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THE HIGH TENSION TRANSMISSION SYSTEM OF THE HYDRO-ELECTRIC POWER COMMISSION OF ONTARIO.

FOURTH ARTICLE.

Dundas Station.—The Dundas station (Fig. 25) is the main interswitching station of the present system, and from here the outgoing transmission lines radiate to the various sub-stations.

The station equipment consists of four 750 kv-a. oil insulated, water cooled, 110,000 to 13,200-volt Westinghouse

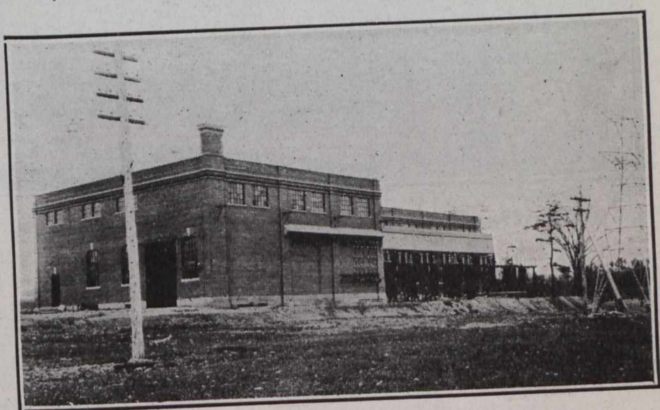


Fig. 25.—The Dundas Inter-switching Station.

step-down transformers, employed to supply the city of Hamilton and vicinity; seven 110,000-volt Westinghouse electrically operated circuit-breakers equipped with condenser type bushings; six sets of outdoor type, 110,000-volt, electrolytic lightning arresters and two sets of 13,200-volt, electrolytic lightning arresters.

Seven 110,000, three-pole automatic solenoid-operated oil switches, one for each incoming and outgoing line and one for each bank of three 750-kv-a. transformers are also installed Two sets of 110,000-volt buses are supported on horizontal I-beams near the roof, in a manner similar to those at the Niagara Falls station. Disconnecting switches are provided on the line side of the oil switches, while on the station side two sets are installed and so arranged that any of the lines may be connected to either set of buses. (Fig. 26).

The same method of installing and removing transformers is employed as at Niagara. In fact, the same arrangement is in all stations in the system. The transformers are connected star delta with low-tension winding potential of 13,200 volts. A spare transformer is provided to replace the transformers of the connected bank, in case any of them become disabled.

The 13,200-volt switches and busbars are enclosed in concrete cells. The present structures accommodate the transformer switch, two line switches, and the service transformer switch. They are all automatic, electrically controlled oil switches, each provided with relays best suited for the requirements of the service for which they are employed. Service transformers are provided to supply light and power to the station. Three oil-insulated, self-cooled, 75-kv-a. transformers, stepping down from 13,200 to 2,200 volts serve the town of Dundas. (Fig. 27).

The apparatus in the station is operated from an enclosed control room situated at one end of the high-tension switch room, in which are located the main control and service boards, similar to those at Niagara. The control switchboard carries all the control switches operating at 110-volt d.c. for the remote control of the high and low-tension

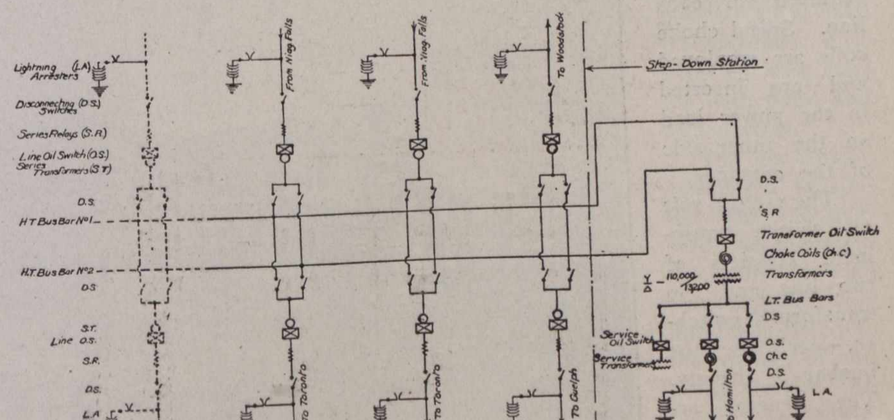


Fig. 26.—Wiring Diagram, Dundas Station.

power switches, and also the meters. The service board is a regular switchboard employed to distribute the power to the different lighting and power circuits in the station.

The mechanical and cooling equipment in general is the same as in the step-up station.

Condenser bushings are used in both the Niagara Falls and the Dundas stations on all high-tension switches and transformers. The Canadian Westinghouse Company furnished and installed the entire equipments, with a few exceptions, of these two stations. Arrangements are being made at the present time for the installation of an additional bank of transformers and the necessary switches. (Fig. 28).

Toronto Station.—This station (Fig. 29) is divided into three rooms, each running the entire length of the building, and consisting of the high - tension switching, transforming, and the low - tension switching sections.

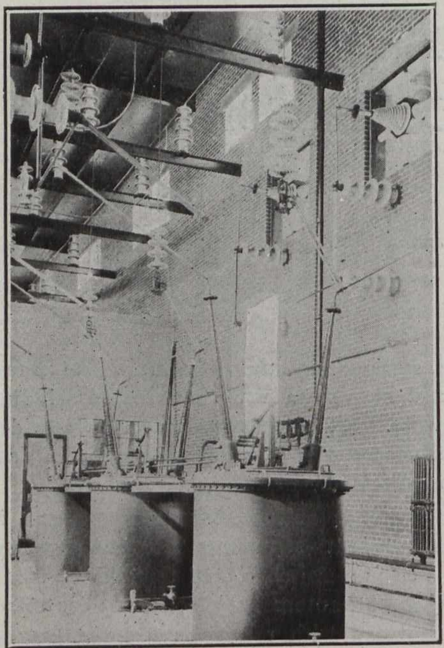


Fig. 27.—110,000-Volt Breaker Unit, Dundas Station.

The incoming lines are protected by electrolytic arresters placed within the building, and provided with horn gaps mounted on steel structures outside. The hoods for the outlets are built with a floor, upon which the entrance bushings, consisting of stacked porcelain rings with a pronounced petticoat, are mounted. The different sections of the bushings are clamped together with a brass bolt extending through the centres, the intervening spaces between the brass and porcelain being filled with concentric fibre rings and insulating compound. Since the arresters are placed inside and the horn gaps outside the building, six bushings are required for each line. Spiral choke coils are employed and are inserted in the power lead on the inner side of the entrance.

The 110,000-volt oil switch equipment consists of two line and two transformer switches, each in the busbar circuits. The general arrangement of the 110,000-volt buses and connections are similar to those at Niagara Falls and Dundas, with the exception that the insulators used are of a corrugated rather than a petticoat type. General Electric oil switches and transformers are employed and provided with bushings built of annular ringed sections of compound clamped together, the interior space being filled with concentric cylinders of treated fibre compound. (Fig. 30).

The transforming equipment consists of two banks of 1250 kv-a. transformers stepping down the transmission

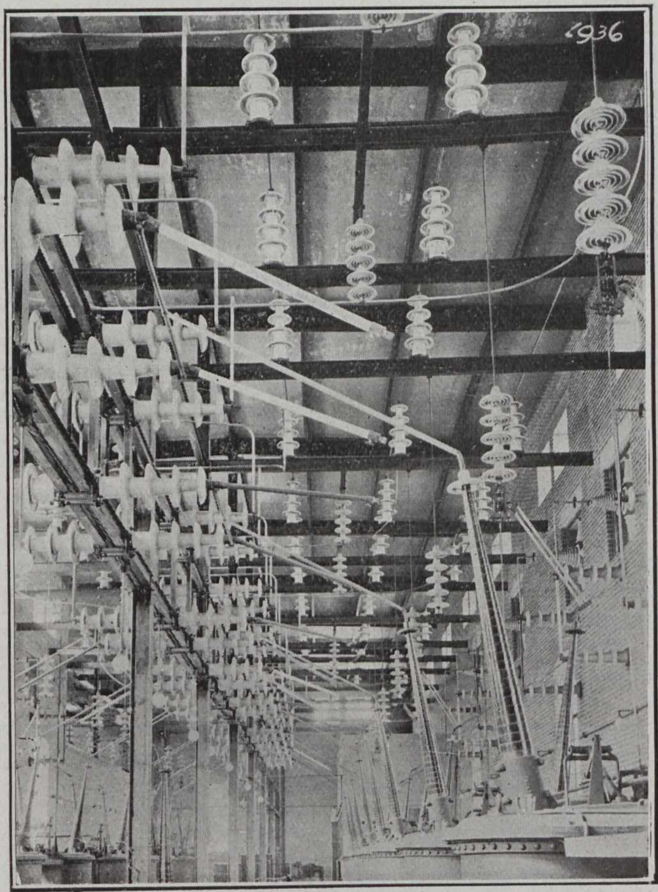


Fig. 28.—General View of 110,000-Volt Layout, Dundas Station.

voltage to 13,200 volts. The low-tension leads branch and run through the oil switches to two sets of buses, each of which is divided into two parts. The cell work is built with pressed brick walls and concrete shelves. Ultimately, two ring buses will be installed, each being divided into four sections. At the present time there are eight feeders installed, each provided with automatic oil switches for connecting to either set of buses. The oil switches and buses are located in two rows on a gallery while the potential and series transformers are placed in compartments on the main floor immediately beneath the switches. The buses are protected by aluminum cell surge protector sets. The outgoing feeders to the five municipal sub-stations in different parts of the city leave

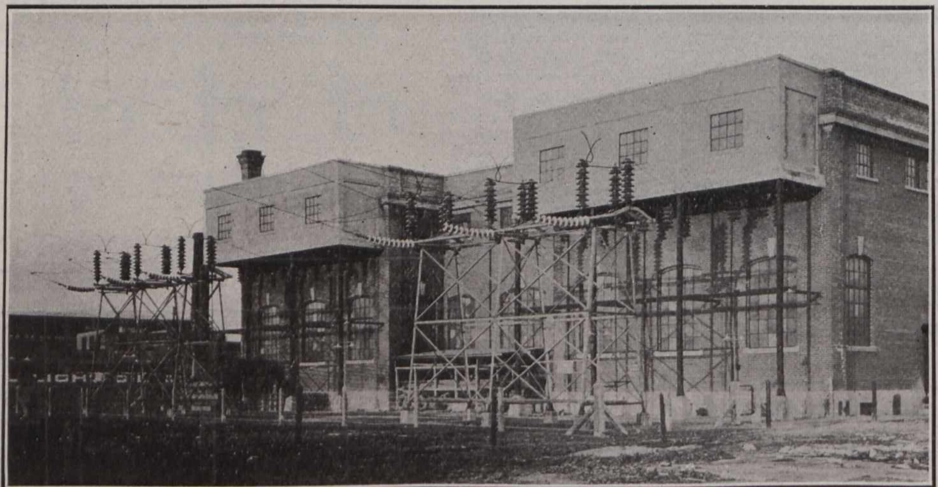


Fig. 29.—Toronto Station.

the building by underground ducts. These municipal stations are located in such a manner that they may be electrically connected in a "loop" circuit.

The city of Toronto is at present installing transformers stepping down from 13,200 to 2,200 volts in the basement of the station, which will be used for city service, mainly to

going lines in each station are provided with electrolytic arresters. The transformers are supplied with current at high potential, from the buses through automatic oil switches. Disconnecting switches are installed on either side of the oil switches, except on the transformer side of the transformer oil switch.

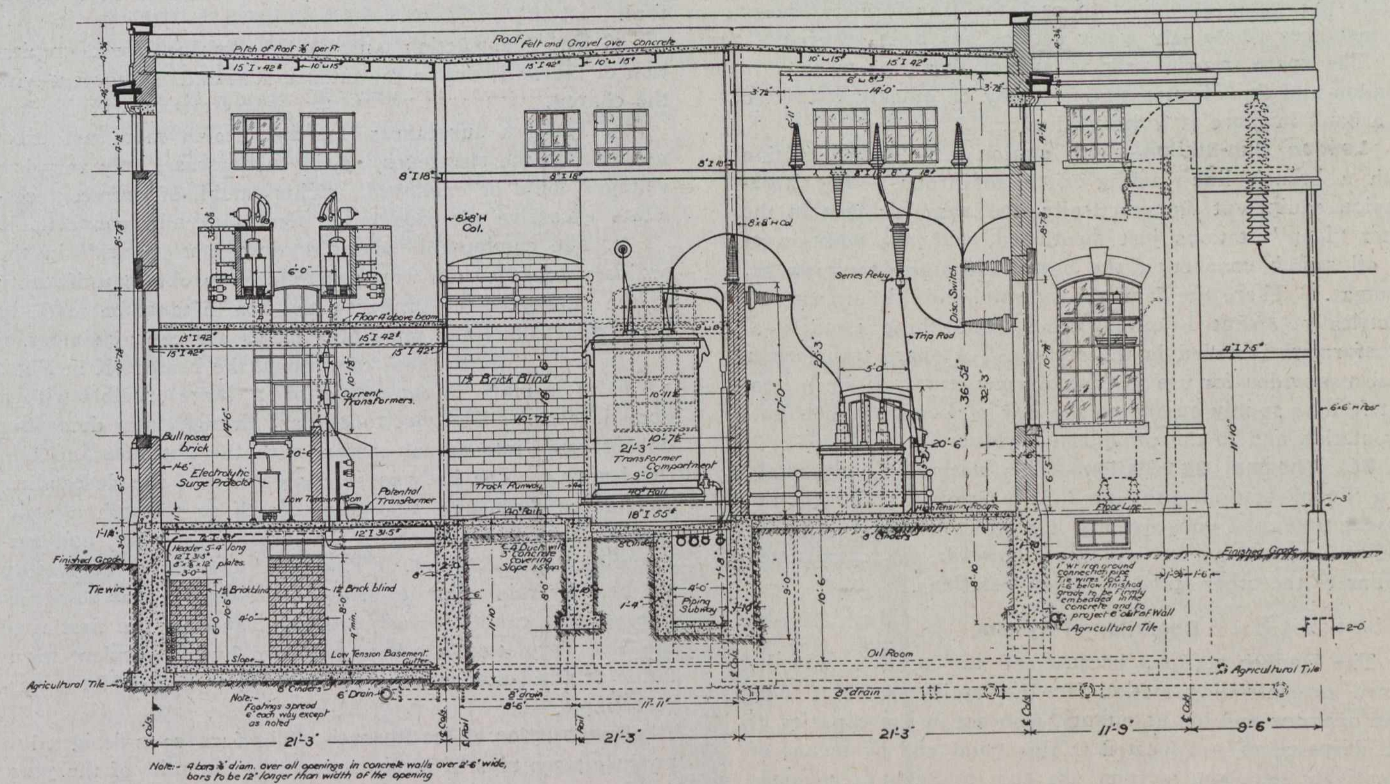


Fig. 30.—Transverse Section, Toronto Station.

supply energy for the factory load of the city, a large part of which is located within one-half mile of the station. (Fig. 31).

The control switchboard is located on a small gallery. All 110,000 and 13,200-volt switches are operated from the board. Curve drawing meters are mounted on the feeder panel for recording both the load and power factors.

A concrete pump house has been constructed a few hundred yards distant on the shore of Lake Ontario with an intake pipe extending 500 feet into the lake to provide cold water for cooling purposes. Duplicate motor-driven pumps and a service equipment similar to that at the Niagara Falls station is employed.

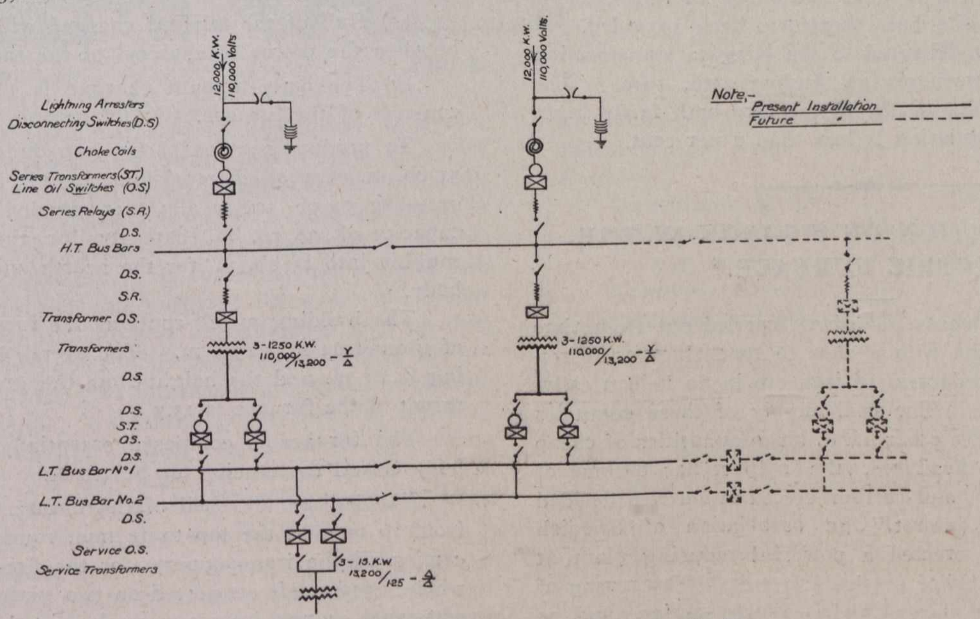


Fig. 31.—Wiring Diagram, Toronto Station.

Loop Stations.—The 110,000-volt equipment is similar in each of the "loop" stations. The lines enter the stations through automatic oil switches to the buses, and pass out through similar circuit-breakers. The incoming and out-

Each station is equipped with a bank of three single-phase 750 kv-a. oil-insulated, water-cooled transformers and also a spare unit available for use in case of an emergency. The low-tension winding potential is 13,200 in every case with the exception of Preston, where the greatest transmission distance is only six miles, and 6,600 volts potential was adopted for distributing purposes. All transformers are supplied with taps for both 6,600 and 13,200 volts.

The low-tension equipment is similar, and the general arrangement the same in all stations, the only difference being in the number of outgoing feeders. All feeders are equipped with automatic, hand-operated oil switches, disconnecting switches, switchboard panels containing indication and recording meters, relays and handles for operating the switches, and protected by electrolytic lightning arresters.

Provisions were made for six outgoing feeders at each of the present stations. Preston, Berlin and

Woodstock are now utilizing their full complement of feeders.

The service equipments, both electrical and mechanical are in general the same as those employed in the stations previously described, except that no storage batteries or motor generator sets are required because the switches are hand-operated. Duplicate water-pumps are provided to circulate the water employed to cool the transformers except in instances where city water service has been secured.

The spare transformers in any of these, as well as in London and St. Thomas stations, may be quickly connected in a bank in place of a disabled one.

London Sub-Station.—This station is a "loop" station with a branch line running off the main bus. The high-tension equipment is practically the same as that in the other "loop" stations just mentioned, with the addition of an oil switch connecting the buses and line supplying St. Thomas. There are four 110,000-volt and six 13,200-volt electrically operated oil switches, and three 1,250 kv-a. transformers installed in the station. A spare transformer is also provided for use in case of emergency. Four 13,200-volt feeders supply energy to the city of London's distributing station and to the provincial asylum.

St. Thomas Sub-Station.—This station will ultimately be a "loop" station, although it is a terminal station at the present time, and consequently has no 110,000-volt outgoing line equipment. The building, however, is constructed similar to the other standard "loop" stations.

Operation of System.

The Dundas station, because of its location, was designed as controlling station for the entire system. The chief operator and his assistants, who act in the capacity of load despatchers, are located at this point and by means of the private telephone system are able to keep in constant communication with the operators at the other stations. The switching equipment which has been provided makes it possible to cut out a section should trouble occur and yet supply energy to all the stations on the high-tension line. Since the Niagara station is the source of supply for the entire system it is essential that communication be maintained between this and Dundas station at all times, and a duplicate telephone line has, therefore, been provided.

Energy was first delivered to the Niagara transforming station for testing purposes on August 25th, 1910. The load and power factors of the system are both fairly high, while the voltage regulation is less than 2 per cent.

THE PRODUCTION OF PIG-IRON IN THE ELECTRIC FURNACE.*

Extensive experiments have been carried out from time to time in Scandinavia with a view to rendering commercially practicable the reduction of iron ore in an "electrically-fired" blast furnace. The coal supply of these countries being poor, and, on the other hand, large quantities of cheap electric power being available, the subject has become of particular importance, and further investigation was decided upon by the "Jern-Kontoret," an association of Swedish ironmasters. They erected a powerful reducing plant at Trollhättan, the site being particularly suitable by reason of its proximity to the large hydro-electric station, and as regards transport facilities. The results recorded in this article cover experiments and investigations which lasted six months, and terminated in June, 1911.

* Translated from Le Génie Civil and printed in the Electrical Review.

Principles Governing the Design of the Furnace.—The following special considerations had to be carefully taken into account in the design:—

1. Working with high temperatures produced electrically, means must be taken to obviate current losses through the linings of the furnace, particularly because the materials in question increase in conductivity with the rise in temperature.

2. The construction must make allowance for decrepitation of the walls due to the intense heat and the contact with the charge.

3. The hot substances in the hearth must not exert pressure on the electrodes, as, in such a case, only very low voltages could be employed. This would, of course, necessitate excessive dimensions of electrodes and connections.

4. The combustible material does not "burn" in the ordinary sense of the word; therefore, to obtain uniformity in the quality of the products, the hearth must be made of large dimensions and must also act as a mixing chamber.

In order to fulfil these conditions, the hearth (K in Figs. 1 and 2) is made in the shape of a large crucible with a domed cover. The electrodes pass through this dome but do not come into actual contact with the hot substances in the hearth. The body is so designed that the descending substances discharge into the hearth as through a cone, leaving a clear space above the level of the slag, and surrounding the electrodes. The usual method of regulating the heat by raising or lowering the electrodes, for constructive reasons cannot be adopted here, and for the first time the heat regulation has been achieved by independent regulation of the voltages on each of the two phases of the current employed.

Construction of the Furnace.—The furnace is designed to produce 7,500 tons of pig-iron during 11 months of the year, or about 23 tons per diem. The following data were established as basis for calculation:—

(a) 1 cb. m. of wood charcoal weighs 150 kg.

(b) To produce 3 kg. of iron, 1 kg. of charcoal is required.

(c) 1 kg. of pig-iron can be obtained from 1.725 kg. ore.

(d) Specific gravity of ore employed = 2.5 kg./cu.dcm.

(e) Half of the mineral charged will fill the interstices between the pieces of charcoal of the same charge.

(f) The daily amount charged is 1.55 times the cubic contents of the furnace.

To produce 23 tons of pig-iron under these conditions, 51 cb. m. of wood charcoal must be mixed with 7.9 cb. m. of ore—say 59 cb. m. in all; this, divided by 1.55, gives a capacity of 38 cb. m. capacity for the furnace, divided roughly into 13 cb. m. for the hearth and 25 cb. m. for the body.

The building which contains the furnace covers a piece of ground 24 m. x 15½ m. The overall height of the building is 21 m. and the height from the ground level over the throat of the furnace is 13.7 m.

The furnace is composed essentially of two parts, the body C and the crucible or hearth K.

The boiler-plate shell of the former varies in thickness from 10 mm. at the top to 12 mm. round the cone; it also carries all the iron supports for the fire-brick lining. The whole structure is supported on two girders by means of an octagonal channel-iron framework riveted to the shell. Thus the weakest part of the furnace, the dome of the crucible, is relieved of all stress and independent expansion is possible for each of the essential parts. The joint between them is made with sand. The maximum internal diameter of the lining is 450 mm., tapering to 360 mm. at the throat. The charging cone is actuated by a 2½-b.h.p. motor, and the charges of ore and charcoal are raised to the charging stage by a 16-h.p. motor.

