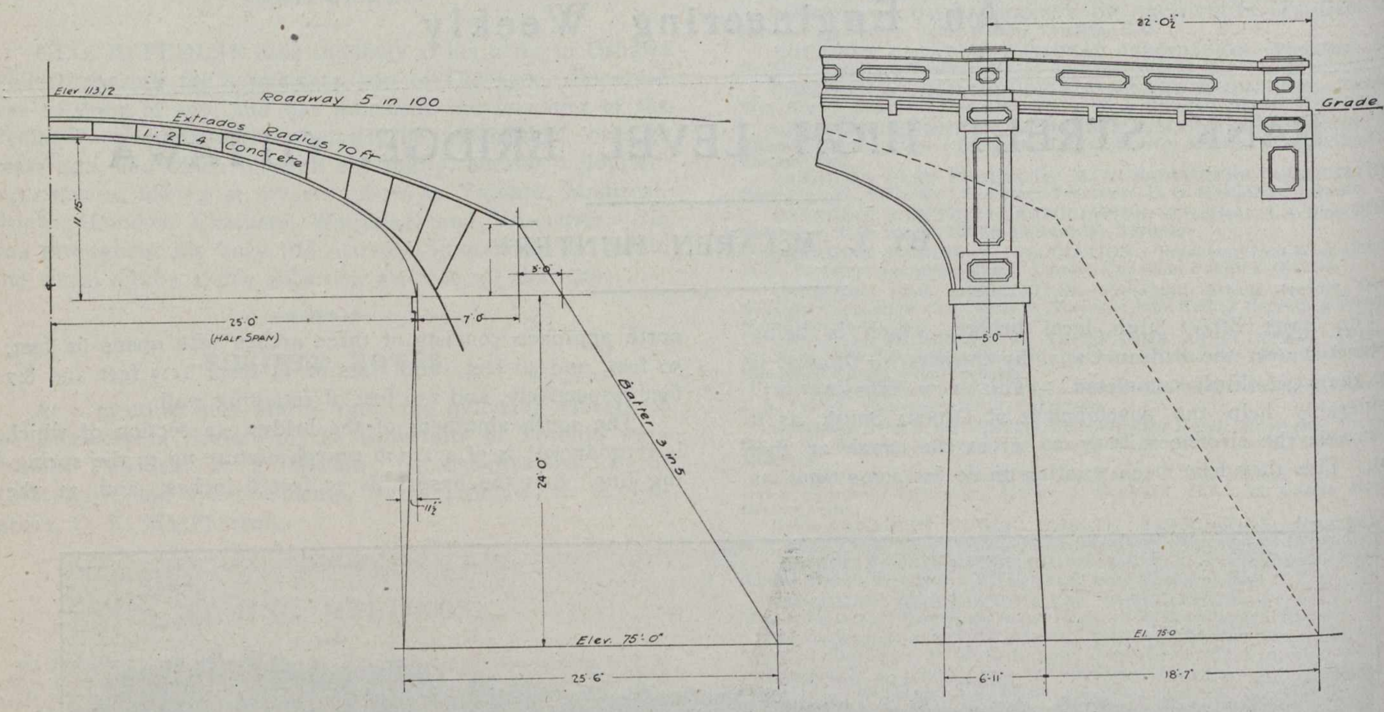
Elevation of Span.

The whole structure has been designed to conform with the specifications of the Department of Railways and Canals.

The Ottawa Improvement Commission's driveway will be continued under the north arches, through to the exhibition grounds, along the north bank of the canal as at present.

* City Engineer's Department, Ottawa.

The roadway, which will have a grade of five per cent. on both approaches, will be 40 feet between walks, and will be paved with creosoted wood blocks. The sidewalks will both be eight feet in width, and conduits will be placed under them to accommodate the cables and wires of the different electrical companies, thus doing away with the unsightly overhead wires. The ornamental lamp posts will be combined to carry the trolley wires of the electric railway and a cluster of four lights.



South Abutment, Bank Street Bridge.

Top of Arches With Reinforcing Bars in Place.

The construction work is nearing completion, everything being completed excepting the main arch, which has the centering and reinforcements ready to receive the concrete. This will be done immediately milder weather is encountered.

During the summer months between sixty and eighty men were employed; the number varying with the particular work in hand. Two steam derricks and two Smith mixers were kept constantly at work. A larger plant would have been difficult to handle, owing to lack of room at the site.

In concreting the arches, the concrete already mixed was hoisted with the derrick boxes to a temporary platform above the arch, and these emptied from it into wooden flumes which carry it to its place. Great care was taken to see that all the reinforcing was properly held in place among concreting.

The total estimated cost of the bridge, including land damages, is $130,000. Messrs. Jones and Girouard, of Ottawa, are the contractors.

Mr. S. D. Parker is the resident engineer on the works.

PORTABLE MIXING PLANT.

The new piers and wharves of the Balboa terminals, Panama Canal, will be supported on concrete caissons, sunk to rock. A portable concrete mixer mounted on cribbing on a flat car so that the spout is 14 feet above the platform is coupled to a box car containing cement, and at the "flat's" other end are alternate cars of sand and crushed rock. Portable runways for wheelbarrows are laid along the tops of the cars. The train is moved ordinarily by an air winch which draws through stationary sheaves at the ends of the track a ⅝-inch hauling cable with connections to the ends of the train.

When the train has been "spotted" opposite a form which is ready the concrete is poured into it through a chute. As it falls from the chute it is caught on a circular wooden platform set over the inner shell, and distributed to the annular space by men with hoes. The placement is quite simple and proceeds at the rate of mixer output. As soon as the shell has been cast the train is moved to another form. The concrete is allowed to set for 24 hours and then the forms are removed and cleaned at a special platform for their storage, after which they are set up again on the operating platform. The caisson shell is allowed to harden for three days before removal to a storage yard. Each section of shell is six feet high, with an inside diameter of 5 feet 6 inches and a thickness of shell of one foot, and contains 4⅔ cubic yards of concrete.

PORTLAND CEMENT TESTS.

At the meeting of the International Association for Testing Materials, the question of accelerated tests for constancy of volume in Portland cement, was under considerable discussion. In last week's issue of *The Canadian Engineer* we published a portion of a paper by Professor Max Gary as regards tests of this description in Germany. That portion of Professor Gary's paper which deals with accelerated tests in France is now given.

Accelerated Tests in France.—According to the paper by Mr. J. Bied during the last 20 years or so, hot water tests have been currently applied to hydraulic binding media in France, and the employment of the Le Chatelier needle cylinder apparatus for this purpose has been absolutely general and free from any objection. It is therefore perfectly natural that a French industrial laboratory should have taken up the matter of investigating the value of the objections raised against the method by the committee on the time of setting and by Messrs. Strebel in Germany and Butler in England.

Having read with a fair amount of attention the publications on this subject, I think that, leaving out of consideration the question of knowing whether or not the expansion in cold water previous to immersion in hot water should be disregarded—which point is quite independent of the test itself—the objections urged against the Le Chatelier hot test can be reduced to three:—

(a) The test would lead to the rejection of cements which would have behaved well in cold water.

(b) If the test be applied immediately after grinding, it will lead to the passing of cements which would, on the contrary, be rejected if the test were not applied until after aeration for a fortnight or a month.

(c) Finally, the test lacks precision, and furnishes results deficient in concordance, when employed in the same or in different laboratories.

These three objections will now be examined in turn.

The Le Chatelier test is likely to cause the rejection of good cements.

Here it is at once necessary to state the case properly, which does not seem to have been done. From a general point of view, the reproach is perhaps well founded, for I have kept in my laboratory for several months specimens of cements which gave an expansion of 50 mm. under the Le Chatelier test without exhibiting any trace of expansion in cold water. If, however, one takes up the point of view of the consumer, the reproach is unfounded, for the two following reasons:—

(a) The Le Chatelier test seems to eliminate all bad cements; and this is the main thing.

(b) Any manufacturer who knows his business can, without any sensible addition to the cost of production, make cements that will pass the Le Chatelier test.

Though it is not my place to point out what means should be adopted to attain this result, I am certain that many manufacturers, and those not the least important, will be entirely of my opinion.

Under these conditions the question of knowing whether the Le Chatelier test eliminates certain good cements should not even be mentioned by cement makers. The consumers are the best judges of the guarantees with which they should surround themselves, whilst the only part the manufacturers should play is to advise consumers on the possibilities of manufacture.

In the present instance, however, it is possible, without increase of cost, to manufacture a cement which will satisfy the Le Chatelier tests; and it is for the consumers alone, and not the manufacturers—one would think—to take up the matter.

It would seem, a priori, that the fact that cements which, though non-expanding when freshly ground, expand after aeration is due to the action of the added calcium sulphate on the calcium aluminate present in the cements.

A long time ago Candlot showed that cements which are retarded by the addition of gypsum, resume their quickness of setting after being aerated. According to Camerman, this little recognized phenomenon is the real cause of numerous accidents.

The company with which I am connected only makes cements which are excessively siliceous and do not contain more than 2 or 3 per cent. of alumina, so that it might be expected that the tests essayed with these would be less decisive than in the case of normal Portland cements. Nevertheless, they were not sufficiently so to be worthy of consideration.

A check specimen of the siliceous cement was mixed with 1, 2, 3 and 5 per cent. of its own weight of gypsum. The Le Chatelier test was applied immediately after mixing, and also after storage for 15 days in the open air.

Eight cylindrical test pieces were prepared from each product, and all the moulds were new and from the same source. After being made, they were kept in water at 17 deg. C. for 24 hours, between two sheets of glass, and then immersed in cold water in a water bath, the temperature of which was raised to 95 deg. C. in half an hour, and maintained thereat for 4½ hours.

A summary of the results indicates that aeration lessens the expansion of the check specimen and of the cements containing 1 and 2 per cent. of added gypsum, but increases the expansion of the test pieces with 3 and 5 per cent. of gypsum. The increase, however, is too small for the experiments to be considered decisive, and they consequently need to be completed.

The third objection urged against the Le Chatelier test is lack of precision.

It would perhaps be interesting in the first place to define what is to be understood by precision. There is no doubt that the Le Chatelier test does not attain the precision sought and obtained by Regnault in his experiments; but that it is not at least quite as accurate, as the other customary tests applied to hydraulic binding media remains to be proved.

After a series of tests carried out with new moulds from the same source, we have investigated successively:—

(a) The influence of the width of the shoulders by which the needles are fixed on the test pieces;

(b) the influence of the age, or degree of wear, of the moulds;

(c) the influence of the method of storage;

(d) the influence of the time elapsing between the final setting of the cement and the immersion in hot water.

From this series of tests it may be concluded that the form of the needle shoulder, and the age of the moulds, or rather the extent to which they have been used, have an influence on the results obtained, while the mode of immersion has but little influence; and that, on the contrary the results are influenced considerably by the time elapsing between the definitely ascertained completion of setting and the immersion of the test pieces in hot water, at least in the case of products with slow initial setting.

It is, in fact, characteristic of the Le Chatelier test that it does not give the measure of the absolute expansion at a given moment, but rather the difference between the effort of expansion and the effort of resistance opposed to this expansion by the cement in consequence of its own previous hardening.

May one not, however, base on this fact for the purpose of removing the reproach that the Le Chatelier is excessively severe? It would be sufficient to examine merely whether the delay of 24 hours after mixing is adapted for all eventualities, or whether it is not too strict, and that by altering the period to 36 or 48 hours one would still meet with the inconvenience of eliminating the cements that are stable in cold water. Moreover, in our opinion, the period allowed to elapse previous to the immersion in hot water has nothing to do with the value of the test. It should be left for each user to fix for each class of cement the period that should be allowed to elapse before the Le Chatelier test is applied.

On the other hand, the results obtained having revealed the slight influence of the method of keeping and of immersion of the test pieces in hot water, and the complete concordance of the tests performed with moulds of one and the same origin, it is in our opinion justifiable to regard the Le Chatelier test as being sufficiently accurate in practice and convenient for use. As regards the shape of the needle shoulders, nothing is easier than to contract this by regulation, in the same manner that one can fix the number of times the moulds may be used before being discarded.

WASTE DESTRUCTION.

Writing in the Municipal Journal, C. E. Crichton, M.D., Commissioner of Health, Seattle, Wash., has the following to say concerning waste destruction in the city of Seattle:

The term waste, as used in the city of Seattle, includes everything on earth that is wasted, deposited or thrown away as being of no further value to the person or persons producing the same.

The city of Seattle, after an exhaustive investigation made, has seen fit to divide this subject into three headings: 1st, Collection; 2nd, Removal; and 3rd, Destruction. The commissioner of health of this city spent one year in visiting the principal foreign nations, the different cities of Canada and the United States and made an exhaustive study of the methods of collection and disposal of waste material.

He believes that by far the most dangerous substances which should be collected and destroyed by the ordinary American city, are those which as a rule receive the least attention. Most cities attempt to make a regular collection of what is generally known as garbage, decaying vegetable and animal tissues. Many American cities collect only at convenient times, and some only once or twice a year, other wastes, which in Seattle are considered the most dangerous. We refer to old mattresses, sheets, soiled bedding, wall paper, carpets, rags and handkerchiefs which have been soiled by direct contact with the evacuations and secretions of those sick with typhoid fever or other communicable diseases, more particularly tuberculosis.

In visiting 28 of the leading cities last summer we found some of those classed as progressive and modern collecting this most dangerous waste only twice a year. It can be seen at a glance that, while table refuse or true garbage may become annoying to the special senses, the material is as harmless as it was before it passed through the kitchen. It is, of course, a feeding ground for flies and rats and to a certain extent furnishes a breeding place for the former.

We adopted the single can collection, into which every known substance is thrown and same collected regularly, because by so doing we cause an immediate destruction of the dangerous wastes and because it gives a mixture of ashes and other wastes with true garbage. It has been found by actual experience to limit the smell from the garbage can and the ashes, being a good absorbent, keep the insides of the cans comparatively dry. This step also enhanced the beauty of the city, since rubbish and refuse are never in evidence for more than a week's time. First of all, let us say that the collection and destruction of garbage was considered as a sanitary measure, and that the cost of collection, removal and disposal was subordinated to that of sanitation. After we had decided upon the most sanitary plan, we then sought to procure the most economical method of collection, removal and destruction.

We have given the matter of removal separate treatment because this city introduced the method of removing its waste by auto truck two years ago and to-day is removing nearly 30 per cent. of its waste in this manner. It is believed that within sixty days more than 50 per cent. will be removed by the auto truck. The removal of a city's waste is much more important than is conceded by most city officials. In removing the same by auto truck the material is taken through the streets of the city in about one-fourth or one-fifth of the time consumed by horse-drawn vehicles. Seattle is a city of hills and it is therefore safe to say that this material is removed as a matter of fact in one-fifth of the time consumed by horse-drawn vehicles. Six tons are removed in one truck bed built for this purpose. It is more easily covered by tarpaulin than would be the same tonnage in three vehicles. It is dumped once instead of three times, thus saving the blowing about and dissemination of disease-bearing germs. Not as many garbage-laden vehicles pass through a given community nor are they repugnant to the people as are horse-drawn vehicles. The collections are more regular because our hillsides are slippery during certain seasons and we were occasionally delayed a day or so at a time, as the case might be, by the use of horses.

In considering the great question of disposal, the one idea dominating at all times was that purification and destruction by fire was far and away superior to any other method. As a consequence, we early adopted the Meldrum Brothers furnace, of Liverpool, England, which is a forced draft, high temperature furnace and did what every American city should do, provided it adopts such a furnace, and that was to buy the right to the patents to build these plants, as many as desired within our corporate limits. This foresight has enabled the city to have in operation to-day three of these destructors, capable of consuming slightly more than 200 tons of mixed waste daily. Right here let it be thoroughly understood that not one pound of fuel is used in our destructor other than the waste itself—no coal, no wood, no oil. We have in the treasury to-day funds for the building of two more units. A unit has a guaranteed capacity of 65 tons of garbage daily. The Heenan & Froude incinerator now operating in Milwaukee is a type of furnace very similar to the one used here. Such furnaces turn out a clinker, or more properly speaking a slag, which we run through regular rock crushers and which is used for practically the same purpose as is crushed rock. We find a steady market for this material for use in paving and sidewalking, and especially for floors in fireproof structures. We sell at the bunker, receiving 75 cents per cubic yard. We also grind the clinker still finer when it is used for many purposes like the manufacture of stationary wash trays, etc.

The wagon which Seattle has adopted for general waste collection is the old type of European rear dump with large hind wheels and small front wheels which allows for turning within the length of the wagon. The rear wheels being high gives us ample opportunity for dumping large bulky material without annoyance. In one single can collection are boxes, barrels, shrubs, limbs of trees and other matter, and as a consequence there must be considerable clearance from the wagon-bed to the ground or there will be difficulty in dumping. Where we are dumping into the bunkers this is not quite so important, although it has its advantages.

The can which we allow to be installed must not contain more than 35 gallons, and is about 18 x 30 inches in size. However, for waste-paper we allow a larger can. Cans must be placed in suitable and accessible locations where they can be conveniently handled and loaded, since the time consumed in loading a ton of waste when taken from cans convenient and accessible as against cans inconveniently located amounts to practically 27 per cent.

We have not been operating with the auto trucks long enough to know exactly what the saving is amounting to over the horse-drawn collection. It is our opinion at this time, however, that we are collecting with the auto truck our waste at a saving of not less than 45 cents on the dollar. We have attempted to lessen the price of the haul by installing at different places in the city small bunkers arranged in cells, each cell having a capacity of about six tons. These are filled by the horse-drawn vehicles. This material is taken from the bunkers by the auto trucks to the incinerators and also at the present time to a large open dump. Five of these auto trucks are being used by the city in this work. They are the rear dump with bed 11 feet long and 6½ feet wide. By the use of these trucks we save the long team haul, the most important money-saving feature of our entire scheme.

The two new furnaces we have installed have each an auxiliary boiler. These were placed with the idea of allowing the sale of steam. We develop 225 h.p. at each plant, but on account of the drawing of our fires about once in four hours, we find it necessary, in order to guarantee the sale of steam, to install the auxiliary boiler, its furnace to be fed with the same material, i.e., the city's waste.

TABLE OF MINERAL PRODUCTION OF THE PROVINCE OF QUEBEC DURING 1912.

Substances.	Production, 1912. Quantities.	Production, 1912. Value.	Value in 1911.
Asbestos, tons	111,175	$ 3,059,084	$3,026,306
Asbestic, tons	25,471	23,358	19,802
Copper and sulphur ore, tons	62,107	631,963	240,097
Gold, ounces	980	19,924	11,800
Silver, ounces	26,526	14,591	11,500
Bog iron ore, tons	....	....	4,041
Ochre, tons	7,054	32,010	28,174
Chromite, tons	....	....	2,469
Mica	....	99,463	76,428
Phosphate, tons	164	1,640	5,832
Graphite, pounds	1,210,278	50,680	33,613
Mineral water, gals.	39,452	9,854	65,648
Titaniferous ores, tons	2,949	4,935	5,684
Slates, squares	1,894	8,939	8,248
Cement, barrels	2,684,002	3,098,350	1,931,183
Magnesite, tons	1,714	9,645	6,416
Marble	....	250,939	143,457
Flagstone	....	600	500
Granite	..	358,749	308,545
Lime, bushels	1,705,937	455,570	284,334
Limestone	....	1,361,082	1,128,402
Bricks, M	100,146	1,284,232	1,129,480
Tiles, drain and sewer pipe, pottery, etc.	....	203,100	142,223
Kaolin, tons	40	520	....
Feldspar, tons	110	2,200	600
Peat, tons	500	2,000	700
Glass sand	152	418	1,179
Sand	81,800	33,200	62,000
Quartz	....	....	1,125
	....	**$11,017,046**	$8,679,786

Records an increase of $2,337,260 in 1912 as compared with 1911. For the last ten years, the record of increases of each year over the previous one has been unbroken, as the following table shows:—

Table Showing the Annual Value of the Mineral Production of the Province of Quebec Since 1903.

Year.	Value.
1903	$ 2,772,762
1904	3,023,568
1905	3,750,300
1906	5,019,932
1907	5,391,368
1908	5,458,998
1909	5,552,062
1910	7,323,281
1911	8,679,786
1912	11,017,046

Notes on Mineral Production in 1912.

