PAGES

MISSING

Volume 25 Toronto, Dec 11, 1913

Contents of this issue on page 839

The Canadian Engineer

A weekly paper for engineers and engineering-contractors

THE DESIGN OF MEDIUM SIZED COAL GAS PLANTS

THE CONDITIONS GOVERNING THE SELECTION OF GAS PLANT—DESCRIPTION OF DESIGN AND OPERATION OF THE COAL GAS PLANT AT NORTH YAKIMA, WASH.

By **GORDON KRIBS,**
Assistant Chief Engineer, Texas Power and Light Co., Dallas, Texas.

GAS plants for supplying towns and cities with illuminating gas may be divided into three classes according to the type of gas they are designed to manufacture. (1) Coal gas plants; (2) water gas plants, and (3) oil gas plants. In deciding on the type of gas plant to be used in any particular locality, several points should be considered, the main ones being as follows:—

1. Location as to source of fuel and gas-making materials.
2. Cost to manufacture.
3. Physical and chemical properties of gas desired.
4. Market for residuals.
5. Likelihood of competition with natural gas.

Let us examine these points in the order in which they come.

Raw Materials.—The location of the source of fuel supply and other raw material and the cost of getting same to the point where they are to be used has an important bearing on the type of gas plant to be used, as it is of prime importance in figuring the cost of manufacture.

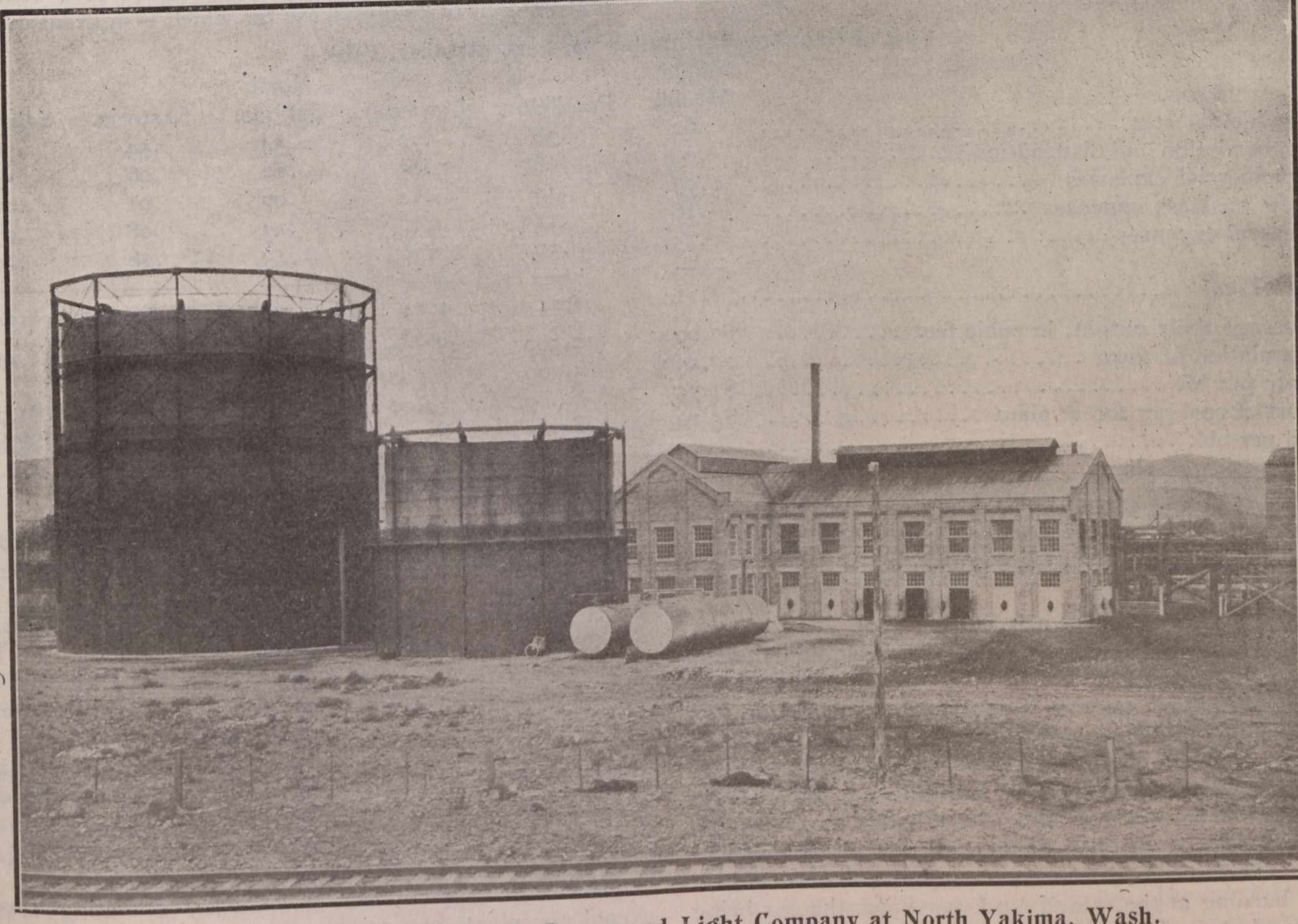


Fig. 1.—Gas Plant of Pacific Power and Light Company at North Yakima, Wash.

For example, at North Yakima, Wash., it was decided to install a coal gas plant for the reason that good gas coal can be procured in the mountains at Rosslyn, about sixty miles away. The haul is short and down grade, and the freight rate low, making the price of raw material correspondingly low. Oil can be had, but as it must come from the California oil fields, the freight rates are high; it has to be transhipped from steamer to cars and the source of supply could not be guaranteed as constant without installing immense storage tanks. Hence, the cost of both oil and water gas would be excessive.

At Portland, Oregon, however, the gas plant installed is of the oil gas type. Oil can be brought from California to the plant in tank steamers and unloaded directly from the steamer into the storage tanks at the plant. Hence oil is comparatively cheap and under the conditions the oil gas type of plant resulted in the lowest cost of manufacture.

At Paris, Texas, however, coke can be procured at a reasonable cost, while oil is also procured at a fair price, and it has been found least expensive to use water gas in the plants in this district than any other. Hence most of the plants in Northern Texas are either water gas or a combination of water and coal gas.

Cost to Manufacture.—The cost to manufacture the various kinds of gas varies in different localities. The following table gives the cost to manufacture coal and oil gas in various localities on the Pacific Coast for October, 1910. These are all medium and small sized plants and, of course, this cost can be somewhat reduced in plants of larger capacity.

it to fall. This also is of very great importance in deciding what type of gas plant will be used. The average heating quality per cu. ft. of various gases is given in the following table:

Pennsylvania natural gas	1,145
Ohio and Indiana natural gas	1,095
Kansas natural gas	1,100
Average coal gas	755
Texas (Petrolia Field) natural gas	630
Average water gas	350
Average bituminous producer gas	155

The presence of injurious and objectionable constituents in the gas is usually entirely the fault of the gas company, as by means of the proper condensing, purifying or reheating apparatus, all objectionable impurities may be removed. Among the more important impurities in crude gas may be mentioned, ammonia, hydrogen-sulphide, carbon-dioxide, carbon-bisulphide, cyanogen, tar, carbon, and naphthalene. The market for residuals has considerable influence on the net cost of manufacture of the gas. Coal gas produces:—

1. Ammonia liquor—and if the plant is large enough to warrant the installation of a still to concentrate the liquor it is a source of considerable revenue.

2. Coal tar—a coal gas plant produces a considerable amount of heavy, dense tar which is in great demand for roofing and as an ingredient in preservative paints and a gas plant can usually dispose of their entire output very readily.

Cost of Gas Manufacture per M. Feet, October, 1910.

Town.	Walla Walla.	Pendleton.	Lewiston.	North Yakima.	*Astoria.	Salem.
Production cost	.62	.38	.70	.54	.54	.70
Transmission and distribution	.09	.08	.05	.12	.06	.35
Commercial expenses	.09	.14	.11	.07	.01	.06
New business expenses	.16	.11	.32	.13	.08	.03
General expenses	.15	.50	.36	.25	.18	.20
Total	1.11	1.21	1.54	1.11	.87	1.34
Average daily output, in cubic feet	82,000	12,500	38,300	24,800	80,000	41,400
Population of town	22,500	5,000	7,000	16,000	10,000	....
Rate per M.	$1.75	$2.00	$2.00	$1.50	$1.75	$1.70
Cost of coal per ton at plant	$5.10	$5.25	$5.10	$3.60	....	$5.89
Oil per bbl.	....	....	....	....	$1.05	....

*Oil gas plants.

Physical and Chemical Properties of Gas Desired.—The principal characteristics of a gas, which are of interest to the consumer, are as follows:—

1. Candle-power.
2. Heat units or B.t.u.'s per cu. ft.
3. Amount of injurious or objectionable constituents in the gas.

The lighting customer is interested, of course, in getting as much light from his burner as possible, and hence in some franchises granted gas companies by the municipality a certain candle-power is stipulated, and to meet this requires care in the manufacture and it may also be a deciding point in the choice of the type of gas plant to be used. The standard for measuring candle-power is a flame burning at the rate of 5 c.f. per hour, the gas being measured at 60 degrees Fahr. and 30″ barometer, or corrected to this. This flame is compared with a standard sperm candle which weighs six to the pound and burns at the rate of from 114 to 126 grains per hour.

The heating customer is much more interested in the number of B.t.u.'s per 1,000 cu. ft. than he is in the candle-power of his gas, and hence franchises are sometimes drawn up stating the limiting heat value of the gas in B.t.u.'s, below which the gas company must not allow

3. Coke—a coal gas plant produces a large amount of coke, the quality, of course, depending on the time that the coal has been in the retorts. The kind of coal used also influences the quality of the coke to a large extent. While some coke can be used in the benches and boilers as fuel, yet only a small proportion can be used up in that way, and the remainder has to be sold or it will accumulate very fast. Usually the breeze and smaller pieces can be used as plant fuel, leaving the best of the coke for sale, and the market is generally very good. It sometimes happens that a company operating several coal gas plants can erect a water gas plant at some convenient point in order to utilize the coke from the coal gas plants.

Water gas produces a very light and watery tar, which is not in such demand as coal tar. It is, however, usually possible to find a market for same, and failing in that it can be sprayed under the boilers and used as fuel, although even then it makes a very indifferent fuel.

Oil gas produces large quantities of lamp black, a finely divided and almost pure carbon. In small plants this may be separated from the plant liquor and dried and used under the boilers. In large plants the carbon may be pressed into briquettes which may be sold as a substitute for coal. The Portland Gas and Coke Company, of Portland, Oregon, handle it this way and find ready sale for all they make. Unless the plant is large, however, it does not pay to do this, as the machinery for handling same is expensive.

All these points regarding residuals should be carefully gone into before deciding on the type of plant to be installed, as they have a marked influence on the net cost of manufacture.

It is the purpose of this paper to consider only the first-mentioned type of plant, namely, the coal gas plant, and in order to facilitate the description of the design and

boiler; the condenser room containing the condenser; tar extractor, etc.; the exhauster room containing the exhausters and compressor, and above the exhauster room is arranged a wash room for the employees, containing toilet, shower baths, bath tub and lockers. The meter house contains the station meter and valves for controlling the operation of the holders. The roof of the retort house consists of steel trusses of the Fink type supporting the roofing material which is of asbestos protected metal. The meter house has a concrete roof. The storage holders are two in number, one being a single lift holding 43,000 cu. ft. capacity and the larger one a double lift of 150,000 cu. ft.

Coal for the plant is brought in by rail and stored in an elevated coal storage bin. From this bin the coal is

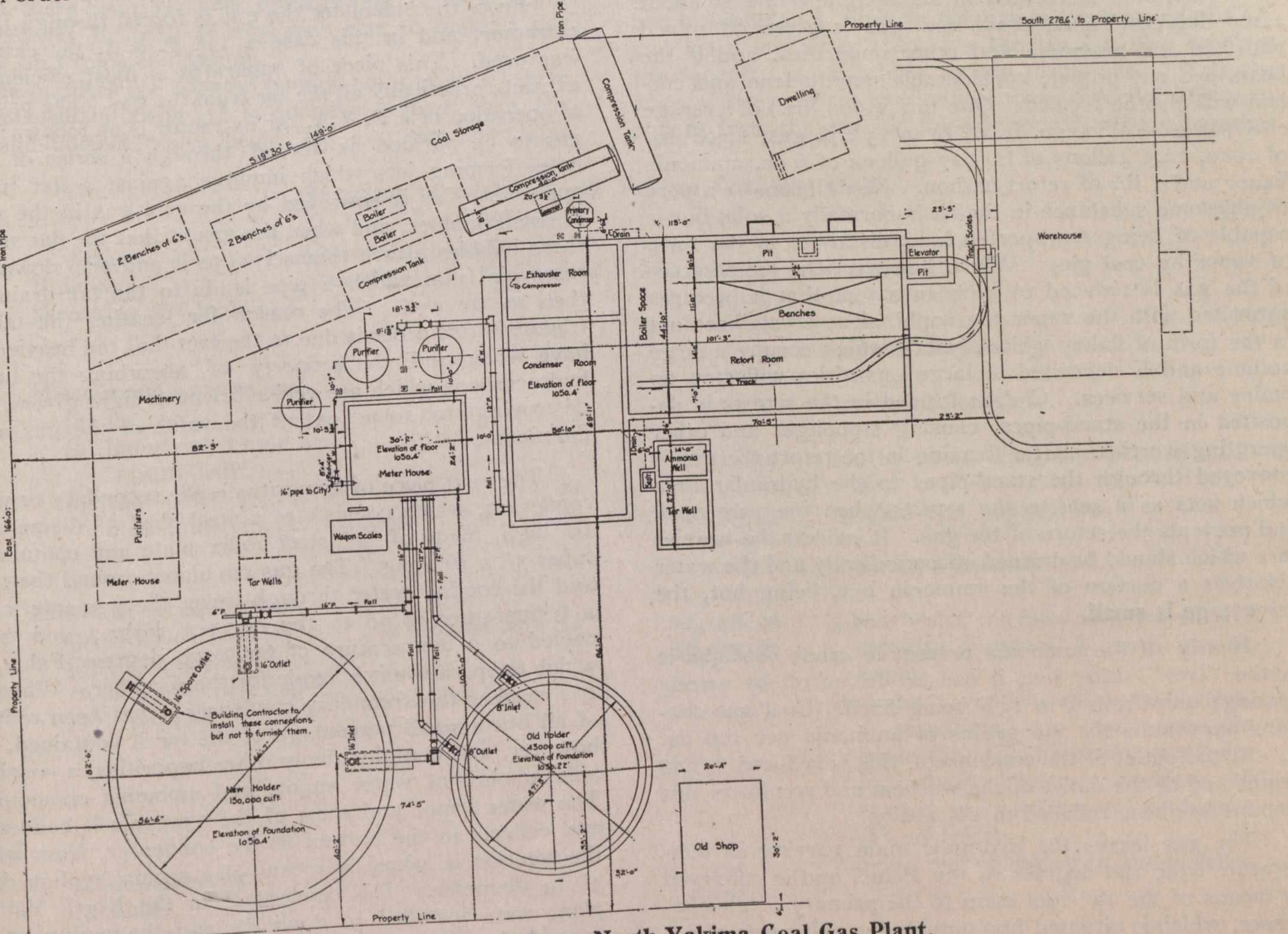


Fig. 2.—General Plan, North Yakima Coal Gas Plant.

operation of a coal gas plant, it is well to select an example, and hence the description which follows applies to the North Yakima plant of the Pacific Power and Light Company, situated in North Yakima, Washington.

In connection with the following description, reference may be had to Figs. 1, 2 and 3. Fig. 1 is a general plan of the coal gas plant, the building in dotted lines being the old plant which was displaced by the new one. Fig. 2 is a detailed layout of the main building, consisting of the retort room, exhauster room and condenser room. Fig. 3 shows elevations and sections of the main building showing type of building used. The buildings are two in number, built of red brick. The larger is the retort house and the smaller the meter house.

The main building is divided into four rooms, namely, the bench or retort house containing the benches and

handled by means of a one-ton car fitted with roller bearings and run on an industrial track of 26-lb. rails, supported on pressed steel ties. The track is so arranged that the car may be run over a track scales and an accurate account is kept of the amount of coal used in the plant. It is then run in front of the benches and the stoker shovels the coal directly from the car into the retorts. There are three benches of 6's manufactured by the La Clede-Christy Company installed at the present time with provision for a fourth. They are of the half depth, rear clinkering, through retort, semi-regenerative type, each bench having 6 retorts 26" x 15" inside by 11 feet long. The coal is shoveled in the front end, and when carbonized, is removed by a special hand-operated coke pusher supplied by Isbell Porter Company, Newark, N.J., and which removes the coke in a few seconds, being much ahead of the old method of hand-raking. The coke is removed by pushing it out the rear end of the retort and falls into steel hoppers in the rear of the benches, where it is quenched with water and dropped into a small industrial car in the pit. This car is similar to coal car, with the exception that it is lined with asbestos. It is elevated to the level of the coke runway by means of a 2-ton platform sidewalk elevator which is motor-driven.

Coke is used in the benches for fuel. About three hundred pounds of coal is charged per retort and is carbonized from twelve to eighteen hours. The capacity of each bench is from 50,000 to 75,000 cu. ft. of gas per day according to the quality of coal used and heats run. The capacity can even be run above this by increasing the heat, but it is detrimental to the life of the retort.

When coal is roasted in an airtight retort at about 1,200 degrees Fahr., crude coal gas is given off mixed with tar and ammonia and other impurities, and if the heats are not proper, considerable naphthalene and carbon will also be formed. One ton (2,000 lbs.) of average coal will give 9,800 cu. ft. of 14 to 15 c.p. gas, 1,300 lbs. of coke, 12.5 gallons of tar, 27 gallons of 6 oz. ammonia liquor and 1 lb. of retort carbon. Naphthalene is a very troublesome substance in that it is normally a solid but is capable of being transported long distances in the form of vapor by coal gas. When, however, the temperature of the gas is reduced to such an extent that it becomes saturated with the vapor the naphthalene crystallizes out in the form of flakey white crystals which occupy a large volume and if deposited in large quantities will stop up mains and services. Carbon formed in the retorts is deposited in the stand-pipes, causing stoppages and other operating worries. After forming in the retort the gas is conveyed through the stand-pipes to the hydraulic main which acts as a seal to the retorts when they are open and prevents the return of the gas. It collects the heavier tars which should be drained off periodically and the water dissolves a portion of the ammonia but, being hot, the percentage is small.

Nearly all the ammonia present in crude coal gas is in the "free" state, i.e., it can be driven off by merely heating; only from 5 to 15% being fixed. Coal gas contains approximately 350 grains of ammonia per 100 cu. ft. At the outlet of the condensers, this is reduced to 250 grains and at the outlet of the washers and scrubbers this amount has been reduced to 1½ grains.

The gas leaves the hydraulic main varying in temperature from 140 degrees to 130 Fahr., and is conveyed by means of the 12″ foul main to the primary or air condenser, which is situated just outside the exhauster room. The gas should be approximately 110 degrees Fahr., in order to be able to extract the tar from it satisfactorily and it is the duty of the primary condenser to reduce the gas to this temperature before it reaches the tar extractor. The primary condenser is 6′ in diameter by 20′ high, made of ¼″ steel shell, has 61 tubes 3″ x 17′ and if fitted with a stack 24″ diameter. by 14′ high, which induces a natural draught through the apparatus, the draft being controlled by means of a stack damper. A portion of the tar and ammonia are deposited in the primary condenser and are drained by means of a suitable drain to the tar and ammonia separator and tar well.

The next piece of apparatus is the exhausters, which are two in number. They are of the P. H. & F. M. Roots type, known as a No. 4, and each have a capacity of 17,700 cu. ft. per hour per 100 revolutions. One exhauster is driven by a 5″ x 7″ vertical engine direct connected while the other is motor-driven, being belted to a 5-h.p. variable speed A.C. motor. The speed of the engine-driven unit is kept proportional to the amount of gas being made by means of an automatic governor. The speed of the motor-driven exhauster is hand-governed. The function of the exhauster is to take the gas from the hydraulic main on top of the benches and force it through the various purifying devices and into the holders against the holder pressure. The only pressure which the gas in the retorts is under is due to the amount of seal of the dip pipes which varies from 1″ to 2″ of water, preferably 1″. By the use of the exhauster the amount of carbon deposit in the retort is lessened; the loss due to leakage is very much less, and the amount of gas obtained from a given quantity of coal greater.

From the exhauster the gas is forced through the tar extractor, and in this case a 12″ P. & A. tar extractor was used. This piece of apparatus is most efficient and extracts practically all the tar from the gas. The principle of operation of a P. & A. tar extractor is as follows: The gas to be purified is forced through a series of small holes forming jets which impinge against a flat surface opposite. Tar is conveyed by the cool gas in the shape of small bubbles, and when the gas strikes the flat surface these bubbles attach themselves to it and drip down to a reservoir from which a pipe leads to the tar drain and then to tar well. The reason for locating the tar extractor in this order is due to the fact that the heavier tars have when cold, the property of absorbing the lighter hydrocarbons which are very efficient as light givers, thus destroying to some extent the value of the gas as an illuminant.