The crucible hearth or melting chamber rests on a solid concrete bed, and like the body is encased in boiler plate, which here is 15 mm. thick. At the point where the weight of the dome is taken, the shell is reinforced by a steel band having a section of 200 mm. x 18 mm. The lining of refractory material is covered with magnesia bricks, and the floor of the hearth is formed of magnesia bound with tar. Fig. 3 shows the original section of the hearth, and its appearance after six months' working.

Four electrodes, (E, Figs. 1 and 2) two to each phase of the two-phase current used, pass through asbestos-packed gas-tight openings in the dome, making an angle of 65 deg. with the horizontal. Each electrode is made up of four pieces of carbon, has a total section of 660 x 660 mm. and weighs 1,300 kg. The average loss in weight by burning away is 5 kg. per ton of iron produced, but to this must be added an equal amount rendered unfit for any further use. Outside the crucible the electrodes pass through copper water jackets. Connection with the cable leads is made by cast-steel terminals, which clamp the cables to the carbons.

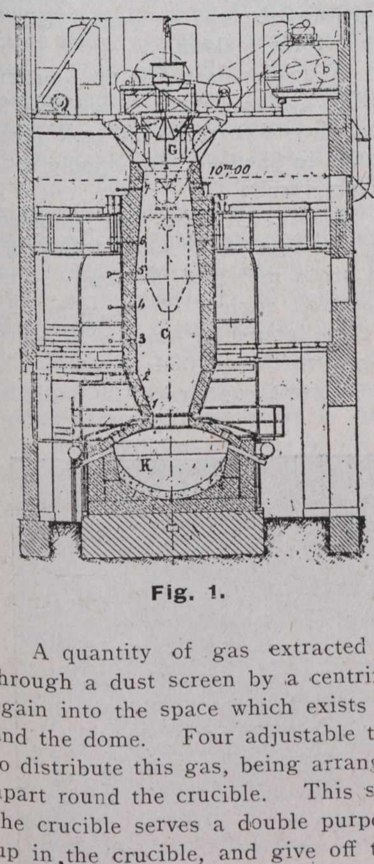


Fig. 1.

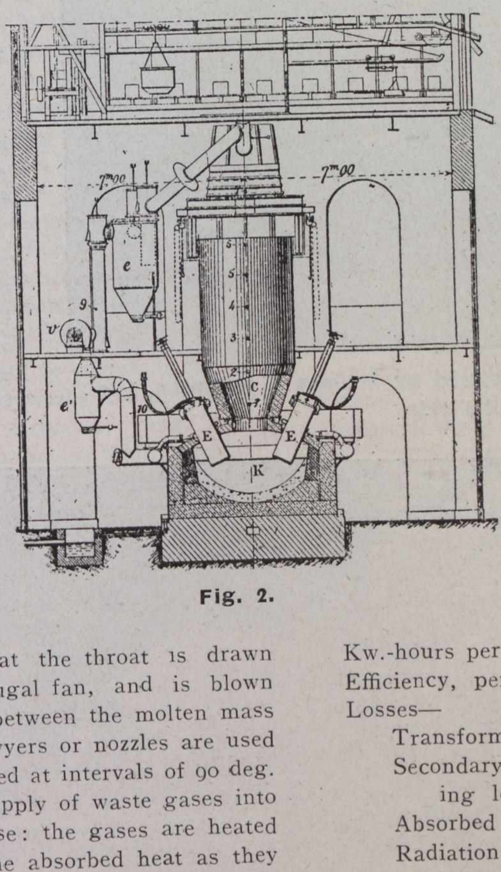


Fig. 2.

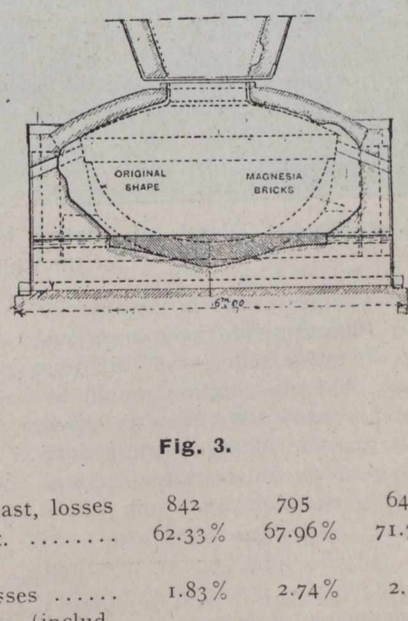


Fig. 3.

A quantity of gas extracted at the throat is drawn through a dust screen by a centrifugal fan, and is blown again into the space which exists between the molten mass and the dome. Four adjustable twyers or nozzles are used to distribute this gas, being arranged at intervals of 90 deg. apart round the crucible. This supply of waste gases into the crucible serves a double purpose: the gases are heated up in the crucible, and give off the absorbed heat as they pass into the upper zones, thus materially assisting the reduction; further, they cool the dome, and thus prevent its too rapid destruction. With gases at 200 deg. C., and containing equal volumes of CO and CO_2, 70 cb. m. per minute at a pressure of 325 mm. water gauge are blown into the crucible by the 8-h.p. electric fan. There are the usual fittings for drawing off the slag and the iron.

Electrical Equipment.—The supply is three-phase at 10,000 volts, and is transformed to two-phase current with a pressure variable in each phase from 50 to 100 volts. From the transformers the energy is led to the furnace by four leads, each lead consisting of six copper strips 200 mm. x 8 mm. in section. Each strip, again, is connected to eight cables, each having 185 sq. mm. section; thus 48 cables having a total section of 8,800 sq. mm. are connected to each electrode.

Electric measuring instruments of various kinds are supplied, including platinum and platinum-rhodium pyrometers.

The current varied between 3,000 and 18,000 amperes, with a pressure variation of between 50 and 100 volts per phase. The power used varied considerably, the load ranging from 300 to 2,000 kw.

Conclusion and Results.—Three series of experiments were made by Messrs. Leffler and Nyström, of the "Jern-Kontoret," in the six months referred to, and the results are tabulated below:—

Number of experiment	I.	II.	III.
Mean primary load, kw.	1,319	1,717	1,680
Mean secondary voltage—			
Phase I.	65.2	75	81.9
Phase II.	65.9	83	88.2
Mean secondary amperes—			
Phase I.	13,731	13,564	11,922
Phase II.	13,416	11,817	10,406
Kw.-hours per ton cast	2,296	2,481	2,241
Kw.-hours per ton cast, useful work	1,454	1,686	1,595
Kw.-hours per ton cast, losses	842	795	646
Efficiency, per cent.	62.33%	67.96%	71.77%
Losses—			
Transformer losses	1.83%	2.74%	2.12%
Secondary losses (including leads)	3.31%	3.83%	3.03%
Absorbed by cooling water	6.53%	6.57%	6.53%
Radiation and other losses	26.00%	18.90%	16.55%
	100%	100%	100%
Calorific value of waste gases per cubic metre	2,786 cal.	2,892 cal.	2,544 cal.
Of this 80% only can be utilized	2,230 cal.	2,315 cal.	2,035 cal.
Consumption of charcoal in hectolitres per ton cast	25.02	23.88	21.66

The average consumption of charcoal in other furnaces is 62.8 hl. per ton.

In conclusion, it is interesting to note that the most serious incident in the six months' work was an explosion in the crucible due to the rapid descent into the molten mass of a quantity of powdered ore which had not been thoroughly dried.

SOME FALLACIES AND FACTS CONCERNING ENGINEERING WORKS IN GREAT BRITAIN.

By W. A. MARTIN,
Late Assistant General Manager of the Toronto Electric Light Company.

(Continued from last issue.)

Messrs. Willans and Robinson, Rugby.

A few years ago a visitor to any of the electric power supply stations in the United Kingdom would have expected to find in almost every power house long rows of vertical steam engines, all exactly alike, direct coupled to electric generators. The generators in the different power stations would have been constructed by a number of different makers, but the engines would almost invariably have been the then highly popular Willans central valve high speed vertical engine. The output of each individual unit would generally have been less than 1,000 h.p. and the total power required would have been obtained by running a large number of these units together.

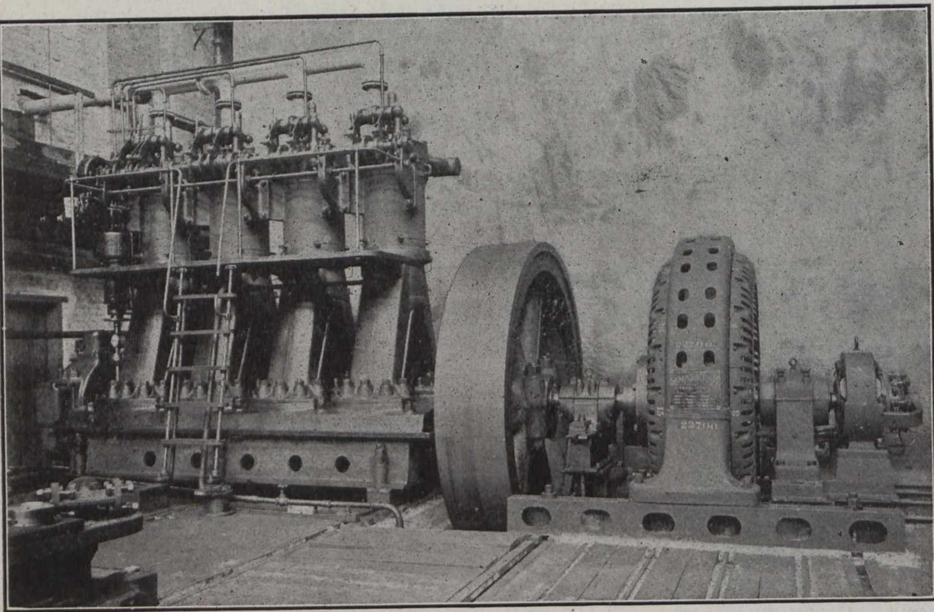


Fig. 6.—200-kw. Diesel Oil Engines Manufactured by Willans & Robinson, Ltd., for the Chilian Oil Fields.

The perfecting of the steam turbine with its higher economy, smaller floor space and lower capital cost, has, however, changed all that, and for the last eight years Messrs. Willans and Robinson have had to compete with the Willans steam turbine for every contract going with a number of other makers of this newer type of prime mover. Their well-equipped works enables them, however, to generally quote prices that compete favorably with other makers, and there are a number of special details in the construction of their turbines that appeal to the engineering buyer. One of these features is the shrouding of the turbine blades, which has practically eliminated the frequent stripping of blades, which was at one time such a source of trouble in steam turbines. Such troubles as were still encountered were due to the excessive unsupported length of the shaft and the admission to the turbine body proper of steam at high temperatures. The firm's latest disc and drum design overcomes these difficulties entirely. It embodies the impulse principle at the high pressure end and retains the reaction principle at the low pressure stages. A further advantage of this design is that it occupies considerably less floor space than the earlier types.

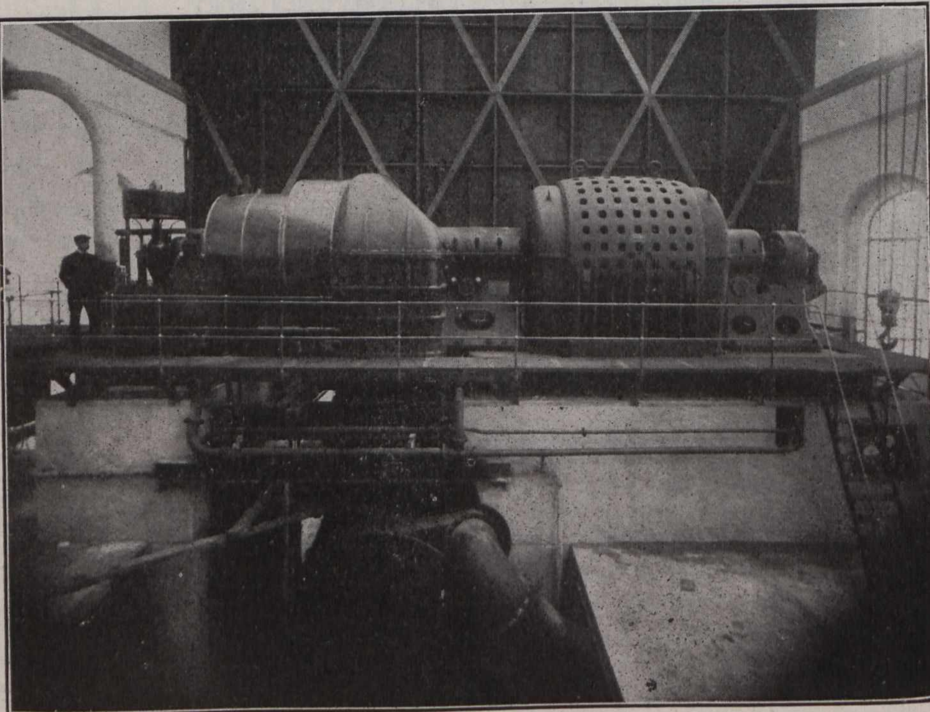


Fig. 7.—8000-kw. Disc and Drum Steam Turbine Built by Willans & Robinson, for the Sheffield Corporation.

Messrs. Willans and Robinson have recently executed an order for one of their new disc and drum type 8000-kw. turbo generators for the Sheffield corporation electricity department, and through the courtesy of Mr. S. E. Fedden, the city electrical engineer, I was afforded an opportunity of seeing this plant in operation. It appeared to be running perfectly in every respect, and the engineer in charge spoke very highly of its performance, which, he informs me, was in some respects better than called for in the specifications.

The condensing plant is of the surface type with vacuum augmentor and Edwards type air pump, built by the turbine makers.

A 400-kw. set of the maker's earlier design has been working for a number of years, in the same power station in Sheffield with equally satisfactory results.

Messrs. Willans and Robinson are amongst those who believe that the prime mover of the future is the Diesel oil engine. I saw a number of these interesting engines in course of construction at their works. The firm's great experience in building high-speed vertical steam engines particularly qualifies them for constructing engines of this type, which calls for specially careful workmanship and the use of the highest class materials. Here again I was struck by the large amount of work being executed for shipment, and was pleased to see steam turbines and Diesel engines being built for Canada.

The illustrations show the Sheffield disc. and drum turbine coupled to a Dick Kerr alternator. The Diesel engine shown is one of four 200-kw. sets sent last year to the Chilian nitrate fields.

Since returning to Canada I have been informed that the Electric Power Company has ordered a Diesel engine of about 600 h.p. capacity for their Oshawa plant from Messrs. Willans and Robinson after very thorough investigation by their consulting engineers, who sent an engineer to Europe for the purpose.

This firm has also, I am informed, recently received an order for a large steam turbine of some 9,000 k.w. capacity for shipment to British Columbia.

Messrs. The Sandycroft Foundry Company.

The Sandycroft Foundry Co., which is probably the oldest established concern of its kind in Great Britain, at their works near Chester specialize in the manufacture of mining machinery of all descriptions, including ore crushers, stamp mills, cyanide plants, winding engines, haulage gear, etc. They have also perfected an interesting alternating current motor known as the "Hunt Cascade Motor," which possesses the valuable property of being able to develop an output approaching its maximum over a very wide range of speeds. The Sandycroft Company have carried out a large number of contracts for complete mine equipment in India, South Africa, Spain, the Australian Colonies, South America and in other parts of the world. They are particularly interested in the prospects of mining developments in Canada, and intend to cater vigorously for this market.

They had a large amount of plant in course of construction at the time of my visit to their works and showed me, among other things, parts of an 8,000-h.p. steam engine they were building for one of the mines in South Africa. I was informed that the shipping weight of this engine, when completed, would be 280 tons.

Messrs. Mather and Platt, Limited.

This well-known firm was established nearly one hundred years ago and has recently built entirely new works on the most up-to-date principles, which are fitted with most modern machinery. They employ somewhere about 3,000 work-people, and the concern is the foremost in the world for the manufacture of machinery for the bleaching, printing, and finishing of cotton cloth; in fact, I was informed that almost all the machinery used in these processes of textile manufacturing owes its origin to them, and wherever cotton cloth is made the name of Mather & Platt is known in connection with the supplying of machinery for the finishing processes.

They are also very large electrical engineers, who have carried through the earliest railway traction work in Great Britain; and I was shown an immense amount of apparatus in course of construction in their electrical shops.

They were also the original manufacturers of the centrifugal turbine pump, now so widely known throughout the world.

Amongst their other departments those for the manufacture of fire appliances and plants for the purification of water are the most important.

A visit to these new workshops impresses one with the idea that the concern is full of enterprise and vigor, and is by no means falling behind in the engineering race, notwithstanding the long time it has been established.

Messrs. Dorman, Long & Company, Limited.

The Britannia Works of Messrs. Dorman, Long & Co., Limited, comprise steel furnaces, rolling mills and constructional and bridge shops. The steel is made by the basic open hearth process and is rolled into sections of all descriptions for use in engineering, shipbuilding, general constructional work and allied trades. The steel plant consists of ten basic open hearth steel furnaces and two large hot metal mixers and all operations in handling the material required for the manufacture of the steel are controlled by modern overhead electric cranes and charging machines. The output of ingots from this plant is approximately 20,000 tons per month. The hot ingots are delivered direct into the soaking pits of four rolling mills. The 32-in. and 31-in. reversing mills are steam-driven and the equipment is perhaps notable for the three-cylinder type of marine engine driving the finishing mills which is of 16,000-h.p. capacity. The entire mills are equipped with fast traveling electric cranes covering all operations. The output of sections of all kinds from these two mills is approximately 14,000 tons per month. The company have recently put into operation a new exhaust turbo station for the generating of electricity. The exhaust from the steam-driven mills is delivered through steam accumulators to four 1280-kw. mixed-pressure turbo-generators. This power station is of a most up-to-date and modern construction. The current from this station, in addition to driving two electric mills, supplies the power for the whole works. The electric mills consist of one 18-in. reversing mill and one 11-in. three high direct-driven mill. The sections rolled in these two electric mills are rounds, squares, flats, angles and bars of all kinds required in the engineering and shipbuilding trades. The output of these mills is approximately 6,000 tons per month.

The constructional and bridge department is the best equipped of its nature in Great Britain and has no equal on the Continent of Europe. The shops are 540 feet in length and consist of four bays with several lean-to buildings for special work. Each bay of the main shop is served by fast-traveling overhead electric cranes. Many novel features and improvements have been incorporated quite recently, all of which have independent motor drives. The shops are equipped with pneumatic and hydraulic appliances and are entirely closed in and well lighted. The output of bridge and building materials is approximately 3,500 tons per month. The current for both lighting and power purposes is generated at the company's central power station above mentioned.

At the Clarence Steelworks of the company the melting shop department consists of a gas-heated metal mixer capable of holding 400 tons of molten metal, and nine open hearth steel furnaces, of which eight are of 50 tons capacity and one of 60 tons. The bulk of the steel manufactured at these works is for special purposes in various carbons ranging from 0.08 per cent. to 1.5 per cent., a few of the specialties being soft steel for high conductivity wire and locomotive tubes, and hard steel for saws, picks, wire ropes, files, edge tools, etc. The ingots are taken from the steelworks and placed in coal and gas-fired soaking pits by two five-ton electrically driven cranes, from whence they are taken to the rolling mills, which are three high and consist of three trains of rolls, viz., cogging, roughing and finishing, the diameter of all three mills being 32 inches. The product of these mills is principally high carbon steel rails and billets, bars and slabs for the purposes above described.

A 100-ton electrically driven overhead crane is provided for changing rolls, so that the mills can be readily changed to roll various sections. Duplicate standards are also provided and a set is always ready fitted up with rolls and guides for the next section to be rolled. The blooms are cropped and cut to the required lengths by a pair of specially designed hydraulic shears. The blooms then go on to electrically driven lifting-tables which move them to each pass in the rolls. When the finished bar is rolled it is taken by live rollers, also electrically driven, to the hot saws. There are three "hot banks" and two saws, the second one being placed 291 feet from the rolls.

The wire department consists of wire rod rolling mill, wire drawing, annealing and galvanizing mills. The product is chiefly high-grade wire rods and wire for wire ropes. The department carries on a large export trade in wire rods and rope wire.

The sheet works department comprises eight sheet mills, four galvanized baths, eighteen puddling furnaces, and two ball furnaces. The capacity is 25,000 tons per annum of finished sheets, mostly iron, for roofing and other purposes.

The total number of men and boys employed throughout all the works is 4,500.

Dorman, Lang and Company are already catering for Canadian business and I was informed that they were manufacturing several sizes of structural steel beams in what is known as American sections and had shipped some two thousand tons of structural steel to Canada in the past year.

Messrs. Reavell & Company.

Messrs. Reavell & Company, of Ipswich, have concentrated their attention upon the perfecting of air compressors for all purposes. Their leading specialty is a 4-cylinder machine in which the cylinders are arranged radially in a unique manner so as to give a perfectly even turning effort and high efficiency, not only in working, but also in the small space taken up.

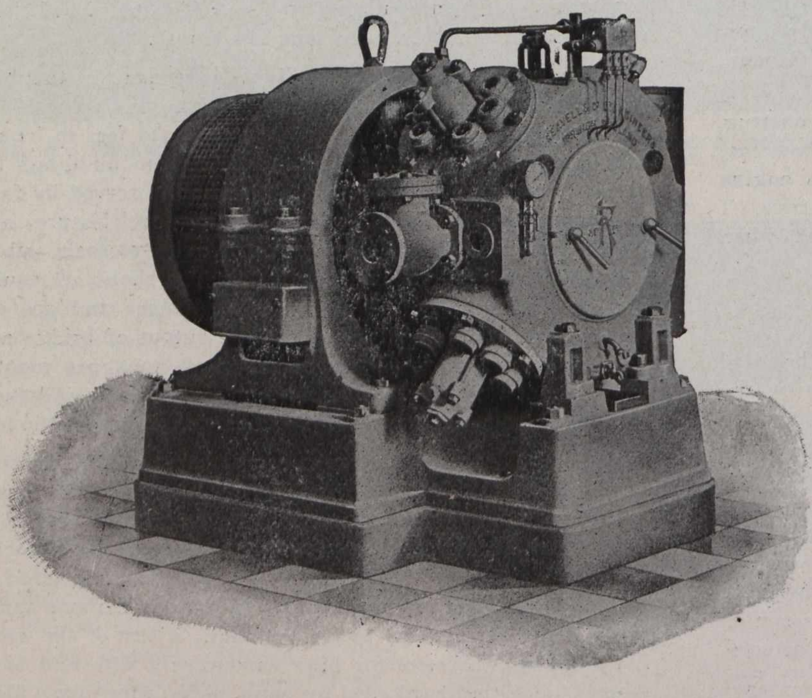


Fig. 8.—Four-Cylinder Reavell Air Compressor, Manufactured by Reavell & Co., Ipswich, Eng.

They are largely used for directly coupling to electric motors.

There should be a considerable demand for compressors of this type in Canada, where cheap electric power can be obtained in practically all districts. Quite a number of these plants have, in fact, already been installed in this country.

Messrs. Reavell also make ordinary straight line compressors, and for very large capacity plants the vertical type of compressor. I was particularly interested to see a large number of special compressors of very high pressure in course of construction for use with Diesel oil engines.

Ransomes, Sims & Jefferies, Limited. The Orwell Works, Ipswich, England.

This great business was established as far back as the year 1789 by Mr. Robert Ransome, and its history has been one of steady and continuous growth and expansion. At the present time about three thousand men and boys are employed at the Orwell Works.

Not only in Great Britain, but throughout the Continent of Europe and in all parts of Asia, South America, Africa and Australasia, where machinery can be used, is the name of Ransomes, Sims & Jefferies, Ltd., famous for the best steam engines and threshing machines the world has ever seen, as well as for stationary engines, ploughs, implements and the other specialties named.

The Orwell Works cover about thirty acres and consist of a group of four separate factories, comprising:—

(1) Engine and boiler works, foundry and smith shops.
(2) Threshing machinery and tea machinery works.
(3) Plough and implement works.
(4) Lawn mower works.

The various shops are well laid out and lighted by a first-class system of high-pressure gas, and in winter time warmed by steam for the comfort of the workmen.

