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The Canadian Engineer

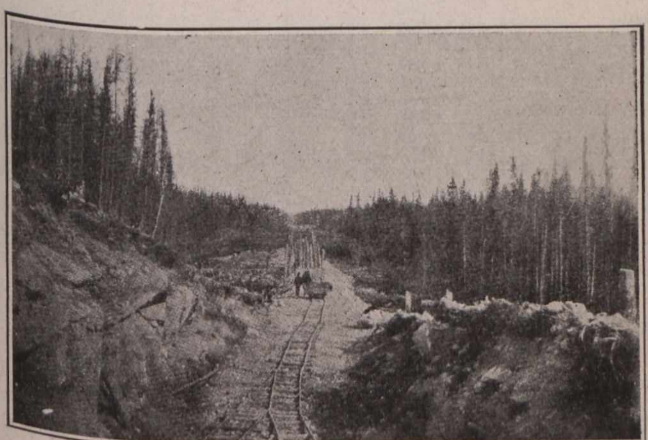
An Engineering Weekly

# THE GRAND TRUNK PACIFIC RAILWAY.

The Grand Trunk Pacific Railway Company, which was incorporated by Act of Parliament, 1903, is under agreements with the Canadian Government for the construction and operation of a line of railway across Canada, from the Atlantic to the Pacific Ocean, wholly within Canadian territory, of an estimated mileage of main line of 3,600 miles; in addition to which there will be constructed several branch lines of considerable length and importance, including a branch from the main line southerly 188 miles to Fort William and Port Arthur, on Lake Superior, for the purpose of reaching navigation on the Great Lakes; also from the main line southerly about 229 miles to North Bay or Gravenhurst, in the Province of Ontario, to make connection with the lines of the Grand Trunk Railway Company of Canada, and another from the main line southerly to Montreal.

This great undertaking has been projected to meet the pressing demand for transportation facilities in British North America, caused by the large tide of immigration which is now flowing into the country from Great Britain, Northern Europe, and still more extensively from the Western States of the United States of America.

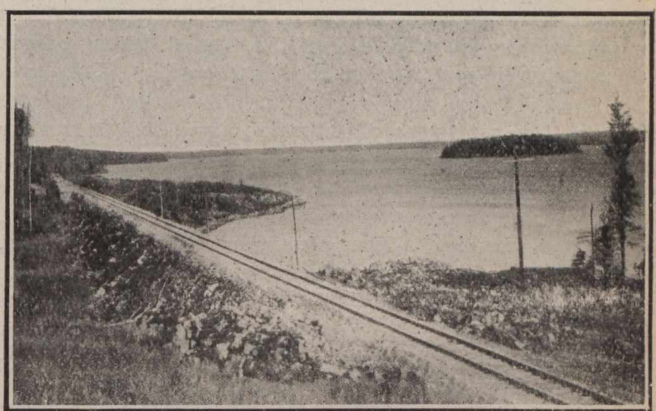
The authorized capital stock of the company is $45,000,000, of which $20,000,000 may be issued as preferred. The Grand Trunk Railway Company of Canada is to acquire all of the common stock (except shares held by directors) in consideration of guarantees, etc., and must retain a majority holding during the term of the agreements with the government.



Constructing Line North of Lake Superior.

Mr. Charles Melville Hays was the originator of this project, and, according to Mr. Frederick A. Talbot, of London, England, who has made a considerable study of this railway and its history, Sir Wilfrid Laurier and his government must be credited with their great share of the work by securing the consent of the people of Canada to participate in such a project as a government transcontinental railway. The whole of the western country was canvassed religiously. No one knew for whom these parties were working, or just what the scheme in hand comprised, as it was revealed in a somewhat hazy manner. Secret meetings were held in the cities, large towns, villages, and even in remote settlements. Extreme caution had to be taken to prevent any tangible particulars of the undertaking reaching the management of the C.P.R., insomuch as the Canadian Pacific regarded the West as its own territory.

Investigation of the dormant wealth of the land through which it was to pass caused the promoters of the enterprise to keep the line well to the north, so as to open a new country in the widest sense of the word. President Hays adopted a sound policy when he decided on following more the methods of the English railways, and that the first cost was to be the last. Any one connected with English railways knows how solidly this construction work is carried out, and that there are absolutely no permanent ways in the whole world better constructed.



On North Shore of Lake Superior.

The Grand Trunk Pacific called for the irreducible minimum in curvature and grades—the former were to be no sharper than four degrees and the latter not to exceed four tenths. The railway threads the mountains with a "ruling" grade of four-tenths, or 21.12 feet to the mile, against both east and westbound traffic. Rises not exceeding 52.8 feet to the mile have been sought diligently by railroad builders in North America.

The Dominion Government undertook to build one-half of the line from the Atlantic seaboard to Winnipeg, and to control it as a national undertaking, while the Grand Trunk Pacific was to construct the second half, stretching from Winnipeg to the Pacific Coast, and the government would assist in the construction of this latter section, inasmuch as it involved the crossing of the Rocky and Cascade Mountains, by guaranteeing the first mortgage bonds.

By deciding upon Winnipeg as the dividing point between the two parts the undertaking was split into sections of almost equal length, the eastern division measuring 1,801 miles from Moncton, while the western division is 1,755 miles in length.

The eastern terminus of the railway will be at Moncton, New Brunswick, from which point the seaport of Halifax will be reached over the Intercolonial Railway, a branch line being projected to St. John. The distance from Moncton to the first named port is 185 miles, and to the latter 89 miles. The western terminus will be at Prince Rupert, British Columbia, on the Pacific Coast, near the southern boundary of Alaska.

Commencing at Moncton, the line will take the most direct practicable route within the Province of Quebec, to the city of Quebec. At Chaudiere Junction, five miles above Quebec, the new line will cross the St. Lawrence River, thence taking a direct route, passing in the vicinity of Lake Abitibi, and to the north of Lake Nepigon, to Winnipeg, Manitoba.

Owing to the physical character of the country the Western Division is subdivided into the Prairie Section and the Mountain Section; the former extending from Winnipeg via Edmonton to Wolf Creek, Alberta, a distance of about 916 miles, and the latter, as its name indicates, being the section over the mountains from Wolf Creek, Alberta, to Prince Rupert, British Columbia, about 840 miles.

The country through which the Prairie Section of the railway will pass, contains land now known to be well adapted for the growing of wheat, which in extent is four times the wheat growing area of the United States, and is the great agricultural belt of the North-west. This land, which is now being rapidly taken up by settlers, produces rich crops the first year of cultivation and will furnish a large traffic for the railway as rapidly as it can be extended, therefore amply warranting the company in assuming the payments of the interest charge on the cost of construction, from the beginning. The Mountain Section, however, passing through the mineral deposits, will require a little longer time for development, and as stated, the government has therefore assumed the payment of the interest charges under its guarantee of three-quarters of the cost of construction, for the first seven years after completion (waiving their right of recourse on the company in the event of default, for an additional three years), and allowing for the period of construction, which is fixed at seven years, not until 1919 will the company be required to assume this liability beyond the interest charges on the one-quarter of the cost of construction under the guarantee of the Grand Trunk Railway Company of Canada.

Returning to the question of gradients, mentioned above, the Grand Trunk Pacific will benefit from these exceptional conditions by the great economy and low cost of operation which can be obtained from the commencement, when this item is of such importance in the case of a newly constructed railway at a time when the traffic and the revenue therefrom must of necessity be light, although with the gradual evolution of the enterprise and from explorations which are being made in all directions, it would appear that the period of light traffic will be of short duration.

The Mountain Section of this railroad lies between the 52nd and the 57th parallels of latitude. It is probable that no other area in North America can equal this portion of British Columbia in her natural resources. Where there is no agriculture and pasture, there is mining or lumbering to be developed, and where there are none of these, although they often occur in one district, there is at least trapping and hunting. Lying as it does, far to the north, the climate conditions have in the past been supposed to be extremely severe during the winter season, but the fallacy of this impression is rapidly becoming known on account of the reverse conditions actually existing, due in part large to the proximity of this territory to the Pacific Ocean and the influence of the Japan current. Before the House of Commons Agriculture Committee recently Mr. Elihu Stewart, Dominion Superintendent of Forestry, in testifying as to the resources and conditions concerning the northern country, having particular reference, however, to the district adjacent to Great Slave Lake, which lies many hundred miles still more northerly of where the Grand Trunk Pacific will be constructed, said that the growth of vegitation in the Mackenzie Basin was surprising, the sun in the summer being visible for about twenty hours out of twenty-four. On July 15th, at Fort Providence, near Great Slave Lake, on the Mackenzie River, about 550 miles north of Edmonton, Mr. Stewart said he saw wheat in the milk, potatoes in flower, peas fit to use, tomatoes, turnips, rhubarb, beets, cabbage, onions and other garden vegetables. The strawberries had been ripe there for some time, and the people had currents and gooseberries. To illustrate the heat, he said at Fort Chipewayan it had been 100 degrees in the shade for several days and nights. Indians coming from the Alaska boundary to meet the steamer Wrigley had lost two dogs from the heat in the Arctic Circle. He thought systematic exploration would show a surprising amount of good country, extending down from Slave Lake to Peace River. Along the Mackenzie River, spruce grew clear to the shores of the Arctic Ocean. There were aspen, white poplar, balm of gilead and birch growing as far north as Fort Macpherson. Mr. Stewart said that on Slave River he had passed a bank of burning coal about twenty miles in length near Fort

COMPARISON OF SUMMIT ELEVATIONS, MAXIMUM GRADIENTS AND TOTAL ELEVATION ASCENDED FOR VARIOUS TRANSCONTINENTAL RAILWAYS.

| Name of Railway | Highest Summits | Max. Gradient in feet per mile | | Total Ascent in feet overcome | |
|---|---|---|---|---|---|
| | | East-bound | West-bound | East-bound | West-bound |
| Grand Trunk Pacific: Western Div. Winnipeg to Pr. Rupert.. | 1 Summit 3,712 | 21 | 26 | 6,990 | 6,890 |
| Eastern Div. Winnipeg to Moncton.... | .... | 21 | 31 | .... | .... |
| Canadian Pacific.... | 2 Summits 5,299 4,308 | 116 | 116 | 23,106 | 23,051 |
| Great Northern | 3 Summits 5,202 4,146 3,375 | 116 | 116 | 15,987 | 15,305 |
| Northern Pacific. . | 3 Summits 5,569 5,532 2,849 | 116 | 116 | 17,830 | 17,137 |
| Union Pacific System: Omaha to San Francisco. . | 3 Summits 8,247 7,107 5,631 | 116 | 105 | 18,575 | 17,552 |
| Omaha to Portland.. | 5 Summits 8,247 6,953 3,537 3,936 4,204 | 106 | 116 | 18,171 | 17,171 |
| Western Pacific... .. | 2 Summits 5,712 5,108 | 52.8 | 52.8 | 9,385 | 5,076 |
| Santa Fe System... | 6 Summits 7,510 7,453 6,987 7,132 2,575 3,819 | 175 | 185 | 34,003 | 34,506 |

Norman, which Mackenzie had reported burning in 1789.

The track is laid continuously from Fort William on Lake Superior via Winnipeg and Edmonton to Prairie Creek, Alberta, 1,412 miles, and a daily passenger train service between Winnipeg and Edmonton, 792 miles, was inaugurated July 3rd, 1910. Train service has also been established between Fort William and Winnipeg and between Edmonton and the end of the track at Prairie Creek.

Thriving towns are springing up where a few months ago there was nothing but the bare prairie; grain elevators, warehouses, dwellings, stores and other evidences of remarkable activity are presented immediately following the laying of the track. The growth is especially astonishing at the division points or terminals of Rivers, Man., Melville, Watrous and Biggar, Sask., and Wainwright and Edson, Alta., and there are many other towns which give promise of notable development.

## OPTICAL DETERMINATION OF STRESS.

In his second lecture at the Royal Institution, London, Eng., on "Optical Determination of Stress and Some Applications to Engineering Problems," Professor E. G. Coker first discussed the determination of the lines of principal stress by optical means, taking as an illustration a particular case in which the central lines of a series of dark bands of inclination were shown on a tension member having two fine saw-cuts in it, which diminished its effective cross section by one-half. Great use might be made of the lines of equal inclination, as the positions of the dark bands appeared to be independent of the physical properties of the material. Professor Filon had, in this way, verified experimentally some of the results of his mathematical researches in elasticity, by observations of bands of this type. For many purposes, however, a method which made use of both isoclinic and isochromatic lines was convenient, but it was important to be able to distinguish between black bands which denoted no stress at all and those which showed the positions for which the planes of principal stress coincided with the principal planes of the polarizing and analyzing apparatus. In a general way it was possible to distinguish between each kind, if the stressed plate of material were turned round in its own plane, and was viewed in a beam of plane polarized light between crossed Nicols. Some bands moved while others remained stationary, and the former could be identified as isoclinic lines and the latter as belonging to the isochromatic group. It was often convenient to show this latter system in their true relation to one another, without disturbance by the dark bands due to the optical system. This might be accomplished by using circularly polarized light. Any stressed specimen, viewed under such conditions, showed at every point a color proportional to the difference of the principal stresses, and, since the shear was proportional to this difference, a picture of the shear stress throughout the plate was obtained.

**Sudden Changes of Section.**—Proceeding to consider a few cases which arose in practical applications of engineering work due to sudden changes of section, the lecturer said one of the simplest examples was afforded by a rivet hole. The effect of a simple pull was to cause a complicated stress distribution in the neighborhood of the hole, due to the crowding together of the lines of stress. It was easy to show experimentally that, if the hole was small compared with the breadth of the plate, the maximum stress rose to about three times its normal value, and theoretical calculation verified the experimental values. In a line of rivet holes the maximum stress at the minimum section could be readily determined. In a riveted joint the distribution was still more complicated, because the stress was carried from plate to plate by the direct pressure of the shanks of the rivets, and some idea of the intricate nature of these practical problems might be gained by comparing similar members under the same loads, in which the rivet holes were first without rivets; secondly, had rivets inserted; and, finally, had rivets in them by means of which the load was applied to the member.