The next piece of apparatus is the secondary or water condenser, which consists of a steel shell 5″ diameter by 19′ high, made of ¼″ steel boiler plate and contains 61 tubes 3″ x 16′ long. The gas circulates around the tubes and the cooling water through them, the gas entering at a temperature of 90 to 100 degrees Fahr., and being cooled to a temperature of 60 to 70 degrees Fahr., at which temperature it is ready for the scrubber. When the gas reaches the secondary condenser it has been relieved of all but a small percentage of the tar it contained. It, however, still contains many other impurities, a considerable amount of water vapor, and ammonia compounds. The water vapor and some of the ammonia is condensed and collects in the bottom of the condenser, from which the solution is taken by means of a special syphon drain 3″ in diameter. The condensers in the North Yakima plant were installed in duplicate and the piping so arranged that either of the condensers could be used at a time or both in parallel. It should be noted that cooling the gas too quickly is very detrimental, as it reduces the candle-power by condensing some of the most effective light-giving hydrocarbons.

The gas next passes on to the scrubbers which, in the case of the plant described, consisted of two units arranged so as to be used singly or in parallel, each 6′ diameter by 19′ high with 10″ inlet and outlet nozzles and five 13″ x 18″ manholes. The inside of the shell is filled with wooden trays composed of small slats of wood, over which a small stream of water is kept flowing, just enough water being admitted to keep the slats wet. The gas is admitted at the bottom of the shell and in passing up between the slats is broken up into small streams coming into intimate contact with the water passing down. The cold water meeting the gas previously cooled in the secondary condenser readily absorbs the ammonia remaining in the gas. It also absorbs and combines with a portion of the CO_2, which is very desirable, as one volume of this gas in 100 of illuminating gas will reduce the candle-power 5%. The liquor is collected in the bottom of the scrubber and is drained off by means of a special syphon connection which seals the apparatus and prevents the escape of the gas, at the same time allowing the liquor to escape. The liquor flowing from the condenser and scrubber is conveyed by means of a 3″ main to the tar and liquor separator. The gas then passes out of the condenser by means of a 12″ main and on to the purifiers, which are located just outside the condenser room.

It will be noted that the exhausters are in a room by themselves as are also the condensers and scrubbers, and these can only be reached from the retort room by going outside, there being no inner passageway. This arrangement reduces the risk of explosion due to leaking gas making an explosive mixture.

The purifiers are situated outside and consist of three steel boiler-plate boxes 11″ in diameter and 12′ high, the sides and bottom plates being ¼″ and the top plates 3/16″. Each box is equipped with two layers of oxide trays and a ½-ton duplex chain hoist for lifting cover. They are interconnected by means of valves and piping so that as flexible arrangement as possible was secured. The boxes were arranged so that the direction of the flow could be reversed in all the boxes and any two could be placed in series or any two in parallel with the third in series. The advantage of reversing the flow lies in the fact that when one side of the bed of oxide becomes clogged the other side may be used, thus extending the periods between revivifying. The oxide used in this particular case was made up by the following formula, and gave good satisfaction: 6 bbls. pine shavings, ½ bbl. lime, ½ bbl. copperas.

The principal impurities in the gas when it leaves the scrubbers are hydrogen sulphide, carbon dioxide and carbon bisulphide. Lime is very active in the removal of CO_2 and H_2S and after absorbing the H_2S it also requires the property of absorbing carbon bisulphide. It is the office of the purifiers to eliminate these objectionable compounds from the gas and the efficiency depends altogether

Summary of Costs—North Yakima Coal Gas Plant.

No.	Article.	Quantity.	—Unit— Used.	Cost.	Total.	Remarks.
I.	Buildings	204,755	C.F.	.10¼	$21,023.75	Grand total $21,959.72
II.	Wrecking old buildings.				935.97	On contract
						Total, $23,306.23
III.	Miscellaneous structures:					
	(a) Tar well				746.11	3,300 C.F. capacity.
	(b) Industrial track (installed)				923.59	860 ft. 20-lb. track and pressed steel ties.
	(c) Gas holder ...... (installed)	150,000	C.F.	.14 7.00	21,636.53	150,000 C.F. 305,166 lbs.
						Total, $37,600.86
IV.	Machinery & equipment:					
	(a) Benches (erected)	4 benches		2787.12	11,148.50	3 benches of 6's filled and one empty, capacity 60,000 C.F. each per 24 hours.
	(b) Gas machinery ... 1. Gas treating apparatus				20,145.77	Includes 2 condensers, 2 exhausters, 2 scrubbers, tar and ammonia separator. Works piping, yard piping, station meter, 2 purifiers, all erected on purchasers foundations (by contract).
	2. Compressors				344.17	Moving and changing to motor-drive.
	3. Boiler, 75 h.p.....				1,314.16	
	4. Boiler piping—exhaust head, etc.				101.35	4″ Burt exhaust head and piping.
	5. Coke pusker				1,083.40	Hand-operated discharge machine, including runway.
	6. Coke quenching chutes				1,264.08	8 McDonald & Mann coke-quenching chutes and motor-operated sump pump.
	7. Coke elevator				1,371.19	Two-ton motor-operated sidewalk elevator.
	8. Coke and coal cars	4	cars	$143.60	574.40	
	9. Miscellaneous ...				341.74	Includes labor moving compression tanks, cost of 3 ton track scales, etc.
V.	Overhead charges	14.5%			11,997.03	Includes 10% engineering fee, interest during construction, storeroom expense, superintendence, timekeeping, etc.
	Total.................... ..				$94,951.74	Daily capacity 180,000 C.F. or 52c. per C.F. daily generating Capacity.

on the size of the purifiers, and the condition of the oxide. After the oxide has been used for some time, it loses its efficiency as an oxidizer and is revivified by being removed and spread out in a thin layer on a flat surface and exposed to the air, being turned over repeatedly so as to expose every part of it. When thoroughly revivified it is ready for use again. A large concrete slab is usually provided for treating the oxide. A small shed is also provided for an oxide storage.

From the purifiers the gas passes into the storage holders, which in this case are two in number, the old holder of 43,000 cu. ft. and one new one of 150,000 cu. ft. capacity, having a total weight of 305,166 pounds. The small holder is a single lift type with a steel containing tank, while the new holder is of the double lift type. Each holder is supplied with drip pots to collect tar and gas liquor, the C.I. mains being laid so as to drain towards the holders. All gas house piping is of cast iron, mostly bell and spigot leaded. All fittings are standard gas fittings, reducers being eccentric and all mains being laid so as to convey gas liquor and tar to some point where it can be readily removed to a drip pot or seal. All elbows are provided with hand holes in order that the pipes may be rodded in case they become clogged. Tees are used in the piping instead of ells for the same reason and the tar drains are made as straight and short as possible, allowing as much fall as convenient under the conditions. In passing from the holder on its way to the distributing system the gas is made to flow through the station meter. This meter is of the wet type, 72″ x 72″, and is supplied with a Hinnman drum. The capacity of the meter is 500,000 cu. ft. per day with a loss of 1″ pressure. The inlet and outlet pipes are 10″ and the meter is furnished with a by-pass in order that it may be taken out of commission without seriously interfering with the delivery of gas.

The system of distribution used in North Yakima is known as the high pressure system. The gas is drawn from the holders through the station meter and compressed into two compression tanks 8′ 2″ x 10′ to 40 lbs. pressure by means of an Ingersoll Rand 9″ x 11″ steam-driven compressor running at 160 r.p.m. A 2″ high-pressure main conveys the gas to the centres of distribution in the city where district regulators reduce it to the standard 3″ pressure for commercial use.

A 75-h.p. boiler supplies this compressor as well as the gas exhauster with steam. The boiler also supplies hot water to the holder cup in winter, so as to prevent freezing, and is also used to heat the building during the cold weather and supply hot water to the men's wash-room.

A table showing the cost of the above plant is shown on the previous page.

It is announced from Zanzibar, East Africa, that the building of the railway through German East Africa is going ahead successfully, and if the hopes of the promoters are realized, will be opened for public traffic early in 1914. The line has been completed to within 210 miles west of Tabota, whilst the earthworks has been carried to within 30 miles of Ujiji. No native is allowed to leave the Belgian Congo or German East Africa without special permission, and the regulations which govern them are strictly enforced. Even the Governor is not allowed to grant this permission without a contract from the recruiters of native labor that the men shall be returned to their own country at the expiration of the contract.

SOME TESTS OF CAKED CEMENT.

The following tests of eight samples of caked cement were made at the Kansas City Testing Laboratory, Kansas City, Mo. The object of the tests was to determine the effect of caking on the tensile strength of cement. The tests were made on neat cement and on 1:3 briquettes. The results of the tests are given in Table I.

Table I.—Results of Tests of Briquettes Made From Caked Cement.

	Neat cement			1 cem.:	3 sand.
Ref No.	24 hrs.	7 days.	28 days.	7 days.	28 days.
1	259	691	811	250	317
2	304	778	861	242	391
3	215	646	807	318	404
4	185	545	708	165	265
5	203	510	703	255	325
6	135	643	865	335	443
7	115	505	698	190	304
8	190	650	822	230	390

The breaking strengths in pounds per square inch at various ages are given in the table. Some of the cement used was badly caked. This is especially true of specimen No. 4, as this cement had been stored in an old basement against a porous sandstone wall.

Although these tests show a wide variation, most of them developed sufficient strength to pass standard specifications. They do not show as definite an increase of strength as should be given by fresh cement, but this may in part be due to the lumps not being uniformly pulverized. In reporting these tests it was stated that "while it is safe to use caked cement, it must be observed that unless the cement is again perfectly powdered, any remaining lumps of cement will not have any bonding effect, and more cement in sufficient quantities must be used to compensate for any undisintegrated lumps that may remain."

When practically all of the cement was imported from Europe, it was not uncommon to find that the cement in some of the barrels was sufficiently hardened to remain in position after the staves were knocked off. In such cases the cement was not rejected, but was powdered and used with satisfactory results. It is known by testers of cement that Portland cement which has caked and has then been powdered and used does not set so rapidly nor does it acquire its maximum strength so quickly as does cement which has never caked; yet testers have found that the strength of such material is practically unimpaired and that it will pass the requirements of specifications. Of course, the safe thing to do is to use only fresh cement, but to reject all cement which contains lumps may result in a very considerable loss. If cement which contains some lumps is used, care should be taken to thoroughly pulverize the lumps before using it.

Mr. H. C. Cooke, of the Geological Survey of Canada, has completed researches on Vancouver Island, and asserts that as a result of his investigations, which have been carried on since May of this year, he is able to state authoritatively that there are great prospects of copper development in certain sections, notably in the vicinity of Sooke and also of Ladysmith. It is anticipated that his report, while pregnant with valuable geological data, will attach particular significance to the copper-bearing regions of the Island he has come in contact with.

PAINTING STRUCTURAL STEEL.

A PAPER to be presented to the American Society of Civil Engineers on January 7th next by A. H. Sabin, A. M. Am. Soc. C.E., outlines the situation as it obtains at present in the painting of structural steel. The corrosion of structural metal by atmospheric and other natural causes is a subject which has long been of importance to the engineer. A few years ago, the greatly increased use of concrete structures aroused the hope that danger from such corrosion would be much reduced; but unarmored steel seems to be used as much as ever. Concrete has not taken its place, but has made an entirely distinct place for itself. Much has been written, and much has been done, relative to the protection of steel; but improvement has been slow, progress being made step by step.

Some years ago, Mr. G. W. Thompson attempted to classify pigments, as to their relation with iron, by suspending them in water and immersing pieces of iron or steel in these mixtures. The results were somewhat surprising; some of the pigments which common experience approved, seemed to increase corrosion in this condition, and others, known to be useless in protective paints, seemed to be much better for preventing it. Lampblack, for instance, was the worst in provoking corrosion, and white zinc or pulverized chalk prevented it. This was probably due to the fact that lampblack contains, condensed on the surface of its particles, considerable carbonic acid, which is the most generally active agent in the corrosion of iron, and white zinc and chalk are basic substances by which iron is not rusted; however, the carbonic acid in lampblack is displaced by grinding in oil, and the well-known lack of durability in paints made of white zinc and chalk prevents their good qualities from coming into action.

So great is the need of more knowledge as to the value of pigments in paints, and their mode of action, that nothing promising new information is neglected. A committee of five chemists from different parts of the United States, with the approval of the Society for Testing Materials, made a series of tests of the principal pigments, and of some other substances, on steel immersed in water; and, as was to be expected, arrived at substantially concordant results. These results, as has been stated, were of no value from the standpoint of the paint-maker, being inconsistent with the known value of the pigments when ground in oil or varnish. When the report was published, however, the pigments were classified, according to their water value, into three groups, namely, inhibitors, indeterminates, and stimulators. This was the origin of the use of these now well-known words in paint terminology. It was expressly stated in the report that this was a classification as regards water only; but the names were so convenient and so tempting that those not familiar with the subject and also many who saw their value for advertising purposes (two quite distinct classes), put them into common use to classify pigments in oil. It is obvious that any classification of pigments in oil should be based on their behavior in oil, and if, as must be conceded, this is radically different from water tests, the latter should not be regarded. All this investigation began some years ago; meanwhile numerous young men, mostly students working under the supervision of their teachers, have made brief and generally inconclusive studies of paints, and almost without exception have used these indefinite terms, inhibitors and stimulators. Patents have even been taken out—which, in the writer's opinion, are not only worthless but invalid—covering the use of old and well-known pigments. What is worse, every maker of a paint nostrum assures his hearers or readers that his particular paint absolutely inhibits rust, and that everything else stimulates it. This is the whole history of this jargon about inhibition and stimulation; it never had any particular value to the consumer, and it is generally used to mislead him.

It is obvious that in a good paint the pigment particles are enveloped in a film of oil; they do not come in contact with the iron; if they did, the paint would peel off, for no dry pigment adheres well to metal. It is as true to-day as it has been in the past that steel rusts because air and moisture act on it; and paints are used to keep air and moisture from it. They do not inhibit rusting, except as they inhibit the cause of it.

The important practical question is whether paints have been or can be improved as to being non-porous and durable. This is essentially dependent on the relation between the pigment and the oil. As to the true nature of this relation, very little is known; but something is known about its visible manifestations. It is known, for instance, that 1 lb. of dry red lead mixed with ¼ lb. of oil makes a paint of ordinary consistency, and 1 lb. of dry lampblack requires at least 6 or 8 lbs. of oil, say, thirty times as much, or making allowance for difference in density, six times as much, as the red lead. Similarly, 1 lb. of white zinc takes twice as much oil to make a paint as 1 lb. of white lead; and white lead takes nearly twice as much as red lead. These are things we know; but we have no idea why they are so. Again, red lead, which is an oxide of lead, makes an excellent paint for iron; oxide of iron is neither very good nor very bad; oxide of manganese is bad. Our knowledge of paints is as yet largely empirical; chemists dislike to admit this, for like everybody else, they hate to confess that there is anything they do not know, and thus when a new theory is offered some of them make a great rejoicing over it without first finding out whether or not it agrees with the facts. Where we are gaining is in more general appreciation of the value of the proper application of paint, better preparation of surface, more confidence in good paint rightly used, and in the better preparation of paint materials. For instance, in the older books, and until about twenty years ago, we find analyses of red lead showing as low as 55 per cent. of true red lead, with 45 per cent. of litharge. Red lead is made from litharge, and the presence of the latter is not a sign of adulteration, but of incomplete conversion. At the same time other samples showed as high as 80 per cent. of true red lead. As is well known, there was much difference of opinion in those days as to the value of red lead as a paint for iron; though most users liked it, some thought it poor stuff. It is now known that its value depends on the quantity of red lead it contains. Coarse red lead always contains litharge, because the litharge in the middle of a large particle is never oxidized. It was observed that the finer the red lead, the better it was, and so a demand arose which forced the manufacturers to make higher grades; now they are grinding their litharge to an impalpable powder before roasting it, with the result that 94 per cent. of true red lead has been on the market for some years. Then an unexpected fact was developed. The old red lead when mixed with oil would set in a day or so—often in a few hours—into a cement; just like plaster of Paris and water; this tendency made it work with difficulty and unevenly in application and its coarseness gave it a tendency to run; but the new, or high-grade, article is inactive to oil, and brushes out smoothly like a house-paint. This enables the painter to cover 50 per cent. more surface with the same quantity and still get a coating having a uniform thickness which gives more protection than the thin portions of the paint formerly used. This secures greater economy, even at a slightly greater cost per gallon; and this is an economy not only in the cost of the paint, but in the labor, because the paint works more easily, and a man can cover more surface in a day; it also requires less skill, and, therefore, a less highly paid man, to do good work. For the last year or two, red lead ground in pure linseed oil has been offered to the trade as a paste ready to be thinned with more oil; such a paste keeps for a year or more, or indefinitely as far as known, like white lead paste. Its use saves time and waste in mixing, and, being ground through a mill, the mixture is perfect, which is not the case with hand-mixing; and, as it avoids the presence of a dusty pigment, it is more sanitary.

The only serious objection to the use of such red lead is that it dries more slowly than the older kinds. This can be obviated, however, by the use of a little japan drier. There is a well-founded prejudice against the use of excessive quantities of drier in any paint; but it should be remembered that red lead paint mixed in the (standard) proportion of 28 lbs. of pigment to gal. of oil, contains 20¼ lbs. of pigment per gallon of mixed paint. If this pigment contains 15 per cent. of litharge, it has 3 lbs. of litharge per gallon. Now, ordinary, good lead japan driers, or lead and manganese driers of approved quality, contain the equivalent of 1 lb. of litharge in about 3 gals. of drier; and 3 lbs. of litharge will make 8 or 10 gals. of drier. To make 1 gal. of mixed 94 per cent. red lead paint dry requires only 1 pint of drier; the rest is excess. It is much safer to add the desired quantity of drier. It may be asked why the litharge in the 94 per cent. red lead is not more active; it is probably because, when the peroxidation of the lead has been carried so nearly to completion, the particles of litharge are enveloped so completely by a dense coating of true red lead that the oil does not reach them. This is obviously not the case with the commoner and less thoroughly oxidized pigment.

It has sometimes been suggested, by those not very familiar with the chemical questions involved, that the litharge is the essentially valuable part of the paint, and that the red lead is only an inert extender. This is not so. The whole history of the subject shows that the improvement in red lead for paint during the last twenty-five years has been made by reducing the litharge contained in it; litharge alone, or used with other pigments, has not been satisfactory, though orange mineral, which is red lead free from litharge, is most excellent, and would be used if its cost were not so great. Further progress will undoubtedly produce red lead with a lower percentage of the protoxide; in fact, the 94 per cent. red lead now in the market usually contains much more than 94 per cent. of true red lead.

Progress has also been made in our knowledge of linseed oil. Within a few months, the American Society for Testing Materials has adopted specifications for North American raw linseed oil, which is of better quality than that made from South American seed. These specifications are the result of a great deal of work by many of the best oil chemists, and it is now possible for any good analyst to tell whether or not an oil is pure and good. Methods of paint analysis are in general being standardized; and a vast amount of work is going on in Germany and England, as well as in the United States, on the chemistry and nature of drying oils. At present, linseed oil has adulterants, but no substitute; China wood oil is a valuable drying oil, more valuable for some purposes than any other, but, as an oil for ordinary paints, it is used, as far as the writer knows, only to cover up the use of non-drying oils, which must be regarded as adulterants. At present prices, it is not likely to be used even in this way. Fish oil is used to some extent, as it always has been, in paint for roofs and smokestacks; but one should not be disturbed by talk about the "newer paint oils," for, except China wood oil, there are none.

In closing, Mr. Sabin mentions that the committee appointed by the American Society for Testing Materials has made a final report on the condition of the paints on the Havre de Grace Bridge; as is well known, this bridge was painted six years ago by a committee of that Society, which committee included several members of the American Society of Civil Engineers. This report describes three of the paints as excellent; two of these were straight red lead in oil, and the third was red lead, with about 15 per cent. of a pulverized silicate added, in oil, the red lead being about 98 per cent. true red lead. Nine other paints, of varying composition are reported as affording generally effective protection to the structure. As all these paints were carefully applied, it is fair to conclude that the durability of any good paint may be increased one-half, and probably doubled, by proper care in its use as compared with average practice. It is only by continually reiterating this fact that we shall ever secure the most elementary and fundamental requirement for the economical treatment of structural steel.

PRESERVATION OF WOODEN WATER PIPE.

Since the durability of wooden pipe depends entirely upon its continuous and perfect saturation with water, it follows that the pipe should be thin enough to insure penetration of the water through its pores at a more rapid rate than the loss of water by evaporation from its surface.

The porosity of timber differs to such an extent that a proper thickness of shell of a red cedar pipe, for example, is too great a thickness for Washington fir. Obviously a thickness that is proper for a pressure of 40 pounds per square inch is too great for a pressure of 10 pounds per square inch.

This curious condition of fairly well-recognized facts is pointed out by Engineering and Contracting, which says further that these are fairly well recognized facts, but not until comparatively recently have engineers begun to consider the external conditions that affect the life of the wooden pipe. Enough instances of long life of wooden pipe buried in clay are on record to establish the fact that clay is an admirable preservative.

The reasons for this are probably twofold:—Clay holds moisture and thus insure continuous and thorough saturation of the wood at the surface of the pipe; and moist clay is not a good culture bed for the growth of fungus that causes rot.