Asbestos.—Asbestos, as in the past years, heads the list of the products of the Quebec mines in 1912. After having passed through a severe crisis, the asbestos market is steadily improving. This is specially true for the higher grades, crude and long fibre mill-stock. The demand for the short mill-stock is not brisk, and, as a consequence, the qualities under $30 a ton have to be sacrificed to some extent.

Therefore, under these circumstances, of good prices for high-grade stock and low prices for short mill-stock, it is quite easy to understand that only the mines which can produce the better qualities are able to operate satisfactorily. Hence, none of the mines of the Broughton district were operated during 1912, as the Broughton rock is essentially a milling rock, containing as a rule a gool percentage of disseminated fibre, but short and low in value. The same remark applies to most of the mines of the Robertson district.

On the other hand, the Thetford mines and the Black Lake mines worked steadily and the shipments are higher than for 1911.

WATER REQUIREMENTS OF A LARGE RAILWAY SYSTEM.

At the meeting of the Illinois Water Supply Association C. R. Knowles, general foreman of waterworks, read a paper, of which the following is an abstract:—

The consumption of water by railway systems has greatly increased, and it has been necessary to raise the standard of the supply, both in quantity and quality, to meet traffic conditions. In former years it was the practice to erect a tank and establish a water station at any point where water of any kind was most convenient, with little regard to the quality or future requirements. This has necessitated many changes to meet the new conditions and added requirements, such as relocating water stations with due regard to curvature, grades and the many previously unknown expedients of operation.

To accomplish these results it is often necessary to pipe water a considerable distance, or, if an ample supply is not otherwise available, to sink wells or construct a reservoir impounding a storage supply. In the event that the available supply is not satisfactory in quality, it is often necessary to erect treating plants to convert it into a suitable water for locomotive purposes. All these changing conditions and increasing requirements have made it necessary to maintain a waterworks department organization, whose duties are similar to those of a city waterworks department.

The amount of water required for all purposes by one railroad 6,500 miles long is approximately 16,500,000,000 gal. annually. In the State of Illinois, on 2,000 miles of road, 4,236,838,000 gal. of water was used for locomotives alone, of which 1,751,790,000 gal. is purchased from municipal and privately-owned waterworks plants and 138,645,000 gal. is treated by purifying plants owned by the railroad. It is necessary to maintain 123 water stations to distribute this water to locomotives. In addition to the above, the washing and filling of locomotive boilers at terminals requires approximately 950,000,000 gal. per annum, which is provided by the same pumping plants with additional facilities for maintaining the desired pressure for washing the boilers and the necessary pipe line for the distribution of this water under pressure.

Stationary power plants also require approximately 300,000,000 gal. per annum, including water used for condensing engines, of which 125,000,000 gal. is city water. It is estimated that 250,000,000 gal. additional is required for miscellaneous purposes at shops, roundhouses, offices and stations. This makes a grand total of 5,736,838,000 gal. of water used for all purposes by this one road in Illinois alone.

CITY PAVEMENTS.

By G. G. Powell.*

For the benefit of those readers who were not fortunate enough to be able to attend the recently held annual meeting of the Ontario Good Roads Association, we publish the following abstract of the paper presented by Mr. Powell before it.

During my experience in Toronto I have found that the people are, as a whole, greatly interested in the question of pavements, and will generally take the initiative in this matter; in fact, demands for pavements are often made by property owners before the sewers are constructed, and during a period of great real estate activity the requests for pavements of one kind or another are so great as to tax the best efforts of the Works Department to keep up with them.

The pavement work of Toronto is all carried out on the local improvement plan:

1. On petition.
2. On the initiative or without petition.
3. On the initiative by ⅔-vote of council.

1. When a work is undertaken on petition, the requirements are as follows:—A petition form must be obtained from the Works Department giving the description of the street to be paved, width of pavement, cost per foot frontage, annual cost per foot frontage for the life of the pavement, and in order that the people to whom this petition is presented may have an opportunity of knowing the cost of any other pavement, a table of these costs is printed upon the petition form. This precaution is taken so that a person signing a petition can not plead ignorance or misrepresentation in regard to the price to be paid. Such a petition is considered sufficiently signed when it bears the signatures of sixty-six per cent. of the property owners, representing fifty per cent. of the property value.

When a petition is presented and declared to be sufficiently signed a recommendation is made to the council, and if passed by that body the work may be proceeded with.

2. If a work is deemed necessary by the Works Commissioner a recommendation is made on the initiative. When this recommendation passes council, notices are sent to the property owners, and a month is allowed for the owners to petition against the improvement. If no petition is received within this period, the work may be proceeded with. A petition against, to be sufficiently signed, must have the signatures of a majority of the property owners, representing at least half the property value.

3. In cases where trouble is experienced in getting a local improvement laid and where such an improvement is deemed necessary by the Works Commissioner, as being in the public interest, a recommendation is made, and if passed by a two-thirds vote of council the work may be proceeded with, notwithstanding any objections or petition against by the property owners.

With machinery as outlined above, a municipality is well equipped for carrying out any campaign for street improvements that may be decided upon.

The question of the selection of a pavement for a given street is often a difficult one where there are so many kinds to choose from, but, generally speaking, the elements that enter into this selection are:—

1st. Durability, having regard to the traffic to be expected after paving.
2nd. Grade.
3rd. Cleanliness.
4th. Cost.

Permanent pavements are now generally recognized as being best for the more or less heavy traffic to be encountered in a city, and practically no other pavements are being constructed in Toronto. Permanent pavements are generally defined as those having a concrete foundation, and the practice has been to vary the depth of concrete foundation according to the traffic. These depths vary as follows:—

4" for light traffic..
5" for medium traffic.
6" for heavy traffic.

The so-called permanent pavements are divided as follows:—

1. Sheet pavements.
2. Sectional pavements.
3. Monolithic pavements.

Under sheet pavements are included asphalt, asphaltic concrete, tar concrete, bitulithic, and a number of other patented bituminous pavements.

Sectional pavements comprise brick, stone setts, wooden block and asphalt block.

Monolithic pavements include the various forms of concrete pavements and probably asphalt macadam and tar macadam can be included in this list.

For our guidance in selecting a pavement for a given street, the following table has been made, viz.:—

Up to 3% grade	Any pavement.
From 3% to 5%	Brick, stone sett, asphalt macadam, asphaltic concrete, concrete macadam, rocmac, bitulithic, asphalt block.
From 5% to 7%	Brick, stone sett, macadam, rocmac.
Above 7%	Macadam and rocmac.

For heavy traffic the pavement most in use in Toronto is asphalt, although brick and wooden block have been laid in a number of cases.

The merits of the brick pavement are apparently not very highly appreciated in this city, as almost invariably our recommendations for a pavement of this material are petitioned against, the only reason given being the noise. The repair bill on our brick pavements is much smaller for the same area than for any other pavement.

In the residential districts asphalt, and bitulithic are about the only two pavements laid, although it is expected that asphaltic concrete, asphalt macadam, or rocmac will be laid in increasing quantities as time goes on.

A patented pavement is not recommended unless a sufficiently signed petition has been received asking for such a

*Deputy City Engineer, Toronto, Ont.

pavement. The sheet pavements have reached this popularity for residential streets due largely to their comparative dustlessness and lack of noise.

The standard width of pavement adopted in Toronto for a main thoroughfare, 86-ft. wide, where tracks are laid, is 54-ft. from kerb to kerb, allowing 18-ft. of pavement on either side of the track allowance, or 19′ 3″ if we include the blocks next the rails. This width provides for two lines of traffic. Where the street is only 66′ wide and tracks exist, the standard is 42-ft., giving a pavement 13′ 3″ on either side of the track allowance, including the blocks next to the rails. On residential streets, the standard width of pavement is 24-ft.; although in the past some pavements as narrow as 18-ft. have been constructed. Pavements of greater width than 24-ft. are laid where traffic conditions warrant it. There is now an agitation to have the standard width for residential streets increased to 28-ft. The agitation for this increased width is due to the increase in motor vehicles and the desire of their drivers to be able to pass slow moving vehicles with less inconvenience.

I am of opinion that such a provision is good in so far as the more important thoroughfares are concerned, but it is a hardship to force people to pay for a pavement of greater width than is needed for the traffic of the street, and it will also increase the cost of maintenance materially.

The crown of pavements in a city is also a very important question, and while a high crown tends to increase the life of a pavement by causing the surface water to run quickly to the gutters, it is very hard on horses in frosty weather and in summer time when flushing is being resorted to. This difficulty has become so great during the past year or two that we are now reducing the crown of all new pavements very materially. A few years ago the standard crown for a 24-ft. asphalt pavement was 6″. In 1911 this was reduced to 5″ and a further reduction to 4″ is now contemplated.

Drainage troubles in the construction of city pavements are not very serious, for, as a general rule, the streets are provided with the necessary storm sewers for taking care of the surface water. Catch basins are constructed on opposite sides of the street about every 300-ft., with large openings so that the surface water may quickly reach the sewers. These openings are provided with suitable grates to prevent larger solids from entering the catch basin, and a trap is usually provided to prevent the escape of sewer gas, and also to keep floating rubbish from entering the sewer. In order that the catch basins may be kept clean they are provided with a semi-circular bottom which enables the long scoop to be effectually handled. The main difficulty in connection with surface drainage that has to be contended with in Toronto is getting rid of the water on some of the east and west streets where the grade is practically level. This is usually accomplished by what is termed false grading, that is, the face of the kerb is increased at the catch basin, and decreased at a point some distance away. In this manner five to three inches of additional fall may be secured, which will effectually carry away the water.

One of the most important features of pavement work as carried on by a municipality, is inspection, and as a general thing, great attention is given to both inspection of materials and supervision of the work, to see that the provisions of the specifications are being carried out.

The city of Toronto is provided with a good testing laboratory, in charge of a capable chemist, in which all materials are carefully inspected. Every carload of cement used on city contracts must pass the ordinary seven day test, before used on the work, and if any doubt is aroused as to its soundness, it is held for twenty-eight days. All asphalt, asphaltic mixtures, fluxes, etc., are investigated in the same way, so that the city is reasonably sure of good work, notwithstanding the five year guarantee exacted.

The sand and stone that are used in the manufacture of a pavement must also have careful consideration, and to this end numerous sand and stone gradings have to be made each year to verify the standards laid down in the specification.

The organization in force to look after the actual construction work is as follows: A district superintendent in charge of all contract work in a given district, and under his care sufficient inspectors and time-keepers to take care of every branch of the work. The city also does a good deal of work by day labor.

Probably the feature that gives rise to the greatest amount of controversy between the Engineering Department and the property owners is the question of grade, and the greatest care has to be exercised at all times to see that the grade established on any street does not give rise to claims for damages. Apparently it does not matter whether you cut or fill, the claims for damages appear just the same. Little or no difficulty is experienced in the older parts of the city, but when we start to work on some of the newly annexed portions of the city we are met by conditions that are hard to overcome; buildings have been erected without regard to probable street levels, and as a result the grade has to be mutilated in order to provide proper access to the property.

To overcome this trouble in the future, the department now gives building grades to intending builders and any new streets accepted by the city are only accepted on condition that no claims for damages will be made by reason of the grade established for the roadway.

Instances have occurred in certain parts of the city, where 12 per cent. grades have been established because the cutting or filling necessary would have practically destroyed the adjacent property.

The costs of the various pavements are as follows:—

2″ asphalt, 1″ binder, 6″ concrete	$2.25
2″ asphalt, 1″ binder, 5″ concrete	2.00
2″ asphalt, 4″ concrete	1.60
2″ asphalt, 1″ binder (surface only)	1.05
3″ asphalt block, 4″ concrete	3.45
2″ bitulithic, 4″ concrete	2.15
2″ bitulithic, 5″ concrete	2.30
2″ bitulithic (surface only)	1.75
Brick on 4″ concrete (Canadian)	2.55
Brick on 4″ concrete (American)	2.75
Brick on 6″ concrete (Canadian)	3.00
Brick on 6″ concrete (American)	3.20
Wooden block on 6″ concrete	...

The concrete foundation work is composed of:—1 cement; 3 sand; 7 stone.

By instruction from council the Works Commissioner has to submit a tender for all work advertised, with the exception of large bridges and buildings for which special plant is required. As a result the department does a good deal of work by day labor.

In order to carry out this work economically and efficiently, adequate plant and superintendence is necessary. Last year council sanctioned the purchase of a great deal of plant for sewer and roadway construction, which will place the department in good shape to undertake any work of this character that it may be called upon to do. In addition to good plant a force of efficient foremen and superintendents is necessary, and I am glad to say that the city is as well provided with good men to fill these positions as any similar organization anywhere. The day labor work is carried on as a separate branch of the roadway section, with its own superintendents and timekeepers.

The maintenance of city pavements is probably the most important feature, and at the same time the most difficult to properly carry out, but after a good deal of experiment a scheme has been adopted which will probably give good results. The city is divided into comparatively small sections, and in each one of these sections is located a district foreman who has a store yard, and sufficient men at his disposal to properly patrol the streets and to make the necessary repairs without delay. The additional plant spoken of above will provide us with enough rollers and other plant to do this.

A special feature of this organization is that at definite intervals a report will be made showing the condition of all streets in the city, and will enable the department to plan future work a long way ahead.

One of the most troublesome features of maintenance work is the repair of cuts made for the installation of water services, gas services, and private drains, and apparently in Toronto, nothing has yet been devised to prevent this trouble, although frequent attempts have been made. In some cities legislation has been obtained compelling property owners to have all these services installed before the pavement is laid, but here we have no such law, but are permitted by the Local Improvement Act to recommend both water and sewer services as local improvements, charging back the cost to the property affected. This is not an ideal provision, because property changes hands so frequently and services installed to suit one individual would have to be changed to suit the next, who might desire to arrange his buildings on the lot in a different manner, and, as a consequence, the pavement would have to be cut.

By co-operation with the various public utility corporations it is expected to reduce this cutting to a minimum this year, and it is hoped that all cuts made will be promptly repaired as they will be reported at certain fixed intervals by the patrolmen.

In 1908 the civic asphalt plant was put in operation, and since that time all repairs to pavements out of guarantee, and a good deal of new work has been carried out by the department. Costs have been reduced and a more satisfactory condition of the streets has been maintained. In no time since 1907 has our cost exceeded 77c. per sq. yard..

The city has also a small crushing plant, a No. 4 Austin (Gates) gyratary crusher with a fairly large capacity. This crusher is used to crush old material that comes off the street, and which can be used again as broken stone for concrete in track allowance foundations. This plant enables us to use up material that would otherwise be wasted or remain in the store yards for an indefinite period.

It is also a great convenience in times of shortage of broken stone, for the rubble can be secured and crushed and some of our jobs kept going.

HEATING PIPES UNDER FLOOR.

Heating a building by means of steam pipes embedded in the concrete floor has been successfully accomplished in the chassis testing building of the Moline Automobile Co. at Moline, Ill. The structure is 120 ft. long by 60 ft. wide, with door openings extending completely across the ends of the building.

The workmen are obliged frequently to lie on the floor in making necessary repairs and adjustments, and on this account it was desired to keep the floor surface comfortably warm. To accomplish this, 1¼-in. steam pipes, spaced 42 in. on centres were laid 2 in. below the surface of the 6-in. floor slab. The concrete is reinforced locally against cracking, due to the expansion of the steam pipes, by corrugated, galvanized iron pipes inclosing the former.

Below the floor slab, 8 in. of cinder fill are placed as an insulating material. It is stated that with only five small metal radiators additional, it is possible to obtain a uniform temperature of from 60 to 70 deg. F. throughout the building.

STREET LIGHTING TESTS.

A description of the tests and comparative results obtained from high pressure gas lamps and high candle power arcs was given lately at the Institute of Electrical Engineers, England. The tests were carried on in Manchester, and the paper on these tests by Messrs. S. L. Pearce and H. A. Ratcliff, is given herewith.

Gas Installation in Princess Street.—Four high-pressure lamps were suspended in Princess Street at the same height above the roadway as the arc lamps—namely, 27 ft., 6in. The distance between the lamps varied from 95 ft. 6 in. to 118 ft. 9 in., but 106 ft. 6 in. might be taken as approximately the average.

Each lamp contained three inverted burners, and clear globes were used. At normal pressure each burner was rated at 1,500-candle power, or a total of 4,500-candle power for the complete lamp; but the maximum candle power obtained was only about half this figure.

As originally installed the lamps were fitted with traversing and lowering gears; but these were apparently not successful, as the lamps were at a later date fixed permanently in position. The flexible gas supply tubing was also replaced by rigid galvanized gas barrel.

Princess Street is 60 ft. wide, and as the lamps were, on an average, only 106 ft. 6 in. apart, the resulting illumination was very good, and far superior to any previous example of high-pressure gas lighting in Manchester.

Presumably in order to improve the maximum illuminating effect, but certainly not the uniform distribution of the light, the lamps have been lowered about 1 ft.

Arc Lamps in Portland Street.—The central suspension system was chosen for the lighting of Portland Street, and certain predetermined "units" of light were erected at such calculated distances apart as to give the maximum illumination for the least capital expenditure.

The paper points out that in addition to low initial costs the central lighting system has the following advantages, which appear to outweigh certain known disadvantages:—

(a) The distributing mains can all be kept to one side of the street.

(b) No separate lighting standards are required on the street pavements, with consequent advantage to pedestrian traffic.

(c) A more even illumination is obtained; in other words, the ratio of maximum to minimum illumination is less than with side lighting for a given amount of electrical power employed

The traffic in Portland Street is of a very dense character all day long, and more especially between the hours of 4 p.m. and 6.30, and it was therefore deemed advisable to aim for a high standard of minimum illumination—viz., something of the order of 0.5 foot-candle. The minimum illumination at any point on a horizontal plane at ground level was expected to be not less than 0.44 foot-candle. This figure was not obtained with the lamps as at first installed, but has since been exceeded.

The length of Portland Street is 1,751 ft., and its width 66 ft. Sixteen 550-watt lamps, working four in series on the 200-volt mains, have been erected. Owing to the positions at which certain important side streets intersect the main street, the distance between lamps varies from 114 ft. to 124 ft.

Eight of the sixteen lamps are run on an all-night circuit, and the remaining eight are switched off at 11 p.m. The lamps are so arranged that, when all sixteen are burning, the lighting is balanced across the three-wire distributing mains; but after 11 p.m. the remaining eight lamps are connected to one side of the system only. The lamps are fixtures, in so far as no provision has been made for lowering or drawing them to the side of the street. All trimming has therefore to be done from a tower wagon. This decision was come to after carefully considering the extra expense and complication involved in arranging for lowering gear, and also with due regard to the type of lamp selected, the hours of burning, and the local conditions.

The first results obtained were not considered altogether satisfactory; the shadows under the lamps, thrown by the ash-trays, were most pronounced, as was also the series of concentric rings on the surface of the roadway. As fitted with clear inner and opalescent outer globes, the lamps gave a minimum candle-power on the 20-degree ray of 2,250. This was substantially lower than the result anticipated.

Photometric tests showed that the polar curve of the lamps with the particular inner and outer globes used did not meet the necessary requirements, and the resulting distribution of the light was very unequal. The shadows and concentric rings were practically eliminated by the use of slightly opalescent outer globes, but the efficiency of the lamps was impaired to a very appreciable extent, and the distribution of light was rather worse than before, the change from the dark zone midway between lamps to the bright zone adjacent to the lamps being very pronounced.

The paper mentioned that all the testing was done in the streets at night with the lamps burning under normal conditions, and consequently the results obtained are directly applicable to the requirements of practical work.

General Comparisons.—The authors proceeded to observe that any comparison of the Portland Street and Princess Street lighting other than on an "equal basis of cost and illumination" required to be very unbiassed, since there was much to be said in favor of both systems.

"The gas lamps give a much steadier light than the arc lamps, although the difference is not very noticeable to a casual observer, or even to a keen observer; but it is very noticeable when making measurements with a flicker photometer. . . . Unfortunately, although the gas lamps give a steadier light, their candle-power varies very considerably from day to day. The candle-power of a particular lamp may fall at least 50 per cent. before the mantles are renewed, unless it is arranged to change only one mantle at a time, thus spreading the complete change over a fairly long period.

"The candle-power of the arc lamps may vary quite appreciably within a few minutes; but provided that the same make of carbons is used, the average candle-power at any particular angle will not change to any extent from day to day if the line voltage is reasonably constant.