Another type of discontinuity was afforded by semicircular holes and rectangular slots in plates and beams. For example, in a tension member with two semi-circular notches in it, away from the discontinuity the lines of principal stress formed a rectangular system, but as they approached the notch they came closer and closer together, and at the waist the nearness together of the lines at the periphery indicated that the greatest stress was reached there. If the notches were small compared with the breadth, the stress rose to twice its normal value. If the notch was rectangular the stress at the re-entrant corners became very great. A similar notch in the form of a square hole in a plate forced the lines of stress to pass through the narrow spaces on each side of the hole, and here, again, the corners of the square showed by the close spacing of these lines, and the color effects on the specimen, how great was the influence of this kind of discontinuity.

Another subject of interest and of great importance in practical work related to the behavior of members like springs, hooks, links of chains, and the like, in which the curvature of the member was an important factor in the distribution of stress due to an applied load. A case which had some resemblance to that of a circular hook section was found in some forms of boiler, in which the flues containing the fire grate and for the circulation of the hot gases of combustion were corrugated in order to increase their strength. The determination of the stress distributions in members like these and in the parts of machines and the like, which it was the special province of the mechanical engineer to construct, was one of the greatest complexity, and long experience of the behavior of materials obtained by first-hand acquaintance in some particular branch of this profession as in, for example, the design and construction of tools or locomotives, could not be replaced by any experiments on models. They could help, however, and indeed mechanical engineers did not require to be convinced on this matter, as the use of models of machines for all kinds of practical purposes was the rule and not the exception.

## THE MOTOR SHIP "SALENDIA."

The East Atlantic Company have recently purchased a new vessel designed for ocean traffic and propelled by oil engines.

The "Salendia" is 350 feet long with a beam of 53 feet, and a gross tonnage of 4,964 tons, and is fitted with two sets of four cycle Dissel motors, each with eight cylinders 20.8 in. by 28.7 in., giving together 2,500 i.h.p. at 140 r.p.m. built like the vessel herself, by Messrs. Barmeister & Wain, of Copenhagen. With a dead-weight cargo of 7,400 tons the displacement of the vessel is 9,800 tons, with a speed of 11 knots, on a consumption of 500 lbs. of oil an hour. The storage capacity of the double batten being for 900 tons or sufficient for a round voyage of 20,000 miles at full power. The vessel left her berth in the West India docks recently and the manœuvring necessary in order to bring her into the lock afforded a great demonstration of the ease with which the engines were started and reversed.

## ELECTROLYTIC SEWAGE TREATMENT.

Oklahoma city drains mostly into the North Canadian River, but partly over the divide to the north into Deep Fork. Two years ago the city built a septic tank, costing $8,000 to accommodate some of the people on the Deep Fork slope. Later on bids were received for contact beds to purify the septic effluent. The lowest bid for the cantact beds was $17,000, and at this stage of the proceedings Mr. A. J. McMahan (representing the Electro-Sanitation Co., of Los Angeles) offered to install an electrolytic sewage treating plant for $12,000 and guarantee the results. The unsatisfactory results from the septic tank wrought a change of policy on the part of the city council and instead of building the contact beds, the council, on advice of W. C. Burke, then city engineer, entered into a contract November 4, 1910, for the installation of an electrolytic plant to treat the Deep Fork sewage.

Before the plant had been in operation two months, the use of the septic tank was abandoned except that the small grit chambers are utilized for eliminating the coarser matters. A by-pass now takes the sewage around the main chambers of the septic tank to the reservoir of the electrolytic plant. The results are much more satisfactory without the help of the septic tank. The plant is described in a recent issue of "Engineering and Contracting" by Mr. Howard V. Hincley, consulting and supervising engineer, Oklahoma City.

**Description of the Plant.**—There is a 36,000 gal. reinforced concrete reservoir designed to hold the night run of sewage for the present and eventually to act in the capacity of an equalizer to relieve the plant of any sudden fluctuations in the rate of flow at different hours of the day. Three 8-inch supply pipes conduct the sewage from reservoir to treating flumes. A wasteway carries the treated sewage into the gulch. The supply pipes are separately operated by three valves. The electrical machinery is on a platform about 15 ft. x 18 ft., 2½ ft. above the floor and about even with the tops of the flumes. On this platform are also a table and a filing case. The drive consists of a 7½ h.p. alternating current motor using commercial current at 220 volts. This motor is direct connected, under the switchboard, to a 3 kw. multipolar direct current generator and exciter, all resting on a single bedplate 2 ft. x 5 ft. The combination is designed and built for this special service and delivers to the copper cable conductors of 1,000,000 circular mills 800 to 900 amperes at a voltage of 1½ to 3, these being the limit between which the desired results are obtainable, varying somewhat with the character of the sewage. A double pole, double throw, knife switch allows the reversal of the current at pleasure and a knife switch at the upper end of each flume cuts on or off the current for that flume. Owing to the high amperage as compared with the low voltage the switches and conductors are necessarily heavy. If only one flume is in use, the ammeter is set at 270 to 300. The building is of concrete blocks 18 ft. x 50 ft. on the inside with flat roof and beams exposed on the inside, 8ft. high over platform and 10½ ft. high over main concrete floor which has a slope of 1 in. and on which the flumes are supported on wooden blocks 6 in. x 6 in. x 26 in. The building has one 3 ft. x 7 ft. door, one 6 ft. x 7 ft. double door, and 12 pivoted windows about 3 ft. x 3 ft. just above the ground line.

**Electrodes.**—In each flume there are ten electrode sets spaced about 6 ins. apart, each set consisting of 27 cast iron plates each 3/16x10x24 ins. Alternate plates of each set form the anode and cathode respectively, and are both separated and electrically connected by cylindrical bushing conductors.* These are fitted upon bolts on which they are drawn together for contact by nuts back of the hangers. As these bolts hold up only the ends of the plates, two other bolts of ⅜-in. iron covered with 1/16-in. rubber tubing are passed through the plates in the same plane with the conductor bolts, and on these bolts the plates are separated by cylindrical insulating bushings of hard rubber. Each of the 810 cast iron plates is capped for its entire length with a copper channel of No. 23 (16 oz.) copper 1½ in. x 24 ins., weighing ¼ lb. These copper caps add to the chemistry of the treatment and materially lengthen the life of the electrodes by protecting the plates along the upper edges where the corrosion would otherwise be abnormal. The plates must be decomposed to perfect the treatment, but it is desirable to have the decomposition as evenly distributed as possible and the gases arising tend to throw the reactions to the tops of the plates. Each set of plates with bolts, insulators and hangers forms a complete detachable, interchangeable unit.

**Flumes.**—The three flumes are 18 ins. deep, 22 ins. wide and 30 ft. long, made of 2-in. plank, dressed and painted three coats, held in shape by light bolts every 16 ins. in sides and bottom and by light iron straps across the top every 6 ft. The flumes are spaced 3 ft. apart; where the planks butt against each other wooden splines are used and there is no trouble in making a tight flume. Each flume has two insulated copper bus bars ⅜ in. x 1¼ ins., which bring the current from the knife switch at head of flume and from these bus bars the plates are charged through copper straps connecting the bus bars with the hangers. These straps have each 1/10 the conductivity of the bus bars. Baffles 3 ins. high, prevent any truant microbes from scampering among the floor under the plates. They are of sheet metal hinged at the upper edge over a light rod so that when not in use they may be lifted by a wire handle out of the way for washing out. Fixed baffles of sheet metal on the sides of the flumes projecting 1½ in. and located at the upper ends of the electrode sets, prevent the truants from sneaking along the sides of the flume. Two inches of clear space is allowed under the plates for flushing. At each end of the flume there is about 18 ins. of clear space and between the electrodes about 6 ins. At the lower end of each flume is a cross plank on which is fitted an adjustable weir gate which both regulates the depth of the water over the electrode plates and measures the flow. The weir is adjusted by means of nuts on two vertical bolts but it is found in practice that the spring of the plate and bolts is ample to hold the weir in position and the nuts are seldom used. There is also a washoutgate, that lifts up out of the way for flushing. The water is generally kept 2 ins. deep over the plates, as this seems to give as good results as either greater or less depths.

**Operation.**—The current from the commercial wires is turned on to the motor which drives the generator. The ammeter is set at 270 to 300, according to the operator's judgment. The valve is opened to supply raw sewage from the reservoir to one flume, or the ammeter may be set at 810 to 900 and the valves open to all three flumes with volt meter reading from 1½ to 3. The baffles are lowered and presently the plates are submerged and the sewage becomes milky. It is in a state of thorough and minute ebullition and before it commences to flow over the weir at the foot of flume it is covered with a white foam of gas bubbles. The impurities in the sewage passing between the plates which are spaced ½ in. apart, and which are alternately anodes and cathodes, have become the electrolyte, short-circuiting the current, and millions of globules of water have been decomposed into the original elements, hydrogen and oxygen, which, being liberated in the nascent or formative state, produce remarkable results. The offensive odor, which is strong in the reservoir, has disappeared upon entering the flume. Sulphuretted hydrogen cannot exist in the presence offerric oxide in the electrolytic treatment. The treatment goes on down the flume and down into the gulch below the plant as the sewage and froth of gases roll over each other. There is no scum on the treated sewage except the white froth of generated gases and there seems to be a material lessening of the scum previously accumulated in the gulch.

The time taken by a particle of sewage to pass through the flume and through the ten electrode sets when treating 250,000 gals. per flume per 24 hours, is about 3 minutes. An increase of amperage gives an increase of diffusion or volume of current and consequently of ebullition, while an increase of voltage puts more iron and copper into the chemistry of the treatment. A very small portion of the sludge is collected upon the plates through the agency of the ferric hydrate. Several years ago, when the "Electro" was in the embryonic state, the plates were cleaned by steam through perforated pipes laid on the bottom of the flumes. This was both expensive and unsatisfactory. They are now cleaned by simply reversing the current, and the sterilized sludge, when thrown off from the plates, has the color of ferric oxide. By the reversal of the current the uneven corrosion of the plates is again eliminated. The low voltage necessary to decompose the water and organic matter is in contrast with that reported by Mr. J. L. Campbell in 1908 when he utilized the same process for removal of scale from hard boiler water at a pressure of 112 to 115 volts, the treatment costing $479 per million gals. The electrolytic method—ideal for sanitary or organic purification—seems so far to be wholly unsuited for the removal of scale.

**Chemistry.**—The process is electro-chemical. Oxygen, hydrogen and chlorine are liberated in the nascent state; are powerful reagents and render the effluent neutral—a result not obtained by either chemical or biological treatment. Owing to oxidization no traces are left of albuminates or nitrogenous bodies, which give so much trouble in the way of secondary putrefaction in septic treatment. Nitrates are changed to nitrites and the iron and copper compounds coagulate and clear the effluent. The oxy-chloride of lime and magnesia destroys dangerous (including typhoid) bacteria, while the free sulphuric acid generated in the process kills cholera germs if present.

**Compared with Electrolytic Plant at Santo Monica, California.**—The electrolytic plant at Santa Monica, Cal., has its outfall in the surf at the bathing pier. Even there—with nature lashing the oxygen of the air and the chlorine of the sea water into her purification process by wave action—a nuisance was noticeable when the plant was temporarily shut down. What then might be expected when a half-million gallons of sewage are dumped daily into a dry gulch, for six months of one of the driest seasons ever known in Oklahoma, and especially when the septic tank, and later the grit chamber, have been periodically cleaned out and emptied into the same dry gulch? The official report of the city bacteriologist says that "below the tanks (flumes) and long before the material has reached the creek the outflow was clear and quite limpid and distinctly free from odor."

**Bacterial Reductions.**—The following tests, made at three different times at two different places, tend to show a reasonable percentage of destruction of pathogens in the process, as well as a reasonable uniformity of results obtained.

Dr. Frederick Salathe, Santa Monica, Cal., reported November 16, 1908, bacteria removed 99.1 per cent. "And those remaining were completely destroyed."

Louis A. Turley, state bacteriologist, Norman, Okla., reported October 2, 1911:

| | Per cent. |
|---|---|
| Flume No. 1 reduction—Total bacteria | 86.0 |
| Flume No. 1 reduction—Disease bacteria | 98.5 |
| Flume No. 2 reduction—Total bacteria | 88.0 |
| Flume No. 2 reduction—Disease bacteria | 98.4 |
| Wasteway 20 ft. below reduction—Total bacteria | 92.5 |
| Wasteway 20 ft. below reduction—Disease bacteria | 99.0 |

Clarence E. Lee, city bacteriologist, Oklahoma City, reported September 30, 1911:

| | Per cent. |
|---|---|
| Flume No. 1 reduction—Total bacteria | 99.75 |
| Flume No. 2 reduction—Total bacteria | 99.82 |
| Wasteway 20 ft. below plant—Red. total bacteria | 99.83 |

Dr. Lee says, "It is a noteworthy fact that after leaving the plant the number of germs relatively decreases and the ordinary algae, which do not seem to be affected in the least by electrolysis, relatively and rapidly increase. I find from examination that those germs which are not killed by this process are so markedly inhibited that they are easily cared for by the ordinary algae found in all surface water; consequently with increased admixture with ordinary algae and exposure to air and sunlight the objectionable features are rapidly removed in proportion to the distance from the plant. The findings 20 ft. below the plant correspond to several thousand feet below in small streams in untreated material."

Referring to the last quotation above the absence of odor in the gulch after six months of deposit of sewage therein (the septic tank and grit chamber having always been cleaned out into the gulch) seems quite remarkable. The gases carried into the gulch, tumbling over and over with the water, seem to have continued the purification work far below the plant.

On recommendation of Guy E. Blackwelder, Commissioner of Public Works, the Deep Fork plant was unanimously accepted by the municipal commissioners October 6, 1911, and plans have been ordered for a similar plant for the Packingtown district which is to treat not less than two million gallons daily and to cost not more than $42,000.