In view of the preservative quality of clay, it is asked would it not be good engineering to encase wooden pipe with clay several inches thick? Where the clay is within comparatively easy reach, and particularly where the trench is in soil that is either very porous or contains much vegetable humus, it would seem that a clay jacket around wooden pipe would prove economic. A concrete jacket might serve a similar purpose, but ordinarily at a greater cost than clay.

The lock-gates and sills of the Panama Canal are all made from "Greenheart," a large tree found in the dense jungles of northern South America, especially British Guiana. The wood will bear, without crushing a weight of six tons to the square inch, and will remain sound 100 years under water, being immune to the attacks of the salt water teredo.

TRANSMISSION LINE WORK.

By Ernest V. Pannell, A.M.E.E.,
Chief Engineer, The British Aluminium Company, Limited, Toronto.

DEVELOPMENTS in transmission line practice during recent years have insistently sounded the keynote of reliability. With increase in operating pressures from 40 and 60 up to 130 and 150 kilovolts it has been realized that the weakest part of any power system is the transmission line and practice has shown the weakest link in the transmission line to be the insulators. Notwithstanding the relative perfection to which insulator design and construction have been brought it has still to be accepted as an axiom that the fewer the insulators the less will be the risk of breakdown. This aluminium line an every-day engineering proposition. It is granted that the sag will be greater with aluminium than copper and that the towers will, as a rule, be more costly. Aluminium is, however, in most countries and under usual market conditions, so much cheaper than copper that the credit balance more than pays for the extra high structures. The relative economy effected by the use of aluminium is, however, powerfully influenced by the conditions under which the line is put up. Under what may be called northern conditions, figuring with ½" ice and a wind velocity of 65 miles per hour, the sags will be much greater and towers more costly than where the line is being laid out in California or Mexico where no ice or snow have to be allowed for. It is proposed in this article to discuss only northern conditions, so that any conclusions which tend to be unfavorable to the light metal may be reversed with a change in latitude. The

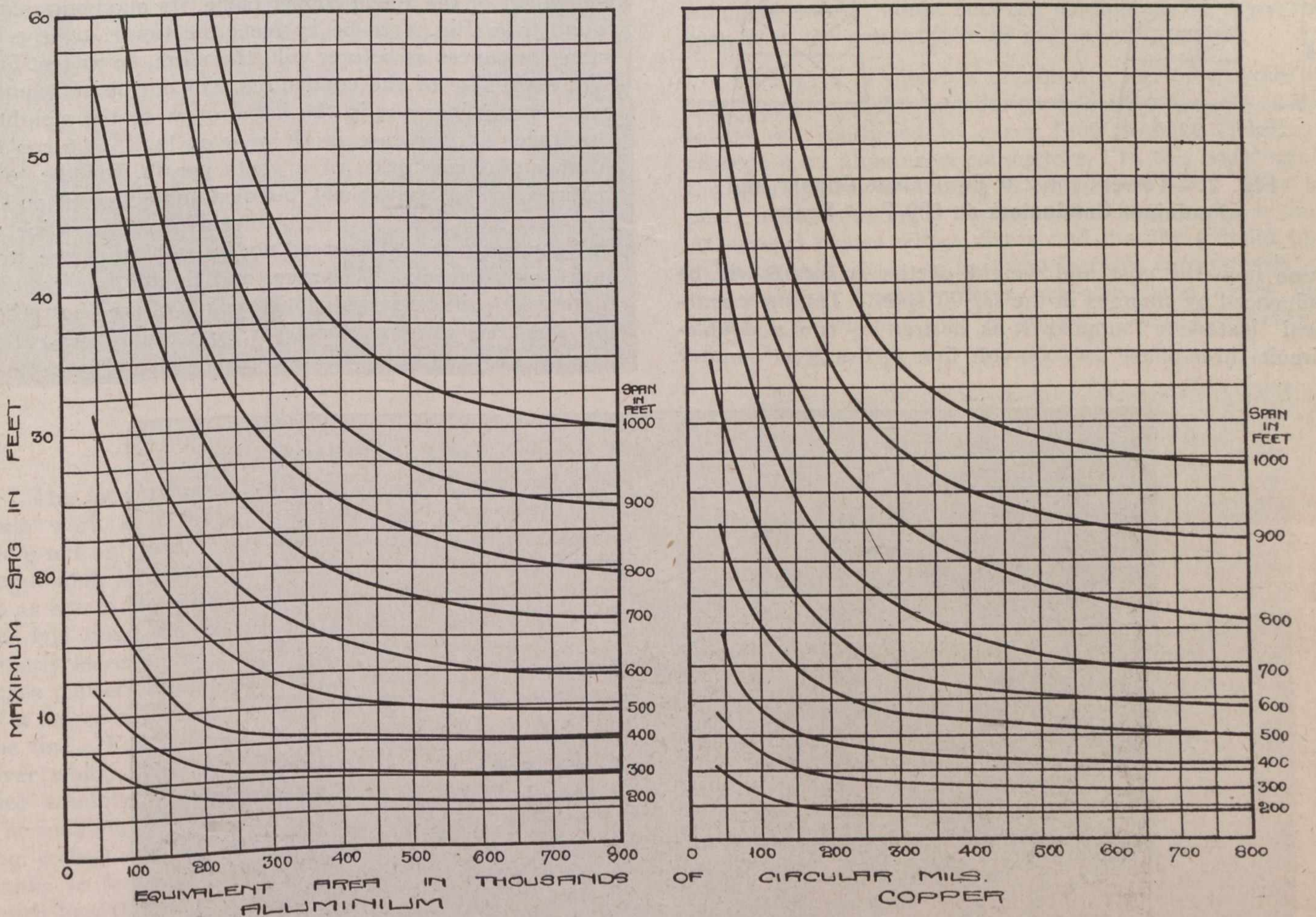


Fig. 1 (a and b).—Maximum Summer Sag on Aluminium and Copper Stranded Overhead Wires for Various Lengths of Span.

has been the chief factor urging the adoption of long spans in transmission line work and the long span has called forth the very best properties of conductor material in general; moreover, it has brought into the field the reinforced conductor by which is understood a wire or cable in which the tension is carried mainly by a core of high tenacity steel wire.

When aluminium was first used for transmission purposes the opponents of this material asserted that a metal of such relatively poor physical properties would be useful on the very shortest pole-spacings only. Improved manufacturing methods and better understanding of the laws of sag and tension have assisted to make the long-span

maximum vertical summer sags on equivalent sizes of copper and aluminium conductors are shown by the curves in Fig. 1. The constants on which these curves were calculated are as follows:—

	Aluminium.	Copper.
Tensile strength, lbs. per sq. in.	28,000	60,000
Yield-point, per cent.	75	60
Working stress	14,000	30,000
Per cent. extension per deg. F...	.00130	.00093
Modulus of elasticity	9,000,000	12,000,000

The design of transmission line towers is at the present stage of development a somewhat complex subject, as there is no recognized standard for the type to be employed, tests to be fulfilled, weight of sections, etc. The weights and cost of towers of different types for precisely the same class of service vary enormously. It is possible, however, given a properly worked out design, to deter-

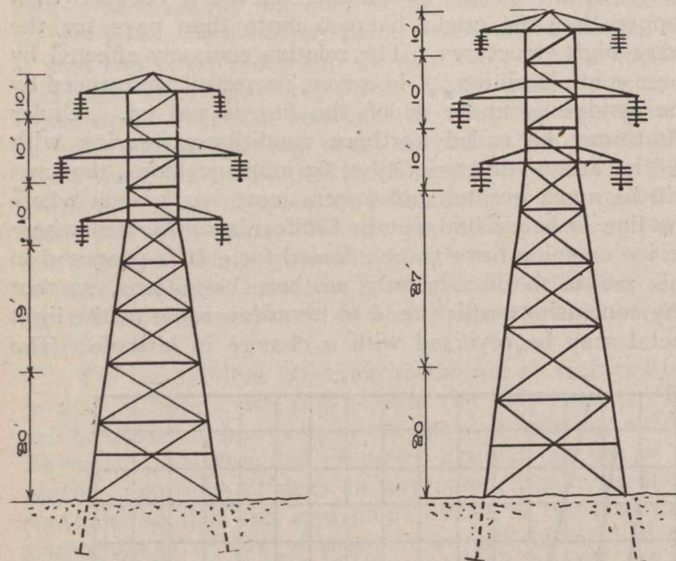


Fig. 2.—Towers for 2/0 Equivalent Copper and Aluminium Conductors on 600-Foot Spans.

mine how the cost and weight of the structure will be influenced by changes in the sag or span. Taking a practical instance: suppose it is desired to run a double-circuit three-phase 100,000-volt line across level country found from Fig. 1 to be 19 feet. As is seen, the total height of the tower from the ground up will be 69 feet and its weight, including the extension angle footings, will be 5,000 lbs. This would function as a dead-end or corner tower, as it would be capable of carrying tests of greater severity than those usually specified for suspension towers. Now, any change in the height of the tower will increase the moments and stresses coming upon the main members, so that the weight will be increased once due to the greater height and once again because all the sections will have to be thicker to give them the necessary stiffness. In short, the tower weight will vary as the square of the height. Expressed in symbols, $W = mH^2$ where W is the weight in lbs., H, the height in feet and m is a constant depending upon the number and size of the wires and whether a suspension or dead-end tower, for the present instance m has the value of 1.05. Considering now the aluminium equivalent of the above copper cable, its maximum sag is found from Fig. 1 to be 27 feet; the tower, to give the same clearances as before, will, therefore, be 77 feet high. The extra size of the conductors will not be sufficient to call for any increase in the value of m so the weight of the tower in this case is $W = 1.05\ (77)^2 = 6{,}200$ lbs. Allowing a base price of 4 cents per lb. for the tower sections drilled, galvanized, bundled and delivered on site, the extra cost on the towers for the aluminium line will be $420 per mile. This need not be so high as the structures are unnecessarily heavy, and lighter towers might quite well be interspersed along the run of the line. Allowing this item to stand, however, and taking present-day average bases of 18 cents for copper wire and 25 cents for

Fig. 3.

with 600-foot spans and copper conductors, size 2/0, B. & S. The type of tower assumed is shown in Fig. 2(*a*) and its height is determined by allowing the usual clearances and adding the amount of the maximum sag, aluminium, however, the use of the latter will save $730 per mile, so that on this particular size of conductor there is a broad margin in favor of aluminum after allowing for the more costly tower line.

A point which has to be considered where a tower or pole line has to support conductors of very large area is that the tension along the line is likely to be very much more than the wind pressure acting laterally on the wires. In other words, the severest strain which may be put upon the tower is not that of a gale of wind blowing sideways on to the line, but the effect of two or more conductors breaking in the same span. Under these conditions the towers for an aluminium line frequently figure out lighter and cheaper than those for use with copper, owing to the fact that the maximum tension in the former case is about 25% lower than in the latter.

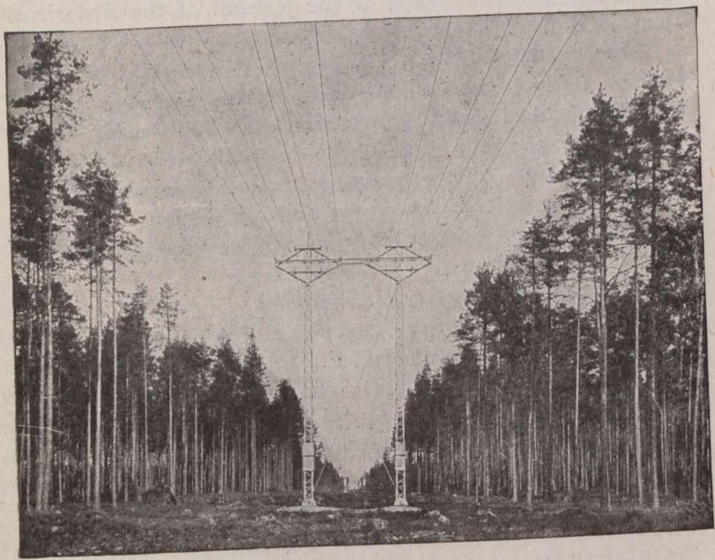


Fig. 4.

The most difficult problems in connection with long-span work are those associated with river crossings. Here not only has a long distance between supports to be negotiated, but the clearance has usually to be extra high so as not to impede navigation and frequently restrictions are laid upon the maximum stress in the wires which greatly increase the complexity of the problem. In most cases matters are considerably simplified by the adoption of a larger size of conductor than that used on the run of the line. For instance, take a 1,000-foot span across a river which is to be crossed by 6 aluminium cables, the size employed along the line being 200,000 cir. mils. The maximum sag on this size will be 65 feet and, allowing 50-foot clearance above the navigation channel with banks 10 feet high, the height of the towers will not be much less than 120 feet. If, however, the cables be increased to 300,000 c.m., the sag will be reduced to 45 feet and the towers consequently to 100 feet. Needless to say, this diminution would be well worth while. Considerably larger sizes of aluminium cable are in use on long spans, the Southern Pacific Railroad having four 2,000,000 c.m. stranded aluminium cables spanning 1,300 feet across a branch of Oakland Harbor. In this case, as in the original spans across the Niagara Gorge, the cables are dead-ended at one end and run over pulleys and weighted at the other so that the tension is constant whatever the weather conditions. On the Southern Power Company's lines in North Carolina 2/0 aluminium conductors are run with 1,500-foot spans with sags very little greater than on the parallel copper wires. Of course, in this latitude no ice or snow are encountered and sags may be correspondingly short.

The illustration (Fig. 3) shows a view on a very remarkable transmission line in Norway. Twenty 3-phase circuits of 600,000 circular mil aluminium cables convey 170,000 kva. along a steep mountain-side. The spans average 700 feet in length and the district is a stormy one, considerable sleet and severe winds having to be reckoned with. Before installing the line the then chief engineer, Dr. F. W. Marguerre, made a number of experiments in order to try out thoroughly the rival merits of copper and aluminium line wires. All things considered, it was found that the light metal offered the most important advantages in this instance. Aluminium wire having the relatively low tenacity of 24,000 lbs. is used and is strung to give its maximum tension at minimum temperature with a ¾-inch ice-coating and a wind-pressure of 14 lbs. per square foot on the projected surface of the cable. A flexible tower line is employed with heavy strain towers at intervals. Among other experiments, tests were made to determine the minimum spacing which would be safe to adopt between conductors on a 700-foot span with the results that 48 inches was adopted.

In Fig. 4 is shown a standard tower on another recently constructed transmission line in Norway. These towers are designed to carry four 3-phase circuits of 260,000 c.m. aluminium conductors. In this case, again, the average tower-spacing is about 700 feet. This appears to be becoming a European standard for tower lines. At several places where rivers and marshy ground have to be crossed spans up to 2,000 feet are encountered. At these places special towers are used and extra high tenacity aluminium wire is strung. Very great care is

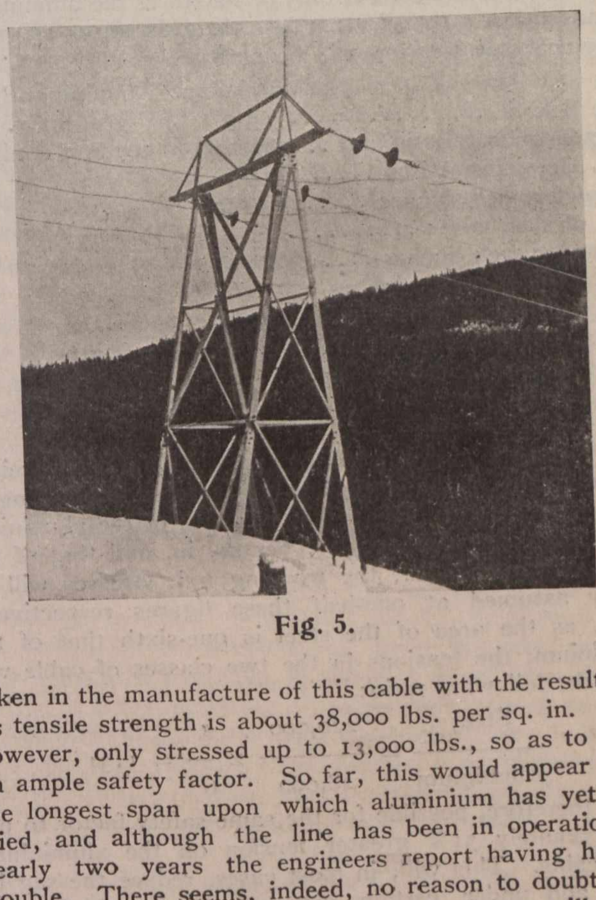


Fig. 5.

taken in the manufacture of this cable with the result that its tensile strength is about 38,000 lbs. per sq. in. It is, however, only stressed up to 13,000 lbs., so as to allow an ample safety factor. So far, this would appear to be the longest span upon which aluminium has yet been tried, and although the line has been in operation for nearly two years the engineers report having had no trouble. There seems, indeed, no reason to doubt that, with careful design and stringing, aluminium will prove a thoroughly satisfactory material for even the longest spans. The two principal troubles likely to be experienced are due to improper methods of tying on to the insulator or to insufficient spacing. In the present instance the insulators (which are duplicated on the long-span towers) are fitted with lead-lined clamps. Any abrasion is, therefore, taken by the soft metal. The spacing between conductors was, after careful tests, fixed at 69 inches.

In this country less attention has been paid to the possibility of improving the physical properties of aluminium *per se* than has been done in Europe; engineers have in general been more attracted by the possibility of reinforcing the aluminium cable by means of a steel core. The view in Fig. 5 shows a 1,000-foot ravine span which is crossed by three steel-reinforced aluminium conductors. (This transmission line was described in the "Electrical News," Vol. XXII., p. 34). The arrangement of a typical steel-core cable size 3/0 is shown in Fig. 6. It has to be remembered in dealing with this class of cable that when the maximum wind and ice stresses come upon

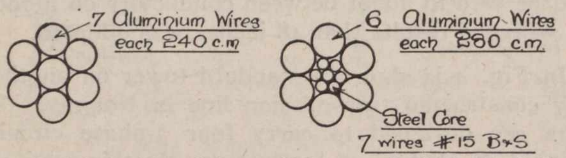


Fig. 6.—3/0 Aluminium Cable and 3/0 Steel-Core Aluminium Cable.

it all the tension will of necessity come upon the steel due to the fact that the aluminium will elongate about three times as much. The core must, therefore, be at least as strong as the rest of the conductor. As, however, the section of the steel is only one-sixth of the aluminium, it must have a tenacity not less than six times as great. A typical specification will be as follows:—

	Aluminium.	Aluminium-Steel.
Size B & S.	3/0	3/0 equiv.
Circular mils (aluminium)	167,805	167,805 equiv.
No. Aluminium wires	7	6
Diameter each, inches	.155	.166
No. of steel wires	—	7
Diameter each, inches	—	.057
Diameter of cable, inches	.465	.498
Diam. of cable with ½" ice.	1.465	1.498
Weight per foot, lbs.	.155	.216
Weight per ft. with ½" ice.	.755	.819
Total loading per foot	1.234	1.290

From the above it will be seen that the extra weight and diameter of the steel does not increase the loading to any great extent. The tensile strength of the aluminium may be taken as 28,000 lbs. per sq. in. and that of the steel as 220,000 lbs., the working unit stresses will be safely assumed at one-half these figures respectively. Now, as the area of the steel is one-sixth that of the aluminium, the tensions in the two classes of cable will have the following ratio:

$$\frac{\text{Steel}}{\text{Aluminium}} = \frac{220,000}{28,000} \times \frac{1}{6} = 1.31$$

It is, therefore, possible for the same safety factor to put approximately 31% greater tension on the aluminium-steel cable. This will, in most cases, reduce the sag by 25%, and under certain circumstances would be well worth the extra expense. In most situations, however, the writer is inclined to favor the European principle of manufacturing aluminium cable of the very highest grade and tenacity, so that reinforcing would be unnecessary.

PROPER INSPECTION OF TRACK PAVING.

The following instructions to inspectors have been developed by Messrs. D. H. Roszel and H. H. George, and adopted by the Public Service Railway Company, of Newark, N.J., upon the recommendation of Mr. Martin Schreiber, Maintenance-of-Way Engineer. The object of these instructions is to secure full compliance with the contract and specifications and the performance of first-class work by the contractors in such minor details as are not generally specifically mentioned, but are implied by the contract and specifications. Those relating to paving inspection are published herewith as outlined in a recent issue of the journal of the American Electric Railway Association.

General Instructions.—The inspector is to make out daily reports on forms provided for the purpose, and also to keep in a field book a detailed record of each day's work, which must contain the following:—

(a) The date of his assignment to the contract and the date of its actual commencement and completion.

(b) Detailed force account for each working day and the amount of material used.

(c) Condition of weather each day.

(d) Delays, reasons for, and the period of duration.

(e) Conditions of sidewalks along the line of paving, previous to commencement of work, to forestall any future claim for damages.

(f) Accidents: date of accident, names of persons concerned and witnesses, cause of accident.

(g) Any neglect or refusal on the part of the contractor to comply with the contract specifications.

(h) Damages to persons or property by reason of any act or omission on the part of the contractor.

(i) Oral instructions or orders received from his superior officer, and all other matters appertaining to the contract that might be worthy of record.