The works are equipped with remarkably fine installations of the most modern machine tools and labor-saving appliances of all kinds, enabling the highest possible degree of accuracy to be attained in the production of work. The machine tools are so arranged as to ensure a continuous flow of work from the entrance of the raw material to the assembling and erecting shops.

Standardization and interchangeability of parts are carried to a high art in the Orwell Works, Ransomes, Sims & Jefferies, Limited, fully recognizing the great importance of this matter in connection with the supply of extra parts for their manufactures. Purchasers in distant countries have always the assurance, therefore, that no difficulties will occur in the adaptability of duplicate parts subsequently ordered.

In the threshing machinery works, where timber is necessarily largely employed, the most perfect system of wood-working machine tools prevails, thus ensuring rapidity of production combined with the highest degree of accuracy. Powerful electrically driven fans are provided in this department, which, by means of a system of exhaust pipes, extract all dust from the wood-working and grinding machines, thus maintaining the various shops in a clean and pure condition, conducing greatly to the comfort of the men. All threshing machines are thoroughly tested before leaving the works, being driven during the trials by electric motors.

The numerous types of threshing machines manufactured by the company are such as to fully meet the many different conditions of all the agricultural countries of the world, the threshing machines being equally suitable for dealing successfully with practically all kinds of cereals grown in both eastern and western countries. For countries where the threshed straw is utilized as food for animals, Ransomes, Sims & Jefferies' threshers are provided with a special apparatus, which reduces the straw to very short lengths, bruising it at the same time, thus facilitating mastication.

The plough and implement works, the largest factory of its kind in Great Britain, is one of the latest additions to the Orwell Works. This department comprises immense and magnificently laid out shops on the ground level, where thousands of types of ploughs and implements destined for all the agricultural countries of the world may be seen in various stages of construction.

The lawn mower works consist of a very perfect self-contained establishment, where the most modern and approved system prevails for the rapid, accurate and economical manufacture of motor, horse-power and hand-power lawn mowers of all kinds, together with well equipped stores where enormous quantities of these machines are kept in stock.

The Orwell Works include extensive stores for engines, threshing machines, ploughs and implements of various types, this being a matter of the highest importance in connection with prompt deliveries.

Electric cranes are in use in all the chief departments of the works, and the larger machine tools are driven independently by their own electric motors, which, together with the cranes, are supplied with current generated in the company's power house.

I visited a number of other engineering works while in the Old Country, notably those of Sir William Arrols & Company, Glasgow, the builders of the Forth Bridge; the Electric Construction Company, Wolverhampton, manufacturers of electrical apparatus; Callender's Cable and Construction Company, Erith, manufacturers of lead and paper insulated cables, anti-friction metals, alloys etc., and Galloways, Limited, Manchester, manufacturers of large gas engines, rolling mill engines, boilers and pumping plant, but space will not permit of my describing them here.

My entire visit convinced me that Great Britain is still able to hold its own as the premier manufacturing centre of the world and that in the design and manufacture of engineering apparatus and allied appliances is keeping quite abreast of the times.

I would strongly advise Canadian buyers who are contemplating making any large purchases of engineering plant to give full consideration to British-made goods before purchasing, and preferably to pay a visit to the works of some manufacturer in Great Britain who has specialized in the particular line of machinery required. Where buyers take the trouble to do this it almost invariably results in the purchase of British-made goods. Such a visit cannot but inspire confidence in the mind of the buyer that he is being shown methods and practices which can have but the one result, viz., the turning out of apparatus of the highest quality.

A double roof of reinforced concrete is one of the features of the ice palace recently built in Hanover, Germany. The barrel arch of this roof, which, as a span of about 69 feet, is supported on nine reinforced concrete rafters, and the thrust is taken up by the rods placed beneath the floor of the structure and anchored to the concrete of the haunches. The panels between the rafters form a thin interior reinforced concrete ceiling, and, being a continuation of the compressing slabs of the barrel arch rafters, they form virtually a complete unit. The second reinforced concrete roof, which rests on the square rafters of the barrel arch, is of heavier construction, and is covered with a layer of waterproofing felt. The air confined between the two roofs acts as an insulating material, and is said to reduce largely the influence of outside temperature.

SOME MECHANICAL CONSIDERATION OF TRANSMISSION SYSTEMS.*

By T. A. Worcester.

In any transmission system each of its elements, the supporting structures, the insulators and conductors, has a vital mechanical function and on each may rest the success or the failure of the system. In the early days of high voltage transmission these points were not given due consideration and there were many cases of the destruction of lines due to wash-outs, sleet and wind storms and frequent breakages of wires due simply to contraction at low temperatures. During later years, however, engineers have profited by these experiences and a greater study has been made of the details of mechanical construction, resulting almost entirely in the elimination of disasters except in cases of most unusual and severe conditions.

The purpose of this is to review in a general way the stresses which must be considered in the various elements of a transmission system and to point out some of the means which have been resorted to to meet certain special conditions. Consideration will be given chiefly to steel tower structures since they are by far the most important type of support for higher voltages. The wooden, steel and concrete poles have their field in the lower voltage range where they are able to compete against the built-up structure.

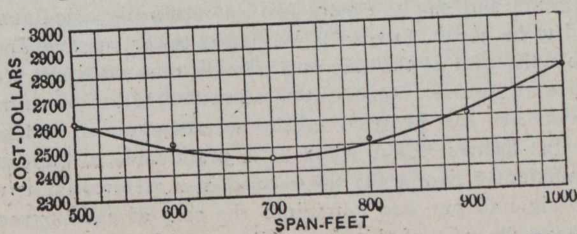


Fig. 1.—Cost per Mile of Towers and Insulators Erected.

Stresses.—The stresses which a tower must be designed to withstand are (a) those acting in a vertical direction, due to the dead weight of the conductors and insulators, plus an allowance for ice covering; (b) in a horizontal direction at right angles to the line, due to wind pressure; (c) in a horizontal direction parallel to the line due to wire breakages. All of these loads are applied at the ends of the cross-arms except a portion of (b) which is distributed over the entire tower.

The vertical load depends on the size, material and number of the conductors and ground wires, length of span and thickness of ice coating; the horizontal load at right angles to the line depends on these same elements which determine the exposed surface, and the wind velocity; the horizontal load in the direction of the line depends on the size and number of conductors, the amount of ice and the number of wires which may break at any one time. Each of these governing factors will be briefly discussed.

The size of conductor depends on electrical considerations except where the length of span is the governing feature.

The length of span, except in river or gorge crossings, is dependent upon the designer and must be chosen so as to give the line the least cost. As the span increases, the number of towers and insulators per mile decrease, but on the other hand the height of the towers must be increased to care for the greater sag and at the same time they must be made proportionately stronger and heavier to care for the greater loads per span. The effect of these changes on the cost of a line is shown by the curve, Fig. 1. The length of a span affects the

*A paper presented to the American Institute of Electrical Engineers, May 17th, 1912.

loads in the vertical direction and in the horizontal direction across the line and not that parallel to the line, since the latter is governed by the size of the conductor, it being necessary to adjust the sag so as not to exceed the safe stress for the wires.

For every size of conductor there is a practical limit of the length of span beyond which the sags and height of tower becomes excessive and there is danger of the wires swinging together. For the smaller sizes of conductor this limit is quite low (300 ft. (91 m.) for No. 4 cable) and in many cases it will be found more economical to increase the size of conductor so as to permit using a greater span. The following tabulation illustrates this:—

	Size of Conductor	Span feet	Sag feet	No. of towers per mile	Cost of towers and insulators per mile erected	Cost of wire and freight per mile	Total per mile
Case I.	No. 4 B.&S.	300	10.5	17.6	$3080	$322	$3402
Case II.	No. 2 B.&S.	360	10.5	14.7	2570	514	3084
					Saving per	mile............	$318

These figures are based on the assumption that the same towers and sags would be used in both cases, giving the same clearance to ground. The sag in Case I is the minimum sag at which wires may be strung on the basis of 0 deg. Fahr., 8 lb. (3.6 kg.) wind, and ½ in. (1.27 cm.) sleet and with these same conditions and sag the span for No. 2 wire is calculated and found to be 360 ft. (109 m.) With this tower spacing and No. 2 cable the cost of the line is $318 less than with No. 4 cable and 300 ft. (91 m.) span. It is allowable to assume that the same towers can be used in the second case as in the first since the lightest tower which it is practicable to build would be sufficiently strong for the second case. However, it would be possible to put $20 more into the cost of each tower and still have the cost of the second line a trifle less than that of the first and the gain would accrue from the electrical advantages of the larger size of conductor.

A span of 360 ft. (109 m.) is not necessarily the most economical span for the No. 2 conductor. Further calculation indicates that a 500-ft. (152 m.) span could be used with only a very slight increase in the cost of the towers. This limit cannot be extended beyond 500-ft. (152 m.) even though the line with greater spans would have a less cost. Here again the limit depends on mechanical considerations rather than on costs and is governed by the danger of lashing together of the wires in gusty winds.

In long spans over rivers, etc., the standard main line towers and conductors are frequently used. This practice may be permissible in some instances where the spans are not very much greater than normal but when the towers have been designed to closely meet the demands of the standard spacing it becomes dangerous to use them for any appreciably longer spans. It is advisable in these instances to use dead end anchor towers with strain insulators and thus isolate the crossing span and prevent any trouble in other parts of the line from being carried into it.

For very long spans it is, of course, necessary to use conductors of greater mechanical strength than are used in the main part of the line and the supporting structures must likewise be made correspondingly stronger. Too great care cannot be taken in planning such structures as unusual stresses are likely to occur and would result seriously unless properly cared for. More than average allowances should be made for wind, sleet and temperature and a greater factor of safety should be used in the design of the steel work.

Ice and Wind.—The amount of ice which may form on wires has been a much-discussed topic and one which will probably never be settled to the satisfaction of all concerned. However, the various engineering bodies have about agreed that it is safe to consider ½ in. (1.27 cm.) ice in conjunction with 8 lb. (3.6 kg.) wind pressure and 0 deg. Fahr. as the worst combination of conditions likely to occur in the United States. It is conceded that there have been thicker formations of ice and greater wind pressures, yet the probability that they will occur simultaneously and with low temperature is so remote as to make it seem unnecessary to consider them. There is little doubt, however, that those engineers who have experienced destruction of their lines by sleet and wind storms will never use anything but the most conservative allowances. For spans crossing rivers, highways or railroads more liberal allowances are always made, the standard being ¾ in. (2 cm.) ice, 11 lb. (5 kg.) wind and 0 deg. Fahr.

Ice and wind on the cables work together to increase all of the loads on a tower structure; the vertical load and the horizontal load in the direction of the line, by giving increased weight to the conductor, and the horizontal crosswise load by giving greater surface for the wind to act upon.

Wind on Towers.—There is a great difference of opinion as to just how much wind pressure shall be allowed on the tower itself. It is certainly not sufficient to base this allowance on the same assumptions as are used for the conductors. Those assumptions are for wind velocities likely to occur simultaneously with heavy loading of ice and low temperature. Greater velocities may occur independent of these last factors. It is, therefore, advisable to allow for at least the highest recorded value. This value, as indicated by the Government anemometer is very nearly 100 mi. per hr., which corresponds to an actual velocity of 76.2 mi. per hr. and a pressure of 23.2 lb. (1005 kg.) per sq. ft. (=0.09 sq. m.) ($0.004 \times V^2$ for flat surface). The government anemometer records the velocities only at intervals and does not give all instantaneous values and these instantaneous values may be somewhat greater than those at the moment the record is taken, due to the gusty character of winds. It has been estimated that these gusts cause velocities 50 per cent. greater than those which are recorded. Another feature enters, however, to somewhat counterbalance this effect, viz., the height above the earth surface. The anemometer records are taken well above the earth surface, while transmission structures are seldom higher than 75 ft. In consideration of these variables and uncertainties it is not possible to give one value of pressure to be used on all lines. A safe range of pressure though would be from 20 to 35 lb. (9 to 16 kg.) per sq. ft. (=0.09 sq. m.) depending on the general character of the country which the line traverses, i.e., whether it is exposed to sweeping winds or protected.

It will usually be found that the maximum wind pressure acting on the bare towers and wires will have a greater overturning moment than that caused by the maximum wind assumed to accompany ice formation, acting on the ice-coated wires and towers, i.e., the greater pressure due to the higher velocity of the wind, even though exerted on a smaller surface, will overbalance the less pressure acting on the greater surface. For this reason the side pressure on towers should be figured for both conditions and the design should be based on the loads caused by the worst of the two.

In calculating the wind on the towers the entire projected area of the two lateral faces should be used as the surface over which the wind acts.

Wire Breakages.—The most serious stresses which a transmission tower is called upon to withstand are those due to the breaking of conductors. Lines are put up with a view of not having the conductors break but there are certain unavoidable conditions which frequently produce breaks. The most usual of these are (a) burning of the conductors due to short circuits or grounds started by lightning, large birds, swinging together of wires, etc., or through malicious intent; (b) breaking of conductors due to crystallization or fatigue of the metal produced by kinking during erection or by insufficiently rounded edges of cable clamps and (c) by overloading of conductors during extreme conditions of temperature, wind, etc.

The causes in (a) have been overcome to a great extent by the use of various devices, principally the arcing ground suppressor, the ground ring and metal sleeve. The swinging together of conductors occurs only when light conductors are used in too long a span where they will be likely to lash in the wind. Ordinarily in well designed spans the wires swing in unison so that there is no danger of their coming together.

The breaking of wires due to kinking is frequently not given due consideration and many lines erected by careless workmen have suffered from this cause. The elasticity and strength of the metal on the inside of the bend is decreased enormously by a short bend and when the wire is straightened out and drawn taught by frequent strains in the line it will finally weaken to the point of rupture. Likewise, many breaks have been caused by repeated bending of the conductor at the wire clamp on the pin type of insulator. The localization of the stress by a hard metal clamp finally makes the metal of the conductor brittle and rupture occurs well below the average tensile strength. A clamp may have well rounded edges and still cause trouble. It is the rigidity of the clamp as well as too sharp an edge which is harmful.

When all of the wires of a transmission line are intact there is no pull on the towers in the direction of the line (i.e., on the intermediate towers, not the dead end or other special structures). As soon, however, as a conductor is broken the strain which it took to cause the break is thrown on the adjacent towers. Obviously, therefore, the maximum load which the cross arms must stand in the direction of the line is equal to the tensile strength of the conductor which is used. For the smaller sizes of conductor this rule is usually observed but for the larger sizes less liberal allowances are usually made. It is customary with the larger sized conductors to allow for a stress equal to one-half of the ultimate strength of the cables. This val e is chosen since it is the maximum safe working stress, above which the cables are likely to stretch permanently.

With the suspension type of insulator the full length of an insulator string is thrown into the line when a break occurs and the strain in the conductor and on the cross arms is greatly reduced. But little consideration should be given to this fact, however, since there is a severe jerk when the insulator is drawn to its new position and the effect on the tower is not less and may be more than occurs when the pin type of insulator is used.

A question which naturally arises is how many conductors may break at any one time. This depends to a large extent on the cause of the breaks. If due to lightning or large birds it is probable that not more than one or possibly two conductors would break; but if due to poorly designed wire clamps, injury of wire during erection, or to excessive sleet and wind, it is conceivable that all might break. It is very rare, however, for all of the conductors to break, and further, it is hardly practicable to make such an assumption when considering main line towers since it would raise the cost of the line to a prohibitive value. It is usual to compromise by allowing for the breakage of only two cables of a three or six conductor line and to safeguard the system by interposing anchor towers at frequent intervals. These anchor towers would be capable of withstanding the strains due to the breakage of all of the cables and would thus divide the line into isolated sections so that any trouble in one could not be communicated to the other.

In the rigid type of tower practically all of the stress caused by the breaking of several conductors is cared for by the tower itself, i.e., the movement of the top of the tower is not sufficient to permit an even distribution of stress between the unbroken cables of the damaged span and those in the adjacent spans. With the flexible type of tower, however, the effect is different. The tower is designed to be rigid in the plane across the line and flexible in the direction parallel to the line so that it will bend and allow an even distribution of stresses in the adjacent spans. For instance, consider a three-conductor system with one ground wire and assume that each cable has an ultimate strength of 6,000 lb. (2,721 kg.) and is strung to have a tension of one-half of its ultimate strength under the worst conditions likely to occur, and assume that these conditions prevail. Suppose that one of the conductors has been injured or is defective and that it breaks under this load. The tops of the towers on either side of the break will be pulled over by the four cables in the next span until the total tension in them would be just balanced by that in the remaining conductors of the damaged span. The tension would amount to very nearly 12,000 lb. (5,443 kg.), i.e., 4,000 lb. (1,814 kg.) per cable or 33 per cent. more than the allowable stress. Thi load would not break the cables but it would stretch them beyond the elastic limit and permanently weaken them.

Suppose that two cables had broken instead of one. Each of the remaining two would be strained with nearly 6,000 lb. (2,721 kg.), an amount almost equal to its ultimate breaking strength. The stress would not be quite 6,000 lb. because the tension in the adjacent spans would decrease rapidly as the cables in the damaged span are stretched to greater length. However, the example serves to illustrate that it is necessary to use very much greater factors of safety in stringing conductors in a flexible tower system than would be used in a rigid system.

Foundations.—The foundations of a tower are of prime importance, yet under average normal conditions they offer but a small problem. In ordinary straight line work, over fairly level country, where the soil is hard or rocky and where the smaller sized conductors are used no special foundations are necessary; the ground stub with cross piece or foot may simply be buried in the ground with a little rock filler and if the spread of the tower legs is normal there is little to fear from tilting. With the larger sizes of conductor and longer spans the overturning moment frequently reaches such proportions as to make it advisable to use concrete foundations and thereby eliminate the need of spreading the tower legs an excessive amount. When towers must be placed where the soil is loose or marshy or where they may be endangered by floods or landslides it is essential that special consideration be given to the design of their foundations. It may be necessary to resort to any one of several types of construction; steel or timber piling, crib work, rock filling or concrete, or a combination of two or more of these. Fig. 4 shows one of the best types of foundation, used to meet a very special condition where it was necessary in order to gain entrance to a city to extend the right-of-way along the lake front and place the tower footings in the water.

Angle, hillside and anchor on long spans present serious problems from the foundation standpoint and must be carefully and liberally designed so as to allow no motion or slip whatever. It frequently pays to make a long detour in order to avoid bad hillsides or crumbly crests.

It must be remembered that a very slight tilt at the base of the tower means large displacement at the top which may exert considerable extra tension in the conductors and in the case of the suspension insulator may bring the conductors dangerously near the tower.

Factors of Safety.—In the design of all mechanical structures it is customary after assuming certain conditions of loading to allow a factor of safety; in other words, to design the parts so that their ultimate strength will be several times their assumed loading. The amount of this factor of safety depends on (a) the character of the load—whether steady, intermittent, or otherwise—(b) on the knowledge one has relative to the amount of load; (c) on the ease or difficulty of calculating the structure to care for the assumed loadings; (d) on the possibility of faults in construction and (e) on the risk to life and property. In a transmission structure the load is intermittent and reversing and our knowledge as to its amount is not definite. These features tend to demand a relatively large factor of safety. However, this tendency is more than counterbalanced by the facts that it is not difficult to calculate the stresses when a definite load is assumed, that the chance for faults in manufacture are but few and that the risk to life and property is a minimum.*

Another feature which makes it possible to use a small factor of safety is that a sample tower may easily be tested with the assumed loadings and with ultimate breaking loads. obviously if a factor of safety is used which will permit the tower to be strained with the assumed loads without being permanently deformed then such factor of safety will be satisfactory, provided the assumed loads correspond with the actual loads. The factor of safety for these conditions would be two if it is considered that the elastic limit of the metal is one-half of its ultimate strength. Many transmission towers have been built on this basis with a consequent saving in the cost of the line. On the other hand more conservative engineers have used values three and even four, these higher values being chosen to care for the uncertainty of load conditions. In one line recently built a factor of safety of 4 was used for all of the main line towers and three for all the strain or dead end structures. This at first sight seems illogical, but it is justified, since the strain towers are figured for a very definite condition, i.e., of all cables being broken in one span and with a maximum load of wind and ice on all those in the next span; whereas the intermediate towers are figured on an indefinite assumption; i.e., of having only two cables break while the others are heavily loaded. The use of these large values, however, makes the cost of the line excessive and for this reason it is common practice to use smaller values, two, two and one-half, or three for the intermediate towers and three or three and one-half for the strain towers. With this arrangement the main part of the line will be safe except in case of some unusual condition which produces worse loads than those assumed and in event of such an accident the strain towers will prevent the trouble from travelling to the next section of the line.

For the conductors themselves a factor of safety of two is sufficient except for very long spans and crossings, in which cases slightly larger values should be used unless a greater allowance is made for ice and wind than in other parts of the line. Large factors of safety also must be used in conductors in flexible tower systems, as pointed out under "Wire Breakages."

Flexible Towers.—The flexible tower was discussed above with special reference to the stresses induced in the unbroken cables when one or two cables should break in one span and it was found necessary to string the cables with less tension than in a rigid tower system. When this is done the flexible system immediately becomes mechanically stable and is of value. Economy is secured by the small weight and cost of the towers without unduly sacrificing the safety of the system.

A special field for the flexible tower appears to be for the higher voltage systems in which a double tower line of three conductors each is desired. There are a number of advantages in using such a system in preference to the six-conductor single tower system, the principal ones being that there is less liability to complete shut-down in case of accident to a tower and that there is greater safety for linemen when repairing damaged towers, conductors or insulators. The reason for the present limited use of double tower lines is the high cost of such a system when made up of the rigid type of tower. If engineers would look more into the possibilities and cost of the flexible structures there would undoubtedly be a more general use of double tower lines.

*Except at railroad and highway crossings, etc.

THE FIRE HYDRANT.*

By C. W. Wiles, Delaware, Ohio.

In setting hydrants at least 6 in. of broken stone or brick should be placed at the bottom of the hydrant, and for at least 6 ft. along the supply pipe. Of course, if the hydrant is set in gravel or sandy soil this is not so necessary, but it will do no harm and may prevent trouble at some time.

In order to facilitate examination and make easy repairs, a gate-valve should be placed on each hydrant. Often this will save shutting off the supply from several streets.

Inspect carefully all hydrants, at least in the fall, before cold weather comes on, and again in the spring. First see that they are empty; if not, see if they have been properly closed. Often the rubber packing valve is defective and should be removed. Sometimes stones get between the valve and the seat, so that no amount of pressure will make it tight, even if there is no water in the hydrant chamber. It is well to test a leak at the valve by listening at the nozzle, or applying an aquaphone to see if there is not a small leak which escapes through the waste. Roots and grass often grow in the bottom of hydrants and prevent drainage.

If, upon examination, the hydrant is found empty and no apparent leakage at the valve, it is well to blow lightly to remove any sediment or mud that has accumulated in the branch supply line, and then close down and watch through the nozzle for it to drain. If all is in proper order, it should empty in five or ten minutes. If it does not, roots may partially obstruct the waste, or the earth may be so closely packed at the bottom as to leave no escape for water.

One of the most frequent causes of frozen hydrants is the opening and closing by inexperienced persons, who fail to fully close it, allowing the barrel to remain full of water. Every hydrant used at a fire or for any other purpose should be carefully examined immediately after its use by a competent person who fully understands its working.

The rule allowing no one but fire department employees, and then only at fires, or experienced waterworks employees to open or close any hydrant should be firmly enforced at all times, and even firemen should be fully instructed as to the methods of opening and closing hydrants, especially which way to open and close. Strange as it may seem, there are cities that have hydrants some of which open right and some left.

Stones, sticks, and even caulking hammers, have been found in hydrants after their use, preventing closing. Of course, this is the result of carelessness in laying mains, and the remedy is obvious to all waterworks men.

Pipe lying along a street is a temptation to children and others to fill with stones; we understand from the pipe-cleaning people that the size and variety of relics they find in mains would stock a museum.

* Paper read before American Waterworks Association.

THE DUNMURRY SEWERAGE SCHEME.

By James Hunter.*

The results of the recent census lately published in Great Britain go to prove that the tendency of the wealthier portion of the population of all the large towns is towards migration to the suburbs....... It is chiefly due to this tendency of the population of cities to overflow and enrich the suburban areas near Belfast that caused the construction of a new drainage scheme for Dunmurry.