"A very important feature directly affecting the comfort of the general public is the absence or otherwise of glare. . . . Obviously the larger the surface of the light source in proportion to the total amount of light emitted the lower the intrinsic brilliancy and the less the effect of glare. In this respect the three-burner high-pressure gas lamps have an advantage over the flame arc lamps with clear inner and outer globes. The use of clear outer globes with flame arc lamps is, in fact, hardly advisable from the point of view of scientific lighting, since any form of lighting which is productive of eyestrain is essentially unscientific, and is certainly unsatisfactory.

"Two noticeable features in Princess Street are the comparative softness of the shadows of objects cast on the ground and the absence of a pronounced dark horizontal zone in line with the reflectors. The first result is, undoubtedly, due in a great measure to the fairly large triple light source, which has the effect of shading off the edges of shadows; and the absence of a dark zone in line with the reflectors is, no doubt, due partly to the fact that the source of light is well below the reflector, and partly to the reflection from the inner surface of the large globes. The shadows cast by the flame arc lamps when burning with clear inner and outer globes are very intense, and there is no appreciable shading of the edges; consequently it is possible to confuse shadows with actual objects. The smallness of the light source, or, in other words, the high intrinsic brilliancy, and the fact that the arc is well up under the reflector, is no doubt the cause of the objectionable horizontal dark zone noticeable in cases where reflectors are used."

The Portland Street light is considered by the authors to have a much warmer and more cheerful effect than the comparatively cold light in Princess Street The actual relative values of the two schemes of lighting is clearly shown by various tables and curves in the paper giving the results of photometric tests and the contour curves showing the portions of the street area within which the illumination on a horizontal plane is equal to or greater than 0.5 foot-candle.

"Purely from the point of view of illuminating effect," the paper adds, "there is much to be said in favor of both systems; but the electric lighting system possesses all the practical advantages, a few of the more important of which are: (a) Lower cost; (b) simplicity of switching operations, and possibility of dispensing with lamplighters; (c) flexibility and ease of erection; (d) lamps not affected by vibration when suspended from traction poles; (e) possibility of reliable check on running costs (i.e., current consumption and carbons); (f) negligible leakage; (g) absence of globe breakages due to heating, &c.

"All the above advantages are absent in the case of the high-pressure gas system, and in contrast may be mentioned the disadvantages incidental to its use: (a) Extensive and highly dangerous leakage of high-pressure gas; (b) the detrimental effect of a foggy or heavily smoke-laden atmosphere on the mantles, resulting in a serious diminution of candle-power just at a time when it is most required; (c) partial and occasionally complete failure in frosty weather."

Conclusions from the Tests.—Messrs. Pearce and Ratcliff expressed the view that the tests referred to in their paper had at least vindicated the lighting of city streets by means of flame arc lamps, not only on the dual basis of equal cost and illumination, but also on the ground of light distribution.

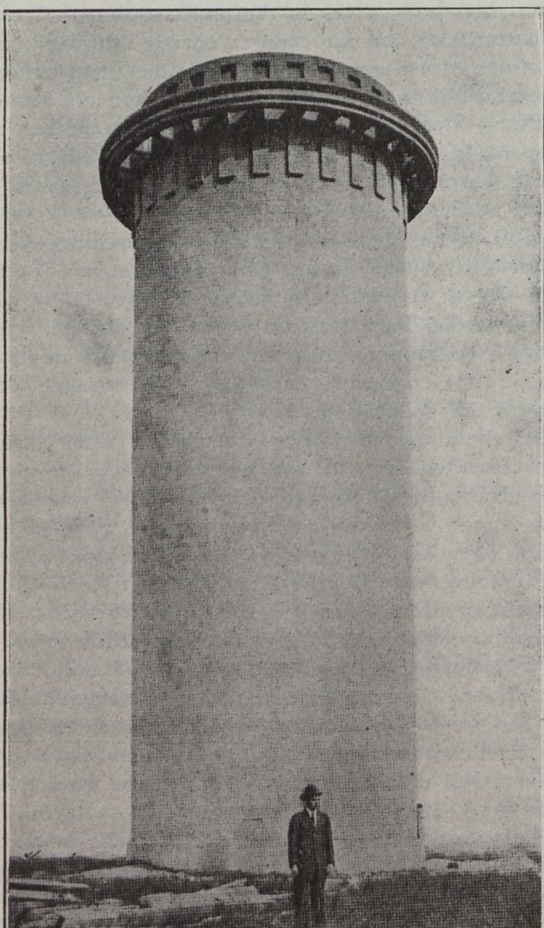
"Unfortunately," they remarked, "owing to many unavoidable difficulties, the experiments with various forms of frosted globes have not yet been quite completed.

As there was a substantial difference between the cost of the flame arcs and the high-pressure gas lamps for the same minimum illumination, it would be possible to improve the arc lighting, if considered desirable, by reducing the distances between lamps in the case of future extensions. If fixed at the present height, and 100 ft. apart, the minimum illumination would be not less than 0.75 foot-candle. No attempt had been made to obtain perfectly uniform illumination, since it was very doubtful whether such a scheme would be desirable, even if possible. A variation factor of 3.75 was not excessive if the change was fairly gradual; and in this respect partially frosted globes gave results quite as favorable as dioptric ones. A well-known authority on street lighting had expressed the opinion that perfectly uniform lighting was flat and uninteresting. From a purely psychological point of view that was no doubt quite correct; but there was probably a more definite psychological explanation. The visual conception of illumination was largely a matter of contrast, in connection with which fatigue of the eye played a very important part. It was therefore quite probable that the hollows in the illumination provided the rest necessary to enable the eye to appreciate the peaks, with the result that the average impression produced was superior to the corresponding effect due to a perfectly uniform system of lighting of equal average intensity.

REINFORCED CONCRETE STANDPIPE.

A standpipe at Belton, Texas, constructed of reinforced concrete, is described by T. L. Fountain, a graduate of Engineering at Cornell University, in the March number of Cornell Civil Engineer.

For many years, the water supply of Belton has been obtained from deep wells, storage and pressure for domestic purposes being secured by use of a steel standpipe located on a hill in the northern part of the city. The pressure thus afforded not being sufficient for satisfactory service to Baylor Female College, located on one of the highest points in the city limits, the height of the standpipe was increased about 30 feet. Several years ago the upper half of this standpipe was torn off by the wind, probably due to the weakness of the plates, which originally were near the top. The pressure and storage afforded by the lower half of the standpipe were so unsatisfactory that a bond issue for extending the mains to the south side of the city and erecting a new standpipe on a hill located there carried without opposition.



Standpipe Complete, Showing Ornamental Cornice and Other Decorative Work at the Top.

The chemical contents of the well water at Belton is such that it rapidly corrodes steel, but has no delterious effect on concrete. The cement mortar coat on the interior of the storage basin at the pumping plant is as sound as when put on 20 years ago, whereas service pipes and fittings all over the city deteriorate rapidly. On this account, estimates for the proposed new standpipe were secured on the basis of using much thicker steel plates than would ordinarily be required. No bids were taken, but the lowest quotation received for a steel standpipe 24 feet in diameter and 75 feet high was over $7,000. At this juncture, the firm of which the writer is a member was employed to prepare plans for the proposed waterworks improvements. Believing that a reinforced concrete standpipe could be constructed at a lower first cost which would last indefinitely without any expense for maintenance or repairs, the design shown in Fig. 1 was submitted to the city, and, upon its approval, work was immediately commenced.

Design.—In the design of this standpipe, certain assumptions were made which resulted in securing its construction at a cost very much less than for a steel standpipe of the same dimensions. However, since its completion, important facts bearing upon the design of the concrete standpipes have been brought out by Mr. Hyram B. Andrews in a paper read by him at a meeting of the Boston Society of Civil Engineers. Had the design been carried out in accordance with his recommendations, the cost would have been nearly as great as for a steel standpipe. A wall thickness of 14 inches was decided upon, as a result of a study of concrete standpipe, previously constructed, this thickness being ample to transmit the stress to the reinforcing steel and to secure imperviousness with the concrete proportions used. The working stress assumed for the steel was 16,000 pounds per square inch. No mechanical bond was used to fasten the bars to each other. They were lapped 36 inches and bound in position with wire. Laps in adjacent rings were not allowed to come in the same vertical line.

When next designing a reinforced standpipe, it is the writer's intention to follow closely the lines laid down by Mr. Andrews in the paper mentioned above, the most important of which are briefly as follows: (1) The use of a very rich mixture of concrete; (2) a thickness of wall sufficient of itself to prevent the rupture of the concrete when the standpipe is full, (3) vertical reinforcement between the base and walls to distribute the bending moment and shearing stress, (4) a steel dam at each horizontal joint, in addition to the usual "keyings" to prevent seepage.

It is of fundamental importance that a standpipe designed and constructed on the assumption that the tensile stress is to be carried by the concrete alone with the reinforcing bars added as a guaranty of safety, should be allowed to stand at least 60 days after completion before being filled so that the concrete can secure its full tensile strength.

The ornamental cornice and other decorative work at the top and base of the standpipe were added to relieve the severe lines of the structure, as the standpipe occupies the crest of the highest hill in the vicinity and can be seen for many miles. As may be seen from the photograph, it has a much more dignified and interesting appearance than a plain cylinder of steel. No manhole is provided in the wall near the base as in a steel standpipe, as the construction difficulties of furnishing such an opening are hard to overcome for a concrete standpipe. The 8-inch inlet pipe is brought up through the bottom for the same reason.

Construction Equipment.—The steel forms for the outside of the standpipe were made from the drawing shown in Fig. 2. Two complete rings were used in order that one might be assembled on top of the other without waiting for the concrete to acquire a hard set and to secure a better bond at the joints by pouring fresh concrete on that still "green." The cost of these forms delivered at Belton was $423.

The concrete was mixed in a 3-cubic-foot batch Smith hand mixer, which discharged into a steel elevator bucket of the same capacity, arranged to run in vertical guides and to dump automatically into a combined bin and chute set above the working platform. The bucket was hoisted by a team, used for other purposes when the pouring was not in progress. The wheelbarrows used in placing the concrete were filled by opening a wooden gate at the lower end of the bin. The outside scaffolding was made of 3-inch by 10-inch discarded bridge flooring cross braced with 1-inch by 8-inch ship lap. It was erected in sections as the work progressed.

The inside working platform was supported on double rows of 3-inch by 8-inch joists projecting radially from a

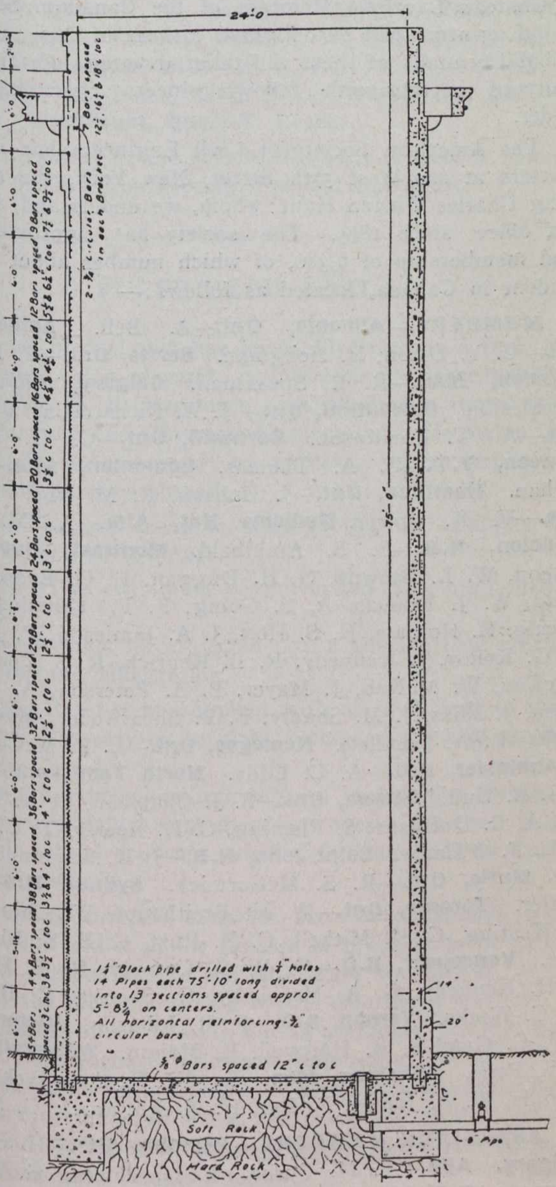


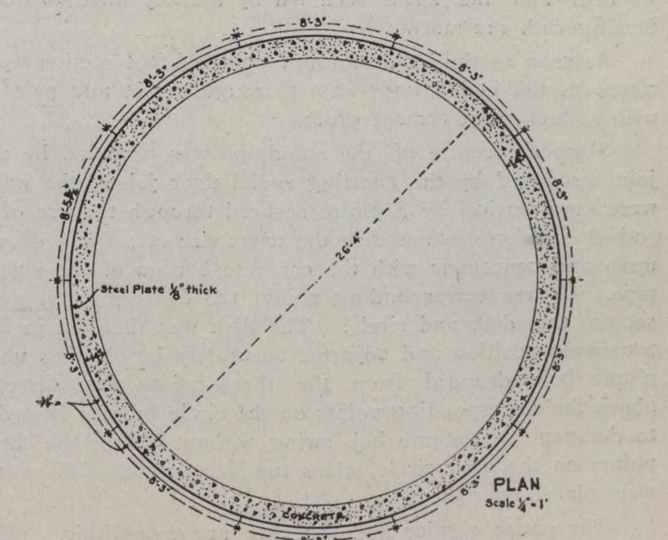
Fig. 1.—Vertical Section of Standpipe.

short central post to which they were rigidly attached. Each pair of floor joists was separated by wooden blocks allowing the 4-inch by 4-inch vertical guide and support studs to pass between them. These studs were set back 2½ feet from the inside of the wall to give room for the wheelbarrows. The only inside flooring was that laid between these studs and the wall. The stud joints were mitered and fastened with bolts. Six feet below the working platform a similar arrangement of joists supported the wooden inside forms, which were made up in sections 6 feet high, or double that of a single set of outside forms. Each of these systems of floor joists was supported by iron pins set in holes bored in the vertical studs at any level required.

Method of Construction.—Excavation for the foundation revealed rather soft rock at the depth originally determined upon for the bottom of the standpipe and wall footings. The excavations for the wall footings was therefore deepened four feet, stopping on solid rock. The concrete for the wall foundation was poured to within about one foot of the lower side of the bottom of the standpipe. The remainder of the wall foundation and the bottom were next placed at one pouring. Keys were left for the walls, as shown in Fig. 1. During this pouring, one-foot lengths of 1¼-inch pipe, threaded on the upper end and provided with sleeves, were set vertically around the periphery in the soft concrete.

The steel forms shown in Fig. 2 were used for the outside of the thicker wall at the base as well as for the remainder of the vertical shell. The increase in the circumference required for the first 6 feet from the bottom was obtained by bolting the plates in each ring against vertical wood spreaders.

The 1¼-inch pipes used for supports for the reinforcing bars came upon the ground cut into sections of the exact length shown in Fig. 1, threaded and drilled. Each 6-foot section was screwed into place as it was reached with the concrete.



DEVELOPMENT OF SEGMENTS IN SECTIONS A and B.

Fig. 2.

The reinforcing bars were bent to the approximate curvature required before hoisting them to position. At each vertical pipe each bar was spaced and held by passing a wire through the ¼-inch holes in the pipe and around the bar. When the work on the walls was first started, only one three-foot section of concrete could be poured in two days on account of the large amount of reinforcing steel which had to be placed. After a height of 24 feet was reached a three-foot section was poured each day. When the pouring of a secton once started, it was finished regardless of the time required, the work frequently running well into the night on account of the difficulties encountered in raising the inside platform. Each pouring of a three-foot section required about three hours, 9 cubic yards of concrete being placed in that time. The concrete was mixed soft but not sloppy and was distributed in wheelbarrows in layers 12 inches thick, care being taken to equalize the pressure against the forms by uniform distribution. As soon as each pouring of a three-foot section was finished large V-shaped wooden keys were placed in the soft concrete. Before the pouring of another section was begun these keys were removed, the whole exposed surface of the concrete was wire brushed and washed, and the space occupied by the key filled to overflowing with 1:2 mortar.

As soon as the inside forms for each 6-foot section were removed, the inside wall was thoroughly wet and painted with a thick, neat cement grout.

Since the centre of the standpipe was occupied by the joint produced by the abutting radial floor joists, the walls were kept vertical by a centre secured through the use of a 30-inch wooden circular disk the exact size of a circle drawn upon and concentric with the concrete bottom of the standpipe. Three corresponding points 120 degrees apart were set on the disk and circle. The disk was then set in approximate position and adjusted accurately by shifting until plumb bobs dropped from the three points were directly above the corresponding points on the circle below. In order to dampen the plumb bob swing without hiding the three points on the floor circle, glass tumblers filled with water were placed over them.

The entire cornice and brackets are monolithic. The forms for this part of the work were supported on the tops of the outside verticals which were cut off at the proper height for this purpose. The tablets below the cornice were moulded on the ground, hoisted to position, and grouted into recesses left in the wall.

The construction force consisted of 1 foreman, 1 carpenter with 2 helpers, 1 driver with team, and 7 laborers. After the completion of the standpipe the outside was scraped, washed and painted with cement grout mixed with sufficient sand to make it spread readily. When the standpipe was first filled some leakage occurred, due to the development of fine vertical cracks in the concrete as the steel elongated under its working stress. This leakage has gradually decreased, until at present it is an immeasurable quantity. The total cost of the standpipe was $6,000, $500 of which amount was spent upon the cornice and ornamental work.

Concrete.—The gravel and sand used for the concrete occur mixed in the same bank which is located about two miles from the standpipe. The sand varies from rather fine to coarse. In order to secure as dense a concrete as possible for the amount of cement used, sufficient fine sand from a sand pocket in the gravel pit was added to fill the voids in the unscreened mixture of combined gravel and sand. Cement was then added to the proportions of 1 part of cement to 6.33 parts of the aggregate, the entire proportion being as follows: 1 part cement, 2.4 parts coarse sand, 3.6 parts gravel, 0.33 parts fine sand. All gravel and sand particles passing through a ⅜-inch mesh inclined screen were classed as coarse sand. The resulting concrete was very rich in appearance. Cut into some time after the erection of the standpipe, it was found to be hard and dense.

AMERICAN SOCIETY OF CIVIL ENGINEERS TO HOLD SUMMER MEETING AT OTTAWA.

It will doubtless interest a great many of our readers to know that the American Society of Civil Engineers intends to hold their summer convention at Ottawa from June 17th to 20th, inclusive. The headquarters of the convention will be Chateau Laurier. Members of the Canadian Society of Civil Engineers will be delighted to hear of this, and in all probability many of them will take advantage of this opportunity of meeting with fellow-engineers from across the border.

The American Society of Civil Engineers has its headquarters at 220 West 57th Street, New York, the secretary being Charles Warren Hunt, whom, we understand, has held that office since 1895. The society has approximately a total membership of 6,380, of which number about 160 are resident in Canada, located as follows:—

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The president of the society this year is Geo. F. Swain, Professor of Civil Engineering, Harvard University.

PULVERIZED COAL.

The use of coal that has been pulverized as a fuel, and the economic value of same, is interestingly described in a paper by Mr. H. R. Barnhurst, published in a recent issue of Metallurgical and Chemical Engineering. He states that the requirements necessary to success, while simple, are absolute and must be obeyed.

First—The coal must be dried so that it contains not over 1 per cent. of moisture.

Second—The coal must be pulverized to a high degree of fineness.

Third—It must be projected into a chamber hot enough to cause instant deflagration.

Fourth—It must be supplied with air sufficient to yield the oxygen necessary to burn the carbon of the coal at once to CO_2.

Taking up these requirements in order, the drying of the coal to a moisture content of not over 1 per cent. is indispensable. Coal does not grind well if moisture in excess of this be present.