(j) A record of the various types of paving used (such as new, clipped or unclipped block and their kind, sand, cement or tar and gravel joints, etc.) and the exact terminating points of each type.

The inspector must be present on the work at all times when any work is in progress, unless excused by his superior officer.

It is the duty of the inspector to familiarize himself with the local conditions affecting the contract to which he is assigned, in order that the work at all stages may be so carried on as to cause the least possible inconvenience to the operation of the cars, and to the public generally. The street must not be unnecessarily obstructed, and the contractor must provide temporary passageways at crossings, and wherever else necessary.

The inspector must not permit the contractor to interrupt the trolley traffic during the course of the work, and must see that no materials are permitted on or near the track, that will interfere with the operation of cars or the safety of passengers.

All materials, as they are brought on the street, must be piled compactly and neatly at such points as the inspector shall designate, and in such a way as shall comply with the regulations of the municipal authorities. All loose material, excavated matter, and rejected materials must be removed from the site as soon as possible.

Special care must be taken that no material is piled around city fire hydrants, and that the space in front of same is kept clear at all times, and accessible to the fire apparatus.

The inspector shall see that all necessary signals and warning signs are placed on the work to protect the public, and that red lights are properly placed at the close of each day's work.

The inspector must see that the city monuments and bench marks are preserved from injury by the contractor. In case it becomes necessary to move or lower any monument, the inspector shall notify the Division Engineer, and the contractor shall not move same unless so instructed by the Division Engineer.

The inspector is to examine the material as it is brought on the work and see that it conforms to the specifications before permitting it to be used. Should the inspector at any time suspect that the material used is not in accordance with the specifications, samples must be taken by him, with a record of the location, and the office of the Engineer of M. of W. or the Division Engineer notified immediately.

The inspector shall not permit any portion of the paving to be laid at a higher elevation than the top of the head of the rail.

The inspector shall see that the void between the head and the base of the rail is filled either with the paving, or a suitable rail plaster, and shall not permit the contractor to pave against the rail unless this void has been filled.

Where block paving is to have tar and gravel, or cement joints, the inspector shall see that such tar or cement is omitted for a sufficient space around each joint, until the joints are electrically welded, provided such joints are to be so welded.

The inspector shall report to the Division Engineer any variation from the ordinary paving that will require special measurements, and shall keep sufficient records to be able to designate such places until same shall be measured by the engineers.

The inspector shall notify his superior officer at once of any accident, no matter how slight. If the accident is serious the inspector shall immediately notify the claim department by telephone.

In addition to the above general instructions, the inspector shall watch out particularly for the following points: (This is not to be construed by the inspector to mean that they are the only items to be checked; but he is to keep a close supervision over the entire job.)

Concrete.—Cement must be effectually protected from water or dampness. Packages of cement, which when turned out contain hard lumps, should be rejected.

Where the contractor is to place the concrete foundation for the paving, the inspector shall see that the specified proportions are strictly adhered to. Where the sand and stone is supplied to the mixing board by wheelbarrows and the cement in bags, the inspector shall measure same, to see that the contractor is using the right proportions of cement, sand and stone. One standard bag of cement will be considered as one (1) cubic foot, and a barrel of cement as four (4) cubic feet.

In mixing the concrete, the inspector must see that the directions of the specifications are followed. The method of gauging the proportions must be accurate, and the operation of mixing it by hand must be done on suitable mixing boards. The ingredients must be thoroughly mixed. The inspector must see that the concrete is deposited as quickly as it is mixed.

When a concrete mixer is used the inspector must acquaint himself with the theory and principle of operation of that particular type of mixer, and be able to detect at any time any change in the proportion or uniformity of the mixture.

When the mixer is of the automatic-feed type, the inspector must test it at least once during each day's work, at times unexpected by the foreman, by feeding measured quantities of cement, sand and stone, in the proportion specified, into the respective hoppers. If the mixer is gauged properly and feeding freely, the measured quantities of materials will be exhausted simultaneously. Should some cement be retained in the cement hopper after the sand and stone are exhausted, it is sufficient indication that the mixer is either improperly gauged or that the cement feed is clogged. Whatever the trouble is, it must be corrected before the mixing is allowed to continue.

When the contractor employs a concrete mixer into which the materials are not loaded in batches, the inspector is not to depend for the securing of proper proportions on the accuracy of the machine gauging or the proportion of the shovelers used. The material must be placed in properly proportioned piles, not containing more than 10 cubic yards in the case of sand, broken stone or gravel, and the inspector must see that the machine exhausts all material simultaneously. Should it be impossible to obtain these results, due to improper piling of material, the inspector must require the use of measuring boxes for proportioning the charges for the mixer.

Use sufficient water to make what is called a wet mixture, but not so much that free water will drain from the mixed batch before ramming.

The test for the degree of mixing or turning will be that all fragments of stone are fully covered with mortar.

Grouting of concrete after it has been laid, or the application of neat mortar to the surface, and the sweeping of the surface with street brooms to make it smooth or to cover up defects, must not be permitted. Concrete made of fine stone in the stated proportions of mixture may be used for the leveling up of depressions.

The inspector shall see that the concrete is protected from injury while setting, and that no hauling or trucking over it is done, except on planks, and only after a proper hardness has been reached.

Sheet-Asphalt Pavement.—The principal care of the inspector will be to see that the asphalt is not laid at too low a temperature. The minimum temperature permitted by the specifications is 250° F. While the main or interior mass of a wagon-load may be well above that temperature, the top and outer part of the load may be, particularly in cold weather, too cold to be safely used. Some of this colder portion may be sufficiently reheated by mixing it with the hotter material, if properly handling in unloading; but any material that is so cold as to be lumpy when unloaded, or, more particularly, when being raked out, should be discarded. This applies to both surface and binder mixtures. The best practical guide is the manner in which the mixtures behaves in raking. It should always be so hot that it will, under the rake, break up into a uniform crumbling or powdery mass. If it does not do this it is too cold, whatever its temperature may be.

Preparation of Street Surfaces.—Before the binder is laid, all loose material, rubbish, street dirt and other matter foreign to the concrete surface, shall be removed and the concrete surface swept, with street brooms if necessary, to properly clean it.

Neither binder nor surface mixture shall be laid upon wet surfaces. Before the spreading of the surface mixture on the binder, the latter must be cleaned of all foreign matter and swept if necessary. If the binder course already laid has become covered with mud from wagons or other travel, it must be swept clean. No loose fragments of binder material must remain on the surface. Any part of the binder course that may have become broken or loosened must be taken up and new material laid in its place with the same care as the original.

Laying Binder Course.—Nearly the same care in raking and equally as careful rolling should be required as for the surface course. If the binder is not thoroughly compressed and becomes cold before the surface course is laid, it is likely, in the future hot weather, to soften and yield under heavy travel, and thus start small depressions in the pavement.

Laying the Surface Course.—The joints against a cold edge of previously laid surface must be cut back until solid, fully compressed material of full thickness is reached, and the raw edge completely but thinly painted with liquid bitumen. No masses or fragments of cold mixture must be allowed to remain on the surface of the binder, in advance of the placing of the surface course, to be covered up by the latter. Such cold masses will not be compressed by the roller, but will later, under the hot sun and heavy travel, yield and start depressions in the pavement. The raking requires to be properly and skilfully done. The tines of the rake must penetrate to the binder, so that the raked material will be a uniform mass from top to bottom.

Rolling.—The inspector must insist upon the roller being placed upon the freshly raked surface just as soon as the material will bear it without being squeezed out or displaced laterally. The tendency is to keep the roller off too long, thus permitting the chilling of the surface and preventing its proper compression. The inspector must not take the contractor's word as to how soon the rolling may be begun, but should have trials made until he is able to judge for himself.

The rolling of the heavy roller should be very thorough; the roller should be kept at work constantly until the surface is too cold to be impressed. In operating the roller lengthwise of the street the rolling should begin at the gutters and work toward the centre of the street whenever practicable. Cross rolling and diagonal rolling must be insisted upon wherever the width of the street will permit.

Asphalt surface must not be laid when rain or snow is falling or so long as the surfaces are wet. Surface mixture raked out and caught in a shower before it is well enough rolled to exclude water must be taken up and discarded.

Block Paving.—The more important things for the inspector to look after are:—

(a) The quality and shape of the blocks.
(b) The sand cushion.
(c) The setting of the blocks.
(d) The ramming of the surface.
(e) The filling of the joints.

The Blocks.—Assuming that the general quality of the stone has been approved, the inspector will need only to observe and reject blocks made from soft, weathered or otherwise defective stone. Any material divergence from the correct form, or from the sizes specified as permissible, will be readily caught by the eye as the blocks are brought to the street, and such defective blocks thrown out.

The proper dressing of the blocks is important, and should be watched carefully. While the inspector is not expected to examine each individual block, close observation of the blocks as they are handled and laid will enable him to detect and reject those that are materially defective in shape or dressing; or excessively wide joints will call attention to them as they are set.

Sand Cushion.—Screened sand must be used for the cushion bed. It should be moderately coarse and must be fairly clean and pure. The tendency with contractors is to use any dirty sand or sandy loam available on the street. Such material, especially if it becomes filled with water, will yield under the blocks and will not support them properly. The sand bed should not vary materially in thickness. It should be laid and graded not more than 50 nor less than 20 feet in advance of the setting of the blocks.

Setting the Blocks.—Blocks of uniform width and depth must be selected for each course, and each block must be laid upon a full bed of sand and "struck in" at the base, so as to bring the stone in close contact with its neighbor in the preceding course, and thus insure the closest possible joint.

The inspector must see that the joints in the line of traffic are close, and that the alignment of the course is true. This is most important, as a crooked or wavy course lessens the chances of getting close joints, not only along that particular course, but along the courses that are to follow. The inspector must see that all longitudinal joints are broken by a lap of at least 3 inches.

The operation of ramming is not to be permitted to approach within 20 feet of the end of the paving. After ramming, the surface of the pavement may look somewhat wavy and uneven. The inspector must then see that it is back-rammed. All blocks below the general plane of the surface must be raised and more sand placed thereunder, and the blocks rammed again to an even bearing.

Whether sand or grit is used for partly filling the joints before paving cement or pitch is poured, care must be exercised in placing the sand or grit in the joints. Dumping a wheelbarrow load on the surface and then sweeping the joints full is not to be permitted under any circumstances.

Sand and grit or gravel should be dried before being used and put into the joints as nearly as possible to a uniform height, as called for in the particular class of granite pavement.

For pitch joints, the contractor shall remove the gravel for the depth of about 1 inch below the surface before applying the pitch. The latter should be poured into the joint while at such a temperature as to be perfectly fluid.

Clipping Old Block.—In clipping, care should be taken that all blocks are of as nearly uniform size as possible, and that the sides are even and square, in order to insure uniform width of joints.

Any block that falls below the minimum specified size after clipping shall be rejected.

Wood, Asphalt Block, Brick Paving.—The inspector must use special care in the inspection of brick, asphalt or other artificial block, and reject and prevent the use in the pavement of any broken, chipped or otherwise defective blocks. A contractor will often use such brick and lay them with the defective side or face next to the sand cushion. This should not be permitted. The contractor should not be allowed to fill the joints of any stretch or section of paving with cement, pitch or other filler, until such paving has been thoroughly examined by the inspector for defective blocks, and such blocks replaced by perfect ones.

However carefully lumber may have been inspected before its manufacture into blocks, the subsequent seasoning, treating and handling will develop many defects, and you will need to observe the delivered blocks closely and reject those that do not comply with the specifications.

Under certain conditions, wood blocks will develop a great many "season cracks" which should not condemn them unless the cracks open for the full depth and to more than one-third of the thickness of the block. What are called "shakes" result from the separation of the wood along the growth rings, and if well defined or open should condemn the block, though in many cases the blocks, after the defective part has been trimmed off, may be used.

The inspector shall see that the required crown is given to the concrete before the same is set, as on account of the even size of blocks, any inequality of foundation more easily affects the surface.

When these blocks are to be placed under the head of the rail (as in Tee Rail), the inspector shall see that they are placed tight against the web of the rail, and that all voids are completely filled, to avoid any loosening by the action of the cars on the adjoining rail.

Macadam Paving.—The inspector must see that the stone is spread in a uniform layer to the specified depth before rolling, and that the rolling is continued until the stones are thoroughly settled into place, and show no movement under the roller.

The inspector shall see that the binder is applied in thin layers, and that it is not rolled until dry. The application of binder with intermittent rolling must be continued until all the voids in the stone shall have been filled. He shall then require water to be applied in such quantities that a wave of mud forms in front of the roller. The rolling must continue until the pavement is thoroughly consolidated.

The inspector shall see that the road is again rolled after the final coat of screenings is spread over the surface. He shall not accept the same until the surface becomes thoroughly consolidated, hard and smooth.

Before the application of a bituminous dressing, the inspector shall see that the surface is so swept that the ends of the one and one-half inch stones are exposed. Such dressing must not be applied except when the temperature is above 50° F., and the weather is clear.

The inspector will bear in mind that the foregoing instructions are general and intended as a guide to be used in conjunction with, and as a supplement to, the contract form and specifications. He must not conclude that, because no mention is made of some specification provision in these instructions, they are of minor importance and may be neglected or violated. He must remember that the contract specifications govern in every case, and will be held to strict accountability for the enforcement of every and all provisions contained therein.

TORONTO ASPHALT SPECIFICATIONS.

SPECIFICATIONS for the supply of asphalt for the city of Toronto for the year 1914 were issued last week by City Engineer George C. Powell. The following portions will be of interest to municipal and highway engineers and road contractors:—

All asphalt herein shall be obtained by heating crude natural asphalt or crude asphaltic petroleum without the admixture of any other material to a temperature of 400 degrees F. until all the water and light oils have been driven off, and the refined asphalt thus obtained must meet the following requirements, viz.:—

(1)—It shall contain not less than 90 per cent. of "Bitumen."

(2)—Not less than 98.5 per cent. of its "Bitumen" shall be soluble in carbon tetrachloride at air temperature.

(3)—Not less than 65 per cent. of its "Bitumen" shall be soluble in standard petroleum naphtha at air temperature, and the word "Bitumen," as used in these specifications, shall signify and shall be taken to mean "any hydrocarbon, or hydrocarbons, soluble in carbon bisulphide at air temperature.

(4)—It shall not contain more than 15 per cent. of fixed carbon on ignition.

(5)—Fifty grams of refined asphalt, when heated in an open flat-bottom cylindrical dish, 2⅞ inches in diameter and 1¼ inches high, shall not lose more than 5 per cent. of matter by volatilization at 325 degrees F. in twenty-four hours.

(6)—It shall not be softer than sixty penetration at 77 degrees F. (Dow Machine).

(7)—It shall not be harder than that which will require more than 15 per cent. of flux, calculated on the percentage of "Bitumen," to produce an asphaltic cement of forty-five penetration at 77 degrees F.

(8) The flux used in the preparation of the asphaltic cement above mentioned, will be any suitable standard flux having a specific gravity at 6 degrees F. between 0.9395 and 0.9722.

(9)—All asphalt herein shall be subject to the approval of the Commissioner of Works and be tested at destination.

An affidavit must be submitted with each tender, showing where the material was mixed or the source of supply, and also stating where it is refined and the method of refining, and further stating that nothing whatever has been added to the crude natural material.

The asphalt must be shipped in strong, light packages, capable of being handled in all temperatures, and the gross weight must be marked on each barrel or container. In addition, a list must be forwarded prior to each shipment showing these weights, and upon arrival the weight of each barrel or container, will be checked on the city scales. Should any discrepancies in the weights appear, then the weights as shown on the railway manifest shall govern, for establishing gross weights.

Tenderers must submit a sample lot of not less than two pounds of refined asphalt, together with an analysis of the same, made and certified by a properly qualified chemist, of each class tendered upon at least forty-eight hours before date set for reception of tenders, samples to be addressed to the Commissioner of Works, City Hall, Toronto, plainly marked as to grade and class and by whom submitted. These samples will be subject to the approval of the Commissioner of Works, and will be taken as a guide in considering any asphalt required or delivered under this contract.

The percentage of "Bitumen" found by analysis of the samples submitted with the tender, shall be taken to be the "minimum percentage" of "Bitumen" which the proposed grade of asphalt shall contain, and the award shall be made on the price per ton of "Bitumen" calculated from the percentage of "Bitumen" thus found.

The following is a list of municipally-owned electric railways in Canada: Berlin and Waterloo Street Railway, Calgary Municipal Railway, Edmonton Radial Railway, Guelph Radial Railway, Lethbridge Municipal Railway, Regina Municipal Railway, St. Thomas Street Railway, Saskatoon Municipal Railway, Brandon Municipal Railway, Port Arthur and Fort William Electric Railway and Toronto Civic Car Lines.

PARAFFINE SCALE AND DUCTILITY.

By Leroy M. Law,

Chemist, United States Asphalt Refining Company.

THERE are other tests, besides the Fixed Carbon Test, appearing in some specifications for asphalt supply, which should be omitted until their status is better estabilshed. Among these are the tests for "paraffine scale" and "ductility."

The so-called paraffine determination is supposed to show the amount of hard or "scale" paraffine present in refined asphalt, and is, therefore, considered to be an index as to its liability to crack in cold weather or to granulate with age.

The general procedure employed in this determination is doubtless familiar, consisting of distilling the material rapidly down to dry coke and collecting the distillate. The latter is then weighed, an aliquot portion removed, dissolved in alcohol-ether, chilled, and the crystallized scale filtered off, dried and weighed. Many specifications prescribe that the scale shall not exceed a certain figure, yet few of them prescribe their modifications in detail.

The result is that each customer performs the test in a manner most agreeable or convenient to himself, and the manufacturer must stand for the whims and modifications that the customer may see fit to introduce. Usually the test is conducted in a glass retort, yet some operators substitute in its stead an iron one. That this may influence results matters little, so the manufacturing chemist must visit all these laboratories to become familiar with each chemist's details, then return home and endeavor to duplicate conditions.

Dow and Smith, using an iron vessel, have shown the effects of different rates of heating, type of condenser, etc., and they express the belief that at certain heats soft paraffines may be converted into the scale form. In the face of these experiments and opinions, we have chemists who insist that the higher the paraffine scale obtained the more accurate the method, their claim being that "you cannot get out more than there is in it."

In an effort to learn something as to the paraffine test as generally applied, the six laboratories who replied to the fixed carbon inquiry (see *Canadian Engineer* for Nov. 20th, 1913), were also asked to determine paraffine scale in the same samples. They did so with the exception of one laboratory, which, for reasons not stated, declined to make the determinations. I trust that laboratory E realizes the unscientific status of the paraffine scale test, and it was this realization that prompted them to decline to report on the subject.

Results on Paraffine Scale.

	Sample No. 213. Per cent.	Sample No. 215. Per cent.
Laboratory A.	3.6	2.8
" B.*	0.10	1.58
" C.	2.7	1.49
" D.	1.21	1.25
" F.	4.13	3.04

The above results tend to make a laughing stock of the profession, and are only printed with the hope that asphalt chemists may soon get together and study or eliminate these embarrassing subjects. Our company is furnishing a certain material to one customer, who limits paraffine to one per cent. From him we have had no complaint whatever, yet the same material is ineligible under another specification, having been reported to contain paraffine in excess of four per cent. Which chemist is right, and what is the manufacturer to do under such conflicting evidence?

Turning now to another requirement of questionable scientific value, and non-indicative of either quality or service results, I call attention to a requirement in many road oil and binder specifications which states that the material at, say, 50 penetration shall have a specified minimum ductility. The idea is that the bitumen shall possess adhesiveness, a quality best shown by the ductility test. By concentrating to 50 penetration, the standard consistency for this ductility test, all materials are brought to a uniform basis of comparison. Thus far the idea is sound, but the method of concentration—the all-important feature—is sadly neglected.

Some chemists, in a blind attempt at conserving ductility, stipulate that during concentration the temperature shall not exceed, say, 400° or 500° F. Others provide for "occasional" stirring, but generally they neglect the essential feature in asphalt treatment, namely, the agitation. In hardening the softer asphalts, agitation plays, if anything, a far more important role toward conserving ductility than does the mere restriction of temperatures.

My interviews with inspecting chemists relative to this test show that they are uniform only in following "no regular procedure." Some of them use heat-test residues which, by accident, have just reached 50 penetration, or again, this residue treated to a further heating on a hot plate or in an oven to obtain the desired consistency. Others concentrate the material from an oily state to asphaltic consistency in a single operation, either on a hot plate or in an oven, with or without agitation, as suits their fancy, and the manufacturer must ascertain, and duplicate in his laboratory, all of these eccentricities to find out the chance his material has of passing a so-called scientific specification.

On one occasion the writer submitted to a prospective customer a series of asphalt products varying in consistency from a maltha down to an asphalt cement. These were tested by the inspecting chemist, who passed the harder materials but rejected the softer ones as absolutely lacking in ductility when reduced to 50 penetration.

The chemist allowed me to look over his results, and I observed that with the material requiring the least concentrations he had secured the highest ductility, and in case of the fluid material requiring the greatest concentration to reduce it to 50 penetration, practically no ductility was obtained. All of the products were from the same primary material, the maltha, the harder ones being produced by refinery operations, which he or no one else could duplicate in the evaporation tins of an asphalt laboratory.