Dunmurry lies close up to the city of Belfast, and being delightfully situated as a residential area, the building speculators soon became alive to its possibilities in this direction, and in a short time what was formerly a sleepy country village began to develop into a township. Villas were built all round, a new church and new school buildings erected, and later on a factory, with its attendant new laborers' cottages.

The new population, fresh from the city where they had the advantage of the very best sanitary arrangements, were not long contented with the antiquated sanitary arrangements, which had for ages done duty about Dunmurry, and an appeal was made to the council to have Dunmurry put into a proper sanitary condition. After much discussion and many adjournments the council asked me to make a careful inspection of the Dunmurry district, and a report as to what should be done to remedy the grievances complained of. My report was adopted, and I was instructed to prepare a sewerage scheme along the lines indicated in my report, and Mr. Donald Cameron, of Exeter, was appointed consulting engineer. Accordingly, plans, etc., were prepared, passed by the council, and submitted to the Local Government Board, and, after the usual inquiries, were approved by that board.

The tender of Messrs. H. and J. Martin ($44,365), being the lowest, was accepted, and the work was started in November, 1909.

The scheme itself consists of the usual main and branch sewers, with septic tanks, filter-beds, and irrigation area. The main sewer, 12 ft. diameter, begins at the County Bridge, close to Dunmurry Station, and, following the course of the river, extends to the works at Glenburn, a distance of 2,000 lineal yards, crossing the river twice. At the river crossings the main is constructed with cast-iron piping carried on steel girders, the girders resting on concrete abutments, with concrete waterway between.

Where it approaches the works the main is also iron piping carried across a hollow at the river bank on concrete piers, and thence across the river on the parapet of the new approach bridge to works. Most of the main was laid in open cutting, but we had a rather difficult length of tunneling across the main road and under the mill-race, as the bottom for the entire length was through running sand. Indeed, everywhere in the trenches when we got below 9 ft. from surface we came into the same objectionable bottom.

The length of branch sewers is 3,090 yards, and covers all the outlying portions of Dunmurry.

For proper ventilation and cleansing, ventilating columns and Adamez patent flushing syphons have been fixed at the upper end of all branch sewers, while at the lower levels air inlet chambers have been formed at the side of the manholes and opening into same. These chambers are fitted with open covers and have flap valves of thin hammered copper, hung in narrow strips on metal frame, fitted to opening between chamber and manhole. For the cleansing of the main sewer we were able to utilize the river by constructing a concrete chamber with penstock, etc., in the wall at the upper end of main, close to railway station. We found this arrangement very useful and economical during the testing of the works and in the recent dry weather.

The scheme is designed on the separate system, and practically all street surface drainage has been excluded; however, ample provision against congestion has been made by fixing storm overflows at suitable positions along main and large branch sewer.

The Purification Works.—The purification works are situate about one mile from Dunmurry, in a secluded glen lying between the Dunmurry river and the river Lagan, and well away from any possible residential area. The council purchased three acres at this place from the Northern Banking Company, Limited, and that body very generously made a free gift of six acres additional, being the remainder of the field, together with a free bottom for the approach road. The approach is half a mile long, and is carried over the Dunmurry River at two places by bridges of 22-ft. span. Arches of bridges are of Staffordshire blue brick in cement mortar, and the abutments, waterway, wings, and parapets are of concrete. At the bridge close to works concrete training walls have been constructed to prevent erosion in heavy floods.

The Dunmurry River, I may here state, having its source in the hills, is very liable to sulden spates, and rises very rapidly, and is dangerous in flood, as the contractors found to their cost during the progress of the work.

The works consist of four septic tanks, with grit chambers and storm tank, etc., eight filters, and an irrigation area four acres in extent.

The septic tanks are all arched over with the exception of a 6-ft. length at each end, which is covered with planking, on top of which is a thick layer of peat-moss litter. By means of these lengths at each end the tanks are very easily examined and cleaned out. There are also the usual sludge lagoons and an irrigation area for storm water.

The filters are 4 ft. 9 in. deep, and filled 4 ft. deep with washed cinders: top, 12 in., ½ in. to ⅛ in.; bottom, 12 in., 1½ in. to ⅜ in.; and centre portion, ¾ in. to ⅜ in. The filters are worked by automatic gear supplied by the Septic Tank Company, London, and this is at present working satisfactorily.

The irrigation area is laid out level, and is under-drained by agricultural drain pipes laid at an average depth of 1 ft. 9 in. under the surface. These under-drains are joined to a 9-in. main pipe running the entire width of the area and discharging into the Lagan.

The effluent from the filters is distributed over the irrigation area by means of stoneware channels, 9-in. feeders and 6-in. carriers.

At the upper end of the 9-in. main at irrigation area a weir has been constructed in the river so that the main can be cleansed of sediment as often as necessary.

The septic tanks are designed to accommodate a population of 2,500, or double the existing population at the time the scheme was promoted.

The daily water consumption was taken as 25 gallons per head, and allowance has been made for treating three times this quantity, or 180,000 gallons. The dry-weather flow to works during recent dry spell averaged about 30,000 gallons daily.

An analysis of effluent taken on June 23rd last shows that the works, after twelve months' service, are acting well. Two samples were submitted for analysis, one from the gear chamber of effluent from septic tanks, and a second from the outfall pipe at river Lagan of the final effluent. Taking the standard of purity as the oxygen absorbed test, sample

* Paper read at the Royal Sanitary Institute Congress at Belfast.

No. 1 gives the amount of oxygen absorbed after four hours at 80 deg. Fahr., as 0.57 per 100,000 parts, and sample No. 2 gives 0.16 parts under similar conditions. The suspended solids the analyst gave as practically nil.

Under a separate contract carried out by the Messrs. Martin, the council have spent a sum of almost £2,000 in connecting up all the houses to the new system....... The district, from being the most insanitary, is now perhaps the most sanitary in the North of Ireland.

In conclusion, I may state that the pipes used in the system were supplied by Messrs. Candy & Co., of Newton Abbot, and have given great satisfaction. The manhole and lamphole covers were manufactured by Messrs. Adams, of York, and the automatic gear by the Septic Tank Company, of London.

STATISTICS OF RAILWAYS IN THE UNITED STATES FOR THE YEAR ENDED JUNE 30, 1911.

The statements in this preliminary abstract are based upon compilations for the Twenty-fourth Annual Statistical Report of the Interstate Commerce Commission, covering the fiscal year ended June 30, 1911, and these advance figures, which do not cover switching and terminal companies, may be slightly affected by revision before final publication.

Mileage.—Substantially complete returns were rendered to the commission for 246,124.40 miles of line operated, including 11,006.86 miles used under trackage rights. The aggregate mileage of railway tracks of all kinds covered by operating returns was 362,710.18 miles. This mileage was thus classified: Single track, 246,124.40 miles; second track, 23,451.26; third track, 2,414.16; fourth, fifth, and sixth tracks, 1,747.10; yard track and sidings, 88,973.26. These figures indicate an increase of 10,943.59 miles over corresponding returns for 1910 in the aggregate length of all tracks, of which increase 3,391.33 miles, or 30.99 per cent., represent yard track and sidings.

Equipment.—It appears that there were 61,327 locomotives in the service of the carriers on June 30, 1911, indicating an increase of 2,380 over corresponding returns for the previous year. Of the total number of locomotives, 14,301 were classified as passenger, 36,405 as freight, and 9,324 as switching, and 1,297 were unclassified.

The total number of cars of all classes was 2,359,335, or 69,004 more than on June 30, 1910. This equipment was thus assigned: Passenger service, 49,818 cars; freight service, 2,195,511; and company's service, 114,006. The figures given do not include so-called private cars of commercial firms or corporations.

It appears that the average number of locomotives per 1,000 miles of line was 249, and the average number of cars per 1,000 miles of line was 9,586. The number of passenger-miles per passenger locomotive was 2,268,067, and the number of ton-miles per freight locomotive was 6,913,246.

The returns indicate that the number of locomotives and cars in the service of the carriers aggregate 2,420,662, of which 2,391,438, or 98.79 per cent. as against 97.96 per cent. in 1910, were fitted with train brakes, and 2,409,973, or 99.56 per cent. as against 99.30 per cent. in 1910, were fitted with automatic couplers. Of the 2,195,511 cars in freight service on June 30, 1911, the number fitted with train brakes was 2,180,301, and the number fitted with automatic couplers was 2,186,233.

Employees.—The total number of persons reported as on the pay rolls of the steam roads of the United States on June 30, 1911, was 1,669,809, or an average of 678 per 100 miles of line. As compared with returns for June 30, 1910, there was a decrease of 29,611 in the total number of railway employees. There were 63,390 enginemen, 66,376 firemen, 48,200 conductors, 133,221 other trainmen, and 40,005 switch tenders, crossing tenders, and watchmen.

The total number of railway employees (omitting 93,718 not distributed) was apportioned among the six general divisions of employment as follows: To maintenance of way and structures, 493,926; to maintenance of equipment, 344,112; to traffic expenses, 22,246; to transportation expenses, 629,654, to general expenses, 52,201; and to outside operations, 33,952.

The complete report will include summaries showing the the average daily compensation of 18 classes of employees for a series of years, and also the aggregate amount of compensation reported for each of the several classes. The total amount of wages and salaries reported as paid to railway employees during the year ended June 30, 1911, was $1,208,466,470.

Capitalization of Railway Property.—On June 30, 1911, the par value of the amount of railway capital outstanding, according to the returns of the companies filing reports with the commission, was $19,208,935,081. This amount includes capital held by the railway companies as well as by the public.

Of the total capital outstanding, there existed as stock $8,470,717,611, of which $7,074,917,559 was common and $1,395,800,052 was preferred; the remaining part, $10,738,217,470, representing funded debt, consisted of mortgage bonds, $7,825,269,102; collateral trust bonds, $1,183,766,188; plain bonds, debentures, and notes, $951,377,816; income bonds, $261,777,220; miscellaneous funded obligations, $195,430,395; and equipment trust obligations, $319,596,749.

Of the total capital stock outstanding, $2,740,467,285, or 32.35 per cent., paid no dividends. The amount of dividends declared during the year (by both operating and lessor companies) was $460,195,376, being equivalent to 8.03 per cent. on dividend-paying stock. No interest was paid on $755,449,047, or 7.25 per cent. of the total amount of funded debt (other than equipment trust obligations) outstanding.

Public Service of Railways.—The number of passengers carried during the year ended June 30, 1911, was 997,409,882. The corresponding number for the year ended June 30, 1910, was 971,683,199. The increase in the number of passengers carried during the year over 1910 was 25,726,683.

The number of passengers carried 1 mile, or the passenger mileage, as compiled for 1911, was 33,201,694,699. The corresponding return for 1910 was 863,198,370 less. The number of passengers carried 1 mile per mile of road was 139,191.

The number of tons of freight shown as carried (including freight received from connections) for the year ended June 30, 1911, was 1,781,637,954, while the corresponding figure for the previous year was 1,849,900,101, the decrease being 68,262,147 tons.

The ton mileage, or the number of tons carried 1 mile, as shown for the year ended June 30, 1911, was 253,783,701,839. The total ton mileage as reported for the year ended June 30, 1910, was 255,016,910,451, from which it will be seen that the decrease in the ton mileage for the year ended June 30, 1911, under the return for 1910 was 1,233,208,612. The increase in the number of tons carried 1 mile in 1910 over 1909 was 36,213,923,522. The number of tons carried 1 mile per mile of road for the year 1911 was 1,053,566. The number of tons per train-mile was 383.10.

The average receipts per passenger per mile, as computed for the year ended June 30, 1911, were 1.974 cents; the average receipts per ton per mile, 0.757 cent. The passenger service train revenue per train-mile was $1.30.921; the freight revenue per train-mile was $2.89.548. The average operating revenues per train-mile were $2.24.824. The average operating expenses per train-mile were $1.54.338. The ratio of operating expenses to operating revenues was 68.66 per cent.

Revenues and Expenses.—It should be noted that the following figures under the heading of revenues and expenses exclude returns for a few small roads because of deficiencies in their reports. For the year ended June 30, 1911, the operating revenues of the railways in the United States (average mileage operated, 243,433.61 miles) were $2,789,761,669; their operating expenses were $1,915,054,005. The corresponding returns for 1910 (average mileage operated 236,986.51 miles) were: Operating revenues, $2,750,667,435; operating expenses, $1,822,630,433. The following figures present a statement of the operating revenues for 1911 in detail:—

Freight revenue	$1,925,950,887
Passenger revenue	657,638,291
Mail revenue	50,702,625
Express revenue	70,725,137
Excess baggage revenue and milk revenue (on passenger trains)	15,430,683
Parlor and chair car revenue and other passenger-train revenue	5,274,450
Switching revenue	27,665,997
Special service train revenue and miscellaneous transportation revenue	9,479,809
Total revenue from operations other than transportation	24,707,757
Joint facilities revenue—Dr.	647,247
Joint facilities revenue—Cr.	2,833,280
Total operating revenues	$2,789,761,669

The operating revenues stated above averaged $11,460 per mile of line.

Operating expenses, as assigned to the five general classes, were:—

Maintenance of way and structures	$ 366,025,262
Maintenance of equipment	428,367,306
Traffic expenses	59,166,364
Transportation expenses	987,382,108
General expenses	73,689,373
Unclassified	423,592
Total operating expenses	$1,915,054,005

The foregoing operating expenses averaged $7,867 per mile of line.

MAGAZINES AND THAW HOUSES FOR EXPLOSIVES.

"Magazines and Thaw Houses for Explosives" is the title of Technical Paper No. 18 just issued by the United States Bureau of Mines. The authors, Clarence Hall and S. P. Howell, present the advanced practice abroad and in the United States on the use of material for the construction of magazines and thaw houses and strongly recommend the use of a lean cement mortar consisting of 6 parts of sand and 1 part of cement as the material to be used in the walls, roof, and doors of these buildings in order that the explosives within them may be properly protected, also in order that life and adjacent property may not be jeopardized when magazines and thaw houses are constructed the proper distances from other buildings.

In order that the explosives in magazines may be properly protected they must be guarded against bullets, fire, lightning, and unlawful entry. Different fireproof materials were experimented with to determine their resistance to the penetration of rifle bullets. Sand offered some advantages, but was rejected because it would eventually flow out on the floor of the magazine through the cracks in the walls and could not be depended upon to remain in the structure permanently; moreover, gritty materials of any kind are objectionable on the floor of a magazine. Mineral wool overcame this objection but had little value as a medium for resisting the penetration of rifle bullets. Therefore, in order to overcome the objectionable features of sand, Portland cement was mixed with it in order to form a lean cement mortar and thus enable the sand to be retained within the walls of the magazine, and still be friable enough to crumble readily under a blow. Tests to determine these two features were so satisfactory that a magazine having this cement mortar as a filling was constructed by the Bureau of Mines at a cost of $400 and having a capacity of 20,000 to 30,000 pounds. A working drawing showing the dimensions and necessary sections are included in the publication. The means provided for ventilation in the magazine of the Bureau of Mines has been found to be adequate and, accordingly, the storage of explosives in respect to their keeping qualities is favorable.

The cement mortar construction is effective in resisting the penetration of rifle bullets and owing to its friable nature offers an additional advantage for the reason that, in the event of an explosion in or near the magazine, the large masses of material would not be projected over the surrounding country. The galvanized iron covering is fire-resisting and at the same time it serves as an excellent medium for protection against lightning when the four corners of the building are properly grounded with metal rods.

The method of selecting a magazine site is emphasized and suggestions made. The permissible distance which must obtain between magazines and other structures in England, Prussia, Austria, Italy, Massachusetts, and also the proposed American table of distances are contained therein.

The proper method of thawing explosives in either small or large quantities and a suitable method of transporting them to the place where they are to be used is described in this Technical Paper.

A temperature not exceeding 90 deg. Fahr. is recommended in thawing explosives. In all cases explosives must be protected against moisture and high temperatures and for this reason thawing explosives by placing them before a fire or near a boiler or on steam pipes or by putting them in hot water is condemned.

Copies of this Technical Paper may be obtained by writing to the director of the Bureau of Mines, Washington, D.C.

TELEGRAPH LINES DAMAGED BY DYNAMITE EXPLOSION.

While attempting to loosen dirt for the steam shovel, used in the excavation of the Canadian Pacific Railway station extension in Vancouver, by a charge of dynamite the telephone and telegraph lines of the system were badly damaged. Two poles were cut in two and a third driven into the ground at an angle.

COMPARATIVE STRENGTH AND RESISTANCE OF VARIOUS TIE TIMBERS.

The following series of tests were conducted in the physical laboratory of the Armour Institute of Technology, under the supervision of engineers representing the track department of the Board of Supervising Engineers, Chicago Traction, and were published in the third annual report

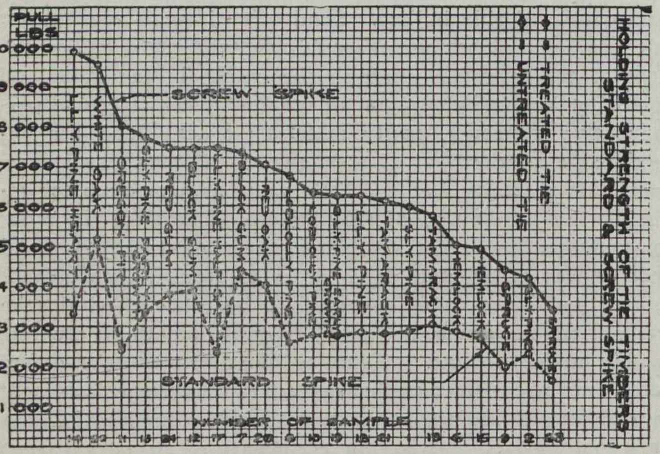


Fig. 1.
Comparative Holding Power of Standard Screw Spikes in Various Timbers.

of the board recently issued. The purpose of the tests was to determine the comparative strength and resistance of various tie timbers used in the construction of street railway track under the board's supervision.

Spike-pulling Tests.—The special object of these tests was to determine the comparative holding power of the standard track spike and of the screw spike developed by the Board, in various timbers. Three spikes of each kind were driven into each timber, a template being used so that all samples would be set at the same depth as would occur in normal track construction. These spikes were then withdrawn at right angles to the face of the tie by a special holder and at a speed of 1/16 in. per minute. The total load was measured on a 60,000-lb. Olsen testing machine, and applied as a vertical pull along the axis of the spike shank.

In the case of the screw spike an entrance hold such as is used in the regular track construction was bored into the tie to receive the spike. For hard woods, this was ½ in. in diameter, and for soft woods 7/16 in. in diameter.

Indentation Tests.—Tie plates were placed on a tie as in track construction. A steel casing with a face equal to that of the base of the standard rail (6 ins.) was mounted on the plate and then loads were applied at right angles to the tie plate, directly from the compression head of the testing machine, at a speed of 1/16 in. per minute, and an initial load of 500 lbs. was used in all tests, to which load frequent returns were made from the higher loads. All indentations were measured by a deflectometer reading to 1/1,000 in., fastened under the compression head of the testing machine.

The materials used in the test timbers were as follows: Short leaf yellow pine (untreated); loblolly pine, treated with chloride of zinc; short leaf yellow pine, early growth, treated with chloride of zinc; long leaf yellow pine, half sap, treated with chloride of zinc; long leaf yellow pine (untreated); black gum, treated with chloride of zinc; white oak (untreated); hemlock (untreated); spruce (untreated); long leaf yellow pine heart (untreated); red gum (untreated); red oak (untreated). All of these ties were well seasoned and dry. The screw spike was of the Board of Supervising Engineers' standard, and the track spike was of the standard railway type, 5½ ins. by 9/16 in. The tie plates tested were of the Board of Supervising Engineers' standard, one with a flat bottom, 6 ins. by 9½ ins., and the other having a corrugated bottom of the same size.

Results of Tests.—The results of the tests as presented in the accompanying tables and curves may be summarized as follows:—

(1) Although the holding power of the screw spike is approximately three times that of the standard 5½-in. by 9½-in. track spike in any given timber, the relative holding power in the different timbers is such as to make the screw spike in treated pine timbers fully equivalent to the standard track spike in good white oak.

(2) In reference to the resistance of the fibre of the wood to the indentation of a tie plate, the ratio of this resistance for a flat bottom plate to that for a corrugated bottom plate is decidedly greater than the ratio of the bearing area of the flat bottom plate to that of the corrugated bottom plate. In other words, for the same unit load per square inch of actual surface contact, the indentation with the corrugated plate is considerably greater than with the flat bottom plate.

(3) The chloride of zinc treatment used for preservation purposes on the loblolly and short leaf yellow pine ties has the additional feature of increasing the fibre strength of these timbers to such an extent as to make

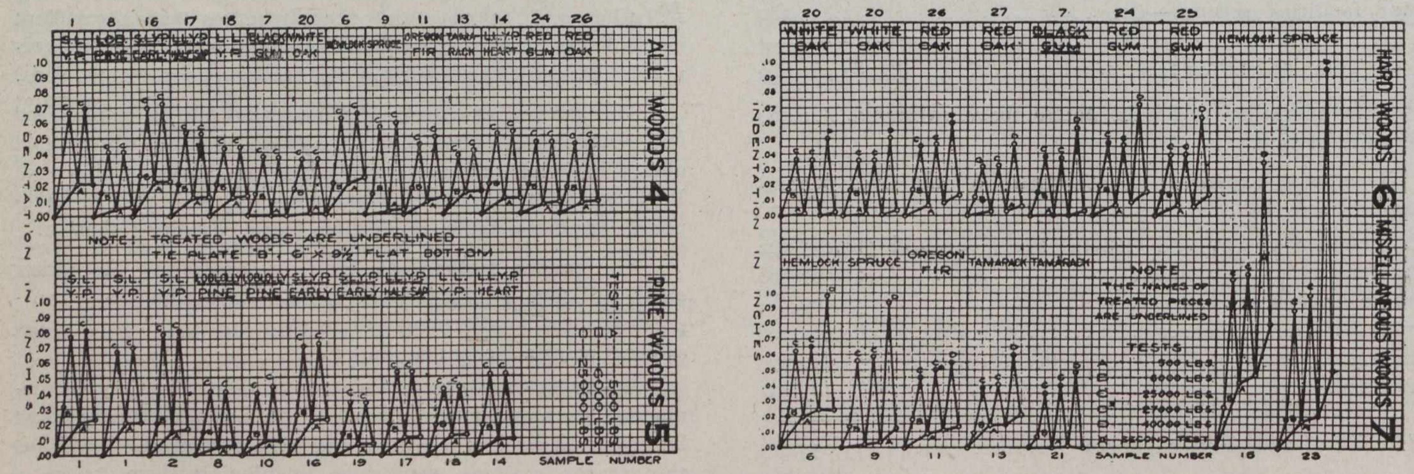
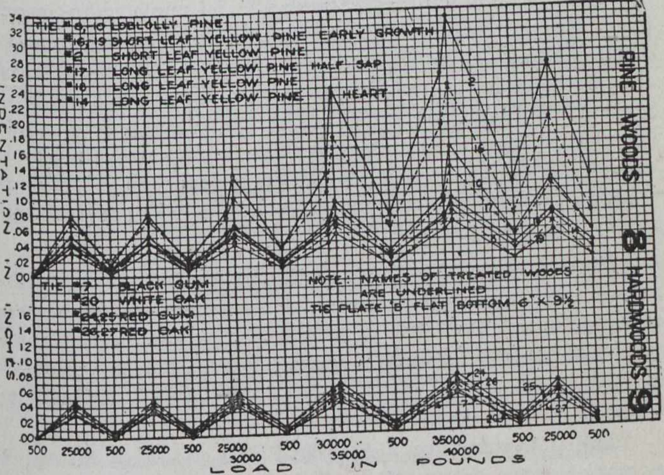


Fig. 2.
(4, 5) Comparative Deformation of Tie Timbers with Flat Tie Plate, for All Woods and for Pine Only.
(6, 7) Comparative Deformation of Hard Woods and Various Woods—Flat Tie Plates.

them compare favorably with the long leaf yellow pine ties in resisting indentation of a tie plate.