**Sludge.**—One of the greatest nuisances of sewage treatment in the disposal of the sludge. With a reasonable breaking up of the legitimate solids by a long run or by centrifugal action there is but little sludge that needs to be taken out, the finer particles all being thoroughly oxidized in the flumes. As to whether the coarser and foreign matter shall be held back by baffles or by screens or both is simply a matter of detail. Experience with this plant seems to indicate top and bottom baffles followed by a vertical screen over face of grit chamber outlet—the screen to be handy of access through the manhole cover for cleaning.

**Cost of Operation.**—The cost of current guaranteed not to exceed $750 per annum or $2.74 per million gallons should probably average about 810 amperes at two volts costing 4 cts. per kw. hour plus 25 per cent. motor loss equals $709.50 per annum. The item of plate renewals is not guaranteed but in the Santa Monica plant treating a half million gals. per day, this item has not exceeded $150 per annum. The attendant at the Oklahoma City plant is paid $55 per month and has the use of house and grounds. His duties keep him busy for two or three hours a day. He could easily handle two or three plants, a mile apart—or five miles apart, if fairly well connected by street car service.

The total estimated cost of operation, including proper fixed charges, is given in Table I.

**Table I.—Estimated Cost of Operating Oklahoma City Electrolytic Sewage Purification Plant.**

| For— | per annum. | Per million gallons. | Per thousand gallons. Cents. |
|---|---|---|---|
| Electric current | $ 709.50 | 2.59 | 0.259 |
| Attendant | 660.00 | 2.41 | 0.241 |
| Lights | 40.00 | 0.15 | 0.015 |
| Total operating | $1,409.50 | $5.15 | 0.515 |
| Renewal of plates | 200.00 | 0.73 | 0.073 |
| Depreciation of electric machinery | 100.00 | 0.37 | 0.037 |
| Five per cent. on investment | 800.00 | 2.92 | 0.292 |
| Total operating and fixed charges | $2,509.50 | $9.17 | 0.917 |

The investment charge is computed upon $16,000, of which $1,000 is for attendant's residence and $15,000 is understood to be the price hereafter for a three-quarter million gallon plant. This plant, however, being introductory, was built "under the market" for $12.000. In a larger plant these figures would be reduced 20 to 30 per cent. It seems inadvisable to make any statement as to the general cost of electrolytic treatment of sewage per capita—even approximately—as long as water consumption per capita is reported all the way from 30 to 300 gals. per day and sewage flow from 15 to 300 gals. The cost must be computed upon the basis of the sewage flow in each case.

**Conclusions.**—The work done by this plant seems to justify the following conclusions: 1. That the septic tank in connection with the electrolytic sewage treatment is a hindrance—not a help. 2. That sedimentation in connection with the electrolytic treatment of sewage is neither necessary nor helpful. 3. That a centrifugal for atomizing the solids and a screen, or series of baffles, or both, for the elimination of the incorrigibles, seems advisable. 4. That a forebay or reservoir, which may be used to hold the night run during the earlier life of the plant, and to act as an equalizer when operated 24 hours a day, is advantageous. 5. That the necessary chemicals for the treatment of sewage are furnished by the electrolytic process. 6. That the nuisance and expense of handling sludge may be largely (but not wholly) eliminated. 7. That the effluent from the electrolytic treating plant is sterilized, deodorized, neutral, non-putrescible and harmless.

## TELEPHONES USED IN THE RECENT REVOLUTION IN MEXICO.

A report from Mexico states that the latest revolution, planned by General Campa, is responsible for an improvement of the telephone as a war instrument. General Campa is an electrical engineer and has formed a corps of line-men which precede the main detachments and are instructed to have telephonic communications completed with the other commanders and the base of supplies by the time that General Campa arrives on the scene of activities.

## RECENT IMPROVEMENTS IN RAILROAD TRACK LAYING.

Railroad track laying is becoming a great factor in the industrial world as time advances, and the recent improvements placed on the market to aid in this work are of interest not only as a means of improving the methods now employed, but as original ideas connected with the engineering profession generally. Most of the apparatus about to be described is dependent on the electric current for operating power and as this factor is not always available, the company manufacturing these goods (The Chicago Pneumatic Tool Company, Fisher Building, Chicago, Ill.) have devised a portable gas-driven generator that will operate some of the smaller devices and will doubtless be improved and enlarged so as to operate machines for heavier work. In municipalities and upon the tracks of the electric lines current is available for the maintenance of the larger machines and the operation of these, except in isolated cases, has so far been confined to this class of track.

Fig. 1 will present an accurate idea of the electric spike-driving apparatus that is capable of placing 5,000 screw spikes firmly in the track during one working day.

The car is built with a welded steel frame, the whole being carried on flat elliptic springs. It is equipped with

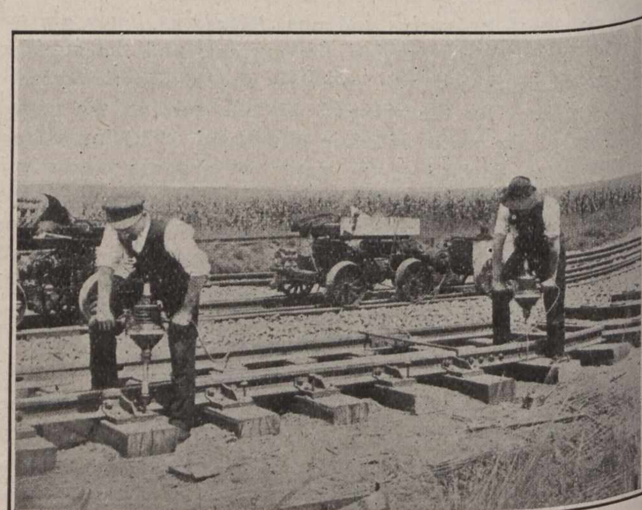


Fig. 1.

a 12-horse power gasoline engine, direct connected through a suitable clutch to a 6-kw. 125-volt. direct current generator, suitable transmission for the car, also being provided, which gives a speed of fifteen miles per hour. This outfit is capable of operating two electric spike drivers; four electric wood boring machines, and an electric grinder, which is mounted on the car for the grinding of the tools. A reel containing five hundred feet of cable is mounted on the car and a light portable switch-board, containing the magnet switches and plug connectors, is provided, to which to connect the spike drivers and wood boring machines. Seventy-five feet of cable is attached to each of the portable tools, thus giving a range of action of five hundred and seventy-five feet on each side of the car, or a total of eleven hundred and fifty feet.

The car weighs fourteen hundred pounds, and can be easily set off of tracks in service out of the way of passing trains.

The spike driving end of the machine is illustrated in Fig. 2(A), and consists of a specially wound, portable electric motor, with suitable gearing, the electric circuit being controlled by means of a magnet switch, mounted on the portable switch-board, previously referred to. This switch itself is under the direct control of the operator by means of a push button on the driver, and the tool may be started or stopped at the will of the operator. In regular operation, the tool is started by the operator and automatically stopped by the opening of the magnet switch when the spike is driven home. This magnet switch, which is shown in Fig. 2(B), is adjustable so that spikes may be driven just as tight as occasion may require.

This company manufacture a car for inspectors and others whose business necessitates them being in close touch with the track work. This car has the same general outside appearance as that used for the spike drivers, but is fitted for the conveyance of eight workmen and their tools and will maintain a speed of twenty miles an hour.

The engine of this car has no cooling device, yet it never overheats and will run under almost any climatic condition. It is remarkably simple in construction and has the fewest possible number of parts. It is economical in fuel consumption, runs smoothly and steadily, and is so easy to operate that only a little instruction is required to enable any one to run it.

The engine is equipped with a special carburetor designed and built for it. This carburetor has the same simplicity of construction and operation which distinguishes the engine itself. It has neither needle valve or float. It is easily adjusted and once regulated needs no further attention.

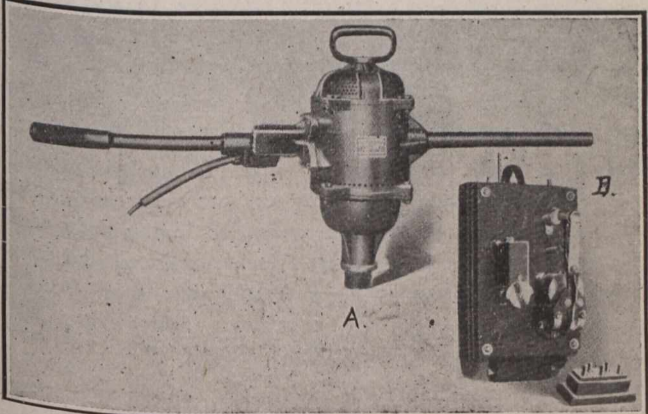



**Fig. 2.**

The cars are all equipped with magneto ignition system. A special high-tension magneto is utilized, and the use of timer, spark coil and dry cell battery is dispensed with. The magneto used upon the cars is very simple in design, but is efficient, reliable and durable. It has no electrical contacts, no moving wires and requires no switch or timer. It has no adjustments and no parts which can be adjusted. It produces a very hot spark, and the strength of this spark is quite independent of the speed at which the car is running. The only parts of the magneto which are subject to wear are two hardened steel blocks, which can be replaced at a very small cost. The wear upon these blocks is very slight, however, and on actual test a car was run five thousand miles without any part of the magneto showing any appreciable wear. The working parts of the magneto are enclosed and it is both dirt and water proof The only outer wires required are those running to the spark plugs. It operates equally well in either direction, and thus does away with a reversing switch when used with a reversible motor. In addition to furnishing a more reliable ignition, the use of this magneto eliminates the possibility of coil and timer troubles, also the necessity of replacing battery cells, which is always present on cars having dry cell battery ignition.

The car has a slatted seat top hinged to open full length and every portion of the mechanism is accessible to the operator easily and quickly. The tray frame has a box for carrying tools and a twelve-inch foot-board for the operator. The car has two-lever control and a brake that is easily reached by the operator from any position. Fig. 3 is from a photograph of this car.

Tools and other appliances operating under currents

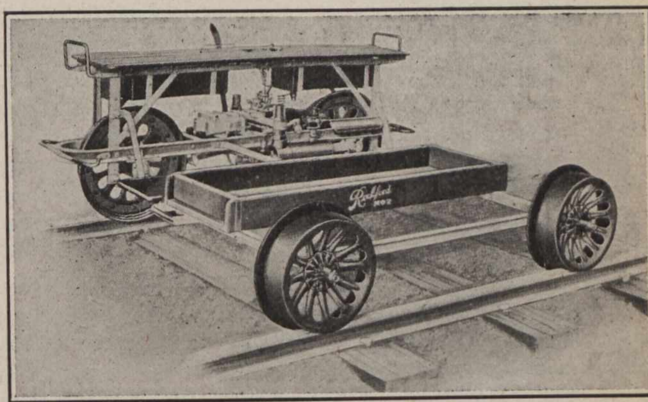


**Fig. 3.**

of low voltage would not require the care and forethought spent upon the track drill shown in figure 4 A and designed for use upon street and interurban railways. The high voltage and rough handling to which tools for this class of work are subjected calls for the careful design, insulation and general construction. An examination of the cut will show that the frame of this drill does not bolt to the track, but is simply hooked over the rail to be drilled, the operator holding down the other end by sitting on the seat provided, and thus brings him into convenient position to operate the feed. The side spindle of the drill permits of close drilling to the ties without the use of an angle attachment, and the vertical adjustment screw with guides for the drill affords a ready means for locating the holes vertically on ordinary tee or deep girder rails. The horizontal rods are of heavy seamless drawn tubing, and the bearing surface of the drill guides on the rods is very long, insuring true, straight holes, so essential for efficient bonding. The cross-

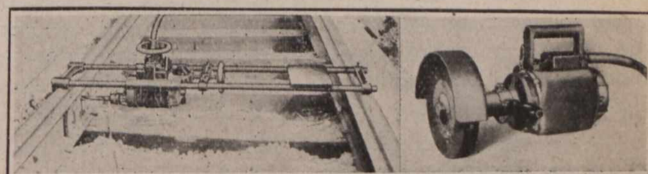


**Fig. 4 A** **Fig. 4 B.**

bar carrying the feed nut is located on the horizontal rods by means of eye pins which are easily withdrawn for the rapid removal of the drill from the track after drilling the hole or for sharpening the drill points. A series of holes in the horizontal rods provides means of accommodating varying lengths of bits. The drill proper may be removed from the frame by taking out four caps which allow the tool to be used as an ordinary electric portable drill. The magnets of this motor are wound for a pressure of six hundred volts.

Figure 4 B illustrates a heavy duty portable electric track grinder for use in grinding joints or for bonds. It carries a 6 x 1¼ x ⅝ emery wheel and revolves at a speed of 2,400 r.p.m., and has plenty of power for rapid work.

## THE CONSTRUCTION OF WOOD BLOCK PAVEMENTS.*

**By Day I. Okes.**

As the success of a creosoted block street is dependent upon a continuous smooth surface, it is essential that the concrete foundation surface have as near the contour of the final pavement surface as possible. Where gravel concrete is used, it is advisable to have the foundation surface made by drawing a template over it. Where stone concrete is used, work should be done to a template curve.

The cushion upon which creosoted blocks are laid should never exceed 1 in., and it should be either ¾ or ½ in. where concrete is templated to an even surface; in fact, the use of the sand cushion under creosoted block streets is essential only in order to obtain a smooth wearing surface of creosoted block pavement.

Sand is not generally designated for the cushion material. Where there is vibration of pavement, as between car tracks, it is most advisable to use a mortar cushion. The manner of placing this cushion is to mix the sand and cement dry, and pull it with a template in a similar manner to pulling the sand cushion. The blocks are then placed and rolled to the final surface contour, the pavement surface is flushed with water in order to dampen the mortar cushion, and is left set up. After the pavement becomes dry the filler can be applied.

In the case of a creosoted-block pavement under heavy traffic, the motor cushion is preferable to the sand cushion, inasmuch as the set in this mortar cushion prevents washing of water leaking through the interstices and prevents displacement of the block surface due to flowing of the cushion and consequent rutting under heavy loads.