In the instance cited the chemist's process was undoubtedly one destructive to ductility, for the longer the heating required to reach 50 penetration, the lower the ductility of the product. The chemist avoided the issue by deciding that to his mind the test represented service conditions where no agitation of the material took place.

The two requirements above dealt with, together with the fixed carbon test previously dealt with, are examples of requirements without theoretical or practical significance.

*Material foamed considerably. Analyst is of opinion that there is no accurate method and results are only approximate.

The Canadian Engineer

ESTABLISHED 1893.

ISSUED WEEKLY in the interests of
CIVIL, MECHANICAL, STRUCTURAL, ELECTRICAL, RAILROAD, MINING, MUNICIPAL, HYDRAULIC, HIGHWAY AND CONSULTING ENGINEERS, SURVEYORS, WATERWORKS SUPERINTENDENTS AND ENGINEERING-CONTRACTORS.

Present Terms of Subscription, payable in advance.
Postpaid to any address in the Postal Union:

One Year	Six Months	Three Months
$3.00 (12s.)	$1.75 (17s).	$1.00 (4s.)

Copies Antedating This Issue by More Than One Month, 25 Cents Each.
Copies Antedating This Issue by More Than Six Months, 50 Cents Each.
ADVERTISING RATES ON APPLICATION.

JAMES J. SALMOND—MANAGING DIRECTOR.
HYNDMAN IRWIN, B.A.Sc., EDITOR.
A. E. JENNINGS, BUSINESS MANAGER.

HEAD OFFICE: 62 Church Street, and Court Street, Toronto, Ont. Telephone Main 7404, 7405 or 7406, branch exchange connecting all departments. Cable Address "ENGINEER, Toronto.'

Montreal Office: Rooms 617 and 628 Transportation Building, T. C. Allum, Editorial Representative, Phone Main 8436.

Winnipeg Office: Room 820, Union Bank Building. Phone Main 2914. G. W. Goodall, Western Manager.

Address all communications to the Company and not to individuals.

Everything affecting the editorial department should be directed to the Editor

The Canadian Engineer absorbed The Canadian Cement and Concrete Review in 1910.

SUBSCRIBERS PLEASE NOTE:

When changing your mailing instructions be sure to state fully *both* your old and your new address.

Published by the Monetary Times Printing Company of Canada, Limited, Toronto, Ontario.

Vol. 25. TORONTO, CANADA, DEC. 11, 1913. No. 24

CONTENTS OF THIS ISSUE.

"IN HONOR OF THE DEAN."

The twenty-fifth annual dinner of the University of Toronto Engineering Society constituted a re-union in honor of a man who, fifty years ago, came to the University of Toronto in search of an engineering training and who, finding none and foreseeing a profound necessity for such, proceeded to establish a foundation and build one; and whose labors, extending over thirty-five years of unceasing devotion to the cause, have produced an institution, still in the building, but now regarded as one of the important factors in the development of the Dominion.

It was a re-union in one of the drafting rooms of the old edifice through whose halls have passed generations of engineering students—familiarly known as the School, but which appellation has enlarged during recent years to include buildings of more modern and special design.

There are many things that might be said about Dr. Galbraith and his institution now known as the Faculty of Applied Science and Engineering of the University of Toronto. Pages might deservedly be devoted to his prominence in any one of many phases of the evolution of applied science and the development of engineering. As a criterion, as convincing as it is genuine, the expressions of student and graduate gratitude and of professional admiration that were in evidence upon the occasion mentioned, are sufficiently indicative of the indebtedness of a nation to the man for so diligently devoting his life and energy to the furtherance of technical and scientific education.

The remarkable assembly comprised prominent engineers from the chief centres of Canada, joined by leaders of the profession in United States, including graduates of years covering a full third of a century, and representative of the forces upon which the development of Canada has so materially depended—a strong phalanx of men of indomitable spirit assembled to do honor to John Galbraith, one of the builders of a Dominion.

A COMMISSION WITHOUT AN ENGINEER.

The following letter from the American Institute of Consulting Engineers, to the President of the United States, is largely self-explanatory. It is reproduced in these pages to exemplify the clear-cut purpose of the Institute to be of what assistance it may in the country's advance. It shows the altruistic motives behind the movement in the interests of a better equipped Interstate Commerce Commission, to rule the transportation forces of the United States, at the same time exposing the remarkable fact that the Commission, with so many duties that are pure engineering or closely allied to it, has worried along with no engineer on its membership, to be of service in the investigation of problems with which he might well be most familiar:—

Sir,—The American Institute of Consulting Engineers recently sought an appointment for its committee to present to you, orally, a request for the appointment of some able and experienced engineer to fill one of the vacancies on the Interstate Commerce Commission, with reasons therefor. A hearing having been found impracticable, the Institute has the honor to present its views through the medium of this communication. It is hoped that the argument that must be so briefly expressed here may so appeal to you that you will grant the hearing desired for the committee representing the Institute.

Membership in the Institute is limited to engineers in independent private practice of such experience and professional standing as enables them to serve their clients in an advisory or executive capacity; therefore, the membership consists only of the older or more experienced engineers Among its members are several of the past presidents of the national societies of Civil, Electrical and Mechanical Engineers.

The Institute has no candidates to present for office, and is, therefore, enabled to address you from an impartial standpoint, free from personal ambitions, and solely in behalf of the public interests.

The Interstate Commerce Commission is charged not only with the regulation of transportation rates, but also with the regulation and inspection of safety appliances used in our railways, with the investigation of accidents, and with the stupendous and expensive task of making a physical valuation of the railways of the country (United States); consequently many of the duties of the Commission are highly technical.

The leading part taken by the engineer in surveys, location, construction and operation of the railroads, gives him special training, skill and acquaintance with their details which would be of the greatest value in the study and decision of the cases that come before the Commission, and particularly in the executive work of physical valuation. Heretofore, with but few exceptions, the Interstate Commerce Commission has included no member having previous training or experience in the peculiar and complex problems that have come before it, and the knowledge and training had to be acquired after appointment.

We submit that while several years are required for a lawyer, politician or other layman to become familiar with the technical details of rail transportation, the engineer, on the other hand, is already acquainted with them. He can examine the details and special facts presented for adjudiation without loss of time or unnecessary expense to the public through lack of preparation. With one or more engineers as members of the Interstate Commerce Commission we believe that the duties and responsibilities of the other Commissioners would be greatly lightened.

While the regulation of rates is not wholly an engineering question, the knowledge of the experienced railroad engineer would be helpful and valuable in its consideration. The economic and commercial factors underlying the rate structure are more familiar to him than to any other except the traffic expert.

Safety appliances and the investigation of accidents on the railways are matters wholly technical, and an engineer commissioner would, therefore, render inestimable service in reviewing the reports of inspectors and giving them proper value. The decisions and recommendations upon the subject of safety appliances, such as block signals and steel equipment, promulgated by the Interstate Commerce Commission, would be authoritative and command the respect and confidence of the general public and of the carriers if participated in by well-known engineers.

The physical valuation of railways is, perhaps, the most important engineering work now being done in this country. Its cost will be great, it has little useful precedent, and the whole responsibility for the task rests with the Commission. While the Commission will be aided, of course, by engineering boards and experts, the work will be dominated and directed by the Commission.

The results of this great work will be of vital import to all classes of society, and the well-being of the investor, shipper and laborer is bound up in the outcome. Moreover, the scrutiny that the valuation must undergo before the courts, the railroads and the general public makes it important that the decision of the many elements entering into the valuation should not be left by the Executive entirely in the hands of a Commission upon which the engineering profession is unrepresented. We respectfully suggest that an Interstate Commerce Commission, including in its membership one or more engineers, would arrive at an authoritative and equitable valuation, in which all concerned would have confidence.

While urging the appointment of an engineer on the Interstate Commerce Commission, we do not maintain that technical knowledge constitutes by itself a sufficient qualification; a judicial temperament, executive ability and tact are as necessary for a useful engineer member of the Commission as for any other; if therefore you decide to appoint an engineer, we ask that you select one having these essential qualifications as well as the highest professional attainments.

An engineer of the type we ask you to consider will not serve in a subordinate capacity under laymen, but would probably make personal sacrifice for the honor of serving under your administration as a member of the Commission and with the thought of performing a duty as a citizen.

We repeat that we have no candidate to offer and no motive except to serve your administration.

Respectfully submitted,

American Institute of Consulting Engineers.

Alfred Noble, President.

Eugene W. Stern, Secretary.

New York, Nov. 26th, 1913.

LETTER TO THE EDITOR.

Some Points for Consideration in Discussing the Reasons Why Some of the Upper Lake Freighters Failed to Weather the Storm on the Great Lakes on November 9th.

Sir,—Now that the first shock caused by the terrible marine disaster upon the Great Lakes of the 9th of November has passed, one can begin calmly to try to think out some reasons for the how and the why. Unfortunately, in all the most important cases not a living soul is left to tell the tale, to lift ever so slightly a corner of the curtain which hides the tragedy, nor to indicate why a number of large steel steamers of modern construction and equipment could not withstand with reasonable safety the force of even such an exceptionally heavy gale as that which sent them to destruction.

It seems almost inconceivable that the "James Carruthers,"* for instance, a brand new ship, which was the product of twenty-five years' experience in steel shipbuilding upon the lakes, beginning with 255-footer and progressing successively through the 300-ft., 400-ft. and 500-ft. classes, until it has reached the modern 10,000-tonner, should disappear utterly, and leave no sign behind to indicate what happened when she took her final plunge into the watery depths of Lake Huron.

A good many possibilities have already been brought forward in the daily papers, and chiefly by practical men, suggesting collision, capsizing through shifting of cargo, want of stability, inefficiency of hatchways, carelessness with regard to hatch fastenings, overloading, deficiency in size, weight and length of ground tackle, stowage of cargo, and want of power, etc., but until an exhaustive enquiry has shown the exact condition of each vessel separately with regard to construction, loading, power,

*For detailed description see *The Canadian Engineer* June 5th, 1913, page 310-11.

nature and quantity of cargo, equipment, draft of water, etc., it is impossible to come to any satisfactory conclusion as to the immediately contributing cause of the catastrophe.

With all available information at hand, it may be possible, by eliminating those conditions which are self-evident, to narrow the enquiry down to such a point as to enable something like a fair and reasonable explanation to be offered in each case as to the cause of the wreck—which is probably as near to the actual result as will ever be attained.

For the sake of humanity, of the shipbuilders, of the owners, of the shippers, and of the insurers, it is imperative that a competent commission be appointed, representing all interests, with power to get at the facts and with ability to draft such regulations as will, as far as it is humanly possible, prevent a recurrence of such a deplorable event.

The loss of life and treasure has been terrible. It would be a still greater calamity if the lessons to be learned by such an enquiry were neglected in any particular whatever.

Whilst it would be premature to discuss matters upon which we have no definite information, there are some phases of the case that can be investigated with propriety from data already made public; such, for instance, as the type of the modern 10,000-ton lake freighter. It would be interesting to compare her with a modern 10,000 gross ton ocean cargo boat, built up to the requirements of Lloyd's Register of British and foreign shipping, and of the British Board of Trade. The leading particulars of the two boats are as follows:

	Ocean boat.	Lake boat.
Length, feet	460	530
Beam, feet	58.5	56
Depth, feet	41.0	31
Draft, feet	27.0	19
Depths to length	11.2	17.1
Drafts to length	17.0	28 nearly
Watertight bulkheads	6	3
Displacement, tons	16,000	15,000
Indicated horse-power	4,000	2,000
Block coefficient	.79	.850
Freeboard, feet	14	12

There are some screen bulkheads in the main hold of the lake freighter, but they are not watertight, and the hold is about 390 feet long, so that if a collision caused any serious damage below water at any point within that cargo space, the vessel's pumps could not keep her free and she would inevitably sink.

These two boats are constructed within a small margin of precisely the same weight of metal, and for a rough-and-ready comparison they may be looked upon as two girders of different dimensions and of equal weight, thus:—

The ocean boat contains 4,750 tons of steel, is 460 feet long, 41 feet deep, and the lake boat with the same weight of material is 530.0 feet long and 31 feet deep. It is evident from this that there is a vast preponderance of longitudinal strength in favor of the ocean boat, which is a point worth considering. This does not prove that the lake freighter is too weak for her work, but if the waves are so much worse for the ships on the lakes than they are on the ocean, as Captain Inkster intimates in his letter to the press upon this subject, one would naturally suppose the preponderance should be the other way. Fortunately, this point can be readily settled, after the plans and specifications have been examined and strength curves made showing the stress upon the materials. These possibly have already been worked out. Lloyd's Rules provide only for normal ships having a maximum length of sixteen depths measured from the keel to the middle deck, or 13 depths measured from keel to gunwale, and even in the latter case, a substantial deck house must, in all cases, be erected extending over half the vessel's midship length. When classification is required for vessels outside or beyond these proportions, special designs have to be prepared and submitted to the committee for their approval, showing how the additional longitudinal strength required is to be provided for.

It is clear that the lake freighter does not begin to measure up to the standard set by Lloyds' for a first-class cargo steamer in this respect, and it cannot be an unreasonable question to ask whether her abnormal proportions of 18 depths to length, with 31 hatchways, each 36 feet wide and 9 feet long, have been adequately provided for so as to enable her to efficiently perform the work she has to do.

Then, as to power. Captain Bassett, in his evidence in the "Wexford" case, stated (according to the press) that "most steamships have sufficient power in relation to their size, although the longest boats would sometimes fail to get headed into the seas if they got in the trough of the seas, because of the tremendous leverage of the boats."

This is a significant statement, coming from such an authority as Captain Bassett, especially in view of the fact that the ocean steamer carries 4,000 i.h.p. and the lake boat only 2,000 i.h.p. The position of the machinery indicating this power is amidships, or nearly so, in the ocean boat, and as far aft as it can be placed in the lake boat. The latter arrangement, of course, leaves all the room forward available for cargo, but it militates against the vessel's seaworthiness—when light, in consequence of her excessive trim by the stern, and at all times owing to the absence of the watertight bulkheads which would have to enclose the machinery space if the latter were amidships.

As regards stability, the ocean boat has a metacentric height of 1 ft. 6 in. at 27 ft. draft with a full load and homogeneous cargo, which would indicate an easy, slow-rolling boat very comfortable in a sea way. The lake boat probably has a metacentric height of something like four feet when full loaded with homogeneous cargo to 19 ft. draft, which indicates ample, if not excessive, stability, but a hard, fast-rolling boat very uncomfortable in a sea way.

When loaded with 10,000 tons of wheat, coal or ore the boat would not be near full, consequently her centre of gravity would be lower and the distance between her metacentre and centre of gravity would be increased proportionately. If, in this condition the cargo should shift heavily, of course it is possible that at a large angle of heel the stability would vanish and the ship capsize, but this is another point that can be cleared up by stability curves made from the drawings of the ship.

It may be asked: Have not the steamboat inspectors power to prevent such vessels proceeding to sea without the proper means for preventing the cargo from shifting, the same as they have for preventing the overloading of passenger steamers? The answer is: There are no detailed regulations in Canada, as yet, for the guidance of inspectors giving them authority over the design, construction or operation of steamers, nor does any competent central body exist, having similar functions to the British Board of Trade, to control marine matters, and to which they could refer in case of necessity. The present inspectors have a very large territory to cover, have an arduous duty to perform, especially during their busy season, and could not possibly be looking after ships on Lake Erie or Lake Ontario, when similarly engaged on the Georgian Bay. They are painstaking and strict in the performance of their existing duties, which they are well qualified to perform, but in the interests of the community at large, the system should be extended. The Canadian merchant marine has become of sufficient importance within a generation to demand a classification of its own, endorsed and supported by government authority.

The pending enquiry will probably result in a coroner's verdict, and it is to be hoped that a trial will be held under competent legal and technical auspices as already indicated.

W. E. REDWAY,
Naval Architect.

Toronto, Nov. 29th, 1913.

STORM SEWERS FOR LONDON, ONT.

A REPORT has recently been submitted to the mayor and council of the city of London by Willis Chipman, C.E., civil and sanitary engineer, of Toronto, upon a system of storm sewers. The city, with a present population of 49,000, has felt for some time the necessity of such a system for the prompt removal of rainfall from its streets. The improvement of roadways and the paving of streets are examples of municipal work that have been seriously held up, pending action in the matter of storm sewers, while the menace to public health through the only existing alternative of connecting into the sanitary sewers to relieve surface flooding has become grievous, owing to cellar and basement flooding by the forcing back of sewage by storm water.

The following information respecting the conditions that have developed during the past twenty years are from Mr. Chipman's latest report upon the situation, and his recommendations and estimates for the improvement of these conditions are appended.

The central business section of the city is now served by a system of combined sewers constructed prior to 1892. At various times drains have been laid in the outlying sections for the removal of cellar and street water, without regard, however, to any system; and, at the present time, fully half of the city is unprovided with storm sewers.

Separate System.—For some years prior to 1891, numerous damage suits had been entered against the city by riparian owners for pollution of the river by sewage which was then discharged into the south branch of the Thames River. Wastes from factories, canneries, and other drains discharged into both branches of the river, and aggravated pollution was the result.

In 1891, Mr. Chipman investigated the problem of disposing of the city's sewage, and presented a report in February, 1892, advising the city to adopt a separate system of sewerage, the domestic sewage to be conveyed by gravity into lands situated west of the city; the sewage from the north area to be collected by an intercepting sewer laid in the valley of Carling's Creek; that from the south area by a similar sewer parallel to the south branch of the river, both interceptors to pass beneath all the existing sewers and to collect from them the normal dry weather flow only. During rains, the interceptors would flow full, the excess passing into the original outlets.

Several tile sewers had been constructed in London South prior to its annexation to the city in 1890. The report referred to recommended a third interceptor for this section.

After lengthy consideration, during which the report was endorsed by Mr. F. X. Goodnough, engineer of the State Board of Health of Massachusetts, and Mr. C. H. Rust, then city engineer of Toronto, the project was eventually adopted by the city council in October, 1896. Construction began that fall and the main sewers were completed in two years' time. In 1901-2, two filter beds were constructed and one sedimentation tank added in 1908-9.

From 1890 to 1913, with the exception of eight streets, storm sewers were not laid with the sanitary sewers, and in the majority of instances the street water was discharged into the small sewers designed for domestic sewage only, notwithstanding the fact that in 1906 it was pointed out by the consulting engineers that the storm water should be rigidly excluded from the latter. The city engineer's department evidently intended to design a comprehensive system of storm sewers, similar to the system of sanitary sewers projected in 1890, but the matter was postponed from year to year, the troubles from storm water constantly increasing.

Catch Basins.—In 1896-97 attention was called to the inadequacy of the "gullies" through which the street water entered the sewers. Each gully comprised a vertical 18-inch sewer pipe or concrete pipe set vertically, with a cast iron grating at the upper end. The earlier form of "gullies" were only 30 inches in depth and 16 inches in diameter, with connections to sewer 8 inches in diameter. About thirty proper brick catch basins, with pits to collect the sand and mud, were built in 1896-99, but since that date the cheap vertical pipe gully that permits the sand, gravel, mud and debris to enter the sewer, has been all but universally constructed. There are now about fifteen hundred of these gullies, as many as twelve being built on one street intersection. The combined capacity of the pipe connections from these gullies would equal the capacity of a main sewer 20 feet in diameter, laid on the same grade as the existing trunk sewer. When it is understood that about fifty gully connections, each running half full, would tax the full capacity of the 36-inch trunk sewer, the folly of discharging the street water into the sanitary sewers can be appreciated.

Drainage Areas.—The total area of the city is now 6,302 acres, while the water sheds of Carling's Creek and other water courses extending beyond the city limits constitute an additional drainage basin with an area approximating 5,000 acres. Mr. Chipman's report recommends the retention of the important natural water courses where practical, as open outlets for the storm water, thus saving the expense of large conduits. A trunk storm sewer is advised for the valley of Carling's Creek, and other storm sewers for London South, Hamilton Road, and Colborne Street. The construction of proper catch basins and the abolition of open gullies are also recommended. One important measure is that emphasizing the advisability of constructing the storm sewers of at least one year in advance of laying down permanent roadways.

Summarizing the estimate in connection with this separate system, the figures in the report are as follows:

Carling's Creek area	$182,000
North area	28,000
Business area	40,500
Hamilton Road area	46,000
London South area	67,000
London West area	28,500
	$392,000

Sanitary System.—The report also includes some observations relative to the existing sanitary system, the proper maintenance of which is regarded of even greater importance to the citizens of London than the construction of storm sewers. The following remarks are taken from the report:—

"The sanitary system has from time to time been the subject of unfair and often dishonest criticism by the ill-informed public, some of which may possibly be traced back to the battle that was fought in 1896 when the system was adopted, but not without strong opposition. Many citizens cannot divest their minds of the idea that if a sewer be properly designed it should carry anything and everything that can be emptied or even forced into it, regardless of public health or of the cost of the works. Some unthinking people occasionally put forth the contention that the garbage and ashes should be disposed of by discharging them into the sewers. These ignorant opinions still exist, notwithstanding that sanitary engineers and city engineers now recognize and admit that the separate system of sewerage is the only scientific and sanitary system, and at the present day it is being universally adopted in Europe, the United States and Canada. The arguments used against the separate system at London in 1892, 1893, 1896, would not be seriously advanced to-day, and the doubts as to the successful operation of the separate system have been exploded by experience wherever the system has been adopted, particularly so in Canadian cities and towns.