(4) The adoption of a flat tie plate with its increased bearing area as a remedy for track deflection, due to permanent deformation of the timber fibres, was fully warranted by the results of this investigation.

three applications of maximum pressure; plates 8 and 9 may be regarded as the deterioration tests indicating the permanent deformation of fibre and cumulative injury under excessive maximum loads; plates 11 and 15 represent typical deterioration tests, on various timber, showing, in addition,



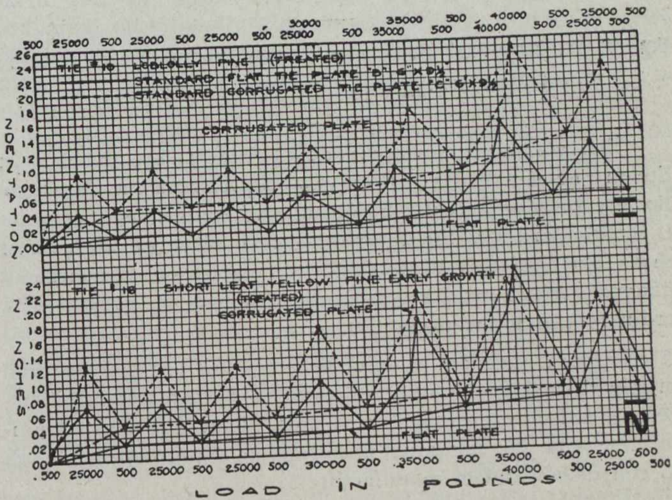


Fig. 2.

(8, 9) Comparative Deformation of Pine Ties and Hard Wood Ties Under Successive Load—Flat Tie Plates.
(11, 12) Comparative Deformation of Loblolly and Short Leaf Yellow Pines, with Flat and Corrugated Tie Plates.

Comparing the results of these spike-pulling tests with those previously recorded by the board, it is of interest that in all cases the preliminary data relating to the holding power of screw spikes were independently confirmed by the results of the 1909 tests, and were shown to be very conservative.

Holding Power.—Fig. 1 compares the relative holding power of standard and screw spikes in various timbers, these timbers being ranked according to the relative holding

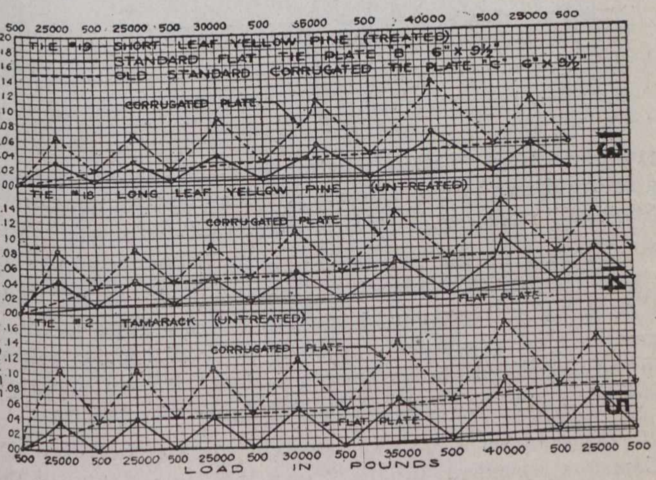


Fig. 2.

(13, 14, 15) Comparative Deformation of Short Leaf and Long Leaf Yellow Pines—Flat and Corrugated Tie Plates

strength with the screw spike. The lower curve indicates the relatively less holding power of the standard spike observed in all cases. With few exceptions, this relative proportion holds throughout the test. It is apparent from the curves that the softer woods have not over one-half the strength of the harder woods, or of long leaf yellow pine, mostly heart.

Indentation.—The indentation tests, Figs. 2 (4, 5), are represented in the two forms; plates 4, 5, 6 and 7 summarize the results on typical timber samples with two or

the fatigue curve resulting from the use of the corrugated tie plate as compared with the flat tie plate. The so-called fatigue manifests itself in the fact that with successive applications of the same pressure, the fibres did not show complete recovery. Gradual assent of the fatigue curve, therefore, indicates permanent deformation of the wood fibres, and in all cases, that of a corrugated tie plate is considerably greater than the flat plate, owing to the smaller bearing area.

During none of these indentation tests was the load entirely removed, as the resulting possible change in tie plate contact might have entirely vitiated the results indicating abnormal recovery at minimum load; consequently, the load was not reduced below 500 lbs. Plate 4 shows clearly recovery from load C to load A in succession, thus with short leaf yellow pine, untreated, permanent deformation resulted only from the first application of 25,000 lbs. load, but the second application showed practically no further deformation. Hemlock, untreated, on the other hand, showed continued deformation, while white oak showed practically complete recovery with no deformation. In these tests, load B represents approximately the tie plate load, such as would result from the passing of an ordinary car. In plate 7, some of the softer woods were tested to practical failure. Tests on hard woods (plate 9) are remarkable in the coincident of the results and the complete recovery.

Deterioration of Screw Spikes.—Examination of track built in previous years showed that where screw spikes have been inserted in ties treated with zinc chloride, a deterioration of the spike resulted. The reason for the damage is believed to be local, chemical and galvanic action in the bored spike hole, which usually contains water, each spike hole forming a single cell containing a strong solution of zinc chloride in which the screw spike is immersed Free chlorine and hydrochloric acid gases assist in the destruction. While there seems to be no immediate remedy at hand which might be applied to stop or partially suspend the deterioration which is going on apparently at all times, the obviation of this difficulty in the future will be obtained by abandonment of zinc treated ties for ties treated with creosote.

MANUFACTURERS' STANDARD FOR FLANGED FITTINGS AND FLANGES, STANDARD AND EXTRA HEAVY PRESSURES, ADOPTED JULY 10, 1912, EFFECTIVE OCTOBER 1, 1912.

By W. H. Douglas, Secretary Committee of Manufacturers on Standardization of Fittings and Valves.

The standard recently adopted jointly by the Master Steam and Hot Water Fitters' Association and the American Society of Mechanical Engineers, and known as the "1912 U.S. Standard," is the outgrowth of an effort on the part of these two societies to establish a universal standard for flanged fittings and flanges for working steam pressures in ordinary use at the present time.

Without question, a universal standard is necessary and highly desirable; but any standard to be commercially successful must be designed to bring about the desired uniformity with the minimum inconvenience and expense, both to consumers and to manufacturers.

Before the "1912 U.S. Standard" was adopted by the two societies mentioned, there existed among the majority of manufacturers, in the United States, a generally accepted standard for flanged fittings and flanges. Most of the large flanged fittings manufacturers in this country had the entire pattern equipment necessary to build this line of goods and many had list prices and dimensions published for general distribution to the trade; in fact, these dimensions have been published in Kent's Pocket Book, 8th Edition.

After having thoroughly investigated the conditions which induced the two societies to adopt the "1912 U.S. Standard," the manufacturers of flanged fittings and flanges throughout the country realized that certain changes in the generally accepted standard were desirable. The tendency of modern engineers to use higher steam working pressures than was their practice some years ago has demonstrated the necessity for an increase in the strength of extra heavy end flange bolting in the larger sizes. In drafting up the "1912 U.S. Standard," the American Society of Mechanical Engineers provided an increase in the bolting of large extra heavy flanges; but this increase seems out of proportion with the nesessities of steam engineering practice. The manufacturers have, therefore, adopted a happy medium and have increased the bolting on these extra heavy flanges, but have been more practical in this increase than the "1912 U.S. Standard."

So far as the strength of the fittings themselves, not considering the bolting, is concerned, the "1912 U.S. Standard" has no advantage whatever over the manufacturers' standard.

While the "1912 U.S. Standard" provides longer centre to face dimensions on many straight sizes, this change was not brought about by any attempt to better the fittings, but was an average of several published sets of dimensions which in many cases were out of date and did not correspond with the goods being made by the respective manufacturers.

This change alone would require a large expenditure for patterns and shop equipment, without a commensurate advantage to the consumers.

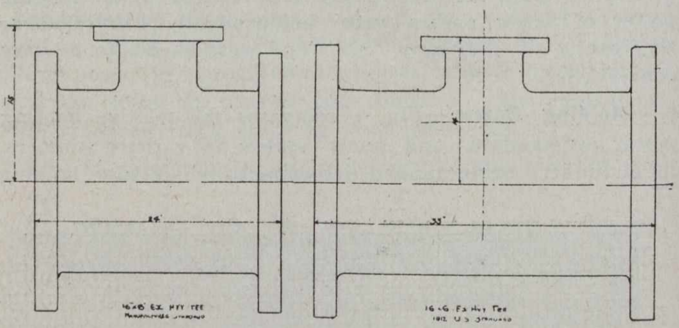
The increase in bolting in the "Manufacturers' Standard" compares very favorably with the table of dimensions on "A Standard for High Pressure Steam Lines," issued by the Society of German Engineers in 1900; also the report issued by the Engineering Standards Committee on British Standard Tables of Pipe Flanges.

While the "1912 U.S. Standard" provides much heavier bolting on the very large extra heavy flanges, this excessive increase does not seem necessary, as the "Manufacturers' Standard" bolting is just as strong as the "1912 U.S. Standard" on the sizes which include the great majority of pipe lines; namely, the ten-inch size and smaller.

The "Manufacturers' Standard" is much more economical for the consumer of the future, in avoiding mistakes when making changes and additions to his plant, as no change is made in the centre to face dimensions from the present "Manufacturers' Standard." This standard is also economical for the manufacturer, as he can use his present equipment, which, to a large extent, is made up in very substantial fashion and cannot be changed without involving a very high expenditure.

Furthermore, the "1912 U.S. Standard" will naturally create a great deal of confusion to the consumer, jobber and manufacturer alike, as it would necessitate carrying two stocks of fittings for several years, or until the new standard is fully in effect. The "Manufacturers' Standard" will not cause this difficulty.

The "Manufacturers' Standard" for reducing fittings is a much better design than the "1912 U.S. Standard," as the fittings are more in proportion with the straight sizes. The "1912 U.S. Standard" has the same dimensions on the run of reducing fittings as the straight sizes, regardless of reduction. It will be readily seen that the proportions of a reducing fitting will not be in harmony with those of a



straight fitting. This is illustrated by the cut, which shows a fitting drawn to the same scale, using the "Manufacturers' Standard" and the "1912 U.S. Standard."

To sum up the situation, it is quite apparent that the "Manufacturers' Standard" has all the merits of the "1912 U.S. Standard" without its disadvantages. While the opinions of some engineers may be in favor of heavier bolting in the larger extra heavy flanges, it does not seem consistent nor necessary with present steam engineering practice.

It would seem apparent that the excessively large bolt diameters specified in the "1912 U.S. Standard" for the larger flanges are much too cumbersome and inconvenient from the steam fitters' standpoint, while the bolt sizes specified in the "Manufacturers' Standard" are more in accordance with general practice. In a standard of this nature convenience as well as strength should be a governing factor.

We feel confident that the public at large will express their preference for the "Manufacturers' Standard," and while the manufacturers may be accused of not taking an interest in the "1912 U.S. Standard" from its inception, their recent action in adopting a universal standard which is fully in accord with the requirements of the engineering trade, will demonstrate that they are acting with absolute sincerity and with a fair-minded attitude towards all interests involved.

The Canadian Engineer

ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

COAL-DUST EXPLOSIONS.

The first report of the Explosions in Mines Committee, of which a summary appeared in the London Times recently, confirms some of the opinions which have already been expressed regarding the deterrent influence of stone-dust upon explosions, and it is satisfactory to observe that the committee are making progress with an investigation which must of necessity be developed by a step-by-step process upon the basis of direct experiment. From the programme of their prospective researches it appears that they have to examine the nature and condition of the coal-dust in mines, the amount and purity of the oxygen supply, and the character of the initial conditions that result in ignition. They have, moreover, to determine the comparative violence of coal-dust explosions, and the modifications of the destructive forces depending upon the general dimensions and layout of the mines. It is an investigation in which theory is singularly impotent to give direction to the research. Theory, in fact, must play the secondary part of interpreting results and suggesting certain safeguards, and the reason is that the committee are dealing with a set of phenomena that concern the break-up of the substance in a fraction of time altogether too small for the calculation by ordinary means of a series of constants representative of the successive stages of the explosions. Their investigation is, in fact, as far removed as can be imagined from the ideal conditions and the "perfect gas" relationships of thermodynamics. Since 1824, when Sadi Carnot published his remarkable contribution to the problem of the expansion of gases, the internal combustion engine has forced engineers to extend their tests far beyond the conditions of stability which he assumed into the region of explosion and disassociation; nevertheless, there is still a disposition to assume relationships between temperature, volume, and pressure applicable only to the gas in Carnot's engine, which was always brought back to its original condition. Briefly, therefore, the complexity of the task before the committee arises from the circumstance that they have to take account of the intrinsic energy of the working substance, which the laboratories have too often eliminated. The experimental station which has just been established at Eskmeals is destined to play an important part in that investigation, and every engineer will hope that it will rapidly reveal the means of safeguarding the lives of miners and of improving the physical conditions under which they work.

CANADA'S FIRE LOSSES

The fire losses in Canada for the first six months of the current year total $14,740,499, an average of $2,456,750 per month. This is equal to a daily loss of $81,891. In other words, $3,412 worth of property has been burned every hour since the new year dawned, or nearly $57 every minute.

This is an appalling fire loss, and little is being done to check such extravagant waste of capital. The losses during 1909, 1910 and 1911 are as follow:—

	1909.	1910.	1911.
January	$1,500,000	$1,275,246	$2,250,550
February	1,263,005	750,625	941,045
March	851,690	1,076,253	852,380
April	720,650	1,717,237	1,317,900
May	3,358,276	2,735,536	2,564,500
June	1,300,275	1,500,000	1,151,150

	1909.	1910.	1911.
July	1,075,600	6,386,674	5,384,300
August	2,582,915	1,667,270	920,000
September	1,615,405	894,125	1,123,550
October	2,208,718	2,195,781	580,750
November	935,191	1,943,708	1,506,500
December	1,433,813	1,444,860	2,866,950
Total	$18,905,538	$23,593,315	$21,459,575

Adding to these figures the total loss for the first six months of 1912, we have a fire loss in forty-two months of $78,698,927, an average monthly loss of $1,873,785. In addition there has to be recorded a disastrous list of fire fatalities. During June in Canada six people met their deaths in fires. During the first six months of the year 101 people were sacrificed in the same manner. In the forty-two months since January, 1909, no less than 893 persons lost their lives in fires, a monthly average of almost 22 persons. The following table gives the details:—

	1909.	1910.	1911.	1912.
January	16	27	27	27
February	8	15	12	11
March	16	20	18	24
April	18	37	20	15
May	21	15	28	18
June	16	52	13	6
July	4	15	110	..
August	17	11	22	..
September	10	10	13	..
October	26	16	17	..
November	34	19	20	..
December	33	19	17	..
Total	219	256	317	101

In June, burning buildings were responsible for three deaths and three were caused by clothes set on fire.

The presumed causes for fires during June and the number of fires for which they accounted were as follows: Four, lamp explosions; three, children playing with matches; two each, cigarette stubs, incendiary, sparks, friction; one each, oil stove explosion, defective chimney, overflowing of a pot of soap grease. Forest fires did much damage and many fires were reported as of unknown origin.

The structures damaged and destroyed during June were 70 residences, 9 business sections, 5 stores, 4 each lumber mills, factories, 3 foundries, 3 each stables, barns, 2 each churches, hotels, freight sheds, 1 each rolling mill, flour mill, railway depot, roundhouse, power house, club house, ice-house, telephone exchange, pool room, barber shop, college, soda water works, grain warehouse, gasoline container, electric plant.

There were 500,000 staves, 15 tons hay, 6 horses, 2 miles wire fencing, 1 each buggy, motor launch, gasoline truck destroyed.

The National Board of Fire Underwriters of the United States, continuing its plan of education on the need of better protection, issued an exhaustive classification of fire losses recently, showing why the insurance companies are forced to ask higher rates in America than in Europe, and why rates in America itself necessarily vary. Taking thirty of the largest cities of the United States, the per capita loss in 1909 was shown to vary from $1.36 in St. Louis to $4.55 in Kansas City. Higher per capita loss was shown in some of the smaller centres, like the city of Racine, where it ran to $24.29. The total annual fire loss is estimated at $200,000,000, and fire specialists go so far as to assert that $150,000,000 of this is waste from negligence or lack of precautions. The table of comparisons drawn up by the underwriters from consular returns in 1905, the only recent year in which statistics of the kind were gathered in Europe, showed an average loss of 61 cents per capita for thirty European cities as against $3.10 for 252 American cities Taking the number of fires to each 1,000 of population here and in Europe, it was found to be 4.05 in the United States against .86 in Europe.

The annual average losses for six nations in Europe were compiled from records of varying years and years grouped, with this result:—

Country.	Annual fire loss.	Loss per capita. Cents.
Austria	$ 7,601,389	29
Denmark	660,924	26
France	11,699,275	30
Germany	27,655,600	49
Italy	4,112,725	12
Switzerland	999,364	30

Or an average loss per capita of 33 cents.

The fire loss per capita in the Dominion last year was $3.02.

On Berlin, where the losses amount annually to less than those of one moderately large fire in the United States, the excellent conditions are due to the attention paid to the methods of construction. Building police have authority to compel the use of iron and steel girders, fireproof stairways and roofing, heavy fireproof ceilings, and all details that may diminish the risk of conflagration.

Canada cannot claim to be making untrammeled progress until its fire record has been improved considerably.

LETTERS TO THE EDITOR.

Editor Canadian Engineer:

Dear Sir,—In your issue of June 27th, 1912, you published an article by Mr. F. M. Griswold on "Standard Hose Couplings and Hydrant Fittings," being a review of the progress made in introducing a standard in the United States; strange to say, little or nothing has yet been done in Canada in regard to this important matter.

Some time ago the question was taken up by the Western Canada Fire Underwriters' Association, whose jurisdiction extends over the Provinces of Manitoba Saskatchewan and Alberta. It was our intention at first to attempt to introduce the "National Standard," but the suggestion met with opposition from fire chiefs. Our next step was to find out what couplings are used in the towns and cities throughout this territory, and we found that two towns use five threads per inch; seventeen use six threads per inch; four, including two very small places, use seven threads per inch, and three use eight threads per inch. The list includes all the cities and towns which have waterworks systems in this territory, with the exception of four or five small places. We found that fire chiefs are almost unanimously in favor of the six-thread coupling, as it will stand more wear than the finer thread and is not so easily crossed; it is also a heavier coupling, being 3 3-16 inches outside diameter over the male end. After some discussion we came to the conclusion that, as the six-thread coupling is so largely used, it would be very difficult, if not impossible, to have a change made to something else, and we decided it would be best to follow the line of least resistance and make this coupling a standard throughout our territory. As these three provinces extend from the rocky country of Western Ontario on the east to the Rocky Mountains on the west, it is improbable that there will ever be any large cities close to us on either side, and to have a uniform thread all through this territory will be almost as good as a standard for the whole country. One non-standard town in Saskatchewan has practically agreed to change, after which all the towns in that province will be standard.

If you will kindly publish this letter, it will be the means of bringing the matter to the attention of engineers who may be engaged in the installation of water supply systems in this part of the country.

H. STAINTON,
Inspector W.C.F.U.A.

* * * *

THE BLOOR STREET VIADUCT.

Sir,—It is with the greatest degree of satisfaction that I have noted the editorial in your number of the 8th instant protesting against the official statement of the Commissioner of Works of the city of Toronto in a report to the Board of Control that "concrete bridge design is not well understood, while that of steel is upon an assured basis."

The statement is made, apparently, with reference to the type of construction to be adopted for the proposed Bloor Street viaduct in Toronto, but its connection therewith is quite secondary in importance to the statement itself. That such a statement should be officially made by the chief works officer of the second city of our fair Dominion is amazing, and in the interest of truth and in justice to our profession you do well to take issue with the person who made it.

The commissioner must know, if he has studied the subject at all, that the greatest stride made by the engineering and architectural professions in structural design since the development of the great orders of architecture is in reinforced concrete construction. Its adaptability to structures of all kinds is proven beyond all doubt as regards both strength and design. Its permanence equals that of the everlasting hills.

The success or failure of isolated examples of any type of structure as a result of errors in workmanship or design proves nothing. One type is no better than another if errors have crept in anywhere. For the information of the commissioner I would join with you and emphasize your statement that "the analysis of stresses and the knowledge of the action of concrete is to-day on as high a plane as any other branch of structural design."

For myself, I cannot think that the commissioner has had any engineering training, and I feel quite certain Mr. Power never made such a statement as that which is contained in the report to the Board. To let such a statement go unnoticed would reflect discredit on the excellent work already done by the civic staff of Toronto, and on the work done by Canadian engineers throughout this broad Dominion. It would hold us up to ridicule before the Dominion, and the profession to ridicule before the world.

Such questions as that with which the report deals cannot be answered lightly. I know of no engineer who would decide such a question for the reasons given in the report. There exists no engineer who would make the statement so manifestly one-sided and at variance with the facts as "concrete bridge design is not well understood, while that of steel is on an assured basis."

WALTER J. FRANCIS,
M.Can.Soc.C.E. M.Am.Soc.C.E.

Montreal, August 12, 1912.

GENERAL NOTES.

The distribution of precipitation during July varied considerably with the district, but speaking generally, the amount recorded from British Columbia, to and including Manitoba, also Eastern Quebec, and the Maritime Provinces was considerably above the average, while in other districts the fall was deficient. Locally in the Lower Mainland of British Columbia, Southeastern Alberta, Southwestern Saskatchewan, and Southwestern Nova Scotia, the registered value was subnormal, while in parts of the Peninsula and Central Districts of Ontario, the fall exceeded the normal. In many parts of the Western Provinces the precipitation was nearly double the normal and heavy thunderstorms were of frequent occurrence.

The table shows for fifteen stations, included in the report of the Meteorological Office, Toronto, the total precipitation of these stations for July, 1912:

	Depth in inches.	Departure from the average of twenty years.
Calgary, Alta.	5.2	+2.6
Edmonton, Alta.	4.7	+0.95
Swift Current, Sask.	2.3	—0.21
Winnipeg, Man.	6.1	+2.77
Port Stanley, Ont.	4.0	+0.64
Toronto, Ont.	1.95	—0.98
Parry Sound, Ont.	1.4	—1.73
Ottawa, Ont.	4.9	+0.80
Kingston, Ont.	1.6	—1.26
Montreal, Que.	2.3	—1.66
Quebec, Que.	2.0	—2.43
Chatham, N.B.	6.5	—2.78
Halifax, N.S.	4.7	+1.14
Victoria, B.C.	1.1	+0.85
Kamloops, B.C.	3.5	+2.24

The value of the material used in the slack cooperage industry in Canada in 1911, according to figures prepared by the Forestry Branch, Department of the Interior, was $1,465,702, or about $130,000 less than the value in 1910. The amount of material consumed, outside of a large element of waste, which cannot be accurately determined, is estimated at 62,353,190 feet, board measure.

Ontario leads in this industry, with the production of 64 per cent. of the total number of staves, 70 per cent. of the headings and 76 per cent. of the hoops. Nova Scotia, with a large proportion of fish-barrels, was next with 29 per cent., 24 per cent. and 20 per cent, respectively, of the total number of staves, heading and hoops. The other provinces produce very limited quantities.

Imports exceeded exports of $135,463 by $194,529. White oak staves form an important part of the imports, numbering, in all, 7,293,000, whereas only 2,768,000 were cut in Canada. The Canadian supply of oak, which alone is suitable for the manufacture of containers for alcoholic beverages, is so nearly exhausted that this branch of the tight cooperage industry will practically cease in a few years.

The cost of materials for slack cooperage averaged as follows per thousand pieces: Staves, $6.91; heading, (sets) $54.77; hoops, $7.62. Figures on the cost of tight cooperage materials were not available.