The objection to this mortar cushion is the time required to set before the pavement can be used. It has the advantage of making possible the use of the sand filler on lighter traffic streets, inasmuch as it provides against the washing away of the cushion during the iron-out of the pavement and the sealing of the joints. It is advisable to do away with a bituminous filler which becomes sticky in hot weather.

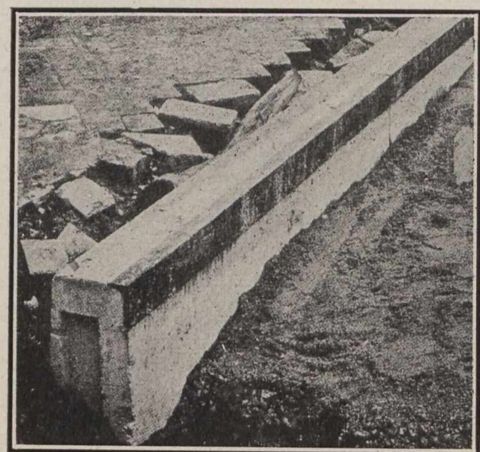
Provision may be made for expansion, first, by producing a block of the kind of wood and oil, and with the required impregnation to allow a minimum percentage of absorption under conditions where water or moisture surround the block entirely, or to provide by construction a sealing of the blocks on the bottom by a mortar cushion and on the four sides by means of a bituminous filler.

As to a satisfactory oil or treatment to be used for creosoted wood block paving from a constructor's standpoint, there has been trouble with heavy, or, as it is called, "waterproofing" oil in the bleeding of the blocks. It is sometimes contended that this bleeding is due to the manner of treatment and to the action of the blocks expanding in the street. However, when the use of a lighter oil under 1.10 sq. gr. is prevalent, trouble was not experienced with the oil exuding and staying on top of the pavement. So if a straight-run creosote oil is used and provision is made against absorption of moisture by the use of a dry mortar cushion and a bituminous filler which would not cut back by the oil from the blocks or would not soften and run in the hot weather —that is to say, an asphaltic-base bituminous filler—there would be a minimum amount of expansion and movement of the blocks. Such a pavement laid smooth would remain so under traffic and weather conditions.

* Abstract of paper presented at annual convention of Wood Preservers' Association, Chicago.

## PREPARED CONCRETE CURBING.

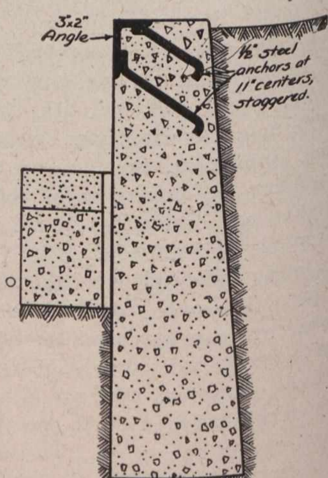
A method of lessening the labor of paving and sewer work has recently been introduced by a company in Pittsburg, U.S.A., and is conducted on the same lines as that used in the manufacture of other concrete objects.



**Concrete Curb Set to Grade.**

The shop system of manufacturing concrete curb units for assembly in the field, eliminates all form work on the street and makes construction in any weather possible. Under good shop conditions, it should be possible to obtain a finished product of high quality at a cost comparable with that for the cast-in-place curb of equal quality. The curb as made, ready to ship, is 5 feet long and of three sections, one 6 by 24 inches for block paved streets under heavy traffic; another 6 by 21 inches for brick and asphalt paved streets under heavy traffic and a 5 by 24-inch section for block paved streets under light traffic. The exposed corner of each is protected by a steel angle held in place by anchors electrically welded to the back of the angles and embedded in the body of the concrete. These anchors are of ½-inch round rod and extend nearly to the opposite face, and are placed on 11½-inch centres. The sections are cast with mortise and tenon joints, so that they lock securely when placed.

The Neville Concrete Co., Neville Island, Pittsburg, who are the only manufacturers of this curb in the field at present, have sold to the city of Pittsburg over 20,000 feet, for use within the city, and are trying to have it adopted as standard by the city of Pittsburg.




**Detail of Angle Protection and Anchors.**

The welded angle is not patented, but the company's location with regard to steel mills will probably make it possible for them to manufacture and sell the steel for use by other concrete products manufacturers at a price lower than would otherwise be obtained, even were they to use the same electrical welding machines.

The cost of the 5 by 21-inch section, the smallest size, is 41 cents per lineal foot, f.o.b. Pittsburg, and for the 6 by 24-inch size, the largest, 48 cents per lineal foot. This makes it possible for them to compete satisfactorily with other types of curb over a radius of seventy-five to a hundred miles out of Pittsburg.

## NOTES ON STRUCTURAL STEEL DESIGNS.*

By Albert Reichmann.

Structural steel nowadays is used so very extensively in the construction of our railroads, industrial buildings, office buildings, apartment buildings, and in almost every means of conveyance, that it represents a large part of the capital outlay in our railroad, industrial and real estate undertakings. For this reason it is of the utmost importance that the most rigid economy be exercised in its use. By an economic design is meant a design wherein the cost of material and labor entering into the construction of said design will be a minimum. In other words, the writer considers a well designed structure one which will most efficiently perform its function with a minimum outlay of capital and the lowest annual maintenance charge.

One of the most important features of a material to be used in construction work, consists in the ease and simplicity, together with the safety and reliability, with which one member can be attached to another. In the case of wooden construction it is almost impossible to make a connection of one member to another with any degree of certainty and use ordinary factors of safety. In the case of reinforced concrete, or, more properly speaking, concrete reinforced with steel, where the joints are largely dependent upon the adhesion of the concrete to the steel, the question of connections is an uncertain problem. In structural steel, owing to its homogeneous nature and uniformity of strength, it is possible to mathematically determine the value of connections of one member to another with reasonable margins of safety and secure a perfectly safe structure. Owing to the importance of securing reliable connections of one member to another, it is perfectly natural that the type of connections used in steel structures should be one of the most important subjects to be considered in structural steel designs. It will be observed that the question of connections is, therefore, given very careful consideration in this paper.

The first iron and steel bridges designed by our American engineers were typically American. That is to say, our type of construction was radically different from that used by other nations. The question of cost was given the most careful study, and justly so, as the railroad companies which purchased these structures had a very difficult time to make both ends meet. In those days the rolling stock of our railroads was very light; the volume of traffic was very small, and the trains did not move over the railroads with the high speed of to-day.

The type of structure referred to is the pin-connected span. When first introduced it was built of any length ranging from 30 ft. upwards. It was very popular owing to the small amount of metal required in its construction, the ease with which its members could be transported over great distances, and the facility with which it could be erected. These bridges were built at a time when the science of building structures of metal was in its infancy. As a consequence most of the old-time bridges were built with very inferior details. Owing to the rapid increase in the weight of the rolling stock of the railroads, they were soon taxed to their capacity and unfortunately sometimes beyond their capacity. As a result it did not take long for these old-time bridges to develop imperfections and it soon became apparent that the pin-connected bridge was not the ideal type of structure to be used in every case.

*Paper delivered to the Western Society of Engineers, Nov. 8th, 1911.

The next step was the introduction of the plate-girder bridge and the riveted-truss bridge, and it soon became common practice to build plate girders for all spans from 20 to 75 ft. in length, and from 75 to 125 ft. various forms of riveted trusses, and spans over 150 ft. of the pin-connected type. In other words we began to follow the practice of European engineers in the building of our shorter span bridges.

Now, let us analyze why we departed from the old-time practice of building pin-connected bridges and substitute the use of the riveted bridges. In the first place the old time pin-connected span was used without consideration of span length. The shorter pin-connected spans, owing to their extreme lightness, the small moment of inertia of their tension members, poor lateral bracing, and generally inferior details, vibrated excessively under traffic. The fact that these small pin-spans were used out of the sphere which naturally belonged to them, led a great many engineers to abandon the pin-connected span almost entirely and of recent years we have adopted more extensively the use of the all-riveted span for our longer span bridges. It has occurred to the writer, however, that in many cases we have substituted riveted spans for our long span bridges where a pin-connected structure would have been preferable.

The ideal span to build would be one that is free from vibrations and without secondary stresses, but as this is impossible, the problem then is to select that type of design which has the minimum number of objectionable features. For an ordinary simple truss span there are four types of construction to be considered:

**First,** the truss with built up chords and diagonals and riveted connections throughout, or what is ordinarily called a riveted span. In this type of construction the span should be made as deep as good designing will permit. The dimension of the chords and web members should be made as narrow in the plane of the truss as permissible. By increasing the depth of the trusses the connections of the diagonals to the chords become smaller; the deformation of the truss under load becomes smaller and consequently the secondary stresses become smaller.

The problem of selecting the proper dimensions of the various members forming a joint requires a great deal of skill and judgment. In the first place the various members should be slender, so as to be as flexible as possible, in order to reduce the secondary stresses due to the bending of the member. On the other hand, with slender members it is exceedingly difficult to concentrate the rivets in the connections. This calls for the rivets to reach far out into the members; hence the use of large gusset plates. The longer the connection becomes, the more uncertain the action of the rivets, and therefore the more objectionable the connection. The size of the gusset plates may, in many cases, be reduced by connecting the main member to both sides of the gusset plate by means of an auxiliary connecting plate. By this means the rivets connecting the main member to the gusset plate take double shear and thus the number of rivets can be reduced in proportion.

The slenderness of members calls for compression members with small moments of inertia, and therefore they are not so economical as a column as one with a greater moment of inertia. In the case of tension members it means thicker material and, therefore, more waste due to deductions on account of rivet holes.

Thus we are confronted with the problem of selecting members having large dimensions of their cross-section in the plane of the truss, with the possibility of their connections being concentrated to a minimum, and, as a consequence thereof, of having large secondary stresses due to bending of the connecting members. Or, on the other hand, selecting a cross-section with the least width possible, which in turn calls for small moments of inertia; that is to say, the members are not economical compression members, nor are they economical tension members, as the material becomes too concentrated. The great problem is, therefore, to know just where to draw the line in the selection of the various members.

In order to somewhat overcome the effects of the secondary stresses in riveted-truss spans, some of our specifications call for their partial elimination by lengthening and shortening the various truss members, amounting to the respective distortions due to dead load plus one-half the live load, and reaming of the chord splices, while the chords are assembled in a straight line, and then forcing them in their proper position before the connections of the diagonals to the chords are drilled or reamed. This is all right as far as it goes in the shop, but when the structure is actually being erected it is an altogether different proposition. If the chords were first riveted together and then put on their camber blocking before they were connected to the diagonals, these results might in a measure be obtained.

Before a long fixed span can be swung it is necessary to rivet all the tension splices in the chords, so that it is very probable that a large part of the refinement that was put on this work in the shop is lost in the field.

**Second,** the truss with built-up continuous chords and built-up diagonals, pin-connected throughout. The vertical posts and diagonals are connected to the chord by means of pins, which in the case of a continuous chord become very small, owing to the fact that the pins merely transmit the increment of the stress to the chords. It is sometimes found desirable to rivet such posts and diagonals, as in case of reversal of stresses in these members, in order to avoid the wear in the pin holes. In such cases the stresses to be transmitted to the chords are very small indeed; consequently the connections are small and, therefore, secondary stresses are also very small. This type of construction can be designed by making the chords sufficiently shallow in order to make the same flexible and the diagonals sufficiently wide in the plane of the truss, so that they are sufficiently strong to rotate upon the pin and overcome the pin friction when the structure deflects. It is believed that this type of construction has a minimum amount of secondary stresses.

The only objection to this type of span is that it weighs more than a span with eye-bars used as tension members, and that the tension chords must be spliced in the field before the span can be safely swung, which in many cases is very objectionable as in most long-span bridges it is desirable to make the span safe in the least time possible.

**Third,** the truss with the chords built up and made shallow in order to be flexible; diagonal eye-bars, pin-connected.

**Fourth,** the truss with bottom chords and diagonals made of eye-bars. While this type of construction is pin-connected throughout and theoretically articulated, the joints are actually more or less rigid, due to the friction of the bearing of the eye-bars on the pins. In order to reduce to a minimum, the secondary stresses due to pin friction, it is desirable to make the bars as wide as permissible and still not exceed the allowable bearing value of the eye-bars upon the pins.

It is extremely difficult to determine the amount of secondary stresses in a pin-connected bridge, due to the weight of the bridge itself, inasmuch as it is impossible to determine the frictional resistance upon the pins which the various members encounter in righting themselves, while the camber blocking is being removed and the span swung.

While the action of eye-bars in a structure is not perfect—that is to say, that bars have more or less secondary stresses—nevertheless, they are one of the safest articles used in the construction of a bridge. When we are using an eye-bar we can feel that we are using something about which our knowledge is reasonably complete. It seems to the writer, however, that it is the common practice of engineers either not to use eye-bars at all or else to use them rght up to the limit of their capacity as determined by full size tests. They seldom figure out what amount of economy could be obtained by using an eye-bar with a somewhat lower unit stress on the same basis that they use a riveted member. In the case of a built-up tension member, there is a large amount of material which is wasted, inasmuch as it does not enter into or carry part of the primary stress; namely, such material as is added to take care of the deductions from this section, necessary on account of rivet holes, and material added for lattice-bars, batten plates, etc. If they realized that they could add considerable material to their eye-bars and still use them with economy, they might not be so adverse to their use. This material added to the eye-bars would reduce the normal stress in the eye-bars to such an extent that the secondary stresses could be entirely ignored.

The vibration of pin-connected spans may be reduced in several ways. First, by making all of the members built-up, with, comparatively speaking, large moments of inertia in the plane of the truss; second, by making the eye-bars sufficiently wide so that their deflection, due to their own weight, will not be too great; third, by weighing down the bridge by means of a ballasted floor. The writer cannot help but feel that when we come to our longer span bridges, the pin-connected type bridge is the proper one to build. The main advantages of a pin-connected span with eye-bar tension members, are that it weighs less than other types of construction and can be built in the shop with extreme accuracy so that there is little possibility of encountering trouble in erection through faulty workmanship. Erection can proceed with greater rapidity than with the riveted span, and the writer believes that less skill is required in designing a pin-connected span than a riveted span.