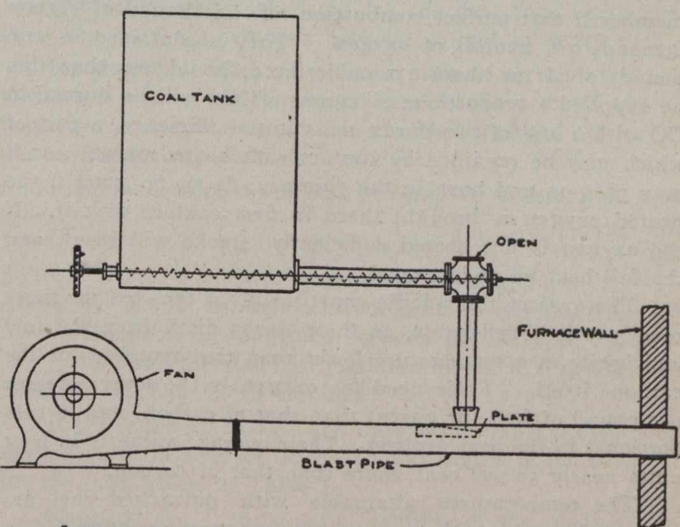
In burning coal the moisture, free or combined, must be disposed of either in the process of preparation or in the moment of combustion. In the latter case not only is the efficiency of the furnace lowered by the calorific investment in the superheated steam passing out as a product, but the temperature of the furnace is lowered materially. The drying of wet coal in the furnace itself, is doing this necessary part of the work in the most expensive place and at the cost of temperatures which may be essential to the industrial process of which high heat is a factor.

Fine grinding—With the best type of machines obtainable for this purpose, the coal and its contained impurities may readily be powdered to such a degree that under the screen tests 85 to 90 per cent. will pass through apertures 1/400 in. square, while the total residuum left upon a screen whose apertures are 1/200 in. square, will be from 2½ to 5 per cent. and this residuum would pass through screens of 1/100 in. square. It must, however, be borne in mind that of the percentage passing the smaller apertures 1/400 in. square there is a high percentage of absolute dust or impalpable powder not commercially measurable. This is proven by the fact that in tests made upon calibrated screens of 1/600 in. square apertures, over 70 per cent. still passed through. It certainly appears to be safe to assume, therefore, that the average size of the particles would be below a cube measuring 1/600 in. on the side.

It may be interesting, therefore, to state that the total numbers of particles resulting from the powdering of 1 cubic inch of coal to the dimensions given would yield 216,000,000 grains of dust. Simple calculation on this basis shows that while a cubic inch of coal exposes 6 square inches for the absorption and liberation of heat, the surface exposed for the same purposes by the powdered coal is 25 square feet. Inasmuch as no fuel burns until it is heated to a temperature at which it developes more heat than it receives, the advantage of this enormous absorbing and delivering surface is apparent. The result of this is shown in the clearness and uniformity of the flame produced. Where coarse particles are permitted to enter the furnace, the distinct sparkles are apparent. These larger particles are carried beyond the region of oxygen supply and are for this reason not fully burned.

Third—While coal ignites freely, in a hot chamber, this ignition means the absorption of heat from somewhere, and if the coal rapidly projected by air does not develop its heat near the point of ignition, means must be devised to maintain the heat necessary for ignition where it is needed, i.e., at the first entrance of the coal into the furnace. It is apparent, therefore, that giving the fuel too great velocity upon entrance is not good practice.

Considering the fourth requirement along with the third we would say that some singular errors and misconceptions have attended the practices of many users of powdered coal. More particularly do we refer to the use of large fans to supply the air necessary for the projection of the fuel, where the air nozzle has been reduced from 16 in. or 18 in. diameter to 4 or 5 in. at the jet under the expectation that all of the air in the 16-in. or 18-in. pipe would be hurried through the 4 or 5-in. nozzle if not a smaller one. The futility of this is apparent.



Arrangement for Using Pulverized Coal as Fuel.

To describe the operation more clearly, the coal is received in a bin over the feeders. (Fig. 1). Its weight is about 38 lb. per cubic foot when loose in the bin. Settling awhile brings the weight to about 45 lb. per cubic foot by displacing the entrained air. Across the bottom of this bin and within a pipe extending horizontally from it is a double-flight worm or feed screw. This double-flight screw resists the tendency of the light coal to flow of itself along the feed pipe. This screw extends over a flanged pipe-cross into which the fuel is delivered. The rear end of the screw is supported by a bearing in a flange on the side of the bin near the bottom, the shaft projecting to receive a driving pulley or chain sprocket. The delivery end of the screw shaft is supported by a bearing in the cover of the horizontal opening of the flanged pipe-cross. The top opening of the cross is uncovered to permit the air to draw down with the falling fuel. This fuel dispersed in the air so drawn in, descends a vertical pipe attached to the lower opening of the cross, the pipe being long enough to be within the funnel or injection pipe. At the bottom of the funnel is a diagonal plate upon which the fuel falls. The plate is tight against the air pipe up the current and flared open on the side, towards the furnace down the current and takes up about one-fourth the diameter of the pipe. This forms at this point a "vena contracta" producing a suction in the funnel, draw-drawing in through it, supplementary air with the fuel. The fuel spraying upon this plate mixes very thoroughly with the air from the fan, the eddy currents caused by it, assisting very materially its dispersal through the main column of air supplied by the fan.

The admission funnel should be far enough from the furnace to permit this mixture to be thorough. Too high pressures defeat this somewhat, as well as tending to project the fuel too far into the furnace before flashing. As soon as this fuel cloud begins to absorb the heat of the chamber into which it passes, a rapid expansion of the air takes place, separating the particles of fuel in suspension, in the proportions of the absolute temperatures to the temperature of the initial air. It is a matter of discussion whether the best results are obtainable by a delivery of all the air found necessary for combustion by the free pipe together with the percentage of excess air found to produce the best results, or to use a smaller quantity of air in the feed pipe and look for the further supply from other openings.

Good practice would seem to point to absolute control of air by the fan and its gates, and the fuel by the varied speed of the feed screw. The furnace should have a good natural draft to a chimney controlled by a damper. It must be remembered that perfect combustion of one pound of carbon demands $2\frac{2}{3}$ pounds of oxygen. This is contained in 11.6 pounds of air or about 154 cubic feet; should less than this be supplied a proportionate amount of fuel will be burned to CO with a loss of two-thirds of its initial efficiency, a part of which may be regained by contact with heated oxygen, or it may pass on and burn in the chimney, doing no good if the heated oxygen is brought there in first contact with it. If the oxygen is not heated sufficiently smoke will result and the full heat be undeveloped.

The greater the volatile constituents of the coal the more readily will it deflagrate, as these gases distil from the fuel and ignite at a temperature lower than that required for the carbon itself. Their need for oxygen is, however, greater per pound of fuel (or gases) than that of carbon, and is proportional to the heat evolved. Their average value is in heat units nearly 50 per cent. more than that of carbon.

The temperatures attainable with pulverized coal are very high, so high that excess air is commonly admitted in proportions ranging between 50 and 100 per cent. This will be shown by the following table based upon the perfect theoretical combustion of carbon with proportion of air given:—

1 lb. carbon with 11.6 lb. air...Normal.	4859° F
1 lb. carbon with 12.76 lb. air...10 per cent. excess.	4448° F
1 lb. carbon with 13.92 lb. air...20 per cent. excess.	4102° F.
1 lb. carbon with 15.08 lb. air...30 per cent. excess.	3807° F.
1 lb. carbon with 16.24 lb. air...40 per cent. excess.	3550° F
1 lb. carbon with 17.40 lb. air...50 per cent. excess.	3326° F.
1 lb. carbon with 18.56 lb. air...60 per cent. excess.	3129° F.
1 lb. carbon with 19.72 lb. air...70 per cent. excess.	2954° F
1 lb. carbon with 20.88 lb. air...80 per cent. excess.	2797° F.
1 lb. carbon with 22.04 lb. air...90 per cent. excess.	2656° F.
1 lb. carbon with 23.20 lb. air..100 per cent. excess.	2529° F.

In practice the furnace tender speedily becomes educated to the point of judging whether a fire is hot enough by its color and by the length of the flame. The more perfect the conditions the shorter and whiter the flame will be.

The pulverized coal introduces very effectively the element of time into the equation. Given a pound of fuel with, say 15,000 heat units, these may all be developed by slow combustion at low temperature, or by burning the fuel in pulverized form, quick combustion gives high temperature. The same quantity of heat developed in both cases, but in one instance in a minute and in the other half an hour.

The influence of preheated air upon the economy of the burning of any fuel resolves itself into ascertaining the quantity of fuel which would be necessary to bring the air to the preheated temperature plus the heating of the excess air also to that temperature. Except as a means of transporting heat, excess air has no effect in furnace as far as the fuel combustion is affected. This preheating, to be of any economical value, must be obtained from heat which would else be wasted. To heat all the primary air necessary to combustion and 50 per cent. excess air to a temperature of 1,000 degrees in excess of the surrounding temperatures would show a saving of some 4,100 heat units or nearly 30 per cent. of the fuel value. But few of the industries, however, outside of the metallurgical arts permit the waste heat to pass off at such temperatures and volume as to be available. The regenerative checker-work of open-hearth steel furnaces is the best example of success in this preheating.

In this case it has been a necessity to boost the temperature in this way, because the gases from gas products burned cold, would not give the temperatures necessary for the work to be done.

We may say that four heat units per degree would represent the saving achieved per pound of fuel fired with 50 per cent. excess air by heating all the air admitted to the furnace. The measure of efficiency is dependent upon the loss finally carried away in the rejected gases. In the case of regenerative furnaces this may be lower than in furnaces not equipped with regenerating checker-work, but if to the percentage of loss with regeneratives be added the losses in the gas producers, the pulverized coal directly fired will afford the greater economy of operation.

With the means at hand of obtaining quickly and safely heat of greater intensity than by the use of coal upon grates or in producers, it would appear to render practicable further steps in many of the arts hitherto restricted by the limitations of furnaces at command.

The fear of explosion of coal need not enter into consideration. Coal lying in a bin or conveyer does not explode. It is only when mixed with air or supported by air currents that coal will "puff." In burning it, therefore, we do not mix the coal and air until just as it enters the furnace at high velocity. Against this column of inrushing air and coal the puff cannot take place.

The air is introduced before the coal is turned on, and the coal is shut off before the air. Only by introducing coal faster than it can burn will an explosion occur and then the effect is trifling. It is the gas produced and not the coal that causes this. It wants oxygen and comes outside to get it.

The presence of impurities in the fuel has not much effect. Of course, only combustibles will burn; the incombustibles are inert and do not affect the operation of the furnace. Their effect is in the lessened results from a dollar's worth of fuel negatived by a goodly percentage of waste substance. The writer has burned effectively fuel in which analysis showed 52 per cent. of ash. Let us reiterate the conditions—Dry coal, fine grinding, hot chamber or fire box, proper air supply.

An important part of the subject must not be overlooked. The durability of the future is, of course, vitally essential. In the metallurgical arts when extreme heat is an essential part of the operation, care must be taken to avoid destroying the furnace by its own operation. This is not difficult. Much of the troubles have come from the gases impinging upon the furnace walls at points where change of direction of gas travel is necessary, and from too high velocity of gases due to contracted ports.

If the utilized heat is largely absorbed from the gases by the charge, the waste gases will be proportionately less active in scouring the brickwork. In almost any construction except perhaps a rotary kiln it is found necessary to change the direction of the gases in their progress toward the flue. This change of direction causes the gases to impunge upon the diverting bricks with an energy proportional to their velocity. The brick at these points can be fully protected by a system of water-cooled pipes embedded in the walls. The brick may frit somewhat until the area of protection is reached, when further progress is arrested.

The surprisingly small amount of water which it has been found necessary to introduce, maintaining the outlet below 200° Fahr. proves that the cooling effect is limited to a prevention of cumulative action and is not perceptibly a drawback upon efficiency. Of course, the piping must be so arranged that no air or steam pockets shall exist and that the circulation will be proportional to the heat stimulus. One other point and we will conclude. The pulverized coal furnace has no ups and downs. There is no thick fire or thin fire, fresh coal or old coal to insure fluctuations.

The furnace can be always kept at its best working point and so kept it will be heated equally all over. Of course, a large charge of metal to be heated will by its very volume absorb heat rapidly, causing a fall in waste gas temperature and possibly a little smoke at first. This is in the nature of things, but the extremely effective conditions quickly bring the charge to a point where the chill is not sufficient to affect combustion and high temperatures come again and smoke disappears. If the work to be done is constant, there is no reason why high conditions may not be uniformly maintained by proper construction and operation.

We believe the subject has been mastered to a point beyond the experimental stage where the full benefits of high efficiency may be confidently relied upon in this beautiful method of burning coal. As before mentioned, the quality of the coal is not with this method of supreme importance. Indeed, its great value in the developments of the future may lie in the efficiencies obtainable from low-class or refractory fuels hitherto unavailable.

PROPOSED POWER PLANTS FOR C.M. AND S.P. RAILWAY.

Details of the proposed electrification of the Chicago, Milwaukee and St. Paul Railroad state that there will be 7 stationary power plants, at least, generating electricity by water-power at Great Falls, Helena, Madison River, Big Hole, and Thompson Falls, near the western border of Montana. All these will be connected in parallel, distributing their power to a single reservoir. Electricity will be conveyed to motors by means of a trolley system. Power will be purchased from the producing company, the railroad having nothing to do with construction and installation of power-plants. St. Paul probably will have 50 electric locomotives to begin the service, specially designed to meet the needs of the situation. These must pull a maximum freight tonnage of 2,100 tons up a 1 per cent. grade. On heavy grades helpers will be added. The locomotives will be limited in design to a speed of 30 miles per hour up grade and 25 miles per hour down grade for passenger motors, and 15 miles per hour for freights.

POLARIS OR NORTH STAR.

By E. S. M. Lovelace, M.Can.Soc.C.E.*

To find the azimuth or true astronomical bearing of a line from an observation taken at any time that the above star happens to be visible.

While the data for an observation to determine the true or astronomical bearing of a line can, of course, always be obtained from one of the almanacs published yearly in this and other countries, yet, to apply the methods therein outlined requires at least some knowledge of field astronomy, and unfortunately, as it happens, numerous engineers, having become rusty on the subejct, have neither the time nor the opportunity to go into the matter when suddenly (as it well may) arises the necessity for making such a determination. Possibly, too, at the particular time an almanac may be not available.

For such, therefore, the following short tables, compiled by the writer in connection with his private practice, and requiring as they do for their application, no previous knowledge of astronomical problems whatever, afford an easy method of making a determination. The principal advantage obtained from the use of the tables (as illustrated by the example given below) is that in place of having to sit up to some inconvenient hour, (waiting, say, for the greatest elongation of the polar star) only, as frequently happens, to find that at the particular moment nothing can be seen, the observation may be made at any convenient time that the star happens to be visible. This is an advantage that at least the men at the instrument will appreciate.

The tables are worked out for the next four years and cover the northern latitudes between 40 and 52 degrees.

Standard time is the local mean time at certain standard meridians west of Greenwich; these standard meridians of longitude corresponding to the various standard times in use in Canada are given in Table III.

t, the hour angle of north star at time of observation T is given by

$$t = T + \Delta T + \Delta' \qquad (1)$$

where T is the standard time of the observation

where ΔT is the correction (four minutes per degree) for difference in longitude between the place of observation and the standard meridian to which T is referred.

where $\Delta' = 3.94$ (D-E) minutes

D being the given date and time of observation expressed decimally to the nearest tenth of a day and E is the constant for the year given in Table I.

Knowing the (approximate) latitude of the place of observation and t, then A the azimuth of north star at time of observation T is given by

$$A = \pm F, a \text{ minutes} \qquad (2)$$

where F and a respectively are interpolated from Tables I. and II., the + sign indicating that the north star is east of true north, the — sign indicating that the north star is west of true north.

T, standard time shown by watch, need only be within three or four minutes of being correct.

ΔT is the correction to the standard time in order to reduce it to local time, this correction corresponding to the difference in longitude between the meridian of the place of observation and the meridian to which the particular standard time shown by the watch is referred. Knowing, therefore, the standard time (whether Atlantic, Eastern, etc.) which the watch is showing, in order to

* Civil and Consulting Engineer, Montreal.

get the correction ΔT it is only necessary to take the difference in degrees between the corresponding longitude given in Table III. and the longitude (approximate only) at the place of observation, for this difference in degrees multiplied by four gives the correction ΔT in minutes.

The correction ΔT is, of course, to be added when the place of observation is to the east of one of the above standard meridians and subtracted when it is to the west of such standard meridian.

In getting $\Delta' = 3.94$ (D-E) minutes, it should be remembered that the astronomical day begins at noon and the hours are numbered consecutively from 0 to 24, while the civil day begins at midnight and the hours are numbered from 0 to 12 a.m. then repeated p.m., thus, civil time August 7th 3h a.m. equals astronomical time August 6th, 15h and D would therefore be August 6.6. In the p.m. hours the dates agree.

Table I.

	1913	1914	1915	1916
	E	E	E	E
	April 14.0	April 14.4	April 14.7	April 14.1
Latitude.	F	F	F	F
40°	0.95	0.94	0.94	0.94
41°	0.97	0.96	0.96	0.95
42°	0.98	0.98	0.98	0.97
43°	1.00	1.00	0.99	0.99
44°	1.02	1.01	1.01	1.01
45°	1.04	1.03	1.03	1.02
46°	1.05	1.05	1.05	1.04
47°	1.07	1.07	1.06	1.06
48°	1.09	1.09	1.08	1.08
49°	1.11	1.10	1.10	1.09
50°	1.13	1.12	1.12	1.11
51°	1.15	1.15	1.14	1.14
52°	1.18	1.18	1.17	1.17

Table II.

Hour Angle t	a	Hour Angle t	a
0 hours	— 0 minutes	13 hours	+ 24 minutes
1 "	—25 "	14 "	+47 "
2 "	—49 "	15 "	+67 "
3 "	—69 "	16 "	+82 "
4 "	—84 "	17 "	+92 "
5 "	—93 "	18 "	+96 "
6 "	—96 "	19 "	+93 "
7 "	—92 "	20 "	+84 "
8 "	—82 "	21 "	+69 "
9 "	—67 "	22 "	+49 "
10 "	—47 "	23 "	+25 "
11 "	—24 "	24 "	+ 0 "
12 "	— 0 "		

Table III.

Standard Time.	Longitude West of Greenwich.
Atlantic standard	60°
Eastern standard	75°
Central standard	90°
Mountain standard	105°
Pacific standard	120°

Example.—Suppose an observation is to be made at Baie St. Paul, County of Charlevoix, Province of Quebec, in 1913. By inspection of a map it can be seen that approximately the latitude of this place is 47° 30′ and the longitude 70° 30′. Say, on August 7th at 8h 22m p.m., eastern standard time, an observation of Polaris is taken: The correction corresponding to one degree of longitude is four minutes.

$\therefore \Delta T = (75° - 70\frac{1}{2}°)\ 4 = +\ 18$ minutes

D = August 7.3 and from Table I., E = April 14.0

$\therefore \Delta' = 3.94$ (difference in days between August 7.3 and April 14.0) $= 3.94 \times 115.3 = 454$m $=$ 7h 34m

By (1) $t = T + \Delta T + \Delta' =$ 8h 22m + 0h 18m + 7h 34m = 16h 14m.

Interpolating from Tables I. and II.

F corresponding to latitude 47° 30′ is 1.08

a corresponding to hour angle 16h 14m is + 84′

$\therefore$ azimuth of Polaris at 8h 22m p.m. is from (2)

$A = F \times a = 1.08 \times 84 = +\ 91' = 1°\ 31'$

That is, at 8h 22m p.m. on August 7th, 1913, the Pole star will be 1° 31′ to the east of the true or astronomical north, and from this the true bearing can be ascertained of any line taken in connection with the observation of the star.

GASKETS AND STEAM.

One could easily write fifty-seven varieties of sermons about gaskets, poor packing, and the steam waste incident thereto, but this is not to be one of the regular fifty-seven varieties; it is to be a new and different one. There is many an instance when emergency, and a species of genius, have led a man, back in the woods, into taking his shirt-tail to make a gasket for a cylinder-head. And while this is often a poor and reckless makeshift, it is really better in effect than are some of the uses of thick gaskets where men think they have prepared and are doing the right thing. In the modern steam-engine the clearance space at the ends of the cylinder has been reduced to a point of small fractions, and even the added fraction of an unnecessarily thick gasket may cause useless waste of steam. Some of the old-style engines may be found yet in the rural districts that will show a clearance of an inch between the cylinder-head and the piston at the end of the stroke. And, strange to say, with this staring them in the face, it seems difficult for some to understand why a new engine of the same size will do more work and use less steam when the general construction is the same. In other words, there are some who do not seem to have realized that it takes steam to fill extra space in a cylinder, just the same as it takes steam to drive the engine—and it's the same kind of steam, too. To the class who are thus thick-headed belongs the engineer who puts gaskets an eighth of an inch thick under the cylinder-head simply because he has material of that kind in stock. He might better emulate the back-woodsman in emergencies and use a piece of his shirt-tail. Fortunately, there are not many of this class, even in the backwoods, but as long as the few remain it is in order to point out that all unnecessary space at the end of a steam cylinder calls for the expenditure of unnecessary steam power.—J. Crow Taylor in The National Engineer.