"In 1908 gaugings of the flow in the interceptors demonstrated that they were not then overtaxed and that they were of ample capacity for the domestic sewage flow. In March, 1893, with the ground saturated with water, the north interceptor was found running nearly full, but there can be no doubt that one-half of this flow was due to infiltration of ground water. Portions of this sewer were laid in quicksand beneath the level of Carling's Creek, and as the storm water from the watershed of this stream is not now removed promptly, the subsoil becomes surcharged with water which finds its way into the sewer through leaky manholes and joints in the sewer. By examining these manholes when the water was high, the visible leaks could be marked and the repairs made during dry weather. With the construction of the storm sewer system the normal flow of the interceptors will be materially decreased, but during rains they may run full, as hundreds of 'gullies' are connected with them.

"The inverted syphon that conveys the domestic sewage from the entire city across the Cove flats to the disposal works site has been overtaxed for several years, the excess flow passing directly to the river through the River Street overflow from the Evergreen Avenue chamber. The discharge of crude sewage at this point is continually increasing in volume and will undoubtedly soon cause such a nuisance that litigation will ensue.

"For several years after completion the syphon was sufficient to carry the normal flow, the River Street overflow operating only during rains. As the normal flow increased, the capacity of the iron main was exceeded. It should be mentioned that with a depth of 14 inches flow in the Evergreen Avenue main sewer, the 20-inch syphon would be carrying its full rated capacity. The existing 20-inch cast iron main has a discharging capacity of 3,250,000 gallons per twenty-four hours at the disposal works, or about thirty per cent. of that of the main sewer east of Evergreen Avenue chamber when running full. Another main is required to convey the remaining seventy per cent. for which service a 30-inch pipe should be laid. The Evergreen Avenue chamber, which was never fully completed or equipped, should also be repaired and proper sluice gates provided. The River Street outlet also requires repairs, and improvements, after fifteen years of service. The cost of this proposed 30-inch main, with overflow at the Cove, will approximate $36,000 if cast iron be adopted. Steel pipes would cost about $5,000 less, but their durability is a matter of speculation. It is possible that a reinforced concrete conduit might be constructed at a less cost than cast iron, but the risk would be greater than with cast iron or steel.

"In 1896 the practicability of carrying the main sewer across the river by a bridge to be constructed at King Street was a matter of controversy, but the results have been most satisfactory, the bridge has proven a boon to the city by relieving traffic over the York Street bridge, and no trouble has arisen with the street sewer, supported beneath the roadway of bridge. An inspection of the pipe in March, however, showed that it was seriously corroded, evidently from washings from the plank roadway above, and no time should be lost in thoroughly cleaning the pipe and repainting it, otherwise it will be necessary to replace it at an early date. The sand blast method of cleaning, which is the only thorough method, should be adopted for this work, although the cleaning will cost several times the cost of painting. To lessen, if not to further prevent corrosion, the pipe should be protected by a roof placed above it, beneath the plank roadway, or a concrete roadway substituted for the planking if the trusses are of sufficient strength to support the extra dead load. The bridge and steel trestles supporting the approaches should be also thoroughly cleaned, repaired and painted.

Sewage Disposal.—"The existing disposal works comprise three sedimentation tanks of 200,000 cubic feet combined capacity, and two bacteria beds each with an area of 15,000 square feet. These beds were more or less experimental, and when constructed it was the intention to add others year by year. Funds were not appropriated, however, and the total flow of the sewage was often discharged through the beds. They are now useless except as crude strainers for part of the effluent from the tanks. By removing or washing the filtering materials, the beds may be revived. Whether additional beds be constructed, or spraying filters, or trickling filters, is a matter for careful consideration, but some system should be decided upon before the pollution of the river attains a dangerous or offensive degree. Material alterations should also be made in the three tanks, to convert them into sludge removers rather than sludge digesters, and provision should be made for periodic removal of the accumulations of sludge, without pumping. Beds should also be constructed for drying the sludge."

FIELD EXAMINATION AND TESTING OF CLAYS.

By J. Keele,
Geological Survey of Canada.

FIELD EXAMINATION.

THE testing of any clay or shale for commercial purposes begins with an examination of the deposit in the field. A clay deposit should be conveniently situated with regard to transportation, in a body large enough to keep a plant going for a considerable time, free from harmful impurities, and easily worked. There are many important questions to be considered, however, in the preliminary inquiry, for example:—

1. Can drainage be provided as excavation or mining proceeds, as it is necessary to keep the workings dry?
2. Is the water supply for all purposes adequate and of good quality?
3. If sand is required for mixing, or moulding, can it be obtained cheaply?
4. Consideration of the fuel supply.
5. Are conditions in the locality favorable for labor?
6. Can breakages of machinery be repaired quickly?
7. Can the kiln foundations be kept dry?
8. Would further prospecting reveal a more desirable deposit?

Some idea of the extent of a clay deposit may be gathered in a preliminary way from outcroppings either in plowed fields, hillsides or ridges and along the banks of streams or dry gullies. Springs issuing from hillsides sometimes furnish a clue to the upper level of a bed of clay, as the surface water cannot seep down through it. Wells and foundations excavated for buildings are useful guides; but, railway cuttings often furnish the best information, especially when they are freshly made. As soft clays in a steep bank are liable to be concealed by slide material which has washed down over them, it is often necessary to cut a deep trench up the slope from top to bottom of the deposit before the true character of the beds are seen. Some banks contain several different grades of clay, some of which may be worthless, and so situated as to render the good clay unworkable.

Fig. 1.—Deposit of Brick Clay, Without Overburden, Easily Worked.

In addition to the information gained from outcrops, it will be necessary to make several borings in order to get at the extent of the deposit and its variations. Borings can be made quickly and cheaply in surface clay deposits with a 2-inch auger, coupled to short lengths of pipe and fitted to a cross-head. The auger is screwed into the clay for about six inches, then withdrawn with a straight pull, and the clay which clings to the auger removed. As the boring proceeds, extra lengths of pipe are added. The clay stripped from the auger is laid out in the proper order on boards or on the grass, from which small samples can be selected at any depth up to 30 feet or more if desired.

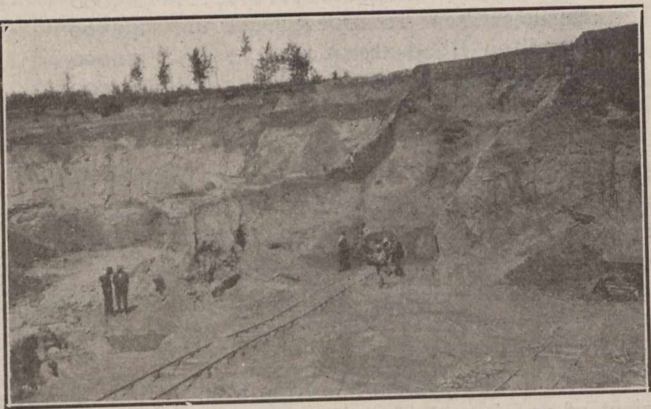


Fig. 2.—Pit Containing Sand, Gravel and Clay, Difficult to Work for Brickmaking.

The clay deposit may be covered with a varying thickness of either gravel or stony clay which cannot be used for any purpose. In most cases it will not pay to strip this overburden if it is very thick; but the higher grades of clay, like stoneware and fire clays, can have an overburden of one foot removed for every foot of clay obtained. If the overburden is composed of sand, much of it may be used for mixing with the clay, especially if it should be a fat clay with high shrinkage. An otherwise useless overburden may sometimes be used for filling or levelling up ground on which it is proposed to erect the plant, or it may be removed cheaply by hydraulicking, if a sufficient head of water is available. An overburden which contains pebbles, especially pebbles of limestone, should be removed completely and kept well back from the face of the bank which is being worked, so that there will be no danger of the pebbles rolling into the material that is being worked for the manufacture of clay products.

Shale deposits are often exposed in fairly steep banks, either in an escarpment or on stream banks or in a railway cutting. From exposures of this kind a good idea of their probable value may often be formed. If the outcrops on the property to be examined are not exposed to any appreciable depth, it will be necessary to sink some shafts before any sampling can be done or any decision formed regarding its economic value.

Several of the soft shale deposits in the plains region of Western Canada can be examined as easily as surface clays from borings with an auger, but the shales in the East are all too hard for this method of sampling.

The shale formation in Eastern Canada are generally uniform in character over very large areas, but those in the West are often extremely variable, so that they require great care in sampling and examination.

Impurities in clay or shale are of two kinds—those which are visible to the naked eye, and those which are not. The field examination detects the first kind, and the laboratory tests should reveal the second kind. Pebbles are probably the most serious visible impurities in surface clays. They may occur sparsely scattered throughout the clay or they may be in the form of gravel streaks, pockets, or regular layers. If the pebbles are mostly of limestone, the deposit is practically hopeless. Some manufacturers in search of material will not consider a deposit, if they find it contains even a few scattered pebbles. Layers or pockets of sand, if not in too large a quantity, are sometimes beneficial in a surface clay, especially if it is of a highly plastic nature. Brickmakers like a clay bank to work itself, meaning one that carries the right proportion of sand for a proper mixture. An excess of sand layers is undesirable in a clay deposit, because the product made

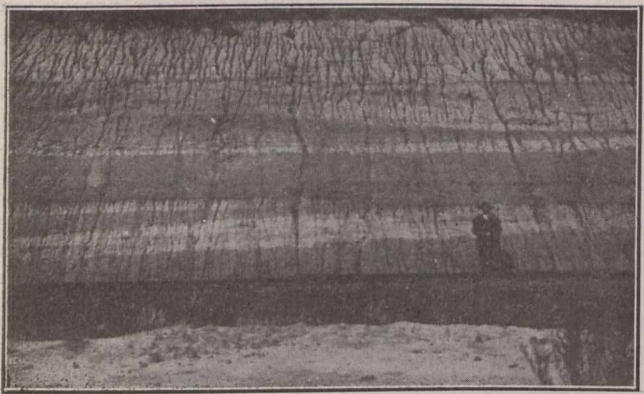


Fig. 3.—Bank of Soft, White Sandstone and Dark Shale These Shale Beds are Unworkable as the Sandstone Overburden is Too Thick.

from it is liable to be weak and porous, or lacking in clay bond. Although a shale deposit may consist largely of beds of true shale, it is possible that it may also contain so many layers of sandstone or limestone as to be of doubtful economic value. If the stone bands are thick enough they may be sold for building stone, if a convenient market exists for them. Ironstone constructions and lumps of iron pyrite are among the serious impurities in shales and clays. They sometimes occur of such large size that they may be discarded in mining. Gypsum or lime sulphate is a frequent impurity in the soft shales of Western Canada. It generally occurs in small glistening particles disseminated through the shale; or it may be in large crystals or rosettes. It generally follows in the west that clays carrying gypsum are hard to dry without cracking.

It is generally impossible to foretell much about the value of a clay or shale by simply inspecting the deposit in the field. An experienced clay worker, however, can gather some information for his guidance in the selection of material. The feel of the moistened clay when kneaded in the hands indicates its degree of plasticity and its probable working qualities. A shale may be distinguished from a slate by grinding a little with a hammer and moistening it. The moistened shale dust will have more or less plasticity, but a slate will have none. Any clay or shale that carries more than about 7 per cent. of lime will probably be useless for the manufacture of vitrified wares, such as paving brick or sewer pipe. If a few drops of diluted hydrochloric acid will produce strong effervescence in a clay it may be discarded as unsuited for this purpose.

Many clays will crack in drying. These can be easily detected by kneading up some of it with water to the proper consistency, shaping it into a rough brick or cube, and setting it to dry exposed to the sun and wind. Some clays thus exposed will crack in less than an hour after being set to dry. Others will not show cracking for several hours. If the clay dries intact, then make another brick by hand and set it over a boiler or in an oven at a temperature of about 150° F., and observe the results. A clay must be able to stand a certain amount of abuse in drying in order to give a large output of finished products.

Since few clay or shale deposits are uniform in character throughout their entire thickness, the selection of samples for testing purposes is a matter of some importance.

If the deposit appears to be uniform, then the sample should represent an average of the depth of the face it is proposed to work. The average sample should be supplemented by two or three other samples taken from different depths, as appearances are frequently misleading in clay investigation. Many persons pick a small sample of clay from the surface of a deposit and send it to be tested. The results of tests from this kind of sampling are generally useless. The body of material, when opened up for working, may give entirely different results from the thin veneer of weathered clay overlying it. In a locality where industries have been located for a long time, working satisfactorily on a material which occurs widespread and uniform in character, the necessary information may be obtained merely by inspection of a suitable site in the vicinity of the older plants. This proceeding is often, but not always, safe where the manufacturer of common brick only is concerned. Where any of the higher class of clay products were to be made, the cheapest method is to take every possible precaution at the outset of the enterprise.

Laboratory Tests.—The invisible impurities in a clay, which may produce defects in the process of manufacture or in the appearance of the finished ware, can be detected only by working up and burning test pieces made from the clay.

A good deal of time and money has been expended on the chemical analysis of clay, and many chemists have been rash enough to state in reports the kind of wares

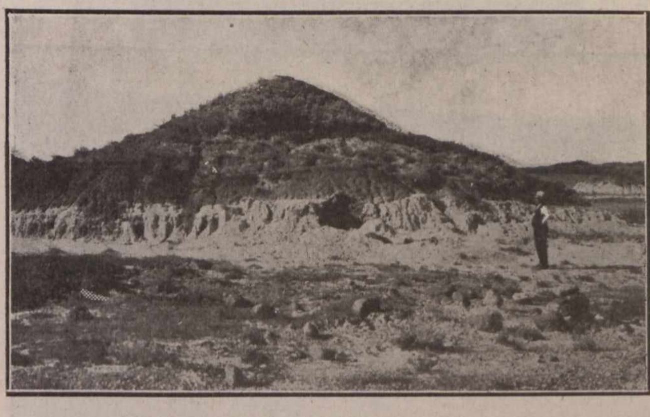


Fig. 4.—White Clay in Central Alberta, Overlain With Worthless Shale.

a clay will make, from the results of their chemical analysis alone. There may be special instances, as in the case of some high-grade clays, where the chemical analysis is of value, but is is worthless for the general group of clays or shales used in the manufacture of structural ware.

What the clay worker desires to know about a clay or shale is:—

1. Its plasticity and working qualities.
2. The rate of drying.
3. The exact drying and burning shrinkages.

4. The commercial limit of burning.
5. The porosity and absorption of the burned wares.
6. The actual difficulties encountered in burning, such as cracking, warping, or swelling, and scumming or whitewash.

Many of the important clay-working plants in the United States and England, especially those making a variety of wares, have an experimental laboratory, with small kilns for burning trials in charge of a competent ceramist. These firms test a large number of clay samples which are sent to them from outside sources. Three or four of the State Universities give courses in Ceramic Engineering, and have very fully equipped clay-testing laboratories. A certain amount of commercial work is done, for which fixed charges are made according to the scope of the investigation. The tests are conducted by experienced men whose reports are reliable and extremely valuable to the person or company about to start a clay-working industry.

Most of the manufacturers of clayworking machinery have a clay-testing department on their premises. These people invite prospective customers for machinery to send samples of their clay and have it worked up into specimens of ware. They generally make the tests free of charge. The specimens of burned wares sent back by the machinery companies to their prospective customers are generally perfect in every respect. These samples should be regarded as a standard to be ultimately attained to, however seldom reached, in the everyday world of clayworking.

Tests Under Working Conditions.—If a company or individual wishes to establish an important clayworking industry at a certain place to make a certain class of wares, a reasonable way to proceed in the tests of their clay, provided the field examination was satisfactory, is as follows: Take an average sample of, say, 50 lbs. from top to bottom of the workable depth of the deposit, if it is uniform in appearance, or as many samples as

Fig. 5.—Shales along Red Deer River, Near Lignite, Alta., Overlain by Too Much Boulder Clay.

there are different beds. Have a complete set of laboratory tests made from the samples. If the laboratory tests prove satisfactory, then make arrangements with some firm, outside the zone of competition, who are making wares similar to those required, to put a large quantity of clay through their process and to burn it in their kilns. It is important to have an experienced man do the sampling and accompany the clay to its destination, so that he may observe the behavior of the material in the various stages of manufacture.

The proper location of the deposit and the assurance of the suitability of the clay for the purpose for which it is to be used, are absolutely essential to begin with.

The plan of the buildings, the design of the kilns or driers and the selection of the best types of clay-working machinery, should be done by a competent ceramic engineer.

It is impossible to provide against all the troubles which may arise in new localities when dealing with a new material; but the chances for the occurrence of trouble can be materially lessened by proper precaution.

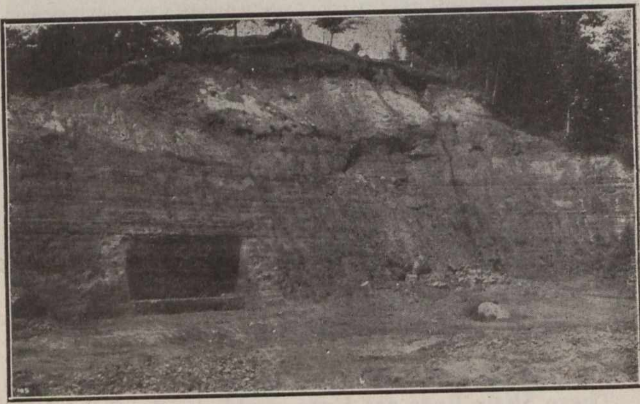


Fig. 6.—Stratified Brick Clay Deposit, Overlain by Too Much Sand.

The business of manufacturing clay products is a desirable one in many respects. It gives healthy employment and produces articles of great use to a community. It is a fairly profitable business when brains and technical skill, as well as capital, are invested in it, varying nowise in this respect from any other complex producing business. It is just as easy, however, for the unwary novice to lose his money in a homely looking clayworking plant as it frequently is in the more spectacular operations of metal mining.

Work of the Geological Survey.—The Geological Survey has carried on a systematic investigation of the clay and shale deposits of the Dominion since 1909. The reports that are published at intervals contain complete results of laboratory tests, together with descriptions of the field occurrence of the materials collected. They are intended as guides for manufacturers in search of material, but are of general interest to all clay workers.

PEAT POWDER AS A LOCOMOTIVE FUEL.

Peat powder has been successfully applied as a locomotive fuel on one of the private railroads in Sweden. In steam raising value about 1½ tons of peat powder is equivalent to one ton of coal. Peat powder is used with a mixture of about 5 per cent. of coal, and is fed into the furnace by an automatic stoker. No change need be made in the boiler end in the fire-box, except for the mounting and application of the automatic stoker. An incidental advantage of the use of the peat powder is that no cold air can get into the fire-box and no smoke or sparks escape from the smoke-stack. As Sweden is very rich in peat bogs, and has practically no coal deposits, the success of the apparatus, which has been worked upon for years by eminent engineers, is of considerable importance. It has been estimated that the cost of peat powder would be only about one-half that of coal.—Conservation.

A DINNER IN HONOR OF DEAN GALBRAITH.

On Friday, December 5th, the University of Toronto Engineering Society held its 25th annual dinner. This year it took the form of a re-union in honor of Dean Galbraith, the founder of the School of Practical Science, known for some years past as the Faculty of Applied Science and Engineering in the University of Toronto. Nearly six hundred engineers were in attendance, and the principal centres of Canada and the United States were well represented. Mr. F. C. Mechin, president of the Engineering Society, acted in the capacity of toast-master, and during the progress of the evening read innumerable letters and telegrams expressive of the profound regret of many prominent graduates in far away localities who found it impossible to attend.

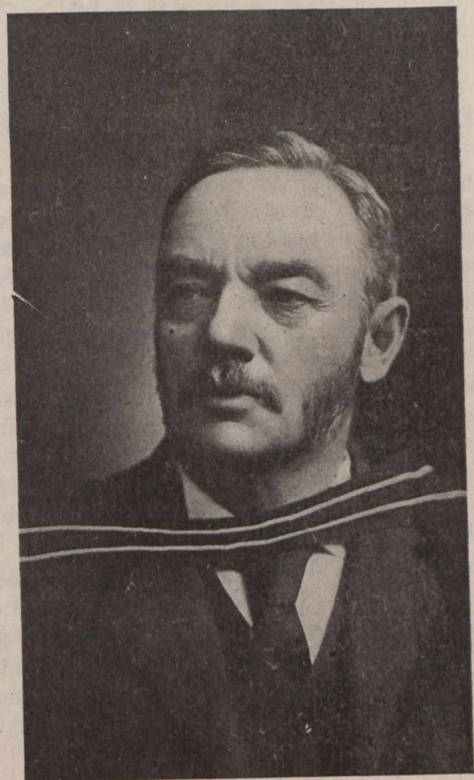
As stated, the dinner was in honor of the Dean of the Faculty, and every toast, together with its response, reverted to his profound patience and unceasing perseverence in the building up of the institution which has broad-casted throughout the world nearly fifteen hundred men whose good fortune it was to partake of the advantages which his training in fundamental principles afforded to them. Many were the reminiscences which at one time or other during the evening ascended bouyantly to the surface and illustrated the spirit which dominated the engineering course since it was founded by John Galbraith thirty-five years ago.