**Lateral Bracing.**—There is a feature in our long span bridges which should be considered very thoroughly, and that is the question of lateral bracing for the compression chords. In the shorter span bridges the loads allowed for wind bracing are ample to provide sufficient material to take care of the actual wind stresses, and also to hold in alignment the compression chords. However, in very long span bridges, the question of providing sufficient lateral bracing for the compression chords to hold them in proper alignment, so that the compression chords will act in unison throughout their entire length and in reality form one compression member when considered in a horizontal plane, should be carefully considered. In this respect the lateral bracing, in addition to performing the function of wind bracing, also performs the same function that the lattice bars do to the individual compression members. However, in the case of an ordinary member the lattice bars connect continuous members, whereas, the lateral bracing must hold in alignment members which are not thoroughly spliced, and are, therefore, more liable to be out of true alignment on account of imperfect workmanship.

It is not an easy matter to determine the amount of lateral bracing which it is necessary to provide to hold the compression chords in proper alignment, owing to the fact that we have not made sufficient tests of large size compression members to determine just how much material is required to hold in proper alignment the main sections of a compression member.

This same question of uncertainty applies to the proper bracing of the top flange of our through plate girder bridges. The writer is well satisfied that a large number of our designers do not have the same margin of safety in the compression flange of their through plate girder bridges as they have in the tension flange. Some recent tests of plate girders show that the ultimate strength of the top flange is about the elastic limit of the material. In order to make the top flange of a through plate girder bridge the same strength as the bottom flange, we should have some formula to guide us in the proper proportioning of the top flange. A formula for this purpose can be developed only by a series of experiments. However, in the meantime it seems to the writer that we should apply our column formula to these flanges. Of course, the value of intermediate supports should be given proper consideration.

Another feature in our plate girder designs, which the writer is inclined to believe will cause our engineers some regret, is that they have not as a rule increased the thickness of their web plates in the same ratio that they have increased their flange areas. This is especially true of the long plate girder spans. When the large web plates are rolled at the mills the edges of the plate cool first, which causes the plate to become "dished." In order to eliminate this dishing or buckles in the web, it is necessary to put these web plates in the bending rolls until the buckles are eliminated. After this the plates are straightened for use. There can be no question but that there are heavy secondary stresses in all these large web plates. In addition to this the web plates are more exposed to corrosion than any other part of the structure and if there is any deterioration in this structure, the web plates will show the greatest portion of this deterioration.

In many cases stringers and the shorter span plate girders could be built not only better, but also cheaper, by omitting stiffeners altogether, except at end connections or bearing points and in cases where necessary on account of other connections, and putting a like amount of material in the web, thereby obtaining a much stronger web and adding some to the strength of the flanges.

It frequently happens that heavy portal or sway bracing is attached to the upper parts of bents, leaving the lower portion unbraced, and due consideration is not given to the bending which this portal or sway bracing might induce into the columns; the columns are merely provided with ordinary lattice bars below the portal or sway bracing instead of being provided with proper web plates or cover plates to transmit the shear to its proper destination.

Lattice bars should be eliminated where it is practicable, inasmuch as their function consists merely in holding members together, and they do not assist materially in transmitting the main stresses, whereas, if a solid plate were used it would form a part of the member as well as take care of any local shear that might be manifest.

In order to get accurate workmanship in large compression members, they should be so designed that they can be completely assembled in the shop before riveting. This practically means that even some of the smaller compression members should have lacing bars with at least two rivets at each end, in order to keep in proper alignment the members while they are being riveted in the shop. The larger members should have sufficient diaphragms to insure the proper amount of rigidity.

There is a tendency among engineers to over-rivet their compression and tension members to make the material act as a unit, and it often happens that the material is weakened by this means. Material should be used as it comes from the mills with as little labor on it as possible.

In many cases the specifications call for symmetrical sections, but do not mention the fact that the connections should be symmetrical or at least an equal number of rivets on each side of the centre line of the member.

Some engineers are inclined to lay down rules to others which they themselves are not following—for instance, in trough floor construction used extensively for track elevation purposes. These troughs are filled with concrete and become inaccessible for painting and inspection. The writer believes that much better results might be obtained by using I-beams and reinforced concrete decking on top of the I-beams with ballasted floor on top of the concrete. In this way the structural material is always accessible for painting and inspection.

In the designing of our mill buildings, especially where high speed traveling cranes are used, special attention should be paid to the proper distribution of the lateral forces induced by the traveling cranes throughout the building. In cases of this kind, the bottom chords of the roof trusses should be provided with a good lateral system extending the full length of the building, so that the lateral forces will be thoroughly absorbed throughout the structure.

**Nickel Steel.**—Of recent years some of our engineers have been advocating the use of nickel steel and other steels of high ultimate strength. Inasmuch as the modulus of elasticity of nickel steel is the same as that of carbon steel, the structures designed with these steels of high ultimate strength, where the unit stresses are from two and one-half to three times those used for ordinary carbon steel, the deformation and deflections will be from two and one-half to three times those of structures built of ordinary carbon steel. As the deformation of the structure increases the secondary stress also increases in proportion. What is more, even if the secondary strains have been rectified for the dead load, the deflections due to the live load will be much greater in proportion in structures of nickel steel than in those of carbon steel, for the reason that the weight of the live load in this case is much greater in porportion to the weight of the dead load than is the case where ordinary steel is used. In addition, the deflections caused by the passing of the live load over the structure are much greater owing to the increased unit stress employed.

For the above mentioned reasons, structures built of steel of high ultimate strength should be designed with the minimum secondary stresses. One of the worst features in connection with the use of nickel steel has been that some of our engineers have used carbon steel in conjunction with nickel steel. Take the case of a simple truss span, where the chords are made of nickel steel and the lateral bracing is made of carbon steel. The two chords are tied together by the lateral bracing forming one compression member, and any deformation which takes place in the chords due to the compression of the same must be borne proportionately by the laterals. This means that the lateral bracing may be stressed up to its elastic limit, while the chords themselves are not stressed beyond their usual requirements.

In stating that nickel steel and carbon steel should not be used together, is meant in such parts of the span that act in unison. For instance, there can be no objection to the use of carbon steel in a nickel steel structure for floor beams and stringers, or such members as act independent of the main structure, provided ample provision is made for the stringer connections to expand. These are points, however, which can be taken care of in the design of the structure.

**Secondary Stresses.**—The future development of our bridges depends upon the careful consideration and elimination, as far as possible, of the secondary stresses. It will be observed that in none of the various types of spans considered is it possible to eliminate entirely the secondary stresses in the chords. The secondary stresses may be reduced by the selection of the proper section for the diagonals and their attachments to the chords. Secondary stresses are developed in trusses through the connections of the lateral bracing and the floor system. In a through bridge the elongation of bottom chord produces an elongation in the bottom laterals, resulting in heavy secondary stresses in both the floor beams and laterals when they are attached to the stringers and intermediate points. In a deck bridge the top chord being in compression is reduced in length, while the bottom flange of the stringers is elongated more or less, for which reason the stringers should be provided with extension joints at the floor beams in order to avoid excessive secondary stresses.

To minimize the effect of secondary stresses in a truss, it is well to omit knee bracing and sway frames at intermediate panel points.

The main posts of a truss should be made the full depth of the truss wherever possible; in other words, bracing to increase the efficiency of posts and the use of sub-struts, materially increases the secondary stresses. Floor beams should be made deep and centrally connected to the posts. In order to avoid chord stresses to be transmitted to stringers, their end connections should be made flexible. This can be done by using a wide gauge of the outstanding leg of the angle connecting the stringer to the floor beam.

When a truss with subdivided panels is used the unit stress of the floor beam hangers should be very low so as to keep down the elongation in same, as the elongation of the hanger produces heavy secondary stresses in the chords to which it connects.

Aside from the make-up of the various members of a truss span and their connections, a great deal depends upon the type of span itself. Secondary stresses are very materially increased or decreased according to the type of the truss, whether it is a single intersection, a multiple intersection or a multiple intersection with vertical posts or without vertical posts.

Another source of secondary stresses in a truss is due to the fact that the bottom laterals are, as a rule, attached to the bottom of the post quite a distance below the bottom chord, so that the chord stresses in the lateral system must travel through bending in the post into the bottom chord. Besides this defect, laterals are not generally run in centrally with the chord, thereby inducing uneven distribution of chord stresses.

## A DIAGRAM FOR SUPER-ELEVATION OF RAIL.

The engineering department of the Ohio Electric Railway, with Gaylord Thompson as chief engineer, has distributed to its roadmasters and section foremen a diagram showing the correct super-elevation to be used on the outside rail for various speeds and curves. A description of the diagram with the reproduction accompanying, is taken from the Electric Railway Journal. The curves on the diagram have been plotted from the accepted super-elevation formula. The limits which the company considers are proper for safe elevation and speed are shown by the irregular heavy black line. The speed of cars and elevation of outside rail must be inside this line. Thus, on a 4-deg. curve the track elevation, according to this diagram, should not exceed 4½ in. and the speed of the car should not exceed 40 m.p.h. On a 20-deg. curve the elevation should not exceed 6 in. and the speed 21 m.p.h. For a 50-deg. curve the figures are respectively 3 in. and 9 m.p.h. A note on the chart says that where line poles are spaced 100 ft. apart four times the number of poles passed in seventeen seconds is about the speed of the car in miles per hour. The broken line designated as one-half the speed at which cars would overturn on level track was computed by using the super-elevation formula in transposed form.

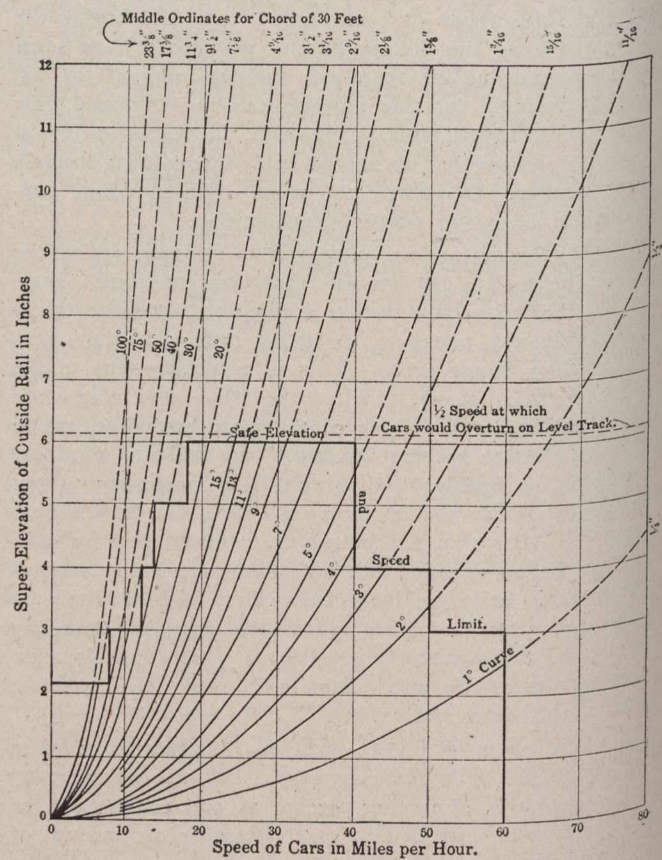



**Diagram Showing Correct Super-Elevation to be Used on the Outside Rail for Various Speeds and Curves.**

Trackmen, as a rule, are unable to determine accurately the degree of curve. They depend usually on their ability to compare by observation any given curve with one of known curvature. Hence to the diagram information has been added by which the trackmen can easily determine the degree of any curve. At the upper part of the diagram, at the ends of the lines representing the super-elevations of each curve, the mid-ordinates for a 30-ft. cord are given. These mid-ordinates are not wholly of assistance in determining the degree of curve and in checking the super-elevation, but are very valuable to check the curvature when rails are being bent to sharp curves with a roller bender.

The outer rails of all curves on the Ohio Electric Railway are being elevated to conform to the super-elevations given on the diagram, in general repair work and on new track construction. The diagram has been in use for several years.

## ENAMEL PAINT FOR STEEL WORK.

Messrs. Wailes, Dove & Company's "Bitumastic" solution and enamels have been adopted for painting the gates and structural steel work in connection with the Panama Canal. Messrs. Wailes, Dove & Co. are represented in Canada by Machau & Hebron, Montreal.

## THE UTILITY OF COKE OVEN TARS AS ROAD MATERIALS.*

The rapidly increasing use in this country of refined coal tar in the treatment and construction of roads and the fact that an immense quantity of coal tar will ultimately become available for this purpose through the installation of by-product coke ovens make it highly desirable to obtain accurate information as to the properties of coke-oven tars which are being produced at present.

While, in the manufacture of coal gas, the production of tar is absolutely unavoidable, this is not true of the manufacture of coke for metallurgical purposes. There are two general types of coke ovens in use at present, in one of which no attempt is made to recover the volatile products of the coal. This is the oldest form of oven, known as the "beehive," and is extensively used in this country to-day. Coke ovens in which the by-products are saved are now used to some extent in this country, and sooner or later will undoubtedly replace the old-style oven entirely, and thus increase our output of tar enormously. With the development of the road-tar industry, which promises to consume vast quantities of tar, and the necessity for refining such tars before use, the general adoption of by-product ovens is only a matter of time. What this will mean in the increase in tar production can be imagined from the fact that in 1908, out of a total of over 26,000,000 tons of coke produced in coke ovens, only a little over 4,000,000 tons were obtained from by-product ovens. About 22,000,000 tons of coke were, therefore, produced without recovery of the tar. As the average yield of coke per ton of coal was 66 per cent., this would represent the consumption of over 33,000,000 tons of coal. Upon the basis of a yield of 10 gals. of tar per ton of coal, it may be seen that over 330,000,000 gals. of tar were lost in 1908 which might have been saved. As the actual production of coal tar both from coke ovens and gas houses amounted to about 101,000,000 gals., it is evident that over three-fourths of our possible production of tar as a by-product was lost during that year. At a valuation of 2½ cts. per gallon, this means a loss of over $8,000,000. At a conservative estimate, the tar lost each year from non-recovery coke ovens is sufficient to build 9,000 miles of tar macadam road 15 ft. wide.