Greater Montreal will erect during the present year forty million dollars' worth of buildings according to the estimate of Mr. R. L. Wherry, secretary of the Builders' Exchange. Last year the figures were $33,080,000.

The Russian Ministry of Ways of Communication has decided to make an investigation in regard to the projected line from Saratov to Novotcherkask. This line would be 400 miles long, would traverse the grain territories of the Don Cossacks territory, and would be of great importance in connection with the future South Siberian Railway, as it would create a direct transit route to the Black Sea for the Siberian agricultural products.

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THE STUDY OF STREAM-FLOW DATA.

The increasing utilization of the water-powers of the country emphasize the necessity for the more thorough compilation and recording of stream-flow records.

It is a fact that the engineering schools in Canada, and also in the United States, have not devoted as much attention to this branch of the profession as the importance of the subject deserves. The elementary principles necessary for the intelligent design of most engineering structures and an introduction to the different basic subjects which lie at the foundation of the several branches are well covered in our technical colleges. This is not true, however, of the courses in hydraulic engineering in at least some of its phases. Professor Mead in a recent paper before the Cornell Society of Civil Engineers, in drawing attention to the above fact, states that experience has demonstrated the fact that more failures have resulted in various projects of hydraulic engineering from a lack of an adequate conception on the part of the designing engineer of the fundamental principles of hydrology, or of the importance of the hydrological factors, than from defects in the design of construction of the various structures involved. In many cases the engineer has not possessed sufficient knowledge to appreciate the necessity for hydrological investigation and study, and very frequently has ignorantly made unwarranted assumptions and neglected any investigation whatsoever, from a lack of such appreciation.

The results of this lack of appreciation are apparent to every engineer who stops to think over the record of past failures, even here in Canada: water-power plants constructed on streams without sufficient available flows, or with such irregular flows as to make the projects entire or practical failures; spillways and gates in dams constructed with inadequate capacities for the passage of extreme floods; pumping stations constructed to utilize supplies of water which are too limited for the purpose for which they were intended, or with supplies polluted or otherwise undesirable; industries built in locations subject to serious overflow and unnecessary land damage; protecting works built with no adequate idea of the maximum necessities of the case or their effect on flood heights. While in a few isolated cases failures have been due to the fact that adequate stream flow records have been impossible to obtain, and the engineer, relying on his judgment, has been in error, in most cases the failures are due to an absolute lack of knowledge of hydrological principles.

The fundamental cause for this neglect in analyzing the conditions on which every sound hydraulic project must rest is due in great part to the lack of training in our engineering colleges. This same lack of training is apparent in other parts of the hydraulic engineering courses.

The use of electric power generated from waterfalls has increased, because it has been possible to develop and compete with electric power developed by steam. To compete successfully with the steam engine it is necessary that there should be close speed regulation of hydro-electric plants. This has been easy to secure in past developments, due to the fact that the easier types of plants have been installed first; that is, plants with open canal or short penstock. With the increase in the length of penstocks and the use of long feeder conduits, speed regulation becomes an important factor. Yet to-day very few, if any, of our engineering colleges are giving any training along this line, or are even drawing attention to the necessity for study of such conditions. As a result, plants are being installed which, from the standpoint of regulation, are failures.

The colleges must soon realize their responsibility to the hydraulic engineering student. Courses must be remodelled to give the needed instruction if the list of failures in hydraulic design is to be curtailed.

PUBLIC CARRIERS versus THE PUBLIC.

Paralleling the rapid growth of the cities of this continent, in population and suburban area, are the steady and popular demands of civic governments upon city tramway companies for extension of lines, new methods of business, and increased rolling stock. There is no doubt or question of the necessity and need of this twin growth of tramway accommodation, on either the tramway's part or the civic, but there is almost invariably a considerable difference of opinion about the effectiveness and sufficiency of the means adopted by the street railways to keep abreast of the times. It has resulted in considerable antagonism on the part of the people, upon any refusal of public carriers to carry out improvements, especially if the carriers appear to be making money and growing rich. Many people, while believing in the efficiency of company management, and preferring it if the companies can be prevented from waxing unduly rich, yet do not know how they are to be checked from so becoming, and are ready to threaten them with non-extension of franchise in the meantime. Street railways, with their usual comparatively short franchises, are particularly subject to the people, and one would expect would be likely to quickly carry into effect any reasonable civic wishes which did not entirely besmirch their financial horizon.

It seems "riches" and "what is a fair profit" are relative terms, depending on individualism. There have been protestations on the part of public carriers that they were being unjustly adjudged of their wealth and unfairly pressed by the public to the point where they would have to cease doing business. This is of special interest to the engineer, not only in a general way, but because it may open up a new field whereby boards composed of either high-class financial engineers, or possibly engineers and financiers, will be called in to adjudicate between the people and public carriers as to "what are fair demands" to be made upon the latter.

The first big step in this direction is seen in the bill passed in March by the United States Government, whereby a gigantic investigation of the valuation of the property of common carriers and the securing of information concerning their claims, bonds and other securities, has been set on foot. The Interstate Commerce Commission, which has charge, may appreciate the situation and create (it has been recommended to do so) a board composed of nine members, three to be selected by the Interstate Commerce Commission, three by the American Railway Association, and one each by the army, the navy and the American Society of Civil Engineers. This would provide for a non-partisan, impartial and authoritative body, the conclusions of which would be final.

The immediate effect upon the carriers will be the preparation of a complete valuation of all railroad property, entailing an expense of $3,000,000 to $5,000,000 to the carriers alone. After the railways submit the data it will be necessary for the Interstate Commerce Commission, through its experts and assistants, to prepare valuations, and this will cost the government at least $3,000,000 more.

The law provides that the Commission shall make an inventory and classify the physical property as follows: (a) The original cost to date; (b) the cost of reproduction (new); (c) the cost of reproduction less depreciation, and (d) other values and elements of value.

It is not apparent how the Commission will arrive at the original cost to date of railroads which have no records extending back to the origin of the property, and this will be found to be the case with nearly all roads or parts of roads constructed twenty-five years or more ago. The original cost to date is now available from the balance sheet of any railway company under the head of "Cost of Road and Equipment." It will cost the railroads and the government perhaps $2,000,000 to ascertain the original cost to date by the laborious method of investigating original records, and the result may be no more accurate and reliable than the information already at hand.

The United States engineering opinion of the investigation is that the net result of securing the valuation of railroad property will likely prove that the railroads are not over-capitalized, and that as a whole they are not earning a fair return on their cost and present fair value.

A further and interesting viewpoint of a street railway management's idea of present money-making possibilities is seen in the statement of the vice-persident of the Boston Elevated Railway before the Electric Railway Association. He claimed that if the public were not made to understand and become acquainted with the facts of street railway conditions the companies would not be able to continue to do business. The point to be emphasized was the effect of the demands from the public in the way of extensions of lines, increased transfers, etc. In their case these demands have eaten up the advantages which are supposed to come from doing business for a long time in a growing community. This may be seen from the following data: In 1888 some five or six horse railways were put together, forming a consolidated system, which gave the railway company virtually the monopoly of the business of the city. The operations of this consolidated company began substantially on January 1st, 1888.

In the first year there were gross earnings of $4,276,000, and the capital invested was about 2.72 times the amount of these gross earnings. The average number of revenue passengers for the half trip in that year was 22.5, the average length of the half trip was 3.62 miles, and the average distance from the centre of the city to the ends of the routes was 4.79 miles. Following along from that time there was a constant tendency to extend to the more sparsely settled territory, and the lines afterward were extended, not only as to the trips that were run, but as to the total length of the routes. The company began also immediately to electrify the lines, so that in 1892 about half of the system was electrified and the number of revenue passengers per half trip had gone up from 22.5 to 28. Four years later, in 1896, the road was 98 per cent. electrified, and there were 29.5 revenue passengers to the half trip.

Later, the rapid-transit system—that is, the subways and the elevated—was introduced with a view to providing more room for the congested district, and with these lines the demands that were made for service cut down the average revenue passengers per half trip, so that these figures in 1903 went down to 23, and in 1912 were only 25.5. In other words, in 1912, with gross earnings of $16,644,000, only three more revenue passengers to the half trip than with the horse cars in 1888.

These figures are rather significant; what has happened in Boston is probably typical of what will happen in many cities as business increases. Not only will there be more demands for transfers, more demands for extension in an unprofitable territory, and more demands for new methods of carrying on the business, but in every way the public may take what would be the only increment of the capital invested. The result in Boston has been that the permanent investment has increased to more than six times the gross revenue. It, therefore, appears extremely difficult to carry on business and satisfactorily meet public demands in the United States.

In Canada conditions between the railways and the public are not exactly similar to those in the United States. Nevertheless, there is a sufficiency of resemblance in the attitude of the public mind to make it well worth our while to note and endeavor to profit by the struggles, successes and failures of our neighbors to the south.

OTTAWA'S WATER SUPPLY.*

Writing in a letter to Mayor Ellis, Dr. C. A. Houston suggests that tests of the water of the Gatineau Lake be made by Mr. Joseph Race, the city bacteriologist. The following is an extract of Dr. Houston's letter: "On the assumption that the lake scheme of supply is provisionally adopted, it will be necessary to carry out the prolonged series of bacteriological, chemical and physical investigations as regards the quality of the water in the lake or lakes likely to be chosen for supply purposes. For the engineering part of the work, Sir Alexander Binnie will, no doubt, send out a competent surveyor; for my part, so far as quality is concerned, I have every confidence in the ability of Mr. Race to carry out the work successfully and to furnish me with such results and reports as will enable me ultimately to pronounce judgment in the matter. The bacteriological side of the question is not so important, as, with the gathering ground freed from all human sources of pollution, there is no possibility of the water conveying disease. Physical and chemical tests, on the other hand, are most important, and the water should also be examined for algæ. It will be necessary to collect samples periodically from the lake or lakes likely to be eventually chosen at various spots, and possibly at different depths, and accurate records must be kept of color, hardness, alkalinity, presence or absence of suspended matter, conditions as regards algal growths, temperatures, presence of iron, etc."

* Dr. Houston and Sir Alexander Binnie, the British experts engaged to report on Ottawa's water supply.

FOREST PROTECTION.

A very important conference upon the matter of forest protection along the lines of operating railways in the West has just closed at Winnipeg, the British Columbia Department of Forestry having been represented by Mr. R. H. Benedict, of the headquarters staff, and the parties to the convention being the federal Board of Railway Commissioners, the Province of British Columbia, the Canadian Pacific, the Grand Trunk Pacific, Canadian Northern and Great Northern Railway Companies. General protection of timber along the rights-of-way was the theme of discussion. Last year every mile of right-of-way was inspected by the provincial officers, and the regulations strictly enforced to guarantee the safety of near forests and due payment of royalty for timber cut on Crown lands. The work of inspection is peculiarly onerous in connection with construction operations, and, on the whole, the provincial officers have been well supported by the railway companies. The rule has been laid down that everything cut without permit is considered to constitute a trespass, and where timber is cut, with or without permit, the brush must be properly disposed of without delay.

EXHAUST STEAM AND ITS UTILIZATION AT COLLIERIES AND MINES.

An interesting paper on the above subject was recently presented by J. M. Gordon, at the annual meeting of the Canadian Mining Institute. In the course of his paper Mr. Gordon stated that up to within comparatively recent years the loss of the exhaust steam, and the amount of live steam that was carried down the mine to haulage engines and pumps received scant attention by mining engineers. There was, until recently, no demand for the small sizes of coal from the dry screening plant, and the silt and sludge from the washery; it was argued, therefore, that it was just as well to burn the small sizes in the boilers, than to dump it in a corner of the colliery yard where it would be in the way and an eyesore. Conditions have now changed. This silt, sludge, culm and buckwheat is no longer valueless. Coking plants, briquetting plants and mechanical stokers must now be fed, while competition and the steady increase in working expenses have made the problem of power distribution in and around mines one of considerable importance. To-day more than ever, the law of the survival of the fittest applies. It is the day of the electrical unit. Thus in many of the more advanced mines in Great Britain and on the Continent, we no longer find those huge old Cornish pumps, grinding and groaning as if in agony; no longer thousands of thermal units going to waste as a result of conducting steam pipes down deep and wet shafts to haulages; no longer long transmission lines of compressed air under ground to distant coal cutters. The day for these has passed. In their place we find high lift centrifugal pumps driven at from 1,500 to 2,000 revolutions per minute; three-phase high-tension armored cables passing down the shaft; and the transformation of the current near the distant coal-cutters to drive an inbye air compressor, or to work the coal-cutters by electricity direct. And this electric power has been generated from the exhaust steam formerly disregarded and wasted.

Meanwhile condensers cannot be used with reciprocating winding engines on account of the difficulty in controlling them; and the compounding of existing reciprocating engines, and the installation of condensing plant gives such a narrow margin of profit with a disproportional increase of worry to the management, together with so heavy an initial expenditure, that it has been found preferable to run these engines non-condensing. But the advent of the exhaust and mixed pressure turbine has made it possible to utilize this hitherto tremendous waste of heat units by converting them into electric units.

Before describing, however, the application and the possibilities of this new power producer, it may be advantageous to first point out the chief differences between the reciprocating engine and the turbine, and to indicate when and how thew should be placed. In the case of the reciprocating engine, the heat units are, by their expansion in a cylinder and change of configuration, made available for useful work through the medium of a fly-wheel; while in a turbine this transformation of static heat energy into kinetic energy may be brought about in one of three different ways: (1) In the impulse turbine by the expansion of the steam in nozzles, impinging on buckets on the periphery of the turbine wheel, which in turn levers the shaft and attains as high a speed in some sizes as 30,000 revolutions per minute; (2) In the reaction turbine, by the alternate passage of the steam through revolving and fixed blades the expansion is performed on both sets of blades, the fixed blades acting as guides; and (3) the operation is performed by means of a combination of the first and the second.

Theoretical thermodynamics teach that when a given quantity of steam at a given pressure and temperature exhausts into a condenser at a certain pressure and corresponding temperature, an equal number of units are available whether a reciprocating engine of a turbine has performed the functions.

The difference lies in the fact that the expansion of steam in a reciprocating engine is controlled by the size of the low pressure cylinder, and the maximum size to which this can be built economically, without undue cylinder condensation and friction, is generally acknowledged to be the equivalent of from 85 per cent. to 88 per cent. of the possible vacuum; while in the case of the turbine the expansion of the steam is only limited by the efficiency of the condensing plant. The higher the vacuum, the greater the efficiency of the turbine; so when purchasing a turbine set, it is absolutely essential to purchase the best condenser on the market.

A glance at the P.V. curve will at once show the greater work-producing capacity of the steam turbine than of the reciprocating engine. The curve shows the adiabatic expansion of unit weight of steam. This curve is theoretical, and only shows the wider limits the turbine can control; and it has nothing whatever to do with the mechanical efficiency of the power producers. The advantage the turbine has lies in its capacity of efficiency utilizing the vacuum.

The advantage of the utilization of this vacuum can be thoroughly appreciated when it is considered that one pound of saturated steam expanded from say 16 lbs. per sq. inch (a little above atmospheric) to 95 per cent. of possible vacuum, that is 0.7 lbs. per sq. inch, generates the same amount of heat units as does the same quantity of superheated steam at 572 F., expanded from 170 pounds per square inch absolute to about atmospheric pressure. Another way of demonstrating the thermo-dynamic advantages of the turbine is by the means of entropy diagram. The first diagram shows a non-condensing engine expanding from the average colliery pressure of 165 pounds per square inch absolute to 20 pounds absolute, and exhausting against a back pressure of 17 pounds absolute. This diagram represents the available energy performed by the non-condensing reciprocating engines at collieries and mines. The second diagram shows the reciprocating engine expanding the steam from 165 pounds absolute down to 10 pounds absolute, and exhausting into a 26-inch vacuum. The third diagram shows the non-condensing engine that performs the work in the first cast, now exhausting into an exhaust steam accumulator and a low pressure turbine utilizing this discarded steam and expanding it from 16 pounds absolute to 28 inches of vacuum.

The increase of available energy demonstrated in the last diagram, makes it so glaringly apparent that further reasoning is not necessary to demonstrate the advantages and economy of the exhaust steam turbine over the reciprocating engine when working with low pressure steam.

On looking at these diagrams the question arises why cannot the exhaust steam which one sees so frequently almost enveloping the whole of a bankhead of a deep mine, be used by a condenser. This problem has taxed the ingenuity of engineers for years, and the difficulties to be surmounted have caused such complications that any available advantages have been more than discounted by the initial expense and trouble in connection with the operation of the prime mover and its auxiliaries. When the extreme duties of a winding-engine winding out of a vertical shaft are realized, it is scarcely surprising that condensers are not in use.

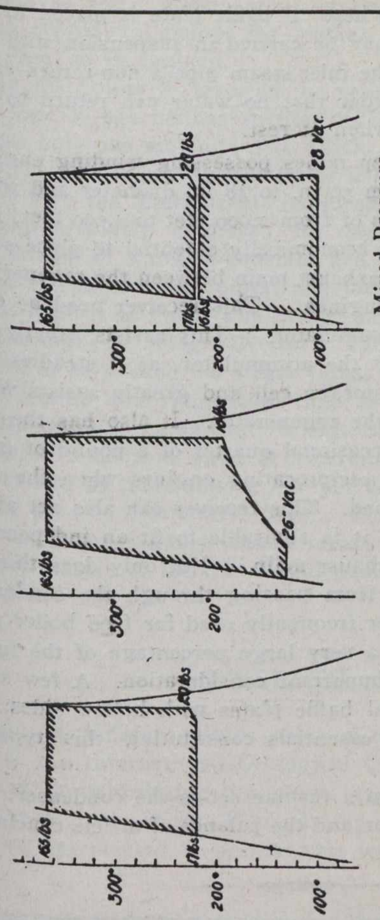
Some of the difficulties to overcome are: fluctuating loads; acute speed variations; reversals of direction of rotation, which have sometimes to take place quickly, and at almost any position of the engine; and, at the most, an average wind of from 20 to 30 seconds. These, then, are the difficulties to be surmounted, and which have baffled engineers for so long, and have resulted in the loss of countless millions of horse-power. The invention of the accumulator by Professor Rateau introduced the low pressure turbine into this field of intermittent steam, with very beneficial results.

Figure 3 is interesting, as it shows the amount of energy available by the adiabatic expansion of one pound of dry saturated steam when expanded from 120 pounds absolute; with the increase 0.5 in. of vacuum, from 27 in. to 29 in., with a barometer at 30 in. Expanded to atmospheric pressure we have 120,000 foot-pounds, and on the continuance of expansion to 1 lb. absolute, or 28 in. of vacuum the number of foot-pounds are almost doubled. In other words, the power available with a low pressure turbine, is increased almost 100 per cent. The utilization of this extra 100 per cent. by such a prime mover working on a 28-in. vacuum, is plotted in Fig. 4. This shows the consumption of steam per kw. hour at full load, with the amount of energy in kw. hours that can be recovered from a given quantity of exhaust steam per hour. On a 750 kw. set, the steam consumption is 36.5 lbs. per kw. hour or 39 lbs. per b.h.p., i.e., for every thousand pounds of exhaust steam per hour, 39 b.h.p. can be regained.

The history of the steam turbine is well known and hence any recapitulation is unnecessary, but it may be mentioned that it was not until the year 1902 that the exhaust steam turbine was introduced, when almost simultaneously engines of this type were patented by the Hon. C. A. Parsons and Prof. Rateau. The first Rateau turbine was installed at the Bonay mines in France.

In applying exhaust steam turbines to reciprocating engines at collieries and mines, there are two distinct propositions to be confronted. First, the case where the supply of exhaust steam is constant, but variable in quantity, and second, where the supply is intermittent and erratic, and where winding engines cease operating at night, but pumping must continue.