President Falconer, in response to the toast "University of Toronto," outlined the remarkable influence of Universities upon the national life in Germany and other countries, as evidenced by the strenuous activity of these countries in the progress of the world. In this connection he referred to the evidences of spreading influence of the University of Toronto as shown by a recent trip through the Canadian West. The president referred in most kindly terms to Dean Galbraith and the regard in which he was held at the University, pronouncing him as the man who, above all others, had made possible in the engineering faculty of the University an atmosphere of integrity and cleanliness of character yielding results of untold value to this Dominion.

Col. W. M. Ponton, of Belleville, in an interesting response to "Canada," mentioned numerous instances in the career of Dean Galbraith indicative of his personality, his potentiality, and his position in the regard of men outside of the University and in other professions. His closing sentence related to those assembled, in the following terms: "Looking upon this throng that has assembled to honor Dean Galbraith, some of you from great distances and with much inconvenience, I cannot but admire your spirit of loyalty to the man who instilled into you those first principles of character and thought, and I can see in my mind's eye hundreds of others of the School graduates in all parts of the earth regretting with heartfelt sorrow that they cannot be with you to do honor to their Dean."

A toast to the "Profession" was responded to by R. A. Ross, Consulting Engineer, Montreal, a graduate, '91, and H. F. Ballantyne, '93, a prominent architect of New York. Mr. Ross referred to the preparatory importance of the University course in fitting a man for the profession of engineering. He noted the various ways in which the public regarded the profession in general, and intimated in this connection that possibly the engineer did not take the place in public life that he should, suggesting that too much work and too great a devotion to his own particular field, might be the cause of the engineer's shortcomings in the matter of participation in public affairs. The broadening field of engineering leading as it now does to administrative work and to positions on commissions was in itself an indication of the necessity for an exceptionally broad training for the engineer of the future.

Mr. Ballantyne's tribute to the profession centred chiefly about the Dean, and he dwelt briefly upon the remarkable appreciative manner in which the engineers of prominence in the city of New York regarded him and his work.



John Galbraith, M.A., LL.D.,
Dean, Faculty of Applied Science and Engineering, University of Toronto.

Dr. Galbraith, in responding to the toast given in his honor, dwelt reminiscently upon his early experiences at the University, which he entered fifty years ago as a student, his object being to learn engineering. Much to his surprise, he found that although the University assigned examinations and awarded diplomas in engineering in 1863, no actual instruction was given. Hence, he enrolled in Arts.

In 1878, he undertook the task of teaching engineering. This was the beginning of the "School." From 1878 to 1889, Dr. Galbraith and Dr. Ellis, assisted by professors in Arts, gave all the instruction. The Dean pointed out that his first assistant was Mr. G. H. Duggan, a graduate of 1883, now vice-President and Chief Engineer of the Dominion Bridge Company, who was present at the meeting.

Dr. Galbraith pronounced the graduates of thirty years ago to be as well trained as are our present graduates. The course of training given at that time equipped a man for the responsibilities of his work as fully as does the present curriculum, the difference being in the scope of the engineering field now as compared with thirty years ago. He stated that his long experience indicated that the system of training engineering students in the University of Toronto compared very favorably with the systems which obtain in the other great Universities of the world.

This brief summary of the prominent features of the event does not serve to illustrate in any manner the general feelings of loyalty, appreciation and gratitude, which accompanied every remark and every occurrence throughout the occasion. From the first graduate of the School who left its halls in 1881, to the men who anticipate graduation ceremonies in 1917, it is sufficient to state that practically all years were represented, and that almost every city in the Dominion sent its quota to participate in an event to honor Dean Galbraith.

HANDLING SHIPPING IN PANAMA CANAL

Development of plans for meeting the demands of shipping in the Panama Canal in the way of terminals, coaling stations, warehouses, wharves, dry docks and repair shops, are outlined in the report to the war department of the Isthmian Canal Commission for the year ended June 30 last. The report was prepared by Colonel George W. Goethals, chairman and chief engineer of the Corps of Engineers, U.S.A.

Terminal facilities for shipping, the report states, cannot be completed by the time the canal is ready for passing vessels. The reason for this is the fact that the authorization for preparing such facilities was not made by Congress till August 24, 1912, and active operations could not be begun until the fall of that year.

The Pacific terminals which are being constructed by the commission, will consist of a main dry dock capable of docking any vessel than can utilize the locks, a smaller dry dock for use of smaller craft, a plant for supplying coal and fuel oil to vessels, the necessary wharves and piers for commercial purposes, and the permanent shops for use in connection with the dry docks.

The Atlantic terminals consist of wharves and piers at Cristobal, including the Cristobal mole, all of which are being constructed by the Panama Railroad at its own expense, and the main plant for supplying coal and fuel oil to vessels. The cost of the coaling plant will be divided between the commission and the railroad, while the commission will furnish facilities for oil.

Numerous applications, the report states, have been received from coal dealers for loading space for the handling of their coal in supplying vessels that will use the canal. In order to encourage the business of furnishing coal to vessels which use the canal, the policy has been adopted of providing storage in connection with both coaling plants for the coal piles of individuals and companies who desire to participate. It was never intended that the government should exercise a monopoly of the coal business on the Isthmus, but to utilize the coal stored there for the use of the navy in maintaining uniform prices of this product to shipping. There will be a certain rental charge for the areas occupied by the coal dealers, and, in addition, a real estate tax of 1 per cent. of the value of the improvements, should any be made, and a merchandise tax of 5 cents for each 2,000 lbs. of coal sold.

The government will attend to all the handling and charges for putting the coal into storage and taking it out; charges for the use of coal barges, and other labor in connection with this service will be fixed at cost price to the government for such service.

ARMSTRONG, WHITWORTH'S NEW CANADIAN PLANT.

PROMINENT among recent additions to Canada's home industries in the metal trades, is the new plant of Messrs. Armstrong, Whitworth of Canada, Limited, now nearing completion at Longueuil, Quebec, across the river from Montreal. Readers will recall a reference to this new industry in June 19th, 1913, issue. The parent English company, of Sir W. G. Armstrong, Whitworth & Company, Limited, with its several huge plants, is one of the oldest and largest manufacturers of high-speed crucible tool steel in the world. The new

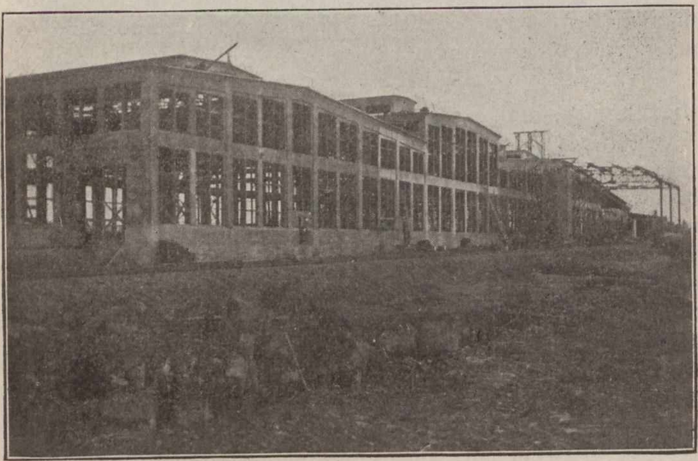


Fig. 1.

Canadian plant profits from this experience, commencing its operations with the advantages of equipment and processes that have been found desirable by the older company. It will manufacture high-grade tool steel, including the "A.W.," "T.Y.R." and "A.W. Premier" brands, drills, reamers, cutters, taps and dies, machine tools, cranes, forgings, lock and dock gates, etc.

With complete equipment for the manufacture of these standard lines, and also of special steels where re-

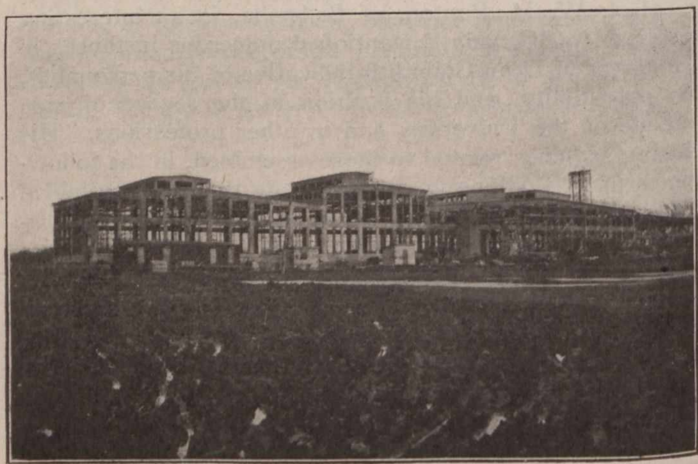


Fig. 2.

quired, and with production capacity large enough to supply all reasonable requirements, the new plant will supply a real need in the Canadian metal trades. It is the company's intention to carry a complete and ample stock of standard lines, so as to insure quick deliveries.

The plant itself embodies the most modern ideas, in layout, construction and equipment. The accompanying illustrations give partial views of the main building, which is located near the main line of the Quebec, Montreal and Southern Railway. A siding was run in alongside of the building and continued to the water-front. Another siding runs along the north side of the building, and a third siding into the building. The total length of all sidings is approximately a mile. The building itself is 500 feet long, 175 feet wide at one end and 100 feet wide at the other end, with a boiler house separate from the main structure. It is of steel construction, with reinforced concrete walls and roofs, except on the north side, where the walls are of timber with metal lath and plaster, thus providing for future extension of all departments, seven in number, in this direction. Both by reducing the size of pilasters and cornices to the medium width, having due regard to strength, and by means of monitors and skylights, all the different departments have been made as light as possible.

Practically all of the foundations are on solid rock. A trench 5 feet wide and from 7 to 14 feet in depth was run from the main building down to the water-front, where the pump-house has been built. This trench contains a 24-inch vitrified clay pipe for water discharge, and an 8-inch cast-iron water pipe for the plant's water supply, provided by electrically driven centrifugal pumps. Underneath the pump-house, a concrete-lined pit was sunk to a depth of 6 feet below the lowest known water level of the St. Lawrence River. From the bottom of this pit, a tunnel lined with heavy timbers was run under the water-front road and from the point at which it emerged on the shore, a trench was dug for a distance of about 300 feet out into the St. Lawrence River. In this trench an intake or crib was built—the end being 5 feet below the lowest recorded level. This insures a continuous supply of water to the pump-house at all times of the year. As the formation in the bottom of the river was hard-pan, the trench was taken out without any sheet piling being used, the excavation from the trench being piled up on either side, thus forming a dam to prevent the trench being flooded. No seepage into this trench took place. A sludge gate is provided on the river side of the pump-house, so that the intake of water may be shut off at any time.

Wonderful turbines will drive the mammoth Cunarder Aquitania, which is now being completed at Clydebank. They have a total weight of 1,400 tons, and to enable them to be lowered into the hull of the ship, one of the four great funnels could not be placed in position. There are more than a million turbine blades, the combined length of which is more than 140 miles. The blades vary in length from one and a half to twenty inches. These turbines are absolutely the latest production of marine engineering.

In a lecture given in Berlin, Germany, before an audience consisting largely of electricians, Herr Reiss, an engineer, described an invention by which he claimed that the range of the telephone will be enormously extended. He stated that with the apparatus, which consists of a new form of relay, conversations over 2,000 kilometres can be heard with as much distinctness as those held over half that distance at present. It would appear that all the financial and other preparations have been made by big electrical companies here for putting the invention on the market without delay.

RESISTANCE OF STEEL TO WEAR.*

By George L. Norris.

THE increasing speeds and heavy duty of machinery and motive power with resultant shortening of length of service of parts through rapid wear, makes the study of wear-resisting qualities of metals, especially steel, one of increasing importance. In the railway field, the increasing wear of tires and rails due to increased loads and speeds is a serious problem. Not only is it desirable to have high resistance to wear, but it is necessary to have other qualifications, strength and toughness, to insure against failure or breakage. The tests described in this paper were undertaken with the object of studying the relations, if any, between the wear resistance of various steels and the various physical properties of elastic limit, tensile strength, and hardness. Owing to several protracted interruptions, only a relatively small proportion of the tests projected have so far been completed.

There are three classes of wear:—

(1) Abrasion, such as grinding, to which crushing and extracting machinery is subjected.

(2) Lubricated sliding or rolling friction; such as that to which machine parts, axles, shafting, etc., are subjected.

(3) Dry rolling friction, to which wheels and rails are subjected.

The first class, wear by abrasion, is in many ways less important than the other two. It has, however, been utilized frequently as a means of comparing the wearing qualities of metals for all three classes. The machines for the purpose are some form of grinding machine and the specimens are ground or abraded under a constant pressure for a certain length of time.

The signs of wear by lubricated friction in the past have been largely confined to bearing metals rather than steel. This has been due undoubtedly to the fact that steel is usually worked against soft bearing metals or bronzes. The investigation of the wear resistance of steel and iron under lubricated friction, however, is growing more important with the increasing severity of the requirements of service. Probably the most satisfactory device for testing wear under lubricated sliding friction is the Derihon machine, consisting of a hard steel disc revolving in oil, and against the edge of which is pressed the test specimen.

The third class, wear by dry rolling friction, is the most important, especially when we consider the vast tonnage of steel in service in the form of rails, wheels and tires.

A machine for investigating wear under dry rolling friction was described by Mr. E. H. Saniter in 1908, before the Iron and Steel Institute, and consists essentially of a revolving test specimen which drives by friction the inner ring of a ball-bearing, the outer ring of which is stationary and loaded.

The investigations of the author have been confined so far to the third class of wear, dry rolling friction. The machine used is a modification of Dr. Stanton's fatigue-testing machine. This machine consists essentially of three case-hardened rollers, 3½ in. in diameter. The two lower rollers are driven by gears, while the third, upper

*From a paper read at the Atlantic City meeting of the American Society for Testing Materials.

roller, is driven by friction. The upper roller is carried in the lever by which the load is applied to the test specimen. A load of 1,000 lbs. on the specimen is possible with this machine. The rollers each have a groove in the middle, ¼ in. wide, to take the corresponding band on the test specimen and to keep it from lateral motion. If the rollers all revolved at a uniform speed the amount of wear on the test specimen would be very slight, practically nothing, as there would be no slippage of the test specimen. In order to accelerate the wear and approximate as nearly as possible the actual wearing conditions of wheels and rails, the two lower rollers are driven at different speeds to produce a slippage of the specimen. This is accomplished by having two less teeth in one of the driving gears.

The test specimens are 2 in. long and ⅞ in. in diameter; the guide band is ⅛ in. larger in diameter and a scant ¼ in. wide. They weigh about 160 grammes, and can be accurately weighed on a chemical balance to 1/10 of a milligramme. The diameter of the specimens which this machine will take can vary from ⅝ in. in diameter to 1½ in. in diameter, if desired. The driving speed of the machine is 1,000 r.p.m., and the speed of the test specimen is about 5,000 r.p.m.

The usual run before weighing is 100,000 revolutions of one of the driving rollers, corresponding to practically 500,000 revolutions of the test piece. In the tests included in Tables I. and II., the applied load was 224 lbs., or 100 kilograms; except in the cases noted in Table I., the specimens were all turned from rolled bars, 1⅛ in. in diameter.

While the tests show a general decrease in the amount of wear as the hardness and strength increase, the progression is irregular, and there are several instances where softer steels show less wear than the harder ones, as for example 12 and E-1; C-1 and F-1.

It is evident that the composition of the steel influences the resistance to wear to a considerable degree. Robin, in his investigations, found that nickel, chromium and vanadium each increased the resistance of the steel to wear. Nusbaumer in his tests found remarkable resistance to wear in low-carbon tests with manganese about 1.5 per cent. Saniter, on the contrary, did not find increased resistance to wear in the case of the few alloy

TABLE I.

Mark.	Wear; milligrammes per 1,000,000 revolutions.	Treatment; degrees Cent.	Carbon, per cent.	Manganese, per cent.	Silicon, per cent.	Chromium, per cent.	Nickel, per cent.	Vanadium, per cent.	Remarks.
P	3813.2	None	0.25	0.60	—	—	—	—	—
P-1	2436.4	825/600	0.25	0.60	—	—	—	—	—
O	1462.0	None	0.45	0.48	—	—	—	—	—
O-1	1334.8	825/600	0.45	0.48	—	—	—	—	—
8	1120.5	None	0.66	0.70	0.27	—	—	—	Tire
M-1	1104.1	825/600	0.28	0.61	0.28	—	3.10	—	—
12	1079.6	825/600	0.75	0.68	0.25	—	—	—	Tire
E-1	1043.1	825/600	0.43	1.30	—	—	—	—	—
U-1	958.0	825/650	0.58	0.65	0.20	1.26	—	0.20	Tire
C-1	829.8	829/600	0.38	0.30	—	1.16	2.08	—	—
K-1	436.8	900/600	0.46	0.90	0.11	1.03	—	0.14	—
F-1	371.9	825/600	0.48	1.15	—	—	—	0.22	—
22	368.8	900/625	0.62	0.62	0.27	0.95	—	0.24	Tire
Y-1	367.8	900/600	0.28	0.50	0.12	0.96	—	0.22	—
J-1	261.0	900/600	0.46	0.86	0.06	1.02	—	0.22	—
D-1	230.1	825/600	0.42	0.22	—	1.27	2.14	0.26	—

NOTE—Under the heading "Treatment," 825/600 degrees Cent., indicates that the specimen was oil-quenched from 825 degrees and drawn back at 600 degrees Cent.

TABLE II.

Mark.	Wear; milligrammes per 1,000,000 revolutions.	Hardness— Brinell.	—Hardness Scleroscope.	Elastic limit; lbs. per sq. in.	Tensile strength; lbs. per sq. in.	Elongation; per cent. in 2 in.	Reduction of area, per cent.	Treatment; degrees Cent.
P	3813.2	134	23	47,000	68,000	33.0	57.3	None
P-1	2436.4	170	27	58,000	80,000	28.5	67.0	825/600
O	1462.0	156	26	43,000	79,000	28.5	47.5	None
O-1	1334.8	207	30	71,000	96,000	23.0	57.3	825/600
8	1120.5	196	34	63,000	121,000	14.0	19.0	None
M-1	1104.1	207	30	87,000	100,000	25.0	67.5	825/600
12	1079.6	228	38	97,560	144,930	15.0	23.0	825/600
E-1	1043.1	223	35	91,000	105,000	23.5	58.6	825/600
U-1	958.0	248	43	98,000	120,000	19.0	52.8	825/650
C-1	829.8	286	47	127,000	134,000	20.0	57.3	825/600
K-1	436.8	340	54	156,000	163,000	15.0	45.0	900/600
F-1	371.9	262	42	115,000	127,500	18.5	54.7	825/600
22	368.8	302	43	128,000	147,000	16.5	42.0	900/625
Y-1	367.8	293	50	137,000	148,000	16.5	46.0	900/600
J-1	261.0	340	54	162,000	167,500	14.5	49.0	900/600
D-1	230.1	340	52	156,000	161,150	16.0	53.3	825/600

steels he reported, except for a high-manganese steel of the Hadfield type. His chrome-vanadium and nickel-chrome steel gave greater wear with greater hardness than simple carbon steel of about 0.70 per cent. carbon and 0.60 per cent. manganese.

The tests which I have made confirm the conclusions of both Robin and Nusbaumer, and also those of actual service experience, that manganese, nickel, chromium, and vanadium have a marked effect on the wearing qualities of steels. Manganese apparently has a greater effect than either nickel or chromium. Vanadium, however, evidently has a much greater effect than either of these three elements, as it only requires a very small percentage to produce a marked increase in resistance to wear. This is apparent in steels E-1 and F-1; and C-1 and D-1, each of which pair is practically alike, except for vanadium. These tests are only a small proportion of those planned, and it is the intention to cover not only a considerable range in composition and heat treatment, but also to study the effect of rollers of different composition and hardness, on the rate of wear of the various steels.

STRUCTURAL MATERIALS AND CLAY PRODUCTS

The following is a statistical table of structural materials and clay products as contained in the Economic Minerals and Associated Industries, by J. McLeish, Chief of the Division of Mineral Resources and Statistics, Canada:—

Product.		Quantity.	Value.
Cement, Portland	Bls.	7,132,732	$ 9,106,556
Clay products: ($10,575,709)			
Brick, common	No.	769,191,532	7,010,375
" pressed	"	125,180,422	1,609,854
" paving	"	4,579,500	85,989
" moulded and ornamental	"	371,356	8,595
Fireclay and fireclay products		....	125,585
Fireproofing and architectural terra-cotta		....	448,853
Pottery		....	43,955
Sewerpipe		....	884,641
Tile, drain		....	357,862
Kaolin	Tons.	20	160
Lime	Bus.	8,475,839	1,844,849
Sand-lime brick	No.	96,448,402	1,020,386
Sand and gravel (partial record)		....	1,512,099
Slate	Sq.	1,894	8,939
Stone: ($4,726,171).			
Granite		....	1,373,119
Limestone		....	2,762,936
Marble		....	260,764
Sandstone		....	329,352
Total		....	$28,794,869
Grand total		....	$135,048,296

Work was begun Nov. 5th on the one thousand foot pier in the Hudson River at Forth-sixth Street, that marked the beginning of harbor improvement which it is claimed by its initiators will place New York on a par in accommodations for shipping with the great harbors of the world. Other piers of equal length are planned, and eventually the entire Hudson River waterfront, city officials predicted to-day, would be re-built for the accommodation of the great ocean liners of the future.