In order to determine the character of coke-oven tars at present being produced in the United States, it was first necessary to obtain samples from all of the known plants.

From a total of 31 manufacturers to whom questions were submitted 30 replies were received, but 4 of these reported their plants as not in operation. The remaining 26 furnished samples of their crude tar for examination and answered the questions in so far as they were able. Upon receipt of each sample the entire contents of the package were thoroughly mixed and a representative sample taken for analysis.

The statements relative to the maximum temperature to which the coal is brought during distillation indicate that two of the plants run below 970° C., that a total of 22 run not over 1,150° C., that 9 run from 950° C. to 1,150° C., and that only 5 run above 1,150° C. The maximum temperature of firing the retorts is, however, reported in most cases as being higher than the maximum temperature to which the coal is brought.

*Abstracted from a circular prepared by Prevost Hubbard, Chemist, U.S. Office of Public Roads, and issued by that office.

The maximum percentage of free carbon reported is from 16 to 24 per cent., but 17 manufacturers reported the maximum percentage of free carbon as being 12 per cent.. or under, and only 4 as 16 per cent. or over.

Analyses of the samples received were made, the work consisting in determining the specific gravity, free carbon, or organic matter insoluble in c. p. carbon disulphide upon a 15-minute digestion at room temperature, material soluble in carbon disulphide, percentage of ash, and percentage of different fractions obtained by distilling a 250 c. c. sample in a 750 c. c. tabulated glass retort with the thermometer so placed that the top of the bulb was level with the bottom of the juncture of the stem and body of the retort.

The gravities of the samples examined range from 1.133 to 1.214 and that the great majority are lower than 1.200. This in itself indicates low percentages of free carbon. The minimum percentage of free carbon was 2.73, the maximum 16.80, and the average for the 26 samples 8.38. Eighteen samples contained less than 10 per cent. of free carbon and 8 more than 10 per cent. About two-thirds of these products might, therefore, be considered as low-carbon tars and the other third as medium-carbon tars. The amount of ash in no case exceeded 0.16 per cent., and in most cases it was practically nil. This is, of course, also true of practically all gas-house coal tars. The percentage of water present varied from a trace to 10.1 per cent. by volume, but in only 3 instances did it exceed 5 per cent. It is of interest to note that 14 of the pitch residues, remaining after distillation had been carried to 315° C., were either soft or plastic —a condition which has seldom been noticed by the author in the distillation of gas-house coal tars. The amount of solids which crystalized or precipitated out of the different fractions was found to vary greatly.

Results were also calculated upon a water-free basis— i.e., the percentages are expressed in terms of the actual tar exclusive of water. Considering these products according to type, the tar produced by the Koppers ovens contained the lowest percentage of free carbon, the Semet-Solvay tars the next lowest, the United Otto next, the Otto Hoffman next, and the mixed tar from the United Otto and Rothberg ovens contained the highest percentage of free carbon. For the sake of comparison the minimum, maximum, and average percentages of free carbon for each of these types are shown in Table I.

**Table I.—Percentage of Free Carbon in Coke-Oven Tars.**

(Water-free basis.)

| Type of oven. | Percentage of free carbon. Minimum. | Maximum. | Average. |
|---|---|---|---|
| Koppers | 2.81 | 3.95 | 3.38 |
| Semet-Solvay | 4.04 | 9.00 | 6.74 |
| United Otto | 5.26 | 12.55 | 9.00 |
| Otto Hoffman | 8.62 | 14.69 | 1.216 |
| Otto Hoffman and United Otto (mixed) | 11.51 | 13.52 | 12.51 |
| United Otto and Rothberg (mixed) | 17.17 | 17.17 | 17.17 |

The percentages of various fractions for the different types of tars overlap to such an extent that no detailed comparison will be made. The maximum, minimum, and average total distillates to 315° C. for the different types are, however, given in Table II.

**Table II.—Percentage by Volume of Total Distillate to 315° C. in Coke-Oven Tars.**

(Water-free basis.)

| Type of oven. | Percentage by volume. Minimum. | Maximum. | Average. |
|---|---|---|---|
| Koppers | 30.5 | 36.0 | 33.3 |
| Semet-Solvay | 22.6 | 40.8 | 29.9 |
| United Otto | 25.6 | 38.5 | 32.6 |
| Otto Hoffman | 25.3 | 43.6 | 36.0 |
| Otto Hoffman and United Otto (mixed) | 19.9 | 32.1 | 26.0 |
| United Otto and Rothberg (mixed) | 26.9 | 26.9 | 26.9 |

From this table it is evident that wide variations exist in the relation of total distillate to pitch residue in the coke-oven tars produced in this country, and this is even true of different tars produced by the same type of oven.

Straight coal-tar road binders or refined coal tars are usually manufactured by subjecting the crude material to a process of distillation with or without steam or air agitation. Distillation is carried to the point at which the residuum remaining in the still has obtained the desired consistency at normal temperatures, and this involves the removal of certain of the more volatile oils present in the crude material. For use in construction work a soft and almost fluid pitch is often produced, and the consistency of this pitch is controlled by means of a melting point of float test. When the crude tar runs abnormally high in free carbon, it is sometimes mixed with crude water-gas tar before distillation. Water-gas tar contains a very low percentage of free carbon, and by properly proportioning the two a product is obtained, upon distillation, which does not carry more than the maximum limit of free carbon set by manufacturers. What the maximum limit should be is a much mooted question among those who have given thought to this matter. The governing considerations are: (1) What is the most economical limit from the standpoint of manufacture? and (2) What is the proper limit with regard to the utilization of the product as a road material? For a number of reasons, which it is unnecessary to mention in this circular, an excessively high-carbon tar is difficult to distill properly and, with other things equal, the lower the percentage of carbon the easier and shorter the distilling process. From this standpoint, therefore, by-product coke-oven tars are well adapted to the manufacture of road binders. Moreover, because of their low percentage of free carbon, they may be employed in a manner similar to water-gas tars, when it is desired to utilize a crude high-carbon tar in the production of a medium-carbon tar road binder.

In an ordinary road tar for use in construction work where free carbon is present to the extent of about 20 per cent., the proportion of total distillate, below 315° C., to pitch residue is approximately 1 to 4. Where this relation exists the pitch residue is hard and brittle. A residue which is soft or plastic is to be preferred, as it would indicate longer life during service, and where such a residue is present the proportion of distillate would naturally be lower for a given consistency, as the distillates may be considered as fluxes for the residues.

In conclusion it may be said that indications point strongly to the fact that by-product coke ovens will eventually play a most important part in the road-material industry. The future demand for economical bituminous road binders in the United States will undoubtedly exceed the supply, and this in spite of the natural increase in petroleum and asphalt road binders. If such is the case, the present loss of enormous quantities of tar, to say nothing of gas and ammonia, because of the use of beehive ovens, is a matter worthy of the utmost consideration on the part of all who are interested in the conservation of our resources.

## WIND PRESSURE.

The report of the National Physical Laboratory, London, presented at the meeting of the General Board, contains particulars of the work carried out last year, and of work it is proposed to undertake during the current year. Dr. Stanton, in the Engineering Department, has continued his study of the lateral variation in the pressure of the wind at any instant over an area of considerable extent, by means of the comparison of the mean pressure record of Dines tubes connected in parallel with the corresponding record of a single tube. Six pressure tubes, 60 ft. above the ground, and 70 ft. apart from each other, were linked up to a recorder so constructed that the movement of the maximum index was proportional to the arithmetical mean of the pressures in the tubes. Another precisely similar recorder was connected to a cluster of six pressure tubes which was so arranged on one of the towers that the six orifices were enclosed in an area of less than 2 sq. ft. The assumption made was that at any instant the pressure in each tube of the cluster was the same, so that a comparison of the maximum readings of the two recorders during any interval of time gave the ratio of the maximum pressure attained at the position of the cluster to the maximum average pressure attained at the six distributed positions. For this work it was necessary to erect four auxiliary steel towers, each 60 ft. high, which were placed between the existing towers. Each of the 12 Dines tubes was connected by a pair of ⅜-inch lead pipes 250 feet long to the recorders in the observation hut. During the last three months of last year there were several favorable opportunities for making observations, and it is now considered that sufficient data have been obtained to enable a prediction of the wind pressure over an area of several thousand square feet to be made from observations at a single point in the area. There remains the investigation of the effect of the more or less exposed nature of the site on the lateral variation of wind force, and for this purpose it will be necessary to carry out similar experiments elsewhere. By the kindness of Sir John Wolfe Barry, permission has been received from the Bridge House Estates Commissioners to make observations on the Tower Bridge.

## CANADA AS A CHEMICAL PRODUCING CENTRE.

The importance of the chemical industries of this country and the opportunity for the growth of their foreign business has been recently exemplified by a report which states that negotiations have been entered into between the British War Office and a large chemical manufactory in this country for the supply of acetone for ammunition explosives. Acetone is a by-product in the distillation of wood for the manufacture of charcoal and wood alcohol.

It is proposed to use the substance as a binder for cordite, which is composed of nitro-glycerine, in a similar manner to the use of kieselguhr, a porous earth that is used as a binder for dynamite.

# The Canadian Engineer

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

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## THE COST OF FIRE.

The fire losses in Canada for the first three months of the current year total $6,904,217, an average of $2,301,405 per month. This is equal to a daily loss of $76,310. In other words, $3,179 worth of property has been burned every hour since the new year dawned, or $53 every minute. This is an appalling fire loss, and little is being done to check such extravagant waste of capital.

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 in 1909, 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.

In 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.

## INCREASED WATER FOR THE CHICAGO DRAINAGE CANAL.

The Board of Trustees of the Chicago Sanitary District have recently applied for a permit to increase the diversion of water from Lake Michigan, and, amongst many others, the Commission of Conservation of Canada protested strongly against such action. The Chicago drainage canal is now taking 4,167 cubic feet per second, and the request of the trustees was that this should be increased to 10,000 cubic feet per second. The

Commission of Conservation have issued a pamphlet embodying their protest, which was presented at Washington on March 27th. The reasons given why no increase should be made in the amount now allowed are interesting, and deserve wide publicity. Among other things, the statement is made that the drainage canal has already cost $62,000,000. Its advocates have insisted that there was no other feasible method of treating Chicago's sewage.

It is pretty clearly understood at the present time that the dilution method of disposing of sewage, as practised by Chicago, has proved a failure, for already the canal has silted up from deposits of slush, and this must be removed by dredging. Already ill effects are noticeable on the Great Lakes from the present diversion, for reports of the United States engineers show a drop of four inches in the lake's levels due to the canal. While it is undoubtedly true that controlling works at the foot of Lake Erie would preserve the mean level of the lakes, it is easily seen that the River St. Lawrence would suffer, since the water passing down the canal would be abstracted from the river.

There seems no good reason why the request of Chicago should be granted. In fact, there is every reason why it should not be granted. A great number of cities in Europe are purifying their sewage. Many cities and municipalities in the United States and Canada are doing likewise. Methods of sewage disposal have arrived at the stage where it is quite possible to secure a high degree of purification with a reasonable expenditure of money. The city of Chicago, therefore, should be compelled to treat their sewage so that the present canal will be able to take care of the effluent.

## CONCRETE PAVEMENTS.

The interest in concrete pavements at the present time appears to be considerable. During 1910, in the United States, about 700,000 square yards were laid. Last year figures recently compiled show that about five times that amount, or approximately 3,000,000 square yards, were laid throughout the country. In Canada it is hard to say how much has been constructed the last two years. However, the amount has been comparatively small compared with the above. There appears to be little uniformity as to methods of construction, but this, however, will be adjusted as more pavement is laid and publicity given to the methods used. There are indications even now of standardization of certain of the methods. The main objections or difficulties with concrete pavements appear to be the white glare of the surface, dust, and lack of resiliency. The question of joints, both transversal and longitudinal, is not adequately settled, and there is discussion as to the use of one or two layers or coats in the construction of the pavement. Some engineers are using lamp-black, or a coloring matter, mixed with the cement, to tone down the concrete and give a grey color pleasing to the eye, and they claim good results, although there appears to be some little difficulty in securing an even color.

Expansion joints are the source of differences of opinion. Most engineers appear to favor the use of transverse expansion joints at intervals of about twenty feet, although a few use no expansion joints whatever. If it were possible to get along without transverse joints and preserve the pavement from cracks and breaks, it would undoubtedly be better, for the edges of these joints appear to be productive of much trouble. The corners soon chip off, and the continuous passing of vehicles gradually forms an unsightly depression. Where pavements have been laid, in some cities, the edges of the joints are protected with steel angles in order to prevent these depressions. It is an open question, however, as to the advantage to be gained by this. If transverse joints are employed, the best method would seem to be the use of a very narrow strip of soft wood, which could be withdrawn and the joint filled with bitumen or tar.

Longitudinal joints appear to be used, more on account of construction reasons. By the use of a longitudinal joint down the centre of the pavement it is much easier to screed and finish the surface; the difficulty of screeding the full width of street is manifest. These joints, however, are open to serious question, as they would appear to invite the formation of ruts.

The use of one or two layers or coats in the laying of the pavement is open to discussion. With the use of one course, the entire pavement is laid in one operation and with one mixture. The surface is formed by tamping and troweling, forming a coating comparatively smooth on the top. The two-coat method seems to be the most in favor, and, providing careful methods are used in construction, will undoubtedly give good results. The bottom coat is a leaner mixture than the top, the top coat being made of about an inch and a half, or two-inch wearing surface. To secure good results with this method the two mixtures must be laid almost simultaneously in order that the materials may bond.

There has been a good deal of concrete pavement laid in the United States and a little in Canada, which has been covered with a thin coating of bituminous material, applied hot, and sprinkled with a layer of fine gravel or stone screenings. The result of recent investigations by Professor Smith, of Michigan University, shows that the expansion and contraction of concrete is due, not, as commonly supposed, to the effects of heat and cold, but rather to alternate wetting and drying. If this be true, it would be logical to assume that the application of a waterproof coating to the surface of concrete pavement would save the use of expansion joints.