The first condition is brought about by fan engines feed pumps, and other auxiliary prime movers. Here a low pressure turbine is applicable, with the addition of a reducing valve, so as to reduce live steam in case of the exhaust steam failing in quantity and thus allowing the output of the turbine to drop below its working demands. This reducing of live steam in a valve before entering an exhaust steam turbine, is anything but economical and cannot be recommended. A turbine known as the mixed-pressure turbine has been devised to utilize this intermittent exhaust steam as well as utilizing live steam in an economical fashion when required to do so. This type of turbine is thus the most adaptable for colliery and mine work. Usually, when the exhaust steam is fairly constant, a receiver, consisting of an old Lancashire boiler-shell, suffices to steady the pressure for all practical purposes; but in extreme cases, and these are the conditions usually encountered at deep mines, it is necessary to resort to the thermal regenerative accumulator through which a comparatively steady supply of steam can be maintained even through the reciprocating engines may be stopped for an interval of five minutes. There are at the present day three or four types of regenerators on the market. Prof. Rateau has the honor of inventing two types of these accumulators, the functions of which are to store up surplus heat supplied when the reciprocating engines are running, and regenerating and delivering when the engines are at rest. These regenerative accumulators to be of a commercial possibility, must be so constructed that they shall have the capacity of storing enough heat units to supply the turbine with exhaust steam, should the exhaust steam be cut off for from, say, three to five minutes. In the scrap



Reciprocating Engine Non-Condensing

Reciprocating Engine, Condensing
Fig. 2.

Mixed Pressure Turbine utilizing Exhaust Steam

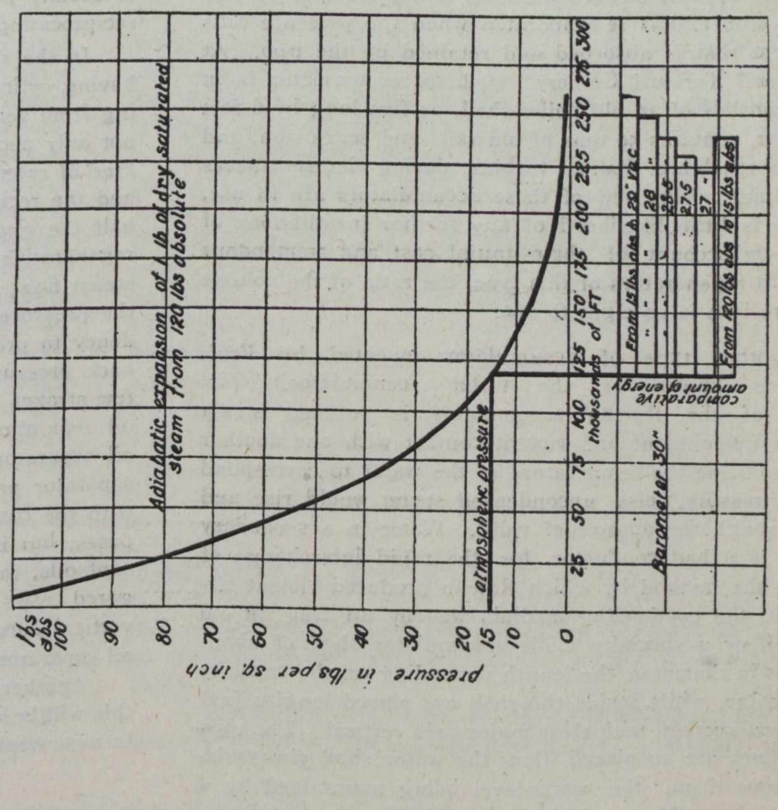
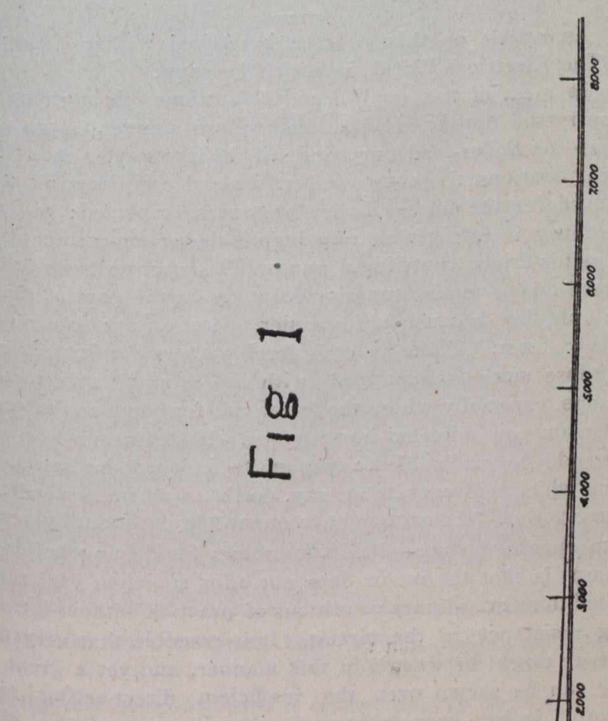
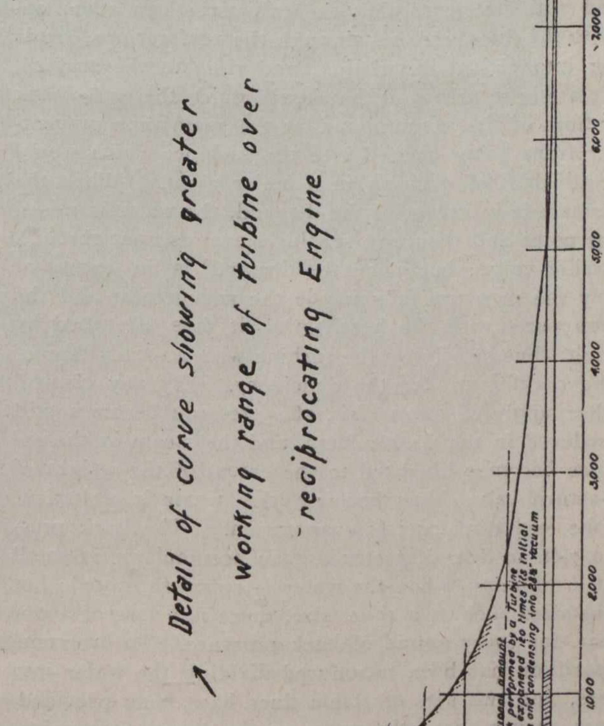


Fig. 3.



P.V. Curve for 1 lb. of saturated steam



iron type of accumulator, the heat storing medium is scrap iron, which is packed in a loose fashion in an old Lancashire or Cornish boiler-shell. Very little water is required in this type. The exhaust steam condenses in the form of dew on the scrap iron and is re-evaporated when the pressure falls by the heat that is absorbed and retained by the iron. At the Hucknall Torkard Colliery, such an accumulator is in use. It consists of an old boiler-shell, 24 feet long by 6 feet in diameter, contains 50 tons of old rails and scrap iron, and supplies a 175 b.h.p. Rateau turbine during intermittances of 40 seconds. Very few of these accumulators are in use, and there is little likelihood of any further installations of this type on account of their initial cost and tremendous weight. In regenerators of this type, the ratio of the volume of water to iron is as eight to one.

The other type of accumulator invented by Prof. Rateau, is known as the water accumulator. The principle of the Rateau accumulator is to keep steam and water in constant and violent contact with one another in order to raise the temperature of the water to correspond with the pressure, else uncondensed steam would rise and escape through the auto-relief valve. Water in a secondary condition is a bad conductor for the rapid interchange of heat, and the method by which Rateau produced violent circulation in the condensing medium was by utilizing an old boiler-shell or a specially made accumulator shell of about 7 to 8 feet in diameter, the length depending on the capacity of the turbine, while inside the shell are placed longitudinal flues of oval section, with their major axis vertical. The tops of these flues are so placed that the water shall always be a foot above them, the water-level being maintained by a ball float valve. The vertical sides of the flues or tubes are perforated with holes, so that the exhaust steam when delivered into the flues, escapes through the perforations, sends the water into violent circulation, and rises to the surface. A baffle plate is so arranged that it will guide the water back to the bottom of the accumulator, at the same time preventing water from being carried into the turbine, which would be the equivalent of priming in a boiler plant. When the exhaust steam is in excess of the demand, the water is raised to boiling point and then any surplus steam escapes through an auto-relief valve; but when the demand is in excess of the supply the pressure falls inside the regenerator and the water then parts with the heat units it has absorbed by evaporating, thus supplying the turbine with a steady flow of steam and making up for the deficiency. By any chance, should the supply of steam fail, the pressure becomes still further reduced in the accumulator, and the steam in the exhaust pipes becomes liberated to the extent of the weight of the non-return valve, thus keeping the water in agitation, and by the excitation assists evaporation. The back pressure in a 7-ft. to 8-ft. diameter Rateau accumulator is small and is at a minimum when the water is steam saturated; but in the big sizes such at a 12-ft. size, there is a loss of about 3 per cent. for every pound of back pressure. To overcome this, a partition has been introduced dividing the water into two layers, and two sets of steam flues have been provided. The steam spaces about the water are in direct communication, hence the pressure in both compartments is equal.

In practice, the common limits of pressure in these regenerators varies usually from 15 to 18 lbs. per square inch absolute, the difference of temperature being 9.30 F.; that is 103.5 lbs. of water is required for every lb. of steam, since the latent heat of steam at these pressures is 961 B.t.u.'s. This figure in actual practice is raised to 250 lbs. as it is impossible to ensure that the whole of the water in the regenerator will be raised to the highest temperature. The steam is supplied to the turbine through a valve on the top of the regenerator, and here a baffle plate is placed to obstruct any water that may be carried in suspension with the out-going steam. On the inlet steam pipe a non-return valve is usually placed, in order that no water can return to the reciprocating engines when at rest.

In the case of deep mines possessing winding engines having cylinders of from 36 in. to 48 in. diameter and winding from vertical depths of from 2,000 feet to 4,000 feet, it is not only necessary, but economically essential to place some kind of receiver on the exhaust main between the regenerator and the reciprocating engines. This receiver need be only half the size of the accumulator. This assists greatly the regenerative organs of the accumulator, as it steadies the steam flow, acts as a storage cell and greatly assists when the pressure drops in the regenerator. It also has the tendency to prevent the occasional quarter of a pound of extra back pressure on the reciprocating engines when the first few strokes are performed. This receiver can also act as an oil separator, although it is advisable to fit an independent oil separator on the exhaust main. Not only does this oil separator prevent oil from passing through the condenser with the condense water frequently used for feed boiler purposes, but is reclaims a very large percentage of the lubricant oils, in itself an important consideration. A few staggered rows of vertical baffle plates with hollow sides and vertical curves are the essentials constituting this type of oil separator.

Another auxiliary in a turbine set is the condenser, and this will be elaborated on and the balance of article concluded in next week's issue.

CENTRIFUGAL FEED PUMPS FOR BOILERS.

An article on this subject, by Alfred Williams, appears in The Electrical World, in which he says:

In most of the small central stations throughout the country the time-tried and time-honored simple reciprocating pump for boiler-feed purposes still holds sway, although in newer stations the compound steam-end reciprocating pump is used for the higher boiler pressures employed; but even the latter is fast giving way before the steam-turbine-driven or motor-driven centrifugal pump This change has not been forced owing to any superior economy on the part of the latter unit, but because of its easier operation and lower maintenance cost. There is considerable room for improvement in those stations equipped with the simple reciprocating pumps, especially where the latter call for some 200 to 300 lb. of steam per indicated horse-power. If steam must be used, it would be preferable to employ an independent steam engine which will operate at, say, 60 lb. of steam per indicated horse-power. An argument frequently brought out by persons who oppose the use of electric motors for driving boiler-feed pumps is that the motor does not offer sufficient variation in speed to meet ordinary conditions of practice without introducing resistance in the circuit. It is possible that very much energy might be wasted in this manner, and yet a great saving can be shown over the inefficient direct-acting steam pump. It has been suggested that in place of the single direct-acting steam pump a triplex pump be installed, and that this pump be driven by a constant-speed motor or belted from the main engines. The variations in the rate of pumping can be taken care of by placing a by-pass valve in the suction to the exhaust of one or two of the pump cylinders. Then to vary the rate of pumping it would only be necessary to open the by-pass valve more or less. With the by-pass valve shut the pump works at maximum output. By opening the two by-pass valves wide the rate of pumping in a triplex pump would be reduced two-thirds. Such a pump would be most economically driven from the main engine shaft.

The advantages and economy of using motor-driven or turbine-driven centrifugal pumps for feeding boilers are, however, too great to be ignored.

Among the points in favor of the centrifugal pump are the following: It has neither suction nor discharge valves; it possesses only one moving part which is in continuous rotary motion, and it delivers the water in a constant stream in contrast with the intermittent impulses of the ordinary duplex pump so widely employed for this class of service. Since the stream of water is constant and without impulses, there is no vibration in the pipes, and there is little chance for scale to deposit in them. The pump, moveover, possesses all the advantages of being valveless. There are, therefore, no plungers to be packed, no steam valves to reseat, and no pistons to require new rings from time to time. A feature of the pump which is paramount is that when running at constant speed it delivers water at a certain pressure, which it cannot exceed by more than a few per cent., even though the delivery pipe be completely closed. With the reciprocating pump the latter calamity usually means a broken pipe or pump. This feature of the centrifugal pump makes it possible for a fireman to shut off the feed to any of the boilers or to all of the boilers without shutting off the pump, which in many plants would entail leaving the boilers and going to another part of the station. It is thus possible to feed the boiler automatically by installing a ball-float for each boiler, which would control a balanced valve in the feed pipe. This makes it unnecessary to have connections with a line supplying steam to the pump, as the latter runs continuously whether any of the boilers are being fed or not. This method of automatic feeding makes the boilers independent of each other, and makes it unnecessary for the water line in all the boilers to be at the same level. This latter feature is important in stations containing several sizes of boilers or where some are of the vertical type and some of the horizontal type. It might be contended that the efficiency of a centrifugal pump operating under these circumstances would be very low when supplying only a small portion of its rated output, and that it would consume power when merely turning the water without delivering any. This objection in the case of a motor-driven centrifugal pump is of little moment when its many advantages are considered.—Electrical World.

TWELFTH INTERNATIONAL GEOLOGICAL CONGRESS.

We have at different times referred in *The Canadian Engineer* to the International Geological Congress which is to be held in Toronto during the month of August this year. Through the courtesy of Mr. W. S. Lecky, secretary of the congress, we are pleased to present this week some further facts regarding this congress, also a photograph of the organization committee in connection with it, which held a session in Ottawa on the 4th of March.

Organization Committee, International Geological Congress, to be Held in Toronto August 6th to 14th, 1913.

At that meeting was considered the general arrangements in connection with the programme. On that occasion addresses were delivered by the president, Dr. Adams, on the general objects and work of the International Geological Congress; Dr. W. G. Miller delivered an address regarding the 10th session which was held in Mexico in 1906, and Dr. Coleman, of Toronto, spoke on the 11th session held in Sweden in 1910. Arrangements for the work of the 12th session to be held in Canada this year were described in detail by the General Secretary of the 12th congress, Mr. R. W. Brock.

It is expected that about one thousand delegates will attend the congress, six hundred professional geologists and about four hundred mining engineers, many of them coming from Europe and the United States.

The meetings of the congress will be held in Convocation Hall and lecture rooms of the University of Toronto. The congress will open Wednesday, August 6th, and will continue until Thursday, August 14th, excluding Sunday the 10th.

A series of very interesting excursions have been arranged, and as many of the men who will attend are university professors it is hoped that these excursions, together with the fact that our mines will be generally open to their inspection, the congress will have far-reaching effects.

HIGH-SPEED BEARINGS.

The issue of *The Canadian Engineer* of March 20th, contained a few cuts and an abstract of a paper on "High-Speed Bearings" by J. C. Balfry, read before the Rugby Engineering Society, England. The former article contained a description of the different types of bearings. This week we publish as abstract of the report which deals more particularly with the results and conclusions on the subject.

The total friction work in a particular bearing can be reduced by shortening it. But here one enters dangerous ground, for the manufacturer has to consider much more than frictional losses and the safe running of the machine at normal speeds. He has to think of the stilling of such vibrations as are set up in the shaft when the latter is passing through a critical speed, as well as a possible reduction in oil supply (this depending upon the lubrication arrangements) when the speed of the shaft is declining.

Pressures.—The ordinary pressures to-day are from 50 to 90 lb. per sq. in. of projected bearing surface. In the discussion on a paper read before the American Society of Mechanical Engineers by Professor Christie, it is reported that Professor Hodgkinson remarked that 80 ft. per sec. and 100 lb. per sq. in. were commonly employed, and he saw no reason why these velocities and pressures could not be materially exceeded. This, to some extent, agrees with Lasche's experiments, for within fairly large limits $p \times \mu$ is practically constant.

Velocities.—As already stated, present-day practice with bearings of this kind rules that velocities should not exceed 60 ft. per sec. As μ increases but slightly between 30 ft. per sec. and 80 ft. per sec., there is little fear that a moderate increase on the higher figure will have any ill effect on the bearing, provided that the temperature is not allowed to rise too high and vibration is not forgotten. Allford's work on "Bearings and Their Lubrication" contains a curve showing the relation between pressure and velocity, used by the General Electric Company, of America, for perfect film lubrication. The following are readings taken from the curve:—

V. in Ft./Sec.	p = Lb. per Sq. In.
20	167
30	190
40	208
60	229
73.5	235

From the above it will be noticed that with increase of velocity there is likewise an allowable increase of pressure. Lasche shows that within the limits of his experiments, with v and t constant, the increase of pressure was accomplished by a decrease in μ. Therefore, since $p \times \mu \times v$ = friction work per sq. in. of projected surface, the friction work is affected only by variation in velocity. These deductions are to a certain extent borne out by data taken from the G.E.C. curve.

Many turbine builders assume that for running speeds μ is a constant quantity, and is left out of account in determining the size of a bearing. The determining factors are then the product of pressure and velocity,

$p \times v$ varies from 2,500 to 5,500;

but in the latter product water cooling is resorted to by some builders.

Oiling.—With pressure or pressure-head systems, oil is admitted to a bearing usually either at the sides or at the top. Each system has its advocates, and it is well to remember Beauchamp Tower's classical experiment before attempting to admit oil at other places. Tower showed that the maximum pressure per unit area in the oil film was about twice as great as the calculated mean pressure per unit area on the projected surface of the bearing. Osborne Reynolds has shown, and others have confirmed, that the position of the shaft within the bearing varies with increase of load, and that the point of maximum pressure, which is on the "off" or leaving side, and not on the "on" side, as is sometimes supposed, moves up the "off" side of the bottom half of the bearing and back again to the bottom as the load is increased. For example, imagine that a shaft is rotating in a counterclockwise direction within a bearing, the end view of which is presented towards the reader. The shaft, whose weight compels it to run on the bottom half of the bearing, rotates at first in the lowest position. Using the four cardinal points to simplify matters, the shaft rubs first at S., with increase of load it gradually mounts up to E., dropping to S.E. as the load is still further increased. It is useless, then, to attempt to pump oil between journal and bearing surface anywhere between S. and E. We therefore admit oil at N., W., or S.W., these being the most convenient places.

Professor Goodman has shown that a reduction of the arc of "contact" of the bearing surface on the journal greatly reduces frictional losses in the bearings.

An inspection of Figs. 5 and 7 shows that this fact has been taken advantage of by the reduction of the effective bearing surface on the bottom half by the well-bevelled oil channels at the horizontal centre lines.

The quantity of oil to be delivered to a bearing surface is proportional to its projected area. The following table gives the practice of three leading turbine builders:—

Gallons per Sq. In. per Minute.	Oil Pressure in Lb. per Sq. In.
0.05	45 to 60
0.05	5 to 10
0.01	—

If p = say 60 lb per sq. in. on the projected area;
μ = coefficient of friction = 0.025;
v = velocity in ft. per sec., say 60 ft.;
$p \times \mu \times v$ = work done in ft.-lb. per sq. in. per sec.
$60 \times 0.025 \times 60 \times 60 = 5{,}400$ ft.-lb. per min.

Taking specific heat of oil at 0.4, and sp. gr. as 0.88,
Q = gals. delivered per sq. in. per min. = 0.45.
T_1 = temperature of inlet oil, Fahrenheit.
T_2 = temperature of outlet oil, Fahrenheit.
$10 \times 0.88 \times 0.4 (T_2 - T_1) Q$ = B.Th.U. taken up by oil in passing through bearing per pound of oil delivered.

With $T_2 = 130°$ F. and $T_1 = 100°$ F., B.Th.U. per min. capable of being taken up by the oil is 47.5 = 37,000 ft.-lb. per min.