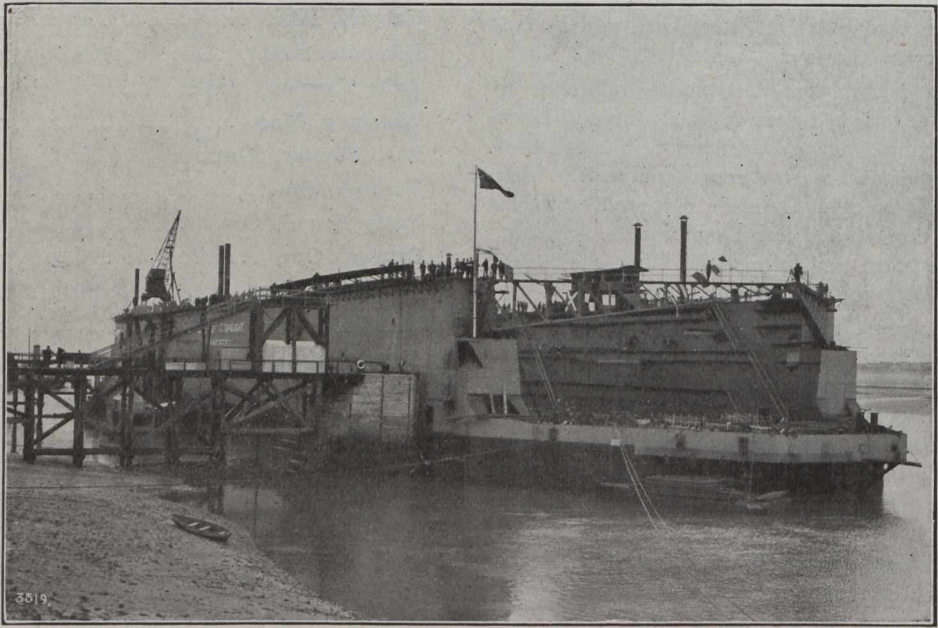
NEW FLOATING DOCK FOR MONTREAL.

An interesting event, during the presence of the Canadian Ministers in London, England, was a visit paid by some of them to the English Lake District, for the purpose of inspecting and naming the "Duke of Connaught," which is the large floating dock that has just been completed by Messrs. Vickers, Ltd., Barrow-in-Furness, for service at Montreal.

The party left by special train on Saturday afternoon, the 20th July, for Furness Abbey, which is situated a few miles from Barrow. The event took place on Monday morning, when the visitors were driven to the new dock, which was then inspected, and the naming ceremony successfully completed by Mrs. J. D. Hazen, wife of the Minister of Marine.

The new dock, which has been named after the Governor-General, with his permission, has been constructed for the firm of Canadian Vickers, Ltd., which is establishing at Montreal, large works for the construction and repair of battleships up to such large vessels as the Dreadnought type and also for other sea-going ships.

It is generally considered in England that this is a great step in connection with the naval policy of Canada, and that it will mean a great deal, not only to the citizens of Montreal but also to the Dominion as a whole. It was pointed out that in the event of a serious accident a ship at Montreal would have to travel 1,000 miles to Halifax before repairs of an extensive nature could be undertaken. This condition would be altogether altered by the presence of a floating dock in the St. Lawrence. The advantage of a floating dock over one of masonry or concrete is that it can be towed to any point on the Atlantic seaboard of the Dominion for the purpose of assisting in the raising of any ship which may have become damaged by running aground.



View of the New Floating Dock for Montreal.

The dock is capable of dealing with some of the largest ships afloat, being able to contain ships of more than 26,000 tons, although, of course, it will frequently be used for much smaller vessels. An interesting item is the introduction of steam heating for the purposes of preventing the freezing of the water in the various compartments, and also the safeguarding of the mechanism. This became advisable due to the probability that it will frequently have considerable work to do in the depths of winter.

Regarding the dimensions the dock is 600 feet long and has a width of 135 feet in all, while the depth of the pontoons is 17 feet, with the walls rising to a height of 42 feet, this makes an over all depth of 59 feet. The enormous dimensions of the structure, which is the second largest that has ever been built in the British Isles, can be better understood from the fact that it will accommodate ships having 100 feet beam, whereas the length is immaterial due to the dock having open ends.

The works are to be situated at Maisonneuve, Montreal. on the banks of the St. Lawrence River; they will cover an area of over 30 acres, including a basin of 12 acres, and will have a quay frontage of 2,500 feet, and it is estimated that 2,000 men will be employed. At this point the river is over one mile wide.

The Harbor Commissioners have offered excellent railway facilities.

On completion of the ceremony the Canadian Ministers made a tour of inspection of the works of Messrs. Vickers, Ltd., and had the opportunity of going inside some submarines.

The company then gathered together at the office when speeches were made by Sir Trevor Dawson, the Hon. J. D. Hazen, Hon. C. J. Doherty, and Mr. C. G. Ballantyne (representing the Montreal Harbor Commission.

The dock is capable of taking the largest existing ship in the British Navy and the heaviest ship trading to Canada.

The building of such a dock has been preferred to the construction of masonry or concrete graving dock, because, although normally it will be utilized within the basin of the new extensive and well-equipped ship-building works of the firm at Montreal, it can be towed to any point on the Atlantic freeboard of the Dominion, to assist in the raising of any ship which may get damaged by running aground, and, in view of the hazards to which the Royal naval and merchants ships are exposed, this will confer very considerable advantage. A feature in the design, too, has been the aim to economize in the working of the dock; thus, although it is capable of taking the heaviest ships afloat, it will more frequently be used for vessels of quite moderate size, and on such occasions it will not be necessary to use the whole of the dock or to run the machinery at its fullest power. In structural details, everything has been done to make the dock continuously reliable. One instance alone need be mentioned: steam-heating is provided to prevent water in the compartments from freezing and to preclude the mechanism from becoming affected by frost. This is most important, because the dock may have to be sunk under a ship in the most severe winter weather, and it is important that the water in the compartments ensuring this sinking can be pumped out when required. All the machinery in the dock—which is very extensive—is in duplicate, and the equipment includes every conceivable appliance to facilitate the docking of a ship.

The length of the dock is 600 feet, and the width over all 135 feet, the depth of the pontoons at the bottom being 17 feet, while the side walls rise to a height of 42 feet from the pontoon deck, so that the over-all depth is 59 feet. Ships of 100 feet beam can easily be docked, and as the ends are open, a vessel of any length can be accommodated. There are bridges at both ends, for the conveyance of workers. The dock will mark an important development in Canada's association with naval defence as well as in merchant shipping. The name of "Duke of Connaught" has been given to it.

It may be added that the Canadian Shipbuilding and Engineering Works of the Vickers Company are situated at Maisonneuve, a township adjoining Montreal, on the banks of the St. Lawrence. The works, which cover an area of over 30 acres, also include a basin of about 12 acres, having a quay frontage of 2,500 feet, and, when fully working, will employ over 2,000 men. The site is admirably situated and the land has been in a great measure reclaimed from the bed of the St. Lawrence, which, at this portion, is over one mile in width, and the dredging has considerably increased the depth of the river channel where it passes the works. Excellent railway facilities have been afforded by the Montreal Harbor Commissioners. The general construction of the buildings is such as to suit the climatic conditions of Canada, where there is such a vast difference in the temperature of the seasons, and was only decided on after the Canadian Vickers Company had sent their representatives there to study the general conditions, in association with the Montreal architects and contractors. Generally the buildings will be constructed of steel framing, the sides instead of being covered with corrugated sheeting, as is the usual practice in British yards, will be formed of brick, which besides being warmer during winter should be cooler during the summer months. The building berths are so arranged that vessels up to 1,000 feet in length can be built. In the meantime, a covered berth has been erected, so that the work may not be stopped during the winter months. The directors of Canadian Vickers Limited, are:—Albert Vickers (chairman), Sir A. Trevor Dawson, Sir Vincent Caillard, F. Orr Lewis (president Canadian Board), Sir H. Montague Allan, Preble MacIntosh, James G. Lewis.

After the ceremony at the dock, the Minister of Marine and the general company of guests made a long tour of inspection of the most important departments of the Vickers works under the guidance of the directors of the company.

The party included:—The Hon. J. D. Hazen and Mrs. Hazen, the Hon. C. J. Doherty, Miss Doherty, Mr. G. J. Desbarets, Admiral and Mrs. Kingsmill, Mr. and Mrs. C. G. Ballantyne, Mrs. R. C. Smith, Mr. MacArthur Smith, Mr. J. T. Hackett, Dr. Hackett, Mr. G. Heidmann, Mr. and Mrs. F. Orr Lewis, Mrs. Grant, Mrs. W. Beardmore, Col. John Hughes, Miss McKeard, Mr. and Mrs. James R. Nelson, Mr. C. B. Reilly, Mr. B. W. Gonin, Mr. Nugent M. Clougher.

NEW RUSSELL MOTOR FACTORY.

The Russell Motor Car Company are building an addition to their plant, consisting of a four-story machine shop, equipped with the latest mach'nery for automobile manufacture. The cost of the building will be approximately $100,000. This increase to the plant of the company will result in the employment of about 200 more skilled workmen, and bring the total number of employees to over 1,200. The company has now completed and occupies its new office building.

NEW METHOD OF TESTING RIVET STEELS.*

By G. Frémont, Paris.

(Translated by C. Salter, London.)

In order to avoid serious errors in calculating the strength of materials, prudence demands that one should take as a basis only the lowest elementary strengths indicated by experience, and in addition apply a sufficiently low coefficient of safety.

Thus, as regards the strength of riveted members, it is usual in calculating to allow only for the shearing strength of the rivets; but in practical construction work it is essential that riveted members should act solely by the adhesion of the plates, and never merely by the resistance to shearing of the rivets, since, in the latter event, these undergo gradual shearing and soon wear out. The same applies to receptacles which have to keep staunch: boilers, tanks, etc., because if there is insufficient adhesion they become leaky.

When engaged in experimental investigations on riveting I was led to isolate each of the factors influencing the holding power of the rivet; and in order to study the influence of the elastic limit of the metal, forming the rivet, on the adhesion strength, I devised in 1904 a new method of determination based on the rotary slip around the rivet,

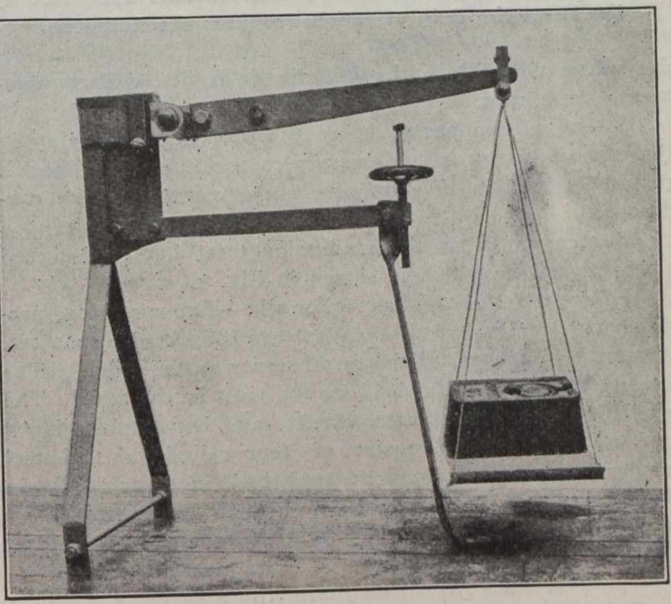


Fig. 1.—Machine for Measuring the Adhesion Produced by a Rivet.

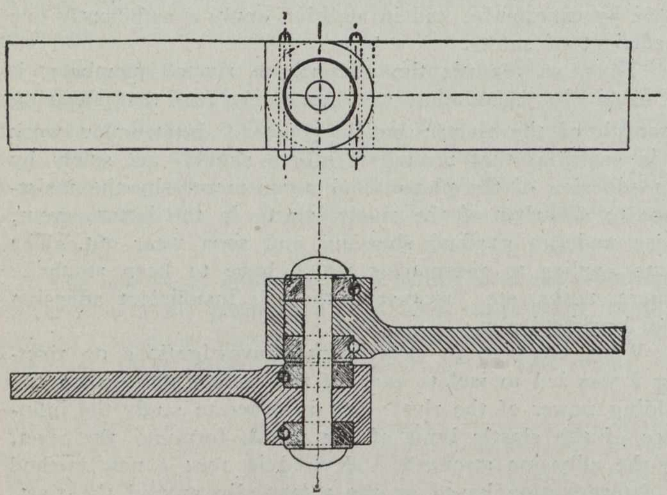
the latter serving as axis. I used plates with unworked surfaces, which gave different results at each test.

The Western Railway Company of France was good enough to prepare plates for me in which the thickness of the metal was reduced beyond the confines of the circular surfaces, concentric with the rivet, which alone were to remain in contact under the pressure of the rivet; but the finish and roughness of the natural surfaces of the plates, varying in each test, prevented me from ascertaining the influence of the elastic limit of the metal of the rivet, and in November, 1905, I was obliged to publish the first part of my report without giving the results of these tests. My failure was due to the mistake I made in following the conditions of practice; and since then the only way in which I have been able to obtain a satisfactory result has been by working with sliding surfaces that could be easily brought into uniform condition in all cases.

* Paper to be delivered at sixth Congress of the International Association for Testing Materials.

These results, moreover, have merely a relative value, since they were obtained with worked, uniform sliding surfaces, but they vary solely under the influence of the effective grip of the rivet. For this it is sufficient that my apparatus should provide—as can easily be done—a smooth cylindrical hole for the insertion of the rivet.

The results of my experiments have been published in a paper on the strength of riveted members ("De la résistance



Figs. 2 and 3.—Cheeks of the Testing Machine Connected by the Rivet the Grip of which Produces the Adhesion.

des pièces rivées") in the Bulletin de la Sté. d'Encouragement, April, 1909.

Strength of adhesion being the predominant quality in the case of rivets, it is necessary to ascertain the adhesion that the metal is able to give under certain definite conditions.

For carrying out these adhesion tests I have designed a small machine which is shown in Fig. 1.

I have described it as follows[1]) :—Two members, provided with cheeks (Figs. 2 and 3) are connected by a rivet, 16 mm. in diameter, of the metal under examination. The total thickness of metal held by the rivet is 100 mm. The bearing pieces between the cheeks, and between the latter and the rivet heads, consist of four cylindrical tool-steel washers, turned, tempered and polished, in order to obtain sliding surfaces which can be accurately reproduced in all cases with ease.

The effort of adhesion is ascertained by the aid of weights which are placed on the platform at the end of the lever until slip is produced between the contact surfaces between the two cheeks of the apparatus.

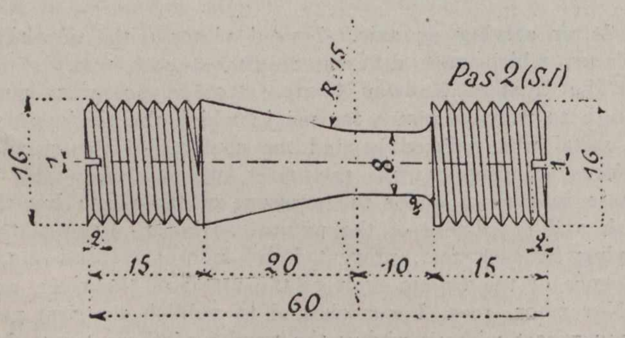


Fig. 4.—Truncated Test Piece for Tensile Test with Determination of the True Elastic Limit.

In this machine the surface of contact on which the slip friction is set up is a circle 40 mm. in diameter. The bore for the insertion of the rivet is 16 mm. in diameter, and the distance between the axis of the rivet and the knife edge of the balance is 0.594 m.

These data enable the moment of resistance to be calculated.

The value of the effort of adhesion per square millimetre of sectional area of a rivet 16 mm. in diameter is P 0.2.

P is the load formed by the weights placed on the platform, plus the weight of the lever itself, which in this instance is 2.850 kilos.

A screw stop, operated by a small handwheel, limits the travel of the lever, and enables several slip tests to be performed in succession.

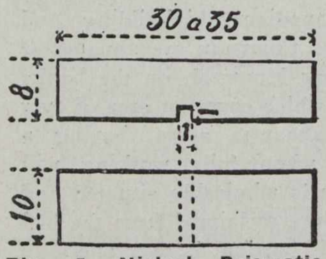


Fig. 5.—Nicked Prismatic Test Piece for the Impact Bending Test.

In these tests it is important to standardize the method of riveting the specimen of steel; and the conditions must be less favorable than those occurring in practice.

After the adhesion test the rivet is taken out by removing one of its heads, and the metal is tested. The thickness of the rivet shank: 100 mm., enables a test piece to be prepared in the shape of a truncated cone (Fig. 4) for the tensile test with determination of the true elastic limit, and a prismatic test piece (Fig. 5) 8 x 10 mm., nicked with a saw cut, for impact bending tests to ascertain the brittleness or toughness of the metal.

[1]) Le Génie Civil, 19. November, 1910.

SOME CONSIDERATIONS IN THE CHOICE OF A PAVEMENT.*

By Prof. Leonard S. Smith, University of Wisconsin, Madison, Wis.

What is the best pavement? is a question which citizens, city officials and even some engineers are not infrequently guilty of asking, forgetful of the plain fact that such a question admits of no ready or simple answer. As well might it be asked what is the best bridge or the best house to build. It is a most hopeful sign that the past year has seen many papers read at engineering society meetings discussing this question of considerations affecting the choice of a pavement.

It cannot be too emphatically stated that in each case the best structure for a pavement depends upon the particular service required of it and also, too, upon the widely varying local conditions. These modifying factors naturally divide themselves into two general classes. The first of these govern the conditions to which the pavement will be subjected. Chief among these factors are the quality, nature and even the direction of the traffic, the character of the district served by the pavement, the grade of the street and the presence of car tracks.

On the other hand, the second class of factors which may determine the selection have reference to the character of the pavement itself, such as durability, smoothness, noiselessness, slipperiness, cost, etc.

The best pavement for some particular street, then, would be the one which would give the greatest and most needed service, using the word service in a broad way. The limits of this paper will not allow of a full discussion of this

*A paper read before the Engineering Society of Wisconsin.

question, but my point can be most clearly explained by giving a few applications of the principle. For example, if the street had a steep grade, all such considerations as smoothness, noiselessness, cost, etc., must needs give way to the single governing quality of non-slipperiness. Again, if the street in question were on a moderate grade in a high-class residence district or in the office-building district of a large city, the factors of smoothness and noiselessness might properly determine the final selection. Such a selection, while involving a very expensive pavement, has repeatedly been shown to fully justify itself by the added value and earning capacity of the property. As a third example, considering the choice of a pavement in a wholesale district, subject to concentrated heavy traffic, the qualities of durability and non-slipperiness would here naturally receive the greatest consideration.

The above statements are so obviously based on common sense that it may seem to some useless to take up valuable time in their presentation. Repeated inspection of the pavements in a score of our largest cities has shown the writer that the choice of pavements has too frequently been left to chance or prejudice. Our growing vision of municipal efficiency discerns a much-needed reform in the choice of our pavements, a reform certain of realization.

But while there is great economic need that the best fitted pavement for each particular street should be thoughtfully and carefully chosen, it is at least of equal importance that all such paving improvements should proceed in accordance with some well-considered plan—some comprehensive system for future improvement of the entire city, ward or region. For example, pavement improvements should be so planned as to provide several parallel routes for through traffic. If this be not done, the single route becomes congested and the pavement is prematurely worn out. Again, pavements should be continuous, both for the convenience of traffic and for ease of maintenance.

In the case of country highways, it is necessary to construct disconnected stretches of pavement, but even here it it of prime importance that such construction should proceed in accordance with a systematic plan, so that disconnected stretches may eventually become a part of a complete system. For example, in our own State it would be easy to select a few trunk roads leading from the metropolis of the State to the adjoining cities, and still others connecting the largest city or county seat of each county, as being certain to attract the heaviest traffic. Portions of such trunk roads should be improved with reference to sustaining heavy traffic and also with a view of becoming a part of an intra-state system.

Unhappily the city paving program is too often determined by the ward politician or the opposition or favor of short-sighted real estate owners. A few cities which have tried this plan of adopting a paving program extending over ten years will soon occupy an enviable position. Our cities cannot do better in this respect than to follow the example of the most successful railroad companies.

While future traffic conditions may render necessary here and there a change in the detail plan, the city is certain to gain largely in the end because of having a carefully prepared plan for all street improvements, including water, sewer and gas as well as pavements.

The charter of many American cities provides that the abutting property owners shall pay for the first pavement, while the city must pay for all repairs and renewals. As might be foreseen, this has resulted in the selection and construction of many cheap and inferior pavements, where much more permanent construction would have been justified. But this abuse has not stopped here. Long time bonds have been commonly issued to secure the payment of such temporary pavements, in many cases falling due twenty-five years or more after such pavement has utterly worn out.

Such a system of financing pavements cannot be characterized as anything short of dishonest. It simply transfers to the backs of our children the burdens we of right should bear ourselves. For the future will doubtless have sufficient burdens and problems of its own without being required to shoulder in addition those of to-day.

Already legislatures are considering corrective legislation. The writer knows of at least one eastern legislature which in 1910 passed a law prohibiting a city from paying for short-life pavements out of the proceeds of any bond sales. This principle of "pay as you go" deserves a wide adoption.

It is worthy of restatement that cheapness does not necessarily mean a cheap price of the pavement when laid; indeed, such a pavement may likely prove the most expensive in the end. The other governing elements which determine the actual cost of a pavement are the annual cost of repairs and the term of life of the pavement. Permanent pavements may properly be paid for out of the proceeds of bond issues payable during the life of the pavement. In such cases the public will eventually have to pay for the following items: Interest on the bonds, cost of repairs and annual sums for a sinking fund, which by the time the pavement is worn out will pay off the bonds. Such a plan may be shown by the following formula:

$$S + CI + \frac{R}{L} = \text{annual cost,}$$

where S = the yearly amount put in the sinking fund
C = first cost of the pavement
I = the rate of interest
L = the life of the pavement in years
R = the total cost of repairs.

Obviously, the cheapest pavement is the one involving the least annual cost. If, for example, macadam pavement be chosen for a street having traffic, the last term $\frac{R}{L}$ would be so large as to make such a pavement the most expensive type that could be chosen. This fact is an added illustration of the importance of a wise selection of a pavement for the traffic conditions.

New York State for several years has been making the colossal mistake of issuing many millions of long-time bonds in payment of some form of macadam even on heavy traffic trunk highways, where they very frequently have failed after a comparatively short term of service. Such is the judgment of well qualified engineers who have had charge of the construction and maintenance of such roads. The seriousness of this situation will not be fully realized until after the officials responsible for this error have passed to their final reward. Other States nearer home have made similar mistakes.

The construction of some form of the macadam road fulfills at a minimum cost all reasonable demands on streets or country highways carrying a moderate traffic, especially if such roads have the added protection of continuous maintenance. This class includes over half of our country roads.

But if such improved highways happen to connect two or more large cities, the unusually heavy traffic which such a road at once attracts results in certain and speedy failure. The advent of automobile and other forms of motor traffic, while it has lengthened the life of hard city pavements, has been the chief cause of the destruction of macadam roads.

The seriousness of this problem of the choice of proper road material is realized when we reflect that the demands made by this new form of motor traffic are certain to greatly increase in the near future. Highway engineers of every land are looking for an adequate remedy, but so far with only partial success. While constructional methods in nearly all other lines of engineering have been satisfactorily perfected and standardized, we find present highway construction on main trunk roads grossly inadequate for even the traffic of to-day, thereby causing needlessly large charges for maintenance.

It has seemed to the writer that real progress would be made by breaking away entirely from macadam construction on heavy traffic main highways. The improved and more permanent construction best suited to replace the macadam on such roads will here again be largely a local question. Ohio, Indiana and Pennsylvania have taken the first steps toward satisfying the demand for a more permanent construction by building many hundreds of miles of brick pavements laid on a concrete base with a cement grout filler, all supplemented usually by wings of dirt, gravel or macadam. The expense of such a pavement, about $1,000 per foot of width per mile, does not exceed the average price paid by New York State for its wider but short-life macadam roads, while the brick roads, if properly constructed, promise to be in good condition twenty-five years hence.