As concrete can be laid more cheaply than any other type of permanent pavement, since it forms the base of all permanent pavements, there appears to be a wide future for its use. By the provision of a higher curb it may be used temporarily and afterwards converted into a brick or asphalt pavement, the original concrete pavement furnishing the base of the new pavement.

## EDITORIAL COMMENT.

In all the talk of heroism shown by the passengers on board the Titanic, most people seem to have lost sight of one part of the crew who, above all others, showed magnificent qualities of courage. Of the engineers on board ship, not one was saved, all remaining at their posts below deck until the vessel sank.

* * * *

The annual report of the Interstate Commerce Commission of the United States, just issued, shows that there has been an increase in the number of derailments due to defective track much greater than would be accounted for by the increase in mileage and volume of traffic. The report states that the construction of cars and locomotives is tending towards an ever-increasing standard of dimensions without a proportionate betterment of track condition. This is a state of affairs to which the railway engineer must devote immediate attention. There is no doubt that the weight of rolling stock and the speed of trains have increased in a greater rate than the improvement in rail design and roadbed.

## A NEW GAS-ELECTRIC CAR.

The management of the Canadian Northern Railway have recently introduced on their lines a self-propelled car that bids fair to solve the problem of cost reduction on the branch lines. The car presents many interesting features to the engineer, not the least being the method of transmitting the propelling power to the wheels and low operating cost.

In general appearance the car is similar to the palace types, used behind a steam locomotive, but its mechanical construction, of course, is greatly different. In the front portion of the car illustrated in Figure 1, is contained the power plant which consists of an eight-cylinder, 550 r.p.m., 4-cycle, 200 h.p. gas engine of the V type, direct connected to an eight-pole, 600-volt, commutating pole, electric generator. The magnet frame of the generator is bolted directly to the end of the engine frame, and the outboard bearing is ring oiled and contained in a three-arm bracket. The engine base is of cast iron and is provided with hand holes fitted with clamp covers for the inspection of the main bearings, etc. The bore of the cylinder is 8 inches and the stroke 10 inches. The exhaust and inlet valves, the air starting check valves and the spark plugs are mounted in dome shaped cylinder heads which are thoroughly water jacketed and are secured by four large studs tapped directly into the crank case. The cylinders are provided with auxiliary exhaust ports which are uncovered by the piston at a point near the bottom of the stroke, allowing the major portion of the hot gas to pass out through a water-cooled valve.

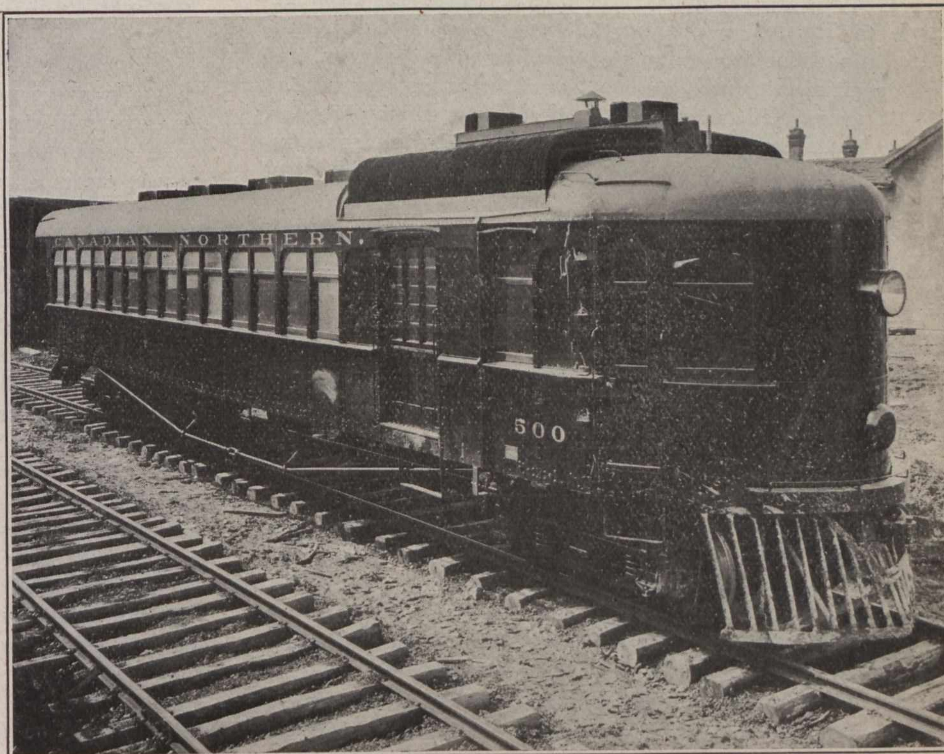
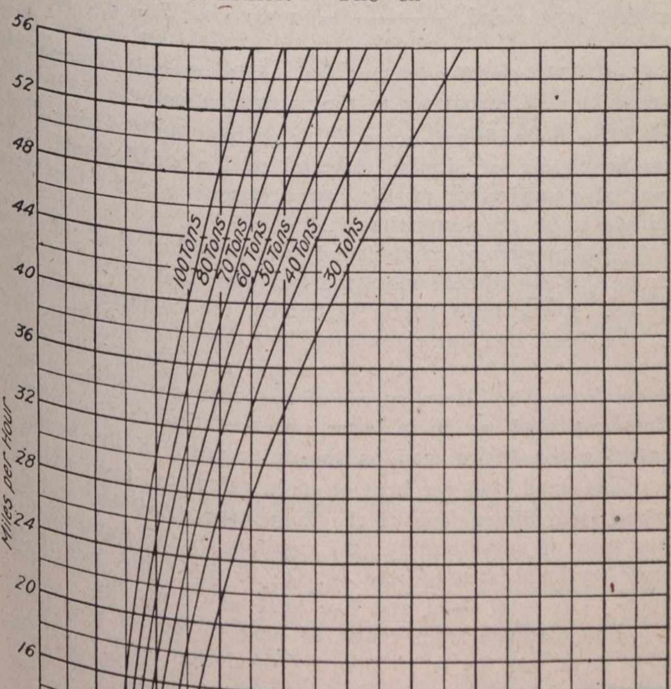



**Fig. 1.—View of Car.**




All the valves are operated by two cam shafts actuated by a single reduction gearing from the main crank shaft; one cam shaft being located on either side of the engine. The pistons are of the trunk type fitted with five cast iron rings. The lighting of the car is not dependent upon the main generator, a combined air compressor and lighting dynamo being included in the equipment for that purpose. The air compressor provides an initial charge for starting the main engine. This compressor has a displacement of 45 cubic feet of free air per minute, and the lighting generator has an output of 1½ kilowatts at 125 volts. A centrifugal governor is provided to insure a constant speed from the engine, of 600 r.p.m.

The forward truck of the car is provided with two standard 600-volt railway motors; these are of box framed, oil-lubricated, commutating pole type, and are mounted directly on the axles, and equipped with standard gears and gear cases.

The electrical control of these motors differs to a considerable extent from the method employed on an ordinary street car. By means of a special controller the driving motors are placed progressively in series and parallel; the voltage is governed by varying the strength of the generator field. This is accomplished by the movement of a single handle on the controller box. Separate handles are provided for reversing the car and for throttling the engine.

The car provides seating capacity for about seventy-five persons when the seats are arranged in a similar order to that of a steam railway carriage, and was built by the General Electric Company, at Schnectady. The Canadian General Electric, however, will build these cars for the Canadian market.

This car was recently given one or two practical working tests on the lines of the Canadian Northern Railway. The first trip was made from Toronto to Richmond Hill and the car was under the personal supervision of important officials of this railway. A second and longer trip was made on the following day; the line of travel was from Toronto to Trenton, a distance of 115 miles. During the latter trip about fifty gallons of gasoline were consumed and the operating expenses were about 18 cents per car mile.

At times this car reached a speed of 50 miles per hour, but it is declared by the manufacturers that under extraordinary conditions of roadbed the car can attain a speed of 75 miles per hour.

Owing to the success of this car it is probable that it will be the forerunner of others of a similar type.

## TIMBER EXPANSION IN FLUMES; CAUSES AND REMEDIES.

**By Godfrey Sperling.***

Several well-defined cases showing longitudinal expansion of timber occurred in flumes constructed during the year 1910 by the Centerville Mining & Milling Co., in Boise basin, Idaho. These flumes were built by contractors who had erected many similar structures in these placer-mining districts and it is particularly interesting that those built by the Centerville Co. were the first recalled wherein the expansion in a direction parallel to the grain was so marked as to be measurable and productive of such large stresses as to be more or less directly traceable to the failure of the higher portion of a long flume.

Experiments by the Forest Service at its various timber-testing stations indicate that the shrinkage of wood in a direction parallel to the grain is very small, and seems to be considered negligible. F. Roth writes: (Timber Forestry, Bulletin No. 10) "Since only an insignificant longitudinal shrinkage takes place (being commonly less than 0.1 in. per 100), the change in volume in drying is about equal to the sum of the radial and tangential shrinkage." That the shrinkage was appreciable in certain species of western soft woods has been brought to the writer's attention at various times by timber constructors. The cases referred to here, however, are the most marked and measurable expansion rather than shrinkage was here manifested.

A smaller straight flume 800 ft. in length showed an expansion of 0.75 ft., as measured from the movement of the mud sills at both ends, to which the last length of flume boards were spiked. This gives 0.083 per cent. expansion.

The timber for the flume box was logged and sawed during the months of July and August, 1910, from mature western yellow pine, and piled with drying strips in the sun. The timber selected was reasonably free from knots and sap-wood and contained little pitch wood. The flume was built about September 1; rains occurred in October and heavy snow fall, thawing and freezing, drying and soaking alternated during the winter until water was turned into the flume April 1. The expansion was measured after water had been in the flume one week and did not change appreciably thereafter.

The boards in the flume box were laid while dry, longitudinally, fitting tightly, end to end, and it can be assumed that the measured expansion very nearly represents that due to soaking and resoaking from air-seasoned condition to the saturation point. Had there been no opposing force to the free expansion of the timber, the measured expansion would represent the sum of expansion due to soaking and the thermal expansion. The latter at an average daily variation of the atmospheric temperature of 30 degrees F. would amount to about 0.1 ft. in 800 ft. of pine timber. Since the daily variation of temperature of the flume timber was about the same as that of the water which was nearly constant through the day, the thermal expansion can be neglected.

One of the forces opposing the free expansion of the flume was the resistance of the mud sills at either end set in firm soil about 2 ft. below the surface of the ground, with a retaining power of about 2 tons per sq. ft.; this would create a compressive stress in the flume box of about 75 lbs. per sq. in. Another opposing force was the resistance to longitudinal movement offered by the flume bents. These were built of square, sawed timbers, set on sills without anchors and without longitudinal diagonal bracing. On these bents the flume box was spiked. After expansion, these bents, near the ends of the flume, leaned toward the flume ends visibly. These bents offered perhaps less resistance to the expansion than that offered by the mud sills at either end. The total force generated by the expanding wood it is impossible to ascertain closely. It was certainly greater than the sum of these two opposing forces and continued to increase up to the saturation point. If we affect an analogy between the compressive stresses generated in a block of wood with its ends held fixed, and tending to expand, due to added moisture, to a block of wood under compression, we can assume that the attempted deformation due to moisture is proportional to unit stress generated. Taking 1,060,000 as the elastic modulas (Tremann, "Effect of Moisture on Wood," Forestry Bulletin No. 70) for resoaked pine wood, $\frac{S}{0.00083} = 1{,}060{,}000$. $S = 870$ lbs. per sq. in., this would represent the maximum unit compressive stress due to resoaking to the saturation point.

The main flume, 4,700 ft. long, was built during September, 1910, of similar material to the small flume. It was also subjected to the same exposure and water was turned in at the same time.

The movement of the mud sills at either end of this flume did not appear more marked than that of the shorter flume. Being built partly in curves, the compressive force in the flume box due to soaking had the effect of lifting the inner posts of bents on curves and actually did lift these posts from the sills on curves of the lower part of the flume. Bents as high as 36 ft. were observed in that condition carrying the entire load on the outer posts of the bents.

The dead load per bent of 16 ft. calculated from weights taken from dimensions of the flume was 3,600 lbs. and the live load of 10 second ft., the capacity of the flume with a cross-sectional area of 2.67 sq. ft., or 2,665 lbs. per 16 ft. bent. The total dead and live load was 6,265 lbs.

The distance from centre of bent to foot of post for a 36-ft. bent was 8.5 ft. Then by resolution let P equal the radial force acting at each bent at the flume box level.

$$P = \frac{6265 \times 8.5}{36} = 1{,}480 \text{ lbs.}$$ sufficient to lift inner post of a 36-ft. bent.

The radius of the curve at this point was 425 ft., the central angle for a 16-ft. bent was 2° 10′, tangential deflection was 1° 5′; therefore, the compressive stress in the flume box necessary to create this force P is

$$S = \frac{P}{\text{Cos. } 1^\circ 5'} = \frac{1480 \text{ lbs.}}{.0184} = 78{,}200 \text{ lbs.}$$

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* Transactions American Metallurgical Society.

The cross sectional area of the flume box is 80 sq. ins., giving a unit compressive stress of 980 lbs. per sq. in., or 110 per cent. of the unit stress arrived at in the smaller flume, and is, therefore, in close agreement therewith. The actual stress in the flume box, allowing for resistance caused by the bents which had no longitudinal diagonal bracing either, did not likely exceed 1,100 lbs. per sq. in. Some buckling, but no rupture was observed in the flume box of either large or small flume.

The relative small expansion noted at the ends of this long flume is accounted for as being thrown into the curves. It appears here that the stresses generated by expanding timber, due to moisture approximate those created in timber under compression.