COAST TO COAST.

Hamilton, Ont.—About one mile of Hydro street-lighting has recently been turned on in Hamilton on Barton Street.

Vancouver, B.C.—Preliminary work on the overhead bridge to be erected by the C.P.R. to produce Granville Street to the waterfront is well advanced.

Regina, Sask.—The report of Superintendent Venzke, of the civic Parks Department shows that 8⅓ miles of new boulevards were graded last year in Regina.

Moose Jaw, Sask.—Another street car service has been formally opened in Moose Jaw, e.g., the car line built to Boulevard Heights, about two miles from the centre of the city.

Ottawa, Ont.—It is stated that the surplus over operating expenses on the I.C.R. will exceed this year by a considerable amount the million dollar mark. Last year's surplus did not attain the million mark; but since rates have been raised, and traffic has increased.

Owen Sound, Ont.—Owing to an extraordinary expenditure upon bridges during the past year, the County Treasurer, Mr. S. J. Parker, has stated to the Council that, in his opinion, the treasury will show a deficit of about $10,000 at the end of the year.

Regina, Sask.—In the recent report made by Superintendent McKay, of the Waterworks Department, it is shown that 101,281 feet of water pipe have been laid under contract during the last ten months, and 2,941 lineal feet of pipe by day labor, making a total length of pipe laid in the city of 104,222 feet, or approximately 20 miles.

Ottawa, Ont.—The last connecting rail has been laid between Quebec Bridge and Yellowhead Pass, no particular ceremony being connected with the event. Though the laying of steel is by no means the final act in completing a line, authoritative information has been given to the effect that when traffic at Winnipeg is offered, the railway will be able to handle it.

Regina, Sask.—The Waterworks Department has shown very economical management during the past year, $17,000 less than the estimated amount of $59,670 having been expended. The estimated capital expenditure of $546,178.70 was also in excess of the actual expenditure of $496,082.06. The operation of the waterworks system showed a profit of $57,327.33, which gives a net surplus of $4,570.69 after debenture charges are deducted.

St. Catharines, Ont.—During the year thus far, building permits of approximately three-quarters of a million dollars have been granted in St. Catharines. A like amount has been expended on local improvements. The expenditure on new constructive work during 1913 will thus be in excess of $1,500,000 within this city; and on the new Welland Ship Canal construction in close proximity to the city, contracts amounting to $34,000,000 have already been let.

Le Pas, Man.—The first trial of the receiving instruments at the wireless station signals has been made, and Operator E. Richards reports signals obtained from Sayville, N.Y.; Arlington, near Washington, D.C.; Cape Cod, Mass.; Glace Bay, N.S.; and also from the stations on the Pacific Coast of the United States; so that this station can hear what is transpiring at both sides of our continent. The signals from all stations on the lake shores can be distinctly heard, and also from most of the boats on the lake.

Fort William, Ont.—The excavating of a tunnel under the main building of the Canadian Car and Foundry Company in connection with the construction of Stanley Avenue sewer has been commenced. The tunnel must be driven approximately 160 feet under the building, and a shaft will have to be sunk in the centre of the floor of the building which will allow four gangs of men to work simultaneously, two gangs at the bottom of the shaft, one working west, the other east; and two gangs, one at either end of the tunnel working centrewards.

Victoria, B.C.—Several small forces of men are already engaged on the north-west sewer construction at different points along the ravine which runs from Burnside Road down to the Gorge Road and thence to Selkirk water. Arrangements with the C.N.P. Railway for the right-of-way are expected to be successfully concluded so that no delay or postponement of the work will be occasioned, and so that the whole work may be opened in this section in a short time. The next section of the undertaking to be commenced will be the Esquimalt section; and on this excavation work will be more difficult, owing to the more rocky nature of the district.

Estevan, Sask.—The experimental plant at Estevan, which the Saskatchewan Government has just lately finished erecting for the purpose of determining the exact value of lignite coal for power purposes, briquetting, etc., is in operation under the management of Mr. S. M. Darling, a well-known expert, under whose supervision the plant has been erected. Mr. Darling has shipped a car of "carbonized lignite fines" to Cape Breton, where this product will be tested as a powdered fuel in the Bettingen boilers of the Dominion Coal Company's plant. The larger sizes of the carbonized lignite it is the intention to use in gas producers to generate electrical energy, and in chain grate furnaces for steam power. It is expected that the result of these tests will solve the power problem of Saskatchewan.

Regina, Sask.—Good progress on the power house under construction at Regina has been reported by Superintendent Bull. The building walls, machine foundations, and a small part of the floor in the boiler-room of the new power house have been completed. Partial equipment of machinery boilers and piping is awaiting installation; and it is hoped to have sufficient equipment to operate the first 1,500 k.w. machine installed and housed under a temporary wood building by Christmas. The output of the plant for the past ten months has been 6,017,610 k.w. hours, while for the corresponding ten months of 1912 it was 3,186,938, which shows an increase of 88.8 per cent. The capital expenditure for the ten months was as follows: on the new power house by-law, $132,418.71, of which $18,994 has been in wages; on the by-law for electric light and power extension, $129,589.71, of which $16,688.10 has been paid in wages.

Vancouver, B.C.—Eight of the nineteen steel bridges on the British Columbia section of the Canadian Northern Pacific Railway have been completed, and are available for traffic. Of the remaining eleven, three are at present well under construction, and another has been commenced near Jackass Mountain, 126 miles east of Port Mann, at the present end of steel. One of the three bridges is at Lytton, where the C.N.P. line crosses the Fraser River a mile below the town. It will be 870 feet long, and will be constructed with four plate girder spans and three deck truss spans. Its foundations have been completed, and its superstructure well advanced. A 250-foot viaduct is being constructed in the Black Canyon, 189 miles east of Port Mann, and will be a 210-foot through truss span with a deck plate girder. At mile 81 on the section of the C.N.P. north of Kamloops, a 600-foot bridge is being erected over the North Thompson River at Birch Island, which will have seven spans. Late reports from the engineers in charge state that four of the spans have been placed, and traffic is being handled over the river to mile 90, the present end of steel, by means of a temporary structure.

Regina, Sask.—City Engineer McArthur has furnished a report of the works completed by his department during the past year. A total area of 140,288.5 square yards of pavement at a total cost of $481,372.12 have been laid. Of this area, 80,874.8 square yards are bitulithic; 58,922.6 square yards, sheet asphalt; and 421.1 square yards, Westrumite. The length of pavement would be about 8 or 9 miles, though the width for residential streets is 24 feet, and otherwise 32 feet. The total length of sewers laid in the city, including the work done on the contracts of the previous year, was 96,936.3 lineal feet, or approximately 18½ miles; and the total cost, $553,731.84. The total current expenditure of the department, which includes repairs to pavements, walks and sewers, street grading, street cleaning and salaries, was $85,174.65, which was about $7,200 over the estimated expenditure for this department. The total expenditure of all the work carried on under the department during the ten months totalled $1,226,939.36. The total engineering expenses, including salaries for the entire staff and inspectors and all office expenses and supplies, came to $23,643.68, being less than two per cent. of the cost of the work.

Calgary, Alta.—City Electrician Brown submitted on November 27th to Commissioner Graves a report on the estimated receipts and the expenditures for the municipal electric department. The total estimated revenue is given as $575,000; the total estimated expenditure, $545,053.01, leaving an estimated surplus of $29,946.99. Commissioner Graves proposes to use this surplus to help pay for the placing of wires underground. Electric light and power rates are now very low in Calgary, and placing the wires underground will add both security and an improved appearance to the city. An approximate estimate of the required electric light extensions for 1914 was also furnished to the commissioner by Mr. Brown. Approximate costs for these amounted in all to $350,000, the money to be secured by the customary by-law.

Kamloops, B.C.—Recently the Hon. F. W. Aylmer, Dominion Government engineer at Chase, had a conference with City Engineer Wilson, of Kamloops, concerning the proposed wharf extensions and promenade along the Riverside Park waterfront. It is expected that the government may consider, in addition to what it will be asked by the city to undertake in the work the erection of a permanent concrete wall along the waterfornt of Riverside Park and the dredging of the river, leaving the city to complete the decking, etc. This would give Kamloops one of the finest river wharves in the Dominion, besides affording easy and safe navigation to steamers at all stages of the water, as well as providing a park promenade and "embankment" that would be well in keeping with the ornamental plans of Riverside Park, as approved by the city, and a magnificent river frontage that would be second to none in the West.

Vancouver, B.C.—Mr. M. Swan, M.I.C.E., M.I.M.E., M.C.S.C.E., at one time engineer for the Montreal Harbor Board, and recently returned from South America, where he has been engaged as a government consulting engineer, has made a personal inspection of Vancouver harbor, and also the sites of harbor projects for Greater Vancouver, and has submitted a report to the Vancouver Harbor Commission. He states that Vancouver has in embryo the finest harbor in the world, and that no expense should be spared in developing it and providing proper facilities. He emphasizes the necessity of securing an eleavtor site and of erecting at once at least a small elevator. He recommends unhesitatingly the widening of the channel to 1,400 feet with a depth in the main channel at low tide of 40 feet. He says that the harbor lines along False Creek should be sharply defined without further delay, and the channel dredged; but points out very emphatically that the dredging must not endanger the basements of the bridge piers now existing. He urges the government to secure water frontage wherever it may be had on the shores of Burrard Inlet or False Creek; and, in referring to Greater Vancouver harbor propositions, he warns promoters to make careful tests to be certain that the works will not be endangered by quicksands.

Regina, Sask.—Superintendent McKay, in his recent report on the work of the Waterworks Department of Regina during the past operating year, urges the construction of a new 27-inch main from Boggy Creek to the city in the coming year. Considerable progress has been made at Boggy Creek throughout the past year. The Tohill 5,000,000 reservoir was completed and filled. This reservoir is at such an elevation above the city that the gravity pressure is sufficient for ordinary pressure. 3,525 feet of vitrified tile pipe have been laid in the Boggy Creek basin for the collection of water, bringing the total length of collection lines up to 10,925 feet. Twenty wells have been sunk, bringing the total to date up to 35 wells, of which 33 are yielding water, the other two being plugged with sand. The duplicate Crossley engine and Allan pump installed in the pumping-house this year gives two units, either of which is able to deliver the whole city's supply. The new 5,000,000 gallon capacity pump will be nistalled at the city power house this year, but in the opinion of Superintendent McKay it will be necessary to use it only for fire purposes.

Vancouver, B.C.—Steel structural operations are reported as started on the overhead bridge to be built by the Canadian Pacific Railway from the foot of Burrard Street to the waterfront in connection with the other units of its terminal improvement scheme. Material is being assembled and work is well under way with piers, the foundations for which have been ready some time. The footings for a portion of the new structure have been already set, but until the immigration sheds are removed it will not be possible to complete the dock-end of the viaduct. However, tenders for the new immigration building have been called; and when this has been completed, the old sheds will be removed. The viaduct will be a substantial structure. The steel bents will be set in concrete piers on concrete foundations. It will be about 300 feet long and 50 feet wide, with a ramp on an easy incline to afford communication with the dock levels. Until the immigration sheds are demolished and the necessary space afforded at the north end of the bridge the viaduct will only be available for pedestrian traffic. Steps will lead from the docks to the waterfront end of the bridge.

CORRECTION.

In the article, entitled "The Rotary Type Air Pump," on page 817 of December 4th issue of *The Canadian Engineer*, the illustration, Fig. 2, showing an interesting installation of a 4,000 K.W. Surface Condensing Plant, appears inverted. We trust the reader will mark it as such without delay, so that a future reference to it will not be misleading.

PERSONAL.

W. A. CLEMENT, engineer of South Vancouver, has tendered his resignation to the Municipal Council.

PATRICK WELCH, of the firm of Foley, Welch & Stewart, prominent railway contractors on the Pacific Coast, is dangerously ill at Seattle.

E. A. JAMES, C.E., of James, Loudon and Hertzberg, consulting engineers, Toronto, has been elected to the standing of member in the American Society of Civil Engineers.

ANGUS SMITH, late City Engineer of Regina, Victoria, and North Victoria, has been chosen by the City Council of Prince Albert to succeed City Engineer M. H. Baker, resigned.

W. L. COULSON, who for several years past has been general manager of the Canadian Collieries (Dunsmuir), Limited, has resigned from that position in order to obtain the rest necessary for his health.

T. C. KEEFER, C.M.G., Ottawa, who was recently elected an honorary member of the American Society of Civil Engineers, and a few months previous, of the Institution of Civil Engineers of Great Britain, entered upon his ninety-third year a few days ago.

GEORGE WESTINGHOUSE was formally awarded the Grashof medal at the annual meeting of the American Society of Mechanical Engineers in New York last week. This is the highest honor which the engineering profession in Germany can bestow upon any individual.

HILDER DAW, A. M. Can. Soc. C.E., has been engaged by the city of Sherbrooke, Que., to revise the existing plans and to design an adequate system of sewers for the city. Mr. Daw has had some years' experience in England upon drainage and sewage purification work, and has spent seven years in America upon similar work.

The City Council of London has appointed Hon. Adam Beck and Mr. Phillip Pocock, chairman of the Water Commission, for a term of two years, and Messrs. William Spittal and M. D. Fraser, for a term of one year, as Commissioners to electrify and operate the London and Port Stanley Railway. Mayor Graham is an ex-officio member.

GORDON KRIBS, the contributor of the first article in this issue, will be remembered by many of our readers as a graduate, with the class of '05, in engineering of the University of Toronto. He was then associated with the firm of Smith, Kerry & Chace, and for several years managed a branch office of that firm at Portland, Ore. Since then he has resided in Dallas, Texas, as assistant chief engineer of the Texas Power and Light Company.

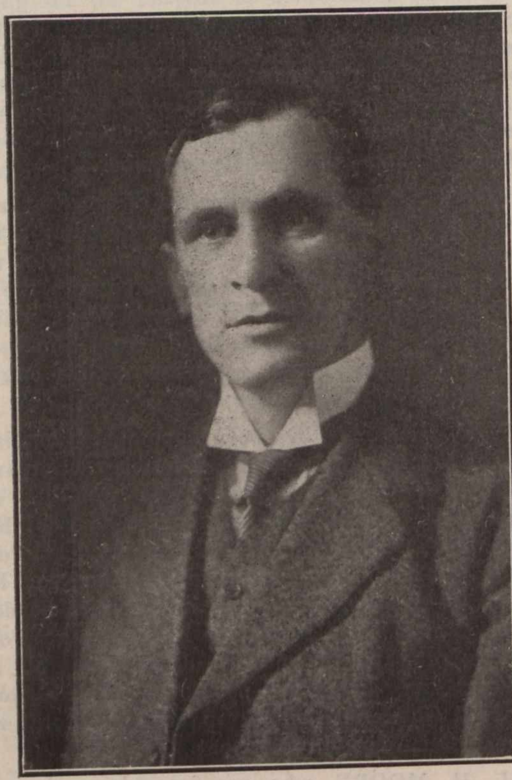
R. P. D. GRAHAM has been appointed Canadian sales manager of the Goodyear Tire and Rubber Company, succeeding P. D. Saylor. Mr. Saylor, who won an enviable reputation while at the head of Canadian sales of both tire and mechanical rubber goods, has been advanced to the presidency and managing-directorship of Goodyear Tire and Rubber Company (Great Britain), Limited, with headquarters in London, Eng. While regretting his departure from Canada, Mr. Saylor's many friends are delighted by his appointment to such an important position. He will now have charge of all Goodyear sales throughout the world with the exception of the American continent.

PHIL. H. MOORE, who was formerly engineer of the McKiernan-Terry Rock Drill Co., of New York, and who has been for some time past sales manager of the cement mill and mining machinery department of Canada Foundry Company, has resigned to become general manager of Rock and Power Machinery, Limited. The last named firm is a new concern organized by Mr. Moore and four well-known Canadians to act as sole Canadian sales agents for a number of United States manufacturers of rock drills, crushers, hoists, pumps, concrete mixers, mining machinery, etc. The head office will be in the Royal Bank Building, Toronto, with sales offices in the King Edward Hotel, Toronto, and in Montreal, Winnipeg and other cities.

E. H. BENNETT, Chicago, has been engaged by the Ottawa and Hull City Planning Commission to take charge of the replanning of these two cities. E. L. COUSINS, engineer Toronto Harbor Commission, was appointed to assist him. As announced in this journal some months ago, the Commission propose to prepare a comprehensive plan for the enlargement and beautification of these cities and surrounding territory, the plan to include park schemes, arrangement of governmental and civic buildings, and industrial sites, a treatment of the waterways, etc. The preparation of these plans constitute the work of the Commission. It is being financed by the Government and the cities, the Government to pay 50 per cent. of the cost, the city of Ottawa 40 per cent. and Hull the remainder.

ADAM CAMERON, M.A., B.Sc., who succeeds Prof. C. M. Carson as head of the Department of Chemistry at the University of New Brunswick, Fredericton, N.B., Professor Carson having resigned to become Professor of Chemistry at the Michigan College of Mines, has recently assumed his official duties.

Professor Cameron was born in Perthshire, Scotland, and as a student had a distinguished career at the University of St. Andrew's, where he later held the Carnegie Research Scholarship. In conjunction with Professor J. C. Irvine, of that University, he conducted valuable research on the sugars, the results of which work were published in the Transactions of the Chemical Society. Later, as assistant to Dr. James Walker, Professor of Chemistry in the University of Edinburgh, he spent five years of active study and research. He comes to Canada direct from the University of Edinburgh, and will be a valuable asset to the Department of Chemistry in the University of New Brunswick.



Adam Cameron, M.A., B.Sc.,
Professor of Chemistry, University of New Brunswick.

T. R. DEACON President and General Manager of the Manitoba Bridge and Iron Works, was, by acclamation, re-elected mayor of the city of Winnipeg on December 2nd.

The Shoal Lake water scheme of the Greater Winnipeg Water District, as it now stands, having successfully passed the periods of contemplation and discussion and reached the stage where actual engineering work is in progress, is the result of the untiring energy which Mr. Deacon has put into it. The furtherance of the scheme is largely accountable to him and his achievements in this respect are remarkable, considering the gigantic proportions of the enterprise, and a good deal of adverse opinion which had to be overcome.

Mr. Deacon graduated from the School of Practical Science, Toronto, with the class of 1891. He followed his profession of civil engineering for eleven years, during which period he was for a time town engineer of Rat Portage (now Kenora), Ontario. In 1902, he founded the Manitoba Bridge and Iron Works at Winnipeg, and since that time has taken a very prominent part in the municipal and administrative duties as a citizen. In 1907, he became a member of a commission to investigate the water supply of the city. Three years later, he was a commissioner in connection with the Workmen's Compensation Act. For two years he was Provincial Vice-President of the Canadian Manufacturers' Association, and for four years a member of the Council of the Winnipeg Board of Trade.

The admirable combination of finance, commerce and engineering, of which it is his good fortune to have such a composite knowledge, fits him well for the position which he now holds, and his re-election by acclamation to the chief executive chair in Winnipeg civic administration, is an indication of the evidences of his efficiency and capability to handle, among other things, the great undertaking upon which Winnipeg is entering to procure a safe and sufficient water supply.

BACK COPIES WANTED.

One of our subscribers, anxious to bind his copies of *The Canadian Engineer*, is minus the following issues: Feb. 19th, 1909; Jan. 19th, 1911; Jan. 26th, 1911; Feb. 9th, 1911; March 16th, 1911; March 30th, 1911; April 6th, 1911; April 13th, 1911; April 20th, 1911; April 27th, 1911; May 4th, 1911; May 11th, 1911; May 18th, 1911; May 25th, 1911; June 1st, 1911, and would be glad to pay 25 cents per copy for any of them. Will subscribers who happen to have these numbers, and who do not care to keep them, kindly send them in to this office, and we will see to it that they are put into the hands of the party interested?

OTTAWA BRANCH, CANADIAN SOCIETY OF CIVIL ENGINEERS.

The Ottawa Branch of the Canadian Society of Civil Engineers held its annual dinner at the Chateau Laurier on December 4th, and the function was well attended. Mr. Geo. A. Mountain, president of the Branch, presided, and his associates at the head table were Prof. Adam Shortt, Collingwood Schreiber, Lieut.-Col. Anderson, G. J. Desbarats, D. McPherson, T. C. Keefer, Mr. A. St. Laurent, and G. A. Mothersill.

COMING MEETINGS.

AMERICAN ROAD BUILDERS' ASSOCIATION.—**Tenth Annual Convention to be held in First Regiment Armory Building, Philadelphia, Pa., December 9th to 12th. Secretary, E. L. Powers, 150 Nassau Street, New York, N.Y.**

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS.—**Annual Meeting to be held in New York, December 10th to 13th. Secretary, C. D. Odsen, Polytechnic Institute, Brooklyn, N.Y.**

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS.—**Seventh Annual Convention will be held at Great Northern Hotel, Chicago, December 29th to 31st. Secretary, I. W. Dickerson, Urbana, Ill.**

AMERICAN CONCRETE INSTITUTE.—**Tenth Annual Convention to be held in Chicago, February 16th to 20th, 1914. Secretary, E. E. Krauss, Harrison Building, Philadelphia, Pa.**