Wayne county, Michigan, has constructed a good many miles of main highways, leading out of Detroit, of rich concrete, seven inches thick, at prices which also compete with eastern macadam, while giving promise of outlasting the latter by many years. Where the proportion of automobile traffic is not too great, a large amount of traffic has generally been economically provided for by some form of the bitulithic construction. It may be that Wisconsin, with her widely distributed rich deposits of good gravel and other road materials can wisely follow one or all of these forms of permanent construction. Few States are more favorably situated for road building than Wisconsin. We are fortunate also in being able to profit by the experiments of our older sister States. These have shown us that there is no one best pavement and no one best way of constructing it under all circumstances.

We now recognize that the selection of road material and the method of incorporating it into a road is in large part a local question; in fact, that highway construction in city and country obeys the same rules of procedure as do all other forms of good engineering.

GRAND TRUNK PACIFIC AFFAIRS

In view of the misleading reports in the daily press respecting Grand Trunk Pacific affairs, Mr. E. J. Chamberlin, president of the road, has issued the following statement:—

"The Grand Trunk Pacific Railway have been operating the section of the National Transcontinental Railway between Winnipeg and Lake Superior Junction since August 1, 1911, handling all of last season's grain business and other traffic offered over that line without any detriment to the public. The Government are now asking that the Grand Trunk Pacific execute a permanent lease of that portion of the line between Winnipeg and Lake Superior Junction, known as district 'F,' and negotiations are pending between the Government and the company on that point, but do not, so far as a matter of accommodation, in any way affect the public.

"The contract between the Government and the Grand Trunk Pacific relative to the Transcontinental, that section between Moncton and Winnipeg, which was to be constructed by the Government and is known as the eastern division, provides that:—

" 'Pending the completion of the eastern division by the Government the company shall be entitled to lease from the Commissioners to be appointed under the said act, and to operate such portions of the eastern division as may from time to time be completed, upon such terms,' etc., but does not bind the railway company to take over any sections unless they desire to do so, until the entire line is completed.

"Negotiations are in progress between the Government and the company relative to a further lease of the section above referred to when it is fully completed and pending the completion of the whole line. Notwithstanding reports in the papers throughout the country, that portion of the Transcontinental line is not yet completed. There is considerable work to be performed on the entrance into Winnipeg, connecting up the Transcontinental with the Grand Trunk Pacific and the Canadian Northern at the Union Station. There is also considerable other work on the line necessary to be done before the terms of the contract are complied with.

"With regard to the Springfield, or Transcona shops: Major Leonard, chairman of the Transcontinental Railway Commission, has decided that the shops are not part of the contract between the Government and the railway, while the company contend that they are part of the Transcontinental contract. If Major Leonard's contention is eventually sustained, the taking over of the line between Winnipeg and Lake Superior Junction would not include the taking over of the shops by the Grand Trunk Pacific Railway. On the other hand, if the Grand Trunk Pacific's contention that the shops are a part of the Transcontinental Railway is sustained, the taking over of the line would also mean the taking over of the shops and placing them promptly in operation."

LAKE ERIE AND NORTHERN RAILWAY COMPANY.

At a meeting of the directors of the Lake Erie and Northern Railway Company, an agreement was concluded with Messrs. G. W. Farrell and Company for the purchase of the entire issue of $1,100,000 5 per cent. mortgage bonds.

The Lake Erie and Northern Railway was incorporated by a special act of the Federal Parliament in May, 1911.

The Dominion Government has granted a subsidy of $6,400 per mile, or a total grant of approximately $340,000.

The charter provides for the construction of an electric railway from Port Dover on Lake Erie through the towns of Simcoe, Waterford, Brantford and Paris, to the town of Galt, a distance of 53 miles. Connections will be made at Galt with the main line of the Canadian Pacific Railway for an interchange of traffic on completion of the road.

The directors of the company comprise a number of the prominent manufacturers in that district and consist of Messrs. John Muir, Harry Cockshutt, Lloyd Harris and John Sanderson, of Brantford; Richard Thompson, general manager of Penmans, Limited; F. H. Deacon, of Toronto; Martin Todd, general manager of the Galt, Preston and Hespeler Railway, and G. W. Farrell, of Montreal.

Mr. Lloyd Harris, one of the directors of the Lake Erie and Northern Railway Company, stated this week that the directors will call for tenders at once and hope to have construction started this fall.

The towns through which the line will pass—Galt, Paris, Brantford, Simcoe, Waterford to Port Dover—have voted to take second mortgage bonds totalling $500,000.

The directors believe that the field is a most promising one for both freight and passenger business, the 53 miles through which the line will pass being thickly populated.

METHODS OF TESTING CLAY.

A report on the clay and shale deposits of the Western Provinces has recently been printed for the Federal Department of Mines. In this report the authors, Heinrich Rieo and Joseph Keele, give their method of ascertaining the physical qualities of these substances. A report compiled by the following methods is of value in ascertaining the commercial aspect of the raw material. Their method consisted of a determination of plasticity; water required for mixing; tensile strength; air shrinkage; fire shrinkage; color and absorption at different temperatures; and fusing point.

Tensile Strength.—The determination of the tensile strength of the raw material is made because it gives a clue to the clay's ability to stand strains in handling before burning, and possibly also of its bonding power or its ability to stand the addition of non-plastic materials like sand or "grog."

The clays and shales submitted to the physical tests were first thoroughly dried, then ground in a jaw crusher and afterwards sifted through a 20-mesh sieve.

A weighed quantity of the sifted material, sufficient to make the necessary number of test pieces, was mixed with just enough water to give it the greatest plasticity, and thoroughly kneaded and wedged so as to render it perfectly homogeneous and free from cavities. The consistency generally arrived at was about midway in stiffness between a soft-mud and stiff-mud brick in practice.

In making briquettes for the tensile test a small piece of the kneaded clay was clamped into the briquette mould, and struck by the hand until it filled the mould completely, the excess of clay being struck off by a fine wire.

The clay was removed from the mould on a dry clay briquette—a set of them being kept for the purpose—and the wet clay briquette was not handled until it had hardened on its support, so that they were not distorted while soft.

The briquettes when hard were dried to 100° C., the cross section at the waist carefully measured, and then broken in an ordinary tensile strength machine.

Shrinkage.—All clays shrink more or less in drying and burning. The shrinkage that occurs while the clay is drying is termed air shrinkage, while that which occurs during the burning is known as fire shrinkage.

Air Shrinkage.—A portion of the kneaded clay was made into bricklets in a mould 4″ × 1½″ × ¾″ in size. Two fine lines, exactly 3 inches apart, were impressed with a steel stencil on the wet clay bricklet immediately after leaving the mould. When the bricklets were thoroughly dry the distance between these lines was measured, and the percentage of air shrinkage calculated.

Fire Shrinkage.—The burning of the bricklets at the lower cones was done in a down-draft muffle kiln, the fuel used being coke, and the time of burning from 12 to 18 hours. For the higher temperatures a gas-fired muffle kiln was used.

The lines on the burned bricklets were again measured after each successive firing, and the total amounts of shrinkage calculated. The difference between the total shrinkage and the air shrinkage represents the fire shrinkage.

Fusibility.—Small pyramids or cones of the ground clays or shales were burned in the gas-fired furnace until they were deformed or melted (Fig. 1). The temperatures at which the test cones melted are expressed in terms of the standard Seger cones.

A Deville furnace, fired with coke, under air blast was used for determining the fusing points of the more refractory clays, including those which did not fuse until a temperature ranging from cone 18 to cone 32 was reached.

Absorption.—The bricklets were carefully weighed after each burning, and immersed in water to about three-fourths of their thickness. This permits the air from the burned clay body to escape freely, allowing the water to better and more quickly fill the pores. After standing at least 24 hours in water, the saturated bricklets are weighed, the increase in weight recorded, and the percentage of absorption calculated as follows:—

$$\frac{\text{Saturated weight} - \text{dry weight}}{\text{Dry weight}} \times 100.$$

Dry-Press Tests.—The clay or shale used for the dry-press test was ground to pass a 20-mesh sieve, and moistened with 5 to 10 per cent. of water. A mould was filled with the damp clay, and pressed in a hand screw-press, the size of the bricklet produced being 4″ × 1½″ × 1″.

Rapid Drying.—For this test the clay or shale was ground to pass a 12-mesh sieve, and kneaded up with sufficient water to a fairly stiff mass, from which a full-sized building brick was made by hand in a wooden mould.

Immediately after coming from the mould the moist brick was placed on a rack in a box open at the bottom and with a perforated top, which stood on a steam-heated radiator. The temperature in this box ranged from 120° to 150° F., which is the heat usually attained in artificial dryers. If the brick cracked under this treatment it was understood that it would not stand rapid drying.

Drying Defects in Certain Clays.—Various Tertiary clays, and some Cretaceous shales found in Alberta and Saskatchewan, have the serious defect of checking while drying.

Clays of this character are usually very fine grained and highly colloidal, absorbing a large percentage of water when tempered for wet moulding. They are exceedingly plastic and sticky when wet, becoming a stiff, soap-like, and sticky mass, which is hard to work.

Generally, within half an hour after leaving the moulds fine cracks appear at the edges of the brick, which quickly spread over the surfaces, and as drying progresses these cracks widen and deepen. In time the outside of the brick becomes bone-dry, but the inside may remain quite moist for several days.

In some clays the cracks which developed in drying closed up completely when the drying was ended, but reappeared again in the burned product.

Several of the clays that displayed this drying defect gave fairly low air and fire shrinkages, were somewhat refractory, and burned to a good, hard body at cone 1.

In several districts they were the only materials available, and, as they might turn out to be sewer-pipe or paving brick clays, it was very desirable to devise some practical method of treatment to make them workable.

Hitherto, whenever brickmakers had to deal with clays which were too "fat" or "strong," as they termed those claps which were highly plastic, they usually added from 10 to 25 per cent. of sand. The sanded clays were found to dry quicker and work easier; the air and fire shrinkages were reduced, and generally a good, burned product is obtained from the mixture.

Apparently, then, the proper remedy to cure the objectionable behaviour of the clays being dealt with was the addition of sand. But when 25 per cent. of sand is added to these clays they crack quite as badly as before. They can be dried with the addition of 40 to 50 per cent. of sand, but this amount is evidently in excess of the bonding power of the clay, because the burned brick made from such a mixture is altogether too porous and weak for any purpose whatever.

It was then found by experiment that if any of these clays be ground and calcined or burned to a red heat, that the calcined clay, which has lost its plasticity, can be added to the raw clay in quantities as large as desired to secure the best working quality; that drying at a moderately fast rate can be accomplished with safety, and the properties of the burned clay body are not affected.

The calcined clay, then, acts as sand during the early stages of manufacture, but when burned it proceeds towards vitrification with the raw clay, and does not remain inert at ordinary burning temperatures as sand will.

Further experiments on preheating clays shows that if the ground clay be heated from 300° to 500° C. that they lose a great deal of their plasticity, and the quality of the clay is changed from a tough, sticky mass when melted to a granular and easily worked body which can be moulded by the stiff-mud process, and will stand fast or moderately fast drying.

How extremely finely divided some of these clays are in the raw state and the change in texture they undergo in preheating is shown in the following mechanical analysis, made by the centrifugal method:—

Material.	Percentage retained on 200-mesh sieve.	Percentage of silt.	Percentage of clay.
1. Normal clay	Trace	57.40	38.40
Preheated to 500° C...	36.20	46.20	15.00
2. Normal clay	6.4	45.6	46.0
Preheated to 450° C...	14.6	62.0	14.4
3. Normal clay	1.5	49.6	46.8
Preheated to 500° C...	22.1	52.0	24.5

1. Brown clay shale—Dirt hills, Alta. Lab. No. 1646.

2. Yellowish clay shale—Redcliff, Alta. Lab. No. 1686.

3. Dark grey underclay—Entwhistle, Alta. Lab. No. 1661.

The gains included under the heading of silt have a diameter from 1-200 to 1-5000 of an inch, and those under clay from 1-5000 to 1-25,000 of an inch.

Inasmuch as calcining and preheating clays involves the expense of extra machinery, fuel, and labor, it follows that only clays used for the higher grade products can be treated economically by this method.

Further experiments were undertaken with certain substances which when added to the clay would reduce the amount of water used in mixing, and also assist in conveying the moisture from the body of the clay to the surface during drying.

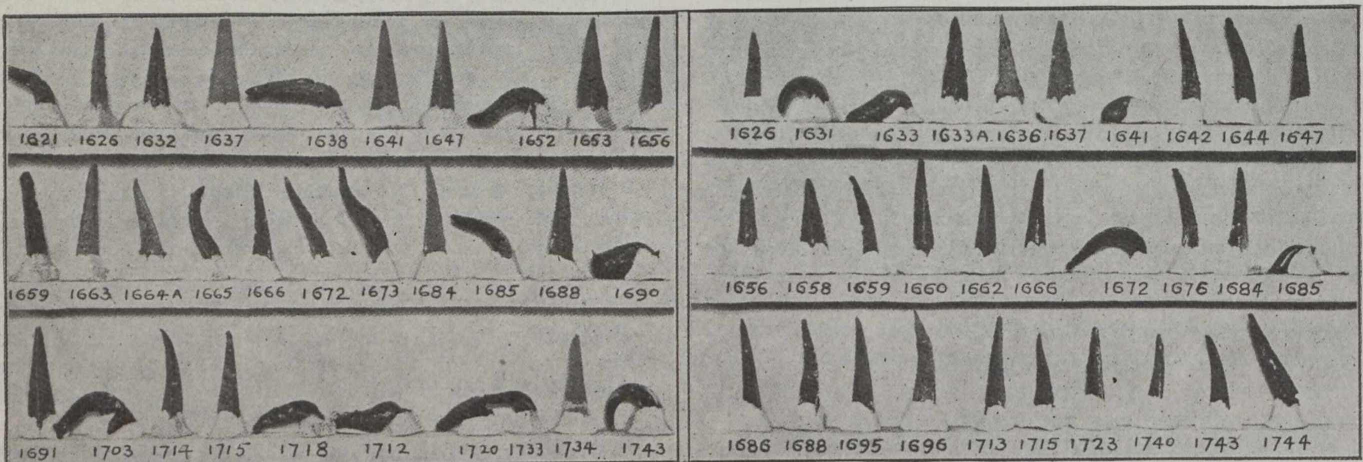
Of the various materials tried for this purpose during the experiments, those that gave the best results were hydrochloric acid and salt. Most cases of cracking could be cured by the addition of 1 to 2 per cent. of hydrochloric acid to the mixing water, or 1 to 2 per cent. by weight of common salt added to the dry clay. The salt seemed to be the most practical, and was used in the greater number of tests.

The amount of water required for tempering the clay was reduced by about 10 per cent. by the addition of salt. The water appeared to convey the salt from the body and deposit it at the surface in a slight scum, but this generally disappeared in burning.

The bricks so treated dried perfectly in about four days at a temperature of 70° to 80° F., but would not stand fast drying.

The object of preheating any clay is to overcome drying difficulties, and the temperature required to accomplish this object varies with different kinds of clay. The amount of heat necessary for some clays would destroy the plasticity of another clay and render it useless for moulding.

In some cases while drying can be carried on safely after preheating, the burned wares may show a tendency to crack, but such clays generally work perfectly when dry pressed.



Pyramids of Clay after Heating to Cone 1. **Pyramids of Clay after Heating to Cone 3.**

(The figures under each refer to the laboratory numbers.)

The temperature used in calcining clay must be sufficiently high to deprive the clay of all plasticity and reduce it to a condition resembling sand. Although this operation requires a higher temperature than preheating with the object of destroying only a portion of the plasticity, the operation is a simpler one because critical temperatures are not observed.

Clays to which salt is added frequently show a slight glaze when burned to cone 1, but the quality of the body does not seem to be affected, especially if the clay is somewhat refractory. The use of salt appears to be detrimental to some of the more easily fusible clays.

No difference was detected in the burned wares made from clay treated with hydrochloric acid.

It is hoped that a more complete investigation will follow the preliminary work already done, but the manufacturer having drying trouble with his clay will probably overcome it by adopting after trial the method which is best suited to his particular case.

The Canadian Fairbanks-Morse Company have increased their capital by the issue of $1,000,000 of preferred stock. The company will increase its Toronto plant by the erection of a new factory, and make other extensions.

STANDARD SPECIFICATION FOR REFRACTORY MATERIAL.

At the recent meeting of the Institute of Gas Engineers of Great Britain, the Refractory Materials Committee presented their annual report, which includes a standard specification for silica bricks, blocks, tiles, etc., which has been drawn up by the committee in collaboration with representatives of the Retort and Firebrick Section of the Society of British Gas Industries, together with several other leading makers of this class of material.

The specification has been prepared upon the basis of the results of tests undertaken by Dr. J. W. Mellor, D.Sc. (Principal of the Staffordshire County Pottery Laboratory), who acted as technical adviser to the committee. In presenting the specification the committee state that, owing to the almost entire absence of authentic tests and results on a working scale of silica and siliceous material, the specification must not be regarded as final, and that revision will be made from time to time as experience is obtained. The following is a copy of the specification referred to:—

Section 3.—Silica Bricks, Blocks, Tiles, etc.

The material covered by this specification is divided into two classes:—

(1) That containing 92 per cent. and upwards of silica, and hereinafter called "silica" material.

(2) That containing from 80 to 92 per cent. of silica, and hereinafter called "siliceous."

Refractoriness.

1. Test pieces of the material shall show no sign of fusion when heated to the following temperatures:—

"Silica" material—not less than Seger cone 32 (about 1,710 deg. C.).

"Siliceous" material—not less than Seger cone 29 (about 1,650 deg. C.).

The test shall be carried out in an oxidizing atmosphere, the temperature of the furnace being increased at the rate of about 50 deg. C. per five minutes.

Chemical Analysis.

2. A complete chemical analysis of the material is to be provided when required by the engineer (or purchaser) for his personal information only.

Surfaces and Texture.

3. The material should be evenly burned throughout and the texture regular, with no holes or flaws. All surfaces shall be reasonably true and free from flaws or winding.

Contraction and Expansion.

4. A test piece, when heated in a gas muffle or electric furnace to a temperature of Seger cone 12 for two hours shall not show, on cooling, more than 0.75 per cent. linear contraction or expansion. The temperature of the furnace shall be maintained constant throughout the testing period; and the test piece shall be at least 4½ in. long by 4½ in. wide—the ends being ground flat, and the contraction or expansion measured by means of Vernier callipers reading to 0.1 mm.—a suitable mark being made on the test piece, so that the callipers may be placed in the same position before and after firing. The test samples shall not be taken out of the middle of a brick, block, or tile, but shall be representative of the whole.

Variations from Measurements.

5. In the case of ordinary bricks, 9 in. by 4½ in. by 3 in. or 2½ in. thick, there shall not be more than ± 1½ per cent. variation in length, nor more than ± 2½ per cent. variation in width or thickness; and in all cases the bricks shall work out their own bond. Special bricks, blocks, or tiles shall not have more than ± 2 per cent. variation from any of the specified dimensions.

Cement Clay.

6. This shall be machine ground, and at the discretion of the manufacturer may contain a suitable percentage of fine grog. But in all cases the cement clay shall be quite suitable for the purposes of binding together the bricks, blocks or tiles for which it is supplied, and shall be capable of withstanding the same test for refractoriness.

Inspectioon and Testing.

7. The engineer (or purchaser), or his agreed representative, shall have access to the works of the maker at any reasonable time, and shall be at liberty to inspect the manufacture at any stage, and to reject any material which does not conform to the terms of this specification. Pieces representative of the bulk may be selected for the purpose of testing either before or after delivery; but in every case a representative of the maker shall, if he choose, be present when such selection is made, and shall be supplied with a similar piece of the material to that taken for the purpose of testing.

Any complaint as to quality of material to be made by the purchaser before the expiration of ten days after delivery.

If the engineer (or purchaser) and the maker are not prepared to accept each other's tests, they shall agree to submit the samples for testing to an independent authority, to be mutually agreed upon; and the engineer (or purchaser) reserves to himself the right, if the material does not conform to the tests laid down in the specification, to reject any or all the material in the consignment from which the test pieces were taken.

The cost of these independent tests, and of any bricks, blocks, or tiles, damaged before delivery for obtaining test pieces, shall be equally divided between the purchaser and the maker, if the test proves satisfactory; and if unsatisfactory, such cost, and that for all other subsequent tests required on this account from the same consignment, shall be borne by the makers.

The cost of any tests of or any material damaged for the purpose of obtaining test pieces after delivery shall be borne by the purchaser in the event of the test being satisfactory, and, if unsatisfactory, by the manufacturer, in a similar manner to that specified for the tests prior to delivery.

APPENDIX AND NOTES.

Refractoriness.

Clause 1.—For general remarks and suggestions for testing, also table for softening temperatures of Seger cones, vide appendices of Sections 1 and 2. The cones should in all cases be placed relative to the sample, so that both are subjected to the same temperature.

Contraction or Expansion.

Clause 2.—For general remarks, vide appendices of Sections 1 and 2. As soon as cone 12 has squatted, it ceases to furnish any further indication of the temperature of the muffle; so that the subsequent temperatures should be ascertained, at about 15-minute intervals, by means of a pyrometer. It is essential, however, that the temperature should be maintained constant; and if it is necessary to remove plugs, etc., for the purpose of obtaining the temperature, great care must be taken to avoid cooling the furnace by such means. As in the test for refractoriness, the cone should be placed in such a position relative to the sample under test, that both may be subjected to the same temperature.

Inspection and Testing.

Clause 7.—It has been pointed out by the representatives of the manufacturers that, owing to the high cost of carriage, they may be involved in serious loss if material is extensively condemned after delivery. They agree that the purchaser must have entire freedom to test, and reject, if necessary, any material delivered to him; but it is suggested that until all the manufacturers have suitable arrangements and appliances for constantly testing their goods, it may be possible to render them some assistance by allowing a fairly large sample of their material to be sent in for testing and general approval before extensive deliveries are made. This is in no way, however, to be construed as removing the right of the purchaser to test material in any subsequent consignment.

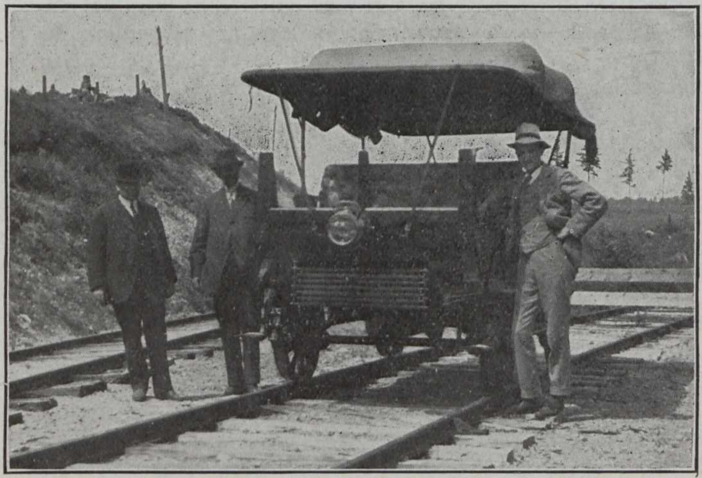
GASOLINE RAILWAY MOTOR CARS.

A new type of gasoline railway motor car has recently been introduced into this country by the Drewry Car Company, Limited, of London, England. This firm manufactures railway motor cars of various types, which they have supplied to over ninety railways in all parts of the world. One of their directors is now in Canada on a visit, and has brought with him a 20 horse-power car to carry six passengers. This car is one of the Drewry Company's most popular models, and is fitted with a four-cylinder water-cooled engine and a three-speed gear and reverse, giving all the speeds in both directions. Two sets of control are provided, one at each end of the car, and the seats are reversible. This enables the driver to sit in the front, and the passengers to face the direction of travel in whichever way the car may be running. This is one of the special features of the car, and entirely obviates the use of a turntable. The body is comfortably upholstered, and is fitted with a Cape cart hood and side curtains, and a folding wind-screen at each end. The car is well sprung, and is fitted with heavy steel wheels and axles, which make for steady running at all speeds.