As the journal generates only 5,400 ft.-lb. of friction work per minute per sq. in., we see that there is more than sufficient oil to keep the temperature of the bushes low.

The effect of shaft vibration has to be remembered, and it is more than probable that if this happens to be excessive much more heat is generated through vibration than by friction due to p, μ, and v only.

The selection of a suitable oil is of importance. Great viscosity means loss of power, μ being greater than with small viscosity. Provided that complete lubrication is obtained, the thinnest oil that will do the work will prove the most economical. The following results were obtained on a Sternol patent oil-testing machine at a pressure of 100 lb. per sq. in. at 100 revolutions per min. Duration of test was 55 mins.:—

Oil No.	Relative Friction at Beginning.	Relative Friction at End.	Temp. at Beginning. Deg. F.	Temp. at End. Deg. F.
4	1.45	0.9	68	107
5	2.8	1.25	68	126
6	3.75	1.5	68	132

The curves from which the above were taken fall very gradually.

The effect on the relative coefficient of friction is shown with the temperature rise, the most suitable oil of the three being No. 4, which has the lowest coefficient of friction and lowest temperature rise.

In the following table results of tests on three turbine oils are given; they were obtained with the same machine as were the previous ones at 100 revolutions per min.:—

Oil No.	Relative Friction at Beginning.	Relative Friction at End.	Temp. at Beginning. Deg. F.	Temp. at End. Deg. F.
1	1.8	0.3	86	147
2	5	1.15	86	147
3	6.5	1.25	86	147

No. 1 gives the lowest coefficient of friction at all temperatures from 86° to 147° F. It will be noticed that the oil is colorless, and is therefore as free from impurities as it is possible to get it. The comparative thickness of these last three lubricants at various temperatures is indicated in the third column. According to tests made on the Sternol oil-testing machine, the quantity of oil required varies according to the quality of the lubricant. It is not correct to say that by using a cheaper oil one may use more of it, for if the oil is put on in very large quantities μ is not reduced whatever.

No. 1 oil—Thin, colorless
No. 2 oil—Green-golden, somewhat heavy.
No. 3 oil—Heavy, golden.
No. 4 oil—Thin, golden.
No. 5 oil—Deep golden, medium.
No. 6 oil—Golden, medium.

In ordinary turbine practice oil is delivered to the bearings at from 100° to 120° F., and returned at from 130° to 150° F.

Radiation.—Lasche has shown that the quantity of heat radiated from a bearing depends upon the extent of the surface exposed to the lower temperature of the surrounding air. Thus a bearing having good metallic contact with a large housing will be able to get rid of a great deal more friction heat than will one that is itself in contact with the cooler surrounding atmosphere.

In Fig. 13 is shown a curve indicating the amount of heat, expressed in foot-pounds, that may be expected to be dissipated into the surrounding air per sec. per sq. in. of projected area.

If Wr = work which bearing can dissipate in foot-pounds per sec. per sq. in. of projected area, t = temperature difference in Fahrenheit degrees, can be closely represented by the equation:

$$Wr = \frac{(t + 31)^2}{3,200}.$$

This may be used when the bearing in question has a relatively thin housing, and is located in still air. If the bearing is situated in a draught—e.g., close to rotating armatures—the right-hand side of the equation may be multiplied by two.

The following table gives the composition of some of the best known anti-friction alloys:—

	Copper.	Lead.	Antimony.	Tin.	Iron.
White metal	.....	87.92	12.08	.....	.....
Delta metal	92.39	5.1	.....	2.37	0.007
Magnolia metal	.....	83.55	16.45	.....	.....
Babbitt metal	8.3	.....	8.3	.....	.....

By the use of the "Eatonia" process in the casting of ordinary white-metal linings for bearings, the bearing surface is rendered much more dense, the molecular contraction is much finer, and there is an absence of segregation. Experiments to show the comparison between a bearing lined with white metal, and another of the same size also lined with white metal but "Eatoniaized," indicated that under exactly similar conditions the former seized up when the temperature of the oil-bath rose to 137° F., and the latter showed no signs of seizing up even at 149° F. The pressures were 1,000 lb. per sq. in. in each case, oil-bath lubrication was used, and the journal speed was nearly 8 ft. per sec.

Ball Bearings.—A paper bearing our title would hardly be complete without some mention being made of the place that ball bearings are beginning to take in the development of high-speed electrical machinery.

The ball bearing in its various forms has been used with electric generators and motors for some time, not only with light but with heavy machines. Up to the present this form of bearing has not found favor with turbine builders, nor, generally speaking, with generator makers.

It is no doubt due to fear of ball breakage through vibration at the critical speeds of the shafts, and the knowledge of the disastrous consequences which such failure would produce, that turbine makers have not advanced in their adoption of ball bearings. Since ordinary turbine shafts revolve at speeds between 4,000 revolutions per min. and 750 revolutions per min., and weigh from one ton upwards, the weights to be carried at these speeds are consequently high.

It is probable that the first cost, bearing for bearing, is greater in the case of the ball type than with the friction type, but the lubrication arrangements of the former are insignificant when compared with those of the latter. The oil consumption is very small indeed with balls, and the coefficient of friction at starting is about the same as running, this being approximately 0.002 to 0.003. It is recommended that for high-speed ball bearings a somewhat thinner oil be used, and a little more of it than would be necessary with slow-running ball bearings. The oil used should be of a non-corrosive nature and free from impurities, especially those likely to act with the oil and produce results in the same way as fine emery powder or even chalk would be expected to do.

After a bearing suitable to the load, speed, and general conditions has been selected, the three most important points to bear in mind are: (1) Accurate fitting; (2) correct alignment; (3) protection from dirt and moisture.

With most makers the load (corresponding to the speed) on a ball journal bearing suitable for a horizontal shaft may be said to vary inversely as the cube root of the speed, or, expressed in algebraic form:—

$$\text{Safe load} \propto \frac{1}{\sqrt[3]{\text{Revs. per min.}}}$$

For thrust bearings—

$$\text{Safe load} \propto \frac{1}{\sqrt{\text{Revs. per min.}}}$$

Canadian railroads plan the construction of 2,700 miles of road in 1913, costing $41,000,000, compared with 1,075 in 1912, costing $30,000.000.

SULPHITE DIGESTER EXPLOSION.

The illustration which accompanies this article will give some idea of the tremendous damage done recently at Grand Mere, Quebec, by the explosion of the sulphide digester of the Laurentide Paper Company. A digester is the vessel in which wood is treated with acid in paper manufacture, and is operated at a pressure of 85 to 90 lbs. per square inch. It was 45 feet high by 14 feet diameter. It was built in three courses of three sheets of steel for each course. These steel plates were one inch thick, united by butt joints with single strops of the same material one and one-sixteenth inches thick. The vertical seams were triple rivetted, the girth seams double rivetted. It was lined first with lead about three inches thick, and then with a cement and tile lining about eight inches thick, the object of this lining being to prevent the acid used in cooking the pulpwood coming into contact with the steel sheets of the digester.

Wreckage from Sulphite Digester Explosion.

The vessel had been regularly inspected by inspectors of the Boiler Inspection and Insurance Company, and it is satisfactory to know that the explosion was due to a cause entirely beyond the control of both the owners and the inspecting company.

The initial rupture occurred in the strap on one of the vertical seams in the middle course, which was eight feet six inches in width. The rupture spread along both of the girth straps of this course, which opened up and was torn from the upper and lower portions of the digester. The top portion was blown directly upwards, falling back on the foundation of the digester house, while the lower portion was blown through the south wall of the digester house, falling on and destroying the blow tanks used to receive the cook when emptying the digesters. The middle course was lying on top of the lower portion and was straightened out with the force of the explosion almost flat. There were no tears or ruptures in any of the plates, but that the failure in material was confined solely to the straps, a fact which can be taken to corroborate the opinion subsequently reached as to the cause of the explosion.

The wrecked digester was very carefully and thoroughly examined soon after the explosion, and the conclusion reached was that the explosion was due to a hidden crack in the strap which first failed, and which, starting from the inner surface, gradually worked its way towards the exterior. Its position between the strap and the sheet made it difficult to discover the defect. What supports the conclusion is the fact that of the vertical straps in the same course one showed a crack on its inner surface about two-thirds of its entire length and in a position which a crack of this nature would be expected to occupy. A similar crack was found in one of the vertical straps that had been removed from one of the other digesters.

The expediency of removing the entire lining of a digester at regular intervals and making a thorough internal examination of the shell, is, in spite of the cost of such a step, deserving of serious consideration. It is certain that the cost would be insignificant as compared with the loss that might be avoided. From such an examination only can the strength of the vessel and the pressure at which it is safe to operate it be accurately determined from time to time. In some continental countries such a step at fixed intervals is compulsory by law.

PANAMA CANAL WORK IN JANUARY.

The grand total of canal excavation to February 1 was 190,892,279 cubic yards, leaving to be excavated 27,246,020 cubic yards. Since the last monthly report of excavation was published there have been added to the excavation yet to be accomplished in Culebra Cut 5,634,161 cubic yards on account of the slides that have been developing there. The total excavation for the month of January was 2,612,020 cubic yards. The dry excavation amounted to 1,672,117 cubic yards and was entirely by steamshovels. The dredges and monitors removed 939,903 cubic yards.

In the Atlantic Division, the total excavation was 555,111 cubic yards. Of this total 46,773 cubic yards consisted of dry excavation at Gatun Locks, and the remainder was wet excavation—508,338 cubic yards from the Atlantic entrance.

The total excavation in the Central Division was 1,135,580 cubic yards, which includes 18,360 cubic yards in the Culebra Cut section charged to Obispo Diversion.

In the Pacific Division, the total excavation was 912,329 cubic yards, 489,764 cubic yards of which consisted of dry excavation. Of the 431,565 cubic yards of wet excavation 215,025 cubic yards were from the channel, and 216,540 cubic yards were taken out at the Balboa terminals.

ENGINEERS' LIBRARY

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

BOOK REVIEWS:

BOOK REVIEWS.

Elements of Heat-Power Engineering. By C. F. Hirshfeld, M.M.E., and Wm. N. Barnard, M.E. 8 vo., xiii. + 811 pages; 480 figures. Price, $5.00 net. John Wiley and Sons, New York.

Reviewed by A. S. L. Barnes, A,M.I.E.E.*

The authors of this book are professors, respectively, of Power and Steam Engineering at Sibley College, Cornell University, Ithaca, N.Y. As set forth in the preface, an attempt has been made "to include in a single volume not only the elementary thermodynamic theory of gases and vapors and of their cycles, but also the consideration of the sources of heat, the methods of making it available for useful purposes, its utilization in the various types of heat-driven prime movers and their auxiliary apparatus, together with a discussion of the fundamental theory, the ideal and actual performance, and the practical considerations connected with such apparatus."

The book is said to be intended primarily for engineering students, but there is much in it which will be found useful by those who have gone beyond their college days.

The arrangement of this work is very good, being subdivided in such a manner as to make reference to any part a very easy matter; approximately the first half is theory, while the latter half is devoted to descriptions and discussion of various types of steam engines, steam turbines, boilers, gas engines, gas plants, etc.

Although, for many persons, the mathematics in the book will prove somewhat too much, as a knowledge of calculus is presumed, a great deal of useful information may be gleaned from its pages, even by those who cannot follow the equations.

From cover to cover it is evident that the authors have spared no effort to render their work of the greatest value to those for whom it is intended, and the book is worthy of being classed as a standard text book on the subject.

The earlier chapters, commencing with the elementary laws of thermodynamics and of gases, go on to discuss expansions and compressions of the latter, such as take place in all engines using heat as a source of power, curves of entropy changes, various gas cycles, such as the Carnot, Stirling and Ericsson cycles are taken up at considerable length and the advantage of theorizing about ideal conditions is clearly shown in that it enables one to understand what would be the maximum efficiency obtainable under such conditions and in what direction success may be sought.

Later on the properties of steam are dealt with as being the gas in most general use for power purposes; it is comforting here to learn that of the following two formulae the latter is accurate enough for ordinary engineering purposes:

(λ = total heat of steam).

(1) $\lambda = 1150.3 + 0.3745\ (tv - 212) - 0.00055\ (tv - 212)^2$.

(2) $\lambda = 1091.7 + 0.305\ (tv - 32)$.

The latter, it will be noted, is the old Regnault formula with which all steam engineers with any knowledge of theory must be familiar; the first formula is apparently a new one of slightly greater accuracy, developed by Dr. H. N. Davis three or four years ago. The latent heat of vaporization is given in this book as 970 B.th.u. The old value, it will be remembered, was 966.6.

Your practical engineer says that an ounce of practice is worth a pound of theory, but the futility of trying to get along entirely without theory may be well illustrated in the case of a steam engine where it can be proved beforehand that the maximum theoretical efficiency is only some 30 or 40 per cent.; of course, in actual engines it is less still, seldom higher than 25 and sometimes as low as 5 per cent. Theory, in this case, enables one to know what degree of excellence is possible and in what directions lie the greatest hope of success. Without such knowledge in designing "heat-power" plants needless mistakes and disappointments would be inevitable.

In Chapter XV. a good deal of space is allotted to the "Action of Steam in Real Engines," and in Chapter XVI. various methods of decreasing cylinder condensation are discussed. It is herein that one of the fundamental reasons why large engines should be more economical than small ones is pointed out, viz., that in large cylinders the volume enclosed is greater in relation to the radiating surface of the cylinder than in small ones and therefore the cylinder condensation in the former will be relatively less.

Following the above are chapters on various types of steam engines, governors, valve gears, indicator diagrams, etc.

Steam turbines are next dealt with, the ideal turbine coming first, followed by descriptions and drawings of De Laval, Rateau, Zoelly, Curtis, Parsons and other types.

External and internal combustion gas engines succeed the turbines, the former being typified by the various kinds of hot air engines which have from time to time been developed. The chief characteristic of such engines appears to be their extremely low thermal efficiency.

* Hydro-Electric Power Commission.

Internal combustion engines are, of course, very much more satisfactory, and a good deal of space is devoted to them.

The chapters dealing with "Fuels," "Combustion" and "Actual Combustion of Fuels" are very good, and in entire accord with the latest ideas and practice.

Boilers, Superheaters, Draft and Draft Apparatus, Gas Producers and Producer Gas, Feed Water Heaters, Condensers, Water Purification, Power Plants, Air Compressors and Refrigerating Machinery form the subjects of the concluding chapters, after which come problems suitable for students, an appendix containing tables of the properties of saturated and superheated steam, together with a temperature-entropy diagram and a heat-entropy chart.

A copious index brings to a close a book ambitious in its scope, but well carried out, and one which would be very useful to engineers of large electric generating stations and similar plants.

A Textbook of Theodolite Surveying and Levelling.—By James Park, Professor of Mining Engineering in the University of Otago, Dunedin, New Zealand. Published by Charles Griffin & Co., Limited, London. Second edition; 5⅝ x 8 ins.; 320 pages; 130 illustrations. Price $1.85.

Reviewed by J. B. Harvey, M.Sc.*

This book is intended to be an elementary textbook to cover a two years' course in surveyng. As the title indicates, surveying with the theodolite is dealt with almost exclusively, the author's contention being that at the present time practically all surveying is done with this instrument.

The author's experience seems to have been in the southern hemisphere and more particularly in New Zealand, and, judging from such statements as the following: "The graduated horizontal circle on most theodolites is a frustum of a cone," one must conclude that he is not familiar with the usual style of transit used in Canada.

Chapter I. deals with the care and adjustment of the instrument. Chapter II. is a short one on chains and steel bands. Chapter III. is on obstacles to alignment. Chapters IV. and V. deal with the measurement of angles, traversing and bearings generally. Chapters VI., VII. and VIII. deal with calculations, such as latitudes and departures, omitted lines, areas, etc. Chapter IX. is on the subdivision of land. Chapter X. is on triangulation. Chapter XI. is a long one, covering nearly 100 pages, and deals with astronomical observations. Here, as in other parts of the book, the author makes use of various formulæ, the derivation of which are not given, nor is there any indication as to where one might look for solutions. Chapter XII. deals with levelling, contouring and the bathymetrical survey of lakes. Chapter XIII. is on railway curves. This is after the usual English practice, where the curve is figured from a stated radius and not from some degree of curve, as is our usual practice. Chapter XIV. is a short one on mine surveying.

Except for the fact that some of the terminology does not agree with Canadian practice, and that practically all the numerical examples, especially those in the chapter on astronomy, are from New Zealand, and are thus not always suited to our latitude, the book should make an excellent elementary text. The explanations are usually short and to the point. The text is well supplied with actual problems completely worked out, and also with numerous diagrams and illustrations.

The book might be criticized for having too much space devoted to astronomy.

* Assistant Professor of Surveying and Geodesy, McGill University.

The Effects of Errors in Surveying.—By Henry Briggs, M.Sc., head of the Mining Department in the Heriot Watt College, Edinburgh. Published by Charles Griffin & Co., London. Cloth; size, 5½ x 8 ins.; 179 pages, 22 cuts. Price, $1.25 net.

Reviewed by J. B. Harvey, M.Sc.

"No branch of mathematics is treated in this country (Great Britain) less according to its deserts than that known as the Theory of Probabilities, of which the Theory of Errors is a part." This statement of the author applies about equally well to Canada, and accordingly this book can be recommended to any surveyor or engineer who would like to get some idea of the effect of accidental errors on his surveys.

The author, recognizing the fact that there are many excellent textbooks on the purely mathematical side of the Theory of Errors, devotes the major portion of his book to practical applications of the theory that should be of use to the working surveyor.

Instead of using the Probable Error, or Mean Square Error, as is done in nearly all works on this subject, the author makes use of the Average Error, which he defines as "the arithmetic mean of the separate errors, taken all with the same sign, either plus or minus."

The headings of the various chapters give a fairly clear idea of the matter contained in each: The Analysis of Error, The Propagation of Error in Traversing, The Best Shape of Triangles, The Application of the Methods of Determining Average Error to Certain Problems in Traversing, and The Propagation of Error in Minor Triangulation. The last chapter is a summary of the results obtained in the foregoing chapters, thus providing easy access to the conclusions reached. The book is also well indexed, and contains a number of special tables which would facilitate calculations of this kind.

Only an ordinary knowledge of mathematics is required to read this book. The explanations are well written, and, followed as they usually are by numerical examples, there should be no difficulty in applying the author's conclusions to one's own problems. A great many of the applications given are taken from mining surveys.

The book is not intended for use in high-class Geodetic surveying.

Applied Statics. By Louis A. Martin, Jr., Professor of Mechanics in Stevens Institute. 198 pages. Price, $1.50 net. John Wiley and Sons.

Reviewed by P. Gillespie, B.A.Sc.*

This is the fourth of Professor Martin's series of text books on mechanics, the preceding companion volumes being "Statics," "Kinematics and Kinetics" and "Mechanics of Materials." Typographically and otherwise the make-up of this volume is similar to that of its predecessors. It measures 7½ x 5 inches, and the paper and type are of the usual excellent quality. Many of the illustrations are of structures and machines. These, wisely, are chiefly diagrammatics, showing the mechanical essentials only, and in consequence are not complicated by unnecessary lines. Emphasis through the medium of black letter type is a feature of the text.

The book is intended by the author as an introduction to structural and machine design. It endeavors to encourage the student "to think and not to memorize," and is methodical and progressive in its treatment. Sufficient of the calculus is employed to give to the text a zest for the student who has read the elements of this branch of pure science. In consequence, the book is scarcely in the class usually designated as elementary.

* Associate Professor of Applied Mechanics, University of Toronto.

Not the least commendable feature is the excellent series of problems, numbering upwards of three hundred in all. These continue throughout all chapters and are of such a character that the student is led to realize that the subject he is studying has something beyond a mere academic interest. The book should commend itself to teachers and students.

The New Steam Tables, together with their Derivation and Application.—By C. A. M. Smith, M.Sc., and A. G. Warren, B.Sc., with an Introduction by Sir J. A. Ewing, K.C.B., F.R.S.. Publishers, Constable & Company, Limited, London. Cloth; size, 5½ x 8½ in.; pp. xii. + 101, with Mollier Chart inserted in cover. Price, $1.00 net.

Reviewed by A. R. Roberts.*

The great amount of research work in the last few years on the properties of steam has resulted in modifications of the values determined by Regnault, and made necessary new tables for the convenience of engineers and students.

Several sets of tables, in addition to the one under review, are available at the present time. They are all based on the same experimental work and give practically the same values, but differ in their arrangement and in the method of calculation adopted.