By the courtesy of the Canadian Pacific Railway a demonstration was recently given on this car, which we illustrate, from Montreal to Mont Laurier and back, a total distance of 316 miles. This is one of the most difficult sections of the road, having a considerable length of 2½ per cent. grade and a large number of short curves. The grades were all taken on top gear at over twenty miles per hour, and on the level the car gave a speed of fifty miles per hour, while at the same time it is capable of running at a slow speed of about five miles per hour, which greatly facilitates track inspection. At the high speeds the running is wonderfully steady, and the railway engineers who were in the car expressed their great appreciation of the capabilities, smoothness of running, and freedom from vibration of the car. Throughout the run an average speed of just under thirty miles per hour was maintained, which, on a heavy line such as the Laurentian branch of the Canadian Pacific Railway, can only be described as a very creditable performance.

The Drewry products are manufactured throughout in England, and their up-to-date models are the result of years of experience and the application of high-grade English methods and materials. Should any further testimony be required of the high standards attained, the following, which was communicated to an English engineering contemporary by their special correspondent in South America, will be found interesting. He reported in part as follows:—

"In many different parts of the world I have heard railway engineers complain of the difficulty in finding a thoroughly satisfactory type of automobile for inspection purposes, and even the most experienced among them have hitherto failed to secure what they want in this respect. Upon the Paraguay Central Railway I have come across what seems to be as perfect and as satisfactory an automobile as has yet been introduced. This is a reversible, six-seated Drewry car, type "K." The car referred to is 16 horse-power, and it has been running now for some six months at an average of 90 to 100 miles a day. Upon numerous occasions it has attained and maintained a speed of 90 kiloms., say, 56 miles an hour. Both the owner, the chairman of the Paraguay Central Railway, and the chauffeur speak enthusiastically of the car and the work which it does. I have travelled many miles over roughly-laid temporary track in this Drewry car, and I must add my testimony to that above quoted, since it would be difficult to find a smoother-running or a more admirably-built automobile than this."



Drewry Railway Motor Car.

The above referred to a similar car to the one herein described. Various models are marketed, ranging from a light car of 4 horse-power to seat two up to cars of 40 and 50 horse-power to carry forty passengers.

Their business in Canada is being handled by Messrs. Peacock Brothers of 68 Beaver Hall Hill, Montreal, and No. 406 Dominion Trust Building, Vancouver, who will be pleased to give anyone interested further particulars.

HOOPS FOR WATER TANKS.

Round iron hoops for wooden water tanks are advocated as preferable to flat hoops, in the report of a committee of the American Railway Bridge and Building Association. Wrought iron is considered as the best material for this purpose, and is more easily obtained in this form than in flats. One argument in favor of the round hoop is that fully 90 per cent. of its surface is exposed to view, hence deterioration is more easily discovered and painting is more effective. Objections to the use of the round hoop are raised on account of its small bearing surface against the staves and the ledge offered by the upper surface for the accumulation of dirt and moisture. The report states that experience has shown that if properly placed the small bearing surface does not induce crushing of the fibre, and suggests the caulking of the round hoops with oakum and filling the top space with roof cement to obviate the second objection.

LAYING SUBAQUEOUS WATER MAINS AT ROME AND MERIDIAN.*

By M. L. Worrell, General Manager, Meridian Waterworks.

While Superintendent of Public Works at Rome, Ga., the writer had three crossings to construct, one through Silver Creek and two through the Etowah River. The creek was to be crossed close to a highway bridge, and it was deemed preferable to lay the pipe on the bottom of the creek rather than to suspend it from the bridge, or to lay it on the floor, on account of the sudden rises and heavy floods in the stream. The creek was 60 ft. wide between banks at the street level, 40 ft. wide at low water, and, at ordinary low water stage, was 12 ft. deep.

Ten-inch cast-iron pipe with the John F. Ward flexible joint was used. It weighed about 87 lb. per foot or 1,034 lb. per section of 12 ft., and cost 2 cents per pound delivered in Rome. The limit of deflection of this joint is said to be 15 deg., though experience at Rome indicated that it was not safe to use the limit, 12 deg. being safer.

The line of five 12-ft. lengths was made up on a platform spanning the creek at the street level and then lowered by tackle into the stream, the two ends being kept clear of the water for later joining to the water mains on each side of the creek. The submerged part was gradually lowered, thus allowing deflection, until it rested on the bottom. The pattern of the Ward bell and spigot being different from the design of ordinary cast iron pipe, the two were connected by short pieces designed by the consulting engineer, Mr. J. N. Hazlehurst, who was in responsible charge of both engineering and construction.

After the Ward pipe was attached to the street main a test for leakage showed a loss of 28,000 gal. per day of 24 hours. This being excessive, a diver was sent into the water, who discovered that the limit of safe deflection had been exceeded, causing three lead joints to leak very badly. The creek line was detached at each end and raised. All joints were recalked, the bottom of the creek partially filled with small boulders to reduce the deflection of the joints to about 12 deg. and the pipe again lowered and tested. The next test showed a leakage of about 380 gal. per day. Later this joint was again calked and the leakage reduced to about 150 gal. per day. The pipe was covered with boulders and no trouble has since been experienced with it.

The cost of this work approximated $300, everything included, or $5.00 per lineal foot.

The first river crossing was at a point where the banks rose about 40 ft. above low water. A wire cable was stretched from bank to bank, to which trolleys for carrying the supply boat and pontoon raft were attached. The pontoon for laying the pipe in the river was constructed as shown in the diagram. The flotation was provided by 25 empty oil barrels lashed together with ½in. manila rope, the barrels being laid in three rows with a "slot" in the middle row at the stern of the raft. The wood-work was so left as to make it easy to transfer the "slot" from the rear to the front.

Two trolleys with the necessary tackle were attached to the wire cable and secured to the raft, and a supply boat was attached to the cable almost immediately beneath it, this boat carrying extra lengths of pipe, pigs of lead, yarn, melting pot, etc. The pontoon carried nothing but a tripod of 2-in. wrought iron pipe supporting a triplex block for handling the pipe. The outfit was moved across the river by a hand rope.

*Paper read before American Waterworks Association.

The first joint was secured to a dead-man on the bank by a heavy chain. The outfit was pushed off, the bell of the pipe being forward, the second joint fitted in and calked, the outfit moved forward again with the next pipe, and this was repeated until the other bank had been reached. The "slot" was then moved to the front end of the pontoon by removing a part of the deck and the short row of five barrels to the stern, thus leaving the last joint of pipe ready for attachment to the forward shore of the river and to the ordinary 10-in. cast iron pipe.

The short joints of pipe for joining the Ward with the ordinary cast-iron pipe were made to lay 3 ft. One had a standard bell on one end and a flexible joint bell on the other and one had a standard bell and a flexible joint spigot.

After the laying was completed two joints on each end of the river pipe were fastened by heavy hog chains to deadmen permanently constructed in the banks.

Before pipe laying was begun the river bottom was sounded. It consists of solid rock, slaty limestone, with three ledges running longitudinally, each ledge having practically the same elevation. These ledges were notched with dynamite and the pipe while being laid was fitted in the notches. These notches secured the pipe from deflection downstream.

The length of this river crossing was 216 ft. and the time required for preparation and actual laying was about 6 days. The work was done under a construction superintendent, who also performed the duties of foreman, a straw boss or gang foreman and five laborers and one water boy, the pipe laying cost being about 35 cents per foot. This particular job cost about $700 all told.

The second river crossing was made with 12-in. pipe. The river was somewhat wider and deeper; no notches in rock had to be cut and no channel to be prepared. The cost was approximately $900. It required less time than the first on account of the experience gained then. The work was done when the river was at the lowest stage known for years. The people were saved upward of $3,000, a waterworks contractor, who had done similar work in Rome, though pursuing a different method, offering to do the work, no material included, for $3,500, the cost of material being approximately $1,200, including equipment.

On each side of the streams through which the pipes were laid valves were placed for cutting off the crossings in case of emergency, and it was by by-passing these valves that it was possible to make the tests heretofore mentioned. One valve at each crossing was enclosed in a manhole, into which was tapped the main on each side of the valve, the inlet tap being ¾ in. and the outlet tap 1 in. Lead connections were attached to the taps and the other ends connected to a sensitive 1-in. meter, thus by-passing the valve which, with the other across the stream, was shut off. The water was turned on at the ¾-in. inlet tap slowly and as slowly let out at the outlet 1-in. tap. As soon as the meter and outlet connection had filled the meter ceased to operate, apparently showing that there were no leaks in first river crossing. The meter was removed and examined, replaced and the line tested with the same result. Both river crossings were tested quarterly with the same results during the writer's service in Rome.

The writer has recently completed another crossing through a stream at Meridian, Miss., by a method entirely different from that at Rome. The two reservoirs at Meridian are some two miles from the city, and it was in laying a 20-in. cast-iron pipe to bring more water to the city that the stream was crossed. The elevation of the bottom of the reservoirs is only 5.4 ft. above the bottom of the settling basin in the city, the elevation of the top of the dam, at high water in the reservoirs, being only 16 ft. above the top of settling basin. Therefore it was absolutely necessary in order to secure the greatest flow to select a route as near to a straight line as possible and to avoid anything like a summit or high point on it. With this in view it was deemed advisable to bridge Sowashee Creek, which had to be crossed, on the way to the city. Upon opening bids for the work the prices named were almost prohibitive, and, besides, great danger was apprehended during flood seasons when the stream carries large quantities of driftwood. The writer was therefore directed by the Meridian Water Commission to devise a safe plan for crossing under the stream.

The route selected has only one turn, an angle of 56 deg. made by laying the pipe at a radius of 270 ft. At the creek there was a downward deflection of approximately 20 ft., the total length of the depressed section being 500 ft. Sowashee Creek carries quite a large amount of sand and has a tendency to fill and widen rather than to narrow and scour. At ordinary winter height it is 30 ft. wide and 9 ft. deep at the crossing.

The writer conceived the idea of using a beam trussed like a freight-car sill, upon which to lay the pipe in saddles, the beam to be 36 ft. in length and 3 ft. wide. The work was started by placing across the creek two house-moving truss beams, secured from a local contractor. The commission's beam was rolled across on top of them, and on it was assembled the pipe, consisting of four joints of ordinary 20-in. Class A cast-iron pipe, one blow-off tee, with a spigot end 6-in. blow-off valve attached. Everything was put together with regulation joints of yarn and lead, and the pipe was secured to the truss beam by U bolts bent to a 22-in. radius and cast-iron washers. The entire bridge was then lowered 4.5 ft. beneath the surface.

Before doing this, however, notches were cut in the banks of the creek of the required depth to allow the beam with its load to rest upon the solid earth on each side. In order to prevent the pipe from filling with sand a large barrel head was fastened in each end. The lowering of the load, an approximate weight of six tons, was successfully accomplished by the use of two gin-poles and two capstans. After clearing away the rigging and beams the water of the creek was dammed at each end of the pipe with sand bags and the two ends joined to the main pipe line.

In order to attain security six creosoted piles in three bents have since been driven, each bent being capped with an oak timber, well seasoned, and the original construction suspended from these bents with U bolts. The piles were driven in the bottom of the creek as far as they could be sunk, some 12 ft., the upper ends sawed off flush with the top of the pipe, the creek having in the meantime fallen several feet, and the capping attached by means of 100-d spikes, generally used in bridge construction. The method used allows the water to pass both above and beneath the pipe. It appears to be strong and is absolutely rigid in every direction. The banks have been secured by driving, in crescent shape, two rows of Wakefield piling into the earth as far as they could be driven, some 10 ft. or more.

WORK ON THE GRAND TRUNK PACIFIC.

The Board of Railway Commissioners has made an order allowing the Grand Trunk Pacific to operate the new Tofield-Calgary branch as far as Trochu, 121 miles south of Tofield. Grading on this branch has already reached Calgary, and steel is laid to mile 134 beyond Trochu.

Rapid progress in track laying is being made on the several branch lines of the Grand Trunk Pacific, over 11 miles of the heaviest steel having been laid in two days last week.

RAILWAY EARNINGS.

The following are the railroad earnings for the week ended July 21:—

	1911.	1912.		Increase or Decrease.
C. P. R.	$2,120,000	$2,593,000	+	$473,000
G. T. R.	960,016	1,047,951	+	87,933
C. N. R.	337,000	426,100	+	89,100
T. & N. O. R.	37,066	30,441	—	6,625
Halifax Electric	5,262	5,628	+	366

The following are the railroad earnings for the week ended July 31:—

	1911.	1912.		Increase or Decrease.
C. P. R.	$2,170,000	$2,701,000	+	$531,000
G. T. R.	1,339,472	1,544,003	+	204,531
C. N. R.	427,700	575,000	+	147,300
T. & N. O. R.	47,833	41,374	—	6,459
Halifax Electric	7,591	7,440	—	151

The official figures on the fiscal year of Canadian Pacific Railway ended June 30 show gross earnings of $123,319,541, and net of $43,298,243.

These compare as follows with last year:

	1912.	1911.	Inc.
Earnings	$123,319,541	$104,167,808	$19,151,576
Expenses	80,021,298	67,467,977	12,553,321
Net profits	43,298,243	36,699,830	6,598,412

The heaviest monthly gross receipts were for April, May and June, when they exceeded $11,300,000, the only other month approaching these figures being October, 1911, when they ran as high as $11,200,000.

The smallest monthly gross was $7,328,781 in January.

In four months of the fiscal year the net earnings exceeded $4,000,000. These were August, October and December, 1911, and April this year.

The gains in gross over the preceding year ranged from $733,872 in September to $2,629,325 in April, and gains in net went from $5,848 in September to $1,239,150 in February.

The company's figures for June and the fiscal year are as follows:—

	June 1912.	July 1st to June 30, 1912.
Gross earnings	$11,311,397.20	$123,319,541.23
Working expenses	7,464,794.51	80,021,298.40
Net profits	3,846,602.69	43,298,242.83

In June, 1911, the net profits were $3,024,671.05; and from June 1st to June 30th, 1911, there was a net profit of $36,699,830.57. The gain in net profits over the same period last year is therefore, for June, $821,931.64; and from July 1st to June 30th, $6,598,412.26.

The Canadian Northern traffic earnings and expenses for the month of June, with comparisons, are as follows:—

	June, 1912.	June, 1911.	Inc.
Gross earnings	$1,769,500	$1,465,600	$303,900
Expenses	1,347,800	1,147,400	200,400
Net earnings	421,700	318,200	103,500
Mileage in operation	4,297	3,698	599

For the year ended June, 1912, earnings and expenses compare as follows with the previous year:—

	June, 1912.	June, 1911.	Inc.
Gross earnings	$19,538,600	$15,199,500	$4,339,100
Expenses	14,422,500	11,033,700	3,388,800
Net earnings	5,116,100	4,165,800	950,300
Mileage average	3,888	3,383	505

TENSILE TESTS OF SPLICES OF REINFORCING BARS.

In constructing the walls of the Washington Street tunnel in Chicago the method of drifting by successive levels necessitated the introduction of vertical reinforcing rods of short lengths, cut according to the height of the drift. The walls were built underground and in sections six or eight feet high.

As it was not deemed prudent to rely entirely on the bonding strength of the concrete to transmit stress from one rod to another, tests were made under the direction of the Board of Supervising Engineers on 1-in. twisted steel rods spliced with one or more simple V⁴ clamps. These were placed in tension and the load applied at the rate of 1,000 lbs. per minute. As the keys left in the concrete face of each drift allowed a minimum of 8 ins. overlap, this length of splice was used in all tests. A description of the tests is given in the third annual report of the Board of Supervising Engineers, from which we abstract this information

Methods of Testing.—The tests were made with one, two and three clamps as follows:—

(1) Single clamp 8 ins. overlap.

(2) Two clamps fastened on opposite sides.

(3) Three clamps, two fastened on one side and one from the opposite side.

The result showed that in general the two-clamp type was the best to use in construction work. This type, when the clamp was tightened enough—slightly enough to bend the plate—showed a resistance of 6,400 lbs. with ⅛-in. slip. When put under further load there was no movement until the load reached 13,690 lbs., when a sudden slip occurred of 3/16 in. in the strap of one of the clamps and ⅛ in. slip in the rods. The rocks then began to pull apart at this or a lower stress.

The single clamp allowed the bars to twist practically as soon as any stress was applied, and showed a slip of ⅛ in. at 4,000 lbs. stress, increasing to ¼ in. slip at 5,600 lbs.

With three clamps a slip of ⅛ in. occurred in the bars with a stress of 6,760 lbs. The strap started at 10,730 lbs., 11,690 lbs. and 18,330 lbs., respectively, with a total slip at this time of ½ in. At 25,580 lbs. there was a sudden slip of the bars and one clamp became entirely loose so that no further load could be applied.

In general, the tendency of this type of lap splice is to offer a fairly uniform resistance to tensile stress up to a point where the clamps become dislocated and lose their grip, when complete failure occurs. The effect of tension on the unconcreted joint also appears to hasten the dislocation of the clamps, and consequently decreases the apparent strength of the plain joint.

The working stress used in all concrete designs provided for 16,000 lbs. per square inch tension in the steel. In these tests the resistance was about 7,000 lbs. up to the first slip. This resistance, however, would be much greater when the rods were embedded in concrete, so it was decided to use a splice of the type with two clamps and rely on the bonding stress of the concrete to supply the deficiency between the resistance of the splice and the stress in the steel.

In estimating this additional strength two forces were relied on: First, a surface adhesion taken conservatively at 100 lbs. per sq. in., which directly augments the net tensile strength of the splice; second, a bonding effect, which prevents the bars from twisting, and consequently defers the displacement of the clamps. By this method the full tensile strength of the bar (16,000 lbs.) could be realized.

In various drift levels the key was about 12 ins. in depth, which always provided at least 8 ins. overlap as previously stated. This made it fairly easy to apply the clamps in position.

A second series of tests as indicated on Fig. 2 were made as follows:—

(1) With a two U-clamp splice with ½-in. plate and no concrete.

(2) Two U-clamp splices embedded in a concrete block and tested when the concrete block was seven days old. (Two tests.)

(3) Two U-clamp splices as above, except with concrete 28 days old.

The first test on the plain joint was in the nature of a check on the previous tests, and a maximum of 27,000 lbs. was reached with the first slip at 8,810 lbs. and a total slip of 2¼ ins.

The mixture of the concrete was 1:2:4 with Portland cement, sand and ½ to ¾ in. crushed limestone. The blocks were each 12-in. cubes, thus embedding the 8-in. lap splice 2 ins. at each end, and in this respect the test could not hope to reveal the full bonding strength of a continuous concrete monolith.

The points of measurement of slippage between bars was necessarily outside the cube, so that the combined effect of unrestricted torsion and stretch in these outer sections of the bars undoubtedly decreased the ultimate strength of the joint as put under test, so that the results here recorded may be regarded in every respect as conservative.

The first seven-day cube took a slowly increasing load up to 23,080 lbs., when a movement of ⅛ in. occurred and the concrete cracked on four sides. No further load could be applied until the total slip increased to ¼ in., from which the load was carried up to a maximum of 31,220 lbs. with continual slipping and a total displacement of 1.29 ins. The second seven-day cube failed practically the same as the first, except that the first slip occurred at 19,400 lbs., and a maximum of 34,120 lbs. was carried with a gradual slipping of 1.33 ins.

The test on 28-day concrete showed a slight movement at 13,550 lbs., holding to 21,000 lbs., and then a gradual stretch up to a maximum of 30,480 lbs. with 3/32 in. total slip. In Fig. 2 a vertical movement represents stress without slip, and conversely, inclination represents a continuous pulling apart with increasing load.

Conclusions.—(1) In all cases the strength of the splicing seems to be dependent upon the strength of the concrete, and there is comparatively little margin between the first evidence of distress and complete failure.

(2) The 28-day concrete specimen took about 50 per cent. more stress at complete failure than the average of the two seven-day specimens.

(3) When such splices are used, the concrete would fail before the splice.

(4) This method of splicing reinforcing bars is safe for a working stress of approximately 16,000 lbs. per square inch in the steel.

Figure 2 shows the curious fact that the three-clamp splice without concrete has less strength than the two clamps at lower loads, but as higher loads are applied the third clamp becomes effective. This anomaly is undoubtedly due to the difficulty of securing an equal bearing between bars and clamps until sufficient load has been applied to start abrasive action.

PERSONAL.

MR. JAMES A. BELL, engineer of the township of Dunwich, Ont., has resigned his position and MR. A. S. COLE, O.L.S., has been appointed as his successor.

MR. ALLEN HAZEN, of New York, will oversee the construction of a duplicate filtration plant for the city of Toronto.

MR. J. R. TODD, A.M. Can. Soc. C.E., has taken charge of a new branch office of the John Galt Engineering Company recently opened at 615 Pender Street, Vancouver, B.C.

MR. WILLIAM McGEORGE MASON has been appointed by the council as chief engineer of the city of Prince Rupert, British Columbia.

COMING MEETINGS.

THE WESTERN CANADA IRRIGATION ASSOCIATION.—Sixth Annual Convention Kelowna, Okanagan Valley, B.C., August 13, 14, 15 and 16, 1912. Secretary, Normon S. Rankin, P.O. Box 1317, Calgary, Alta.

CANADIAN GAS ASSOCIATION.—Fifth annual convention will be held in Toronto, August 24th to Sept. 9th, 1912, during the Exhibition. Secretary, J. B. McNary, 90 Caroline St., North Hamilton, Ont.

THE UNION OF CANADIAN MUNICIPALITIES.—August 27, 28 and 29. Meeting at City Hall, Windsor, Ont. Hon. Secretary-Treasurer, W. D. Lighthall, K.C.

CANADIAN FORESTRY ASSOCIATION.—Convention will be held in Victoria, B.C., Sept. 4th-6th. Secy., James Lawler, Canadian Building, Ottawa.

CANADIAN PUBLIC HEALTH ASSOCIATION.—Second Annual Meeting to be held in Toronto, Sept. 16, 17 and 18.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—Annual Assembly will be held at Ottawa, in the Public Library, on 7th October, 1912. Hon. Sec'y, Alcide Chaussé, 5 Beaver Hall Square, Montreal, Que.

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

EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY.—Opening Meeting, Washington, D.C., September 4th, 1912. Other meetings, Business and Scientific, in New York, beginning Friday, September 6th, 1912 and ending September 13th, 1912. Secretary, Bernhard G. Hesse, Ph. D., 25 Broad Street, New York City.

INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.—Sixth Congress will be held in the Engineering Societies Building, 29 West Thirty-ninth Street, New York, Sept. 2-7, 1912. Secretary, H. F. J. Porter, 29 West Thirty-ninth Street, New York.

ILLUMINATING ENGINEERING SOCIETY.—Sixth Annual Convention to be held at Hotel Clifton, Niagra Falls, Ont., Sept. 16-19, 1912. Secretary, Preston S. Millar, 29 West Thirty-ninth Street, New York.

AMERICAN ROAD BUILDERS' ASSOCIATION.—Ninth Annual Convention will be held in Cincinnati, December 3, 4, 5 and 6, 1912. The Secretary, 150 Nassau St., New York.

ENGINEERING SOCIETIES.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester Street West, Montreal. President, W. F. TYE: Secretary, Professor C. H. McLeod.

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

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, T. C. Irving; Secretary, T. R. Loudon, University of Toronto. Meets last Thursday of the month at Engineers' Club.

VANCOUVER BRANCH—Chairman, C. E. Cartwright; Secretary, Mr. Hugh B. Fergusson, 409 Carter Cotton Bldg., Vancouver, B.C. Headquarters: McGill University College, Vancouver.

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

WINNIPEG BRANCH—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-jack; Meets every first and third Friday of each month, October to April, in University of Manitoba, Winnipeg.

MUNICIPAL ASSOCIATIONS

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

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

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

THE UNION OF CANADIAN MUNICIPALTIES.—President, W. Sanford Evans, Mayor of Winnipeg; Hon. Secretary-Treasurer, W. D. Lighthall, K.C., Ex-Mayor of Westmount.

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

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