The New Steam Tables are calculated from a series of formulæ deduced by the aid of well-known thermodynamic principles from an empirical characteristic equation connecting the pressure, volume, and temperature of steam. These formulæ are due to H. L. Callendar, F.R.S. The constants in the various formulæ have been adjusted to accord with the latest experimental data. The values of the properties, calculated in this manner, are likely to be more consistent among themselves, though not necessarily in better agreement with the experimental data, than those calculated more directly from empirical formulæ.

A comparison of the values in these tables with those in Marks and Davis' shows considerable differences in many places, particularly in the Latent and Total Heats at high pressures. These differences, however, are of little importance in ordinary engineering work.

The New Steam Tables are arranged in two sets. The first set uses the "Pound-Centigrade" system, which is beginning to find favor with English-speaking engineers; and the second, the "Pound-Fahrenheit" system. In each set are two tables of the usual properties of Saturated Steam, one on a pressure base and the other on a temperature base, and two tables of the Specific Heat of Superheated Steam, one giving instantaneous and the other mean values.

The reviewer is of the opinion that a more complete tabulation of the properties of Superheated Steam would greatly increase the usefulness of the book.

Purification of Water.—By T. Aird Murray, M. Can. Soc. C.E.

A pamphlet containing 36 pages, in which the author presents a number of general principles involved where the purification of water is under consideration. The pamphlet, which is based on a paper read before the annual meeting of the Canadian Public Health Association, Toronto, 1912, describes slow and rapid sand filtration methods, and a very interesting series of tables covering the installation cost of slow sand and mechanical filters in various cities in the United States; also tables showing the operating costs of slow sand and mechanical filter plants.

The pamphlet contains a number of illustrations, together with an extract which appeared in *The Canadian Engineer* of November 9th, 1911, describing the mechanical filtration plant at Saskatoon, Sask. To those who are at all interested in this subject this pamphlet will prove very useful. The author will be glad to supply copies to anyone interested on payment of postage.

*Associate Professor of Mechanical Engineering, McGill University.

Directory of Cement, Gypsum and Lime Manufacturers.—Seventh edition. Leather cover; 2½ x 4 inches; 274 pages. Price, $1.00. Cement Era, 1207 Morton Building, Chicago, Ill.

The purpose of the Directory is, first, to present a complete list of manufacturers, so that any prospective purchaser of these products might locate at a glance any near-by mill. The publishers present in condensed forms lists which are very useful and necessary to the proper conduct of business relating to the manufacturers. It contains a list and location of mills in the United States, Canada and Mexico; alphabetical list of officers, superintendents and chemists of cement companies; list of brands of cement companies; list of gypsum companies; list of lime companies; buyers' guide, statistics on output of Portland cement, gypsum and lime.

Notice.—In the review of Martin's "Design and Construction of Steam Turbines," published on page 380 in the issue of *The Canadian Engineer* of February 27th, 1913, we omitted to state that Messrs. Renouf Publishing Company, Montreal, were the Canadian agents for this book. We would like to take this opportunity of notifying our readers of same.

PUBLICATIONS RECEIVED.

Application for Revision of Toronto Building By-law.—55 pages. Apply to City Architect, Toronto, Ont.

Works Administration.—28 pages.—By Gunn, Richards & Company. H. Victor Brayley, C.E., Canadian manager, Ottawa.

Port of Montreal.—177 pages.—Commercial Review, season of 1912. Published by Gazette Printing Company, Montreal.

Mineral Production of Canada.—Preliminary report for calendar year, 1912. By J. McLeish, B.A., Department of Mines, Ottawa.

Five Thousand Facts About Canada.—By Frank Yeigh. 68 pages. Price, 25 cents. Published by Canadian Facts Publishing Company, 588 Huron Street, Toronto.

Fredericton, N.B.—9 x 6 in.; 60 pages. A well-illustrated description of Fredericton and its advantages. Issued by the Publicity Commissioner, Board of Trade, Fredericton, N.B.

Western Canada Irrigation Association.—Report of the sixth annual Convention, held at Kelowna, B.C. 200 pages: 10 x 7 in. Published by the Department of the Interior, Ottawa.

Railway Routes in Alaska.—Transmitting reports of Alaska Railroad Commission. 170 pages, with maps, etc. Document No. 1346. House of Representatives, Washington, D.C.

Columbia River Power Project, near Dallas, Oregon.—By J. H. Lewis, State Engineer, with Technical Report by L. F. Harza and V. H. Reineking; 56 pages. Bulletin No. 3, Office of State Engineer, Salem, Oregon.

Forest Products of Canada.—Bulletin No. 34, on Lumber, Square Timber, Lath and Shingles; 36 pages. Bulletin No. 35, on Poles and Cross-ties; 18 pages. Both by R. G. Lewis, B.Sc.F. Issued by the Department of the Interior, Ottawa.

Pyrites in Canada.—Its occurrence, exploitation, dressing and uses. By A. W. G. Wilson, Chief of the Metal Mines Division, Ottawa. 200 pages, with maps and illustrations. Published by the Department of Mines, Ottawa, Ont.

Data for Use in Designing Culverts and Short-span Bridges.—By Charles H. Moorefield, Highway Engineer, Office of Public Roads; 40 pages. Bulletin No. 45, Office of Public Roads. Issued by the United States Department of Agriculture, Washington, D.C.

Congres Geologique International.—Being second circular issued as regards the International Geological Congress to be held in Canada, 1913. Gives programme and details of arrangements to entertain visitors. Issued by the Secretary, Twelfth International Geological Congress, Victoria Memorial Museum, Ottawa.

CATALOGUES RECEIVED.

Engineering Books.—For 1912. 128 pages. Published by McGraw Hill Book Co., 239 West 39th Street, New York.

The Industrial Building.—Norman A. Hill, supervising engineer and manager. Catalogue of 20 pages of details. Apply 212 Kent Building, Toronto.

Reversible Road Cars for Heavy Freight.—By Buffalo Pitts Company. A handsomely illustrated catalogue 12 x 9 in.; 40 pages. Write Buffalo Pitts Company, Buffalo, N.Y.

Every Man's Encyclopædia.—Twelve volumes of about 640 pages each. Cloth; 7 x 4½ in. Price per volume, cloth, 30 cents; linen-faced cloth, 45 cents; quarter pigskin, 60 cents. J. M. Dent & Sons, Limited, Toronto.

Bridges.—By Ontario Bridge Company. 27 pages; handsomely illustrated with photos, and containing certified letters of work done by different engineers and corporations concerned. Address, main office, Manning Chambers, 72 Queen Street West, Toronto.

Announcement of the Organization of the J. G. White Engineering Corporation and the J. G. White Management Corporation, to assume the functions of J. G. White & Co., Inc. 25 pages of beautifully illustrated and published information. Address, New York.

Chicago Pneumatic Tool Company.—Three catalogues of eight pages each, one being Bulletin No. 129 on Hose, Hose Couplings and Hose Clamp Tools; Bulletin No. 126 on Compression Riveters; Bulletin No. 130, Lubrication of Pneumatic Tools. Canadian offices, the Holden Company, Limited, Montreal, Toronto and Winnipeg.

The Luitwieler System of Water Supply.—Describes the Luitweiler non-pulsating deep well and triplex pumps, hydro-pneumatic system of water supply, elevated tank system, special double service pumps for combination hard and soft water supply, automatic pressure controllers, etc., in an interesting and attractively arranged bulletin. Price lists and full details regarding shipping weight, tank capacities, etc., are appended. A copy of the bulletin will be mailed to any interested person on request. Published by the General Machinery Co., Limited, 22 Mulock Avenue, West Toronto.

SWAN-HUNTER'S BIG SCHEMES.

Presiding at Newcastle, at the annual meeting of Swan, Hunter, Wigham Richardson and Company, the Wallsend shipbuilders, Mr. G. B. Hunter said they were proceeding further in the matter of internal combustion oil engines, and were constructing an interesting vessel to be named "Tynemouth," in which oil would be used to generate power which would be applied to the propelling shaft through electric motors.

COAST TO COAST.

Port Moody, B.C.—The E. J. Dodge Shipping Co., a prominent San Francisco concern, is now in communication with the Vancouver Board of Trade regarding Port Moody's harbor, depth of water and other relative matters with a view to establish the new line of steamships between Port Moody and San Francisco, the cargo coming from the South consisting of cement, and the return fleet bearing large quantities of lumber from the local mills. It is understood that the shipments will be unloaded at Port Moody's newly completed wharf, the only Dominion government wharf on the whole of Burrard Inlet.

Victoria, B.C.—At the present time the forest branch is particularly active in supervising the operation of the railway builders of the 1,890 miles of railway now under construction in British Columbia, every mile of the work now in hand having been gone over during the past few weeks and reports received as to conditions obtaining in the various districts. There are four stages in constructive operations along the railways over which a close supervision is exercised by the forest branch officials. The first is the putting in of the camp and roads. Then comes the stage of right-of-way clearing, followed by that of cutting construction timber and disposing of the slash. In the spring of the year, with the disappearance of the snow, last year's clearings, unless properly attended to at the outset, are likely to constitute a veritable tinder bed.

Washington, D.C.—When the parcels post system had been passed by the legislature the question arose as to the cheapest and most efficient means of delivery of parcels in the big cities. A board of expert engineers was appointed to inspect and report on the many different makes of motor delivery trucks at the recent New York motor show. After a thorough and exhaustive inspection of all the trucks there, they recommended the purchase of Kissel Kar trucks for this purpose, with the result that the United States purchased five Kissel Kar 1,500-pound delivery wagons for the parcels post service of Washington, D.C. These represent the first four wagons of the parcels post service in the United States. If the Kissel Kar reputation is maintained, they are the forerunners of a fleet of Kissel Kars in the service of the United States in all parts of the country.

Regina, Sask.—In view of the fact that there is a great need for additional water supply in the various cities in parts of Southern Saskatchewan, a commission has been appointed for the purpose of investigating the practicability of diverting the water in the Southern Saskatchewan River for domestic and industrial purposes. This commission, which is to be known as the Saskatchewan Water Commission, will be composed of Hon. Senator Ross and A. J. McPherson, chairman of the Highways Commission. The investigation is to be proceeded with as rapidly as possible and consistent with the importance of the project. J. McD. Patton, C.E., who recently resigned the position of superintendent of the city waterworks, is to work in conjunction with the Water Commission, having full charge of the collection of data that is now available in connection with this work.

Victoria, B.C.—Much activity is now going on at Ogden Point, the scene of the new breakwater, which will give Victoria an artificial outer harbor capable of accommodating an enormous fleet of vessels. Heavy blasting is now being done and much rock has been removed by the big charges. The contractors will level the land there down to three feet below the roadbed. As the greater part of that section is rock the work will consume some time. Most of the rock will be used in the filling-in work. The contractors who are building the offices for the Dominion inspectors and engineers, Sir John Jackson's employees and various other offices have almost completed their works and Ogden Point resembles a small settlement. The contractors are greatly favored by having a natural bay close to the Point. The scows are run in at high tide, and as the water recedes they are left high on the sand.

Edmonton, Alta.—Between twenty and thirty elevators will be built, and put into operation by the Alberta Co-Operative Elevator Company, working with government assistance, in time to move the present season's crop.

Toronto, Ont.—The report of Mr. J. F. Whitson, commissioner in charge of the $5,000,000 grant to New Ontario, has been presented to the legislature by Hon. W. H. Hearst. Last year Mr. Whitson spent $208,446 out of the fund and cut or improved 253 miles of road. This year he proposes to spend $1,000,000. Last year the construction was confined entirely to the district of Temiskaming, but work for the current season will be carried out in the districts of Rainy River, Kenora, Thunder Bay, Sudbury, Algoma, and Sault Ste. Marie and Nipissing, as well as an extension of the roads started last year in Temiskaming. Trunk lines are recommended in the Fort William and Port Arthur districts along the lines of the Grand Trunk Pacific and Canadian Pacific Railway, and in the district of Sudbury there will be trunk roads to agricultural and mining sections west and north of the town and north-east through the Wahnapitae Lake district, and a mining road north to the Shining Tree district.

Winnipeg, Man.—The government experiment station at Estevan, for the purpose of demonstrating the commercial possibilities of lignite coal, is now in the initial stages of construction, and it is expected that before many weeks Professor Darling, the leading recognized authority on this mineral in the United States, who has been placed in charge of the investigation by the provincial government, will have proven, through his experimental work, that the extensive coal deposits of the Souris Valley form the most important source of power in the southern portion of the province. The result of the recent exhaustive investigation into this subject, conducted by R. O. Wynne-Roberts, was that lignite coal is now being used extensively in many parts of the world as a fuel and power producer. The matter of installing a gigantic power plant in the near vicinity of Estevan, on the proof of the commercial feasibility of the scheme, is now in the hands of New York financiers, and the money has been found to finance the proposition immediately the tests are completed.

Ottawa, Ont.—That the work of bringing water to Ottawa from the Gatineau Hills will be completed in two years, or in three at the outside, is the statement made by Mayor Ellis. The surveys and preliminary engineering work required for the calling for tenders will be proceeded with at once. Part of this work will be done by the government. The Department of the Interior has never had surveys made of the Gatineau district, though these surveys have to be made sooner or later. Hon. T. W. Crothers, acting Minister of the Interior, stated that the geodetic survey branch of the department will commence its surveys of this district at once. The city is employing a representative of Sir Alexander Binnie & Son's firm, and Mr. J. B. McRae, of Ottawa, to do the required preliminary engineering work, and will also undertake any other survey work which is essential for the proposed water supply, and outside the work of the geodetic survey. It is intended that the geodetic survey should co-operate with those employed by the city. In this way it is expected that the requisite survey and preliminary engineering work will be completed this summer. This becomes possible only through the co-operation of the geodetic survey, so kindly promised by the acting Minister of the Interior. At least a year, and perhaps two, will be gained in this way.

PERSONAL.

MR. J. C. JOHNSTON has been appointed engineer of Port Alberni, B.C.

C. H. TOPP, recently the consulting engineer of Victoria, has been appointed consulting engineer for the municipality of Saanich.

FRANK C. ASKWITH, C.E., who has been acting city engineer since Mr. Ker resigned, has been appointed assistant city engineer of Ottawa.

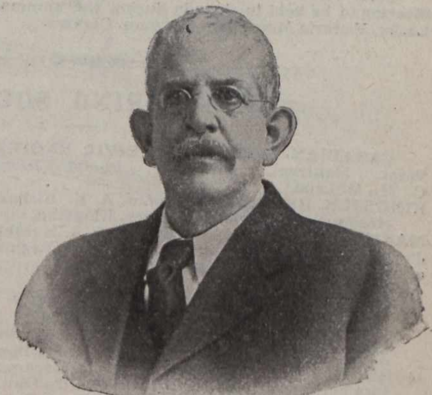
MR. A. W. DOW, Chemical and Consulting Paving Engineer, New York City, on March 11th delivered an illustrated lecture on the "Manufacture of Wood Paving Blocks," before the graduate students in highway engineering at Columbia University.

MR. NELSON P. LEWIS, M.Am.Soc.C.E., Chief Engineer, Board of Estimate and Apportionment, New York City, on March 13th delivered an illustrated lecture on "Methods of Paying for the Construction of Street Pavements," before the Graduate Students in Highway Engineering at Columbia University.

H. F. McDONALD, B.Sc. (McGill), and C. D. BROWN, B.A. Sc. (Queen's), have opened offices at No. 904 Confederation Life Building, Winnipeg, as consulting engineers and land surveyors. H. F. McDonald has for the past three years held the position of townsite surveyor to the Canadian Pacific Railway. C. D. Brown recently resigned the position of right-of-way surveyor to the same company. Both Mr. McDonald and Mr. Brown hold surveyors' commissions for Manitoba, Saskatchewan and Alberta and intend paying particular attention to subdivisions and town planning in the Western provinces.

OBITUARY.

GEO. H. PEDLAR died suddenly at his home in Oshawa while preparing for a business trip to Chicago. Deceased was president and manager of the Pedlar People, Limited, a company he established over 50 years ago, and which through his ability, became a flourishing concern, having at present offices in Toronto, Montreal, Ottawa, London, Chatham, Winnipeg, and Vancouver. He was 70 years of age, and was throughout his busy life actively interested in public and social affairs and a generous giver to all charities.



The Late Geo. H. Pedlar.

CALGARY BRANCH OF THE CANADIAN SOCIETY OF CIVIL ENGINEERS.

At a largely attended meeting of the members of the Canadian Society of Civil Engineers, resident in or near Calgary, held on the evening of the 12th instant, it was resolved to proceed with the organization of a branch in Calgary. Temporary by-laws were adopted, modelled largely on those of the Victoria Branch, and the following officers were appointed to serve until the branch is formally organized, viz.: H. B. Muckleston, chairman; P. M. Sauder, secretary-treasurer; F. H. Peters, A. S. Dawson and E. L. Miles, executive committee. It was decided to secure suitable quarters for a club and reading-room in the near future.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS (TORONTO SECTION).

The fifth regular meeting of the Toronto Section will be held at the Engineers' Club, 96 King Street West, at 8 p.m., on Friday evening, March 28th, 1913. Mr. F. W. Peek, Jr., of the General Electric Company, Schenectady, N.Y., will address the meeting on "High Voltage Engineering." This paper will deal with corona phenomena and insulation problems, as well as transient and voltage control, in connection with long distance high voltage transmission work. No mathematics will be used and the address will be illustrated with stereopticon views.

CANADIAN SOCIETY OF CIVIL ENGINEERS.

The local members of the Canadian Society of Civil Engineers will organize a branch and start a reading and club room in Calgary. The objects of this society are to facilitate the acquirement and interchange of professional knowledge among its members and to encourage original investigation. The membership of the branch will consist of honorary members, members, associate members, juniors, students, and associates of the Canadian Society of Civil Engineers.

COMING MEETINGS.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.—Meeting of the Toronto Section will be held at the Engineers' Club, 96 King St. West, at 8 p.m., Friday, March 28th. Secretary, H. I. Case, 709 Continental Life Bldg., Toronto.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, T. S. Young, 220 King Street W., Toronto.

THE INTERNATIONAL ROADS CONGRESS.—The Third International Roads Congress will be held in London, England, in June, 1913. Secretary, W. Rees Jeffreys, Queen Anne's Chambers, Broadway, Westminster, London, S.W.

THE INTERNATIONAL GEOLOGICAL CONGRESS.—Twelfth Annual Meeting to be held in Canada during the summer of 1913. Secretary, W. S. Lecky, Victoria Memoriam Museum, Ottawa.

ENGINEERING SOCIETIES.

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

KINGSTON BRANCH—Chairman, A. K. Kirkpatrick; Secretary, L. W Gill; Headquarters: School of Mines, Kingston.

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

OTTAWA BRANCH—177 Sparks St. Ottawa. Chairman, R. F. Uniacke, Ottawa; Secretary, H. Victor Brayley, N.T. Ry., Cory Bldg. Meetings at which papers are read, 1st and 3rd Wednesdays of fall and winter months; on other Wednesday nights in month there are informal or business meetings.

QUEBEC BRANCH—Chairman, A. R. Décary; Secretary, A. Amos; meetings held twice a month at room 40, City Hall.

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290.

MUNICIPAL ASSOCIATIONS

ONTARIO MUNICIPAL ASSOCIATION—President, Mayor Lees, Hamilton. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ontario.

SASKATCHEWAN ASSOCIATION OF RURAL MUNICIPALITIES.—President, George Thompson, Indian Head, Sask.; Secy-Treasurer, E. Hingley, Radisson, Sask.

THE ALBERTA L. I. D. ASSOCIATION.—President, Wm Mason, Bon Accord, Alta. Secy-Treasurer, James McNicol, Blackfalds, Alta.

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

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

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. S. MacMillan, Warden, Antigonish, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secy-Treasurer, W. F. Heal, Moose Jaw.

UNION OF BRITISH COLUMBIA MUNICIPALITIES.—President, Mayor Planta, Nanaimo, B.C.; Hon. Secretary-Treasurer, Mr. H. Bose, Surrey Centre, B.C.

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

UNION OF MANITOBA MUNICIPALITIES.—President, Reeve Forke, Pipestone, Man.; Secy-Treasurer, Reeve Cardale, Oak River, Man.

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

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

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

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

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

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, T. S. Young, 220 King Street W., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary, H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

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

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

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

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

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

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

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

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

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, Winnipeg, Man.

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

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, J. N. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S.

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary, H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

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

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

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

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