The flumes were built for placermining purposes where the comparatively short life required and the lower first cost with higher maintenance was an economy and therefore justified the type of construction used. While these features were obtained, criticism might be made of the details of framing used. For instance, no longitudinal diagonal bracing was employed—only longitudinal ties and struts from bent to bent were used. In the latter (apparently an oversight) they were discontinued at one bent joint near the end of the highest part of the flume. It was at this point where the outer post buckled in the direction of the missing strut and all the joints on same level buckled and failed in the same direction, wrecking about 800 ft. of flume from 60 to 95 ft. high. The upper joints of bents, with flume box, dropped vertically and were pushed from 6 to 8 ft. into the ground.

It appears then that the wrecking of the flume was caused primarily by the expansion of the wood box due to soaking. The maximum forces possible from that source were acting and failure occurred at the weak point in the design. This experience shows that suitable provision for expansion of timber should be made where expansion parallel with the grain might be of material effect. More data on the subject of longitudinal expansion of various species of wood would be of help to engineers; nothing definite having come to the writer's attention.

The writer is indebted to Walter C. Locke, civil engineer, of Boise, Idaho, who had charge of the rebuilding of the wrecked portion of the flume, the most of the data concerning the flumes above described. In the rebuilding, an expansion joint allowing 6 ins. of longitudinal movement was used at the ends of curves, also a space of one-half inch was left between the ends of boards in the flume boxes.

## PUBLIC UTILITIES IN EDMONTON.

The February report of these utilities presents a better appearance than that of January for the same civic departments. The municipal telephone system showed a surplus of $912.81. The telephone rentals amounted to $7,417.60; long distance tolls, $3.10; rental of buildings, $95, and bank interest, $119.07, making a total of $7,634.77, and less discounts, which amounted to $274.54, the revenue totalled $7,360. The maintenance expenditure amounted to $1,300.89; operation, $2,496.09, and interest and redemption, $2,650.44, making a total expenditure of $6,447.42. Deducting the expenditure from the revenue, a net surplus of $912.81 is shown. During February there were 109 services installed, and the average rent per 'phone was $2.06, and the cost and maintenance per 'phone $1.80, thus leaving a net revenue of 26 cents per 'phone.

The waterworks department showed a surplus of $459.45. The revenue, less discounts amounting to $1,233.43, was $14,348.43. The total expenditure for the month amounted to $13,888.98, which included a pumping plant charge of $6,373.78; operating and administration, $1,400; maintenance, $1,965.53; and interest and redemption, $4,249.47. The capital expenditure for the month amounted to $14,307.75, leaving a balance of capital account of $253,108.12.

The water pumped through the distribution system was 99,083,240 gallons, at a cost for pumping of 6.42 cents per 1,000 gallons. The revenue for sale of water was $9,527.48, and for frontage tax and miscellaneous $4,820.95, giving a total revenue per 1,000 gallons of 14.51 cents. There were 40,500,000 gallons of water supplied through meters and 58,583,240 supplied otherwise. The revenue from metered services amounted to $4,775.94, and unmetered services $4,751.54. The sum of $15,106.44 represents the month's profits from the operation of the electric light department. The total revenue for the month was $31,103.25, after discounts amounting to $1,120.82 had been deducted. The expenditure in this department amounted to $17,117.63.

The capital expenditure in the engineering department amounted to $819.85, and the capital expenditure on construction $52,108.57. The sum of $5,883.58 was expended on maintenance of boulevards, bridges, and sidewalks and sewers The operating expenses amounted to $317.18, and the administration $3,166.42. The sum of $580.49 was netted from sundry items.

There were 6,957 tons of coal used at the power plant; the electric power plant boiler consumed 4,512 tons; pumping plants, 493; gas power plant, 383; and stocked, 1,569. The cost of alternating current amounted to $15,007.29, and the total output of alternating current was 544,339 kw.h. at 2.76 cents per kw.h. The gas plant alternating current cost $3,908.78. The direct current, steam driven, cost $5,995.73, covering a total output of 199,400 kw.h. at a cost of 3 cents per kw.h. The water pumping plant was supplied with $8,634.51 worth of power, which covers 119,424,310 imperial gallons pumped at a cost of 7.23 cents per 1,000 gallons. The total power-house expenses amounted to $28,231.22 on the north side, and $3,613.31 on the south side.

All these foregoing departments were operated on a paying system; such was not the case with the street railway, as an examination of the following will show.

The total revenue for the month was $26,033.76, which amount is made up as follows: Passenger receipts, $25,101.93; special cars, $207.75; hauling freight cars, $123, and advertising, $315.26.

The expenditure amounted to $28,111.67, out of which there was $3,027.32 expended on maintenance, $10,854 on operation, $8,856.93 for power charges, and $5,372.54 for capital charges. The total car mileage for the month amounted to 86,342.33 miles.

The deficit came to $2,077.91.

## TOUR OF BRITISH ENGINEERS.

A party of engineers and engineering students from the universities, polytechnics and great works throughout Great Britain have left England on a tour of the United States and Canada. Landing at Quebec, they will cross the continent to Vancouver. They will then make their way through Washington, Oregon, and California, will visit all the chief attractions of the Southwest and return east through Colorado and the middle west, ending the tour with visits to New York, Washington and Boston.

The great railways, bridges, tunnels, steel works and latest buildings will all receive attention from the engineers, while other experts will examine financial and banking arrangements.

## PRACTICAL FORESTRY FOR WATERWORKS.*

Most of the land on the protective areas which you control may be classed as agricultural land, brush land, sprout land, woodland, marsh land, and newly made land.

I believe most of you do not favor agriculture on your lands, as the plowed land is apt to be badly washed in the spring of the year. The snow, and the surface layers of the soil, melt under the spring rains before the frost has left the lower layers of the soil. This brings an objectionable amount of sediment into your reservoirs—and this is especially true where the land is heavily manured, as it must be to carry on successful agriculture. Therefore, the only agriculture possible for most of you is the annual cutting of hay lands. As the hay lands run out, their only agricultural use is for pasture, and finally, as they gradually deteriorate, they are reduced to brush land.

All of your brush land and any pastures which are yielding poor feed and small returns can probably be put to more profitable use by planting them to white pine.

Probably, in the case of those of you who control the largest protective areas, a large proportion of your territory is sprout land. Often such land has been bought by your companies with the privilege of cutting the timber reserved to the owner. For this land there is no treatment practicable except to let it grow up with perhaps the addition of a few hundred white pine trees per acre scattered in the openings between the bunches of sprouts.

I understand that the best practice to-day for the protection of watersheds involves the drainage of all swamps so that where these are wooded they are converted into what I have termed woodland. Where there are open meadows, the draining practically puts them in the same class as newly made land. By this term I mean to designate the land which you have made by excavating peat and mud from the beds of your reservoirs and piling it on the adjacent low lands. All of this newly made land, if well drained, is suitable for planting with white pine.

Woodland that is found in the protective areas of the waterworks of New England cities and towns consists largely of sprout hardwoods often reinforced in the older stands, to some extent, by a natural understory of hemlock or of mountain laurel.

In many cases the prevailing popular impression that it is a good thing to burn over, every year, hardwood land, and even pine land, has been further strengthened in the minds of waterworks men in their effort to keep the hardwood leaves out of the reservoirs. The damage that burning over the woods every year causes is not readily apparent to men whose chief interest is not in the woods. They fail to notice that the quality of the woods as a timber-producing machine is lowered each year, and that the water runs off quicker, year by year, bringing a larger and larger amount of silt into the reservoirs. The proper solution of the leaf nuisance lies not in annually burning the leaves, but in cutting away some of the hardwood trees along the edge of the reservoirs and planting white pine, Douglas spruce, and hemlock to catch the leaves. The softwood trees do not make an objectionable amount of litter in the water and their dense evergreen foliage serves to keep the hardwood leaves from blowing into the reservoirs.

In managing your woodlands on forestry principles you have the advantage over all other forms of ownership in the fact that neither the taxes on the land nor a high interest rate are really chargeable against the forestry work. If the land were bare, and kept bare, the water companies would still have to pay taxes on it in order to protect the quality of the water. Such large stable public service concerns can borrow money at an interest rate that is far more favorable than that of any other forest owner except the State. You must also maintain patroleum to keep your watersheds from pollution These men can serve without additional expense as a fire patrol, to detect, report, and extinguish forest fires. You have men on your summer pay-roll whom you want to keep with you. By giving them a job of cutting cordwood, by the cord, you can help them without raising the cost of improving your woodland. Your holdings must be relatively near large cities. That means abundant labor, cheap transportation, and an unlimited market for your products. There is no owner better situated to practice forestry than the water companies and the municipally owned waterworks.

Hardwood land does not retain water so well as softwood land. The softwood trees, by shading the ground all winter, retain the snow better. Their foliage keeps the warm air under them from cooling as quickly or as much as it does in the hardwood land. The mat of fallen needles on the ground keeps the frost out of the soil. Their dense foliage keeps the wind and sun from drying off the winter's accumulation of snow at the top. When a rain or warm thaw comes, the snow melts off at the bottom and the water sinks into the soil gradually, to be slowly added to your water supply through springs instead of rushing down over the surface all at once in spring, at the very time when your reservoirs are already overtaxed by flood waters from agricultural lands farther upstream. Hardwood trees evaporate from their foliage far more water during the summer than a similar area of softwood trees.

Of all the softwoods, white pine is the most profitable to grow in this region. From the time that a plantation first reaches a commercially marketable size at from twenty to twenty-five years of age it does not cease to yield an annual increase in its money value over that of the year before of over eight per cent. until it is fifty years old.

For this reason it is desirable to plant white pine as much as possible wherever planting is advisable. It is also desirable to replace the hardwoods by pine as quickly as possible; all the more so, as the white pine is not subject to attack at all by the browntail moth and in pure stands it is not damaged by the gypsy moth.

It will pay you to market much of the smaller material as thinnings, and concentrate the growth of your hardwoods in the best specimens until they are ready to be made into saw timber. Then underplant the open growth of hardwood with white pine seedlings a couple of years before making the final cutting of the old hardwood. When the old hardwood is removed you have a pine plantation already started which only needs the filling of a few blanks where the small pines have been killed and a small amount of brush cutting in about three years, and six years later, to leave it in good condition to grow until it is thirty years old.

There is only one spacing of white pine trees that is commercially practicable and that is about six feet apart each way. If they are planted closer than that they soon become too crowded, and long before the material which must be removed in a thinning has any commercial value they become too spindly and stunted to grow at a profitable rate. The expense of close planting is also enormous. If white pine is planted at a greater distance apart than about six feet it grows limby and bushy and is subject to great damage by the pine weevil. Plantations set out six feet apart each way grow straight and with small knots at a

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*A paper read by Ed. S. Bryant, Consulting Forester, Boston, Mass., before the Boston Society of Civil Engineers, and printed in the Journal of the Association of Engineering Societies for June, 1911.

maximum rate until they are about thirty years old, when they begin to be crowded. At that age, however, the trees which must be removed are large enough to make saleable cordwood.

To sum up, therefore, I would advise you—to keep out fire from your lands, to plant pine along the shores of your reservoirs and streams, to thin your older stands of hardwood and underplant them with pine before finally cutting them, and to plant up with pine all open areas that are not yielding a fair return. You can both make money by growing timber and at the same time improve your catchment areas.

## PORTLAND REGRADE OPERATION.

Eastern cities may well look to some of their western sisters for progressive ideas in civic improvement.

It is well known that Seattle, Washington, has in recent years veritably remodeled itself. From a city of steep hills she has been changed to one of gentle grades. This great project was eminently successful, largely because of the use of high-grade modern electrical and mechanical hydraulic apparatus.

Portland, Oregon, two hundred miles to the south, noticed the miracles being worked in Seattle and is now following suit by hydraulically reducing an abrupt prominence within her limits, known as Goldsmith's Hill. Because of the satisfaction given by the motors used to operate the pumps which washed the hills of Seattle into the sea, these same motors were later taken to Portland, where they are now being used to drive the pumps in the regrading there. The same successful performance obtained in Seattle from the motors is being experienced in Portland.

**Fig. 1.**

Like all properly engineered projects, the Portland regrading operations have gone through without disappointments. Nothing has been left to chance; every detail of the work was fully considered before operations began, practically insuring the success of the undertaking. The pumping units, including pumps and motors, were selected because their fitness for the work had already been demonstrated at Seattle.

The composition of Goldsmith's Hill is especially gravelly. The streams, therefore, are directed by huge nozzles so as to undermine the lower part of the bank, and the weight of the material above brings down the sand and gravel from the working face. From here it is washed through the sluice way into Guild's Lake, as shown in Fig. 1.

The trestle supporting the sluice through which the debris is conducted to the lake also supports two 18-inch pipes carrying the water pumped from the same lake. Fig. 1 is a general view of the site, showing how far the work had progressed by April 27th, 1910. The trestle is shown extending through the old Lewis and Clark Exposition grounds to Guild's Lake, where the fill is being made.

**Fig. 2.**

Fig. 2 shows Goldsmith's Hill from the corner of Raleigh and Twenty-ninth Streets on March 16th, 1910, before operations on it began. By November 3rd following, work was well under way, as is shown by Fig. 1. It might be mentioned that in some places the height of the bank to be reduced was 140 feet.

The pump house, a temporary structure, of course, is located near the lower end of the trestle. Its foundations were laid in the bottom of the lake at low water before any filling had been done. Now, however, the pump house is in the middle of a filled tract of several acres.

The contractors, the Lewis-Wiley Company, are carrying on the work day and night with no interruption except for Sundays.

It is expected that by the spring of 1913 the so-called Goldsmith's Hill will be no more and that its site will be suitable for no less than 300 residences, while the operation will reclaim to the city several acres of land from Guild's Lake, half a mile away. The project is, therefore, serving a two-fold purpose.

The motors are of Westinghouse make and rated at 650 h.p., 690 r.p.m., 2,300 volts, 2 phase, 60 cycles. Each is direct connected to two Worthington five-stage turbine pumps. The pumping service is amplified by the addition of a booster unit consisting of a Worthington volute pump directly connected to a 900 h.p. Westinghouse induction motor.

The pumping plant is capable of supplying 500,000 gallons of water an hour at a pressure varying between 200 and 300 lbs. per square inch, according to the demand.

Electric energy is supplied by the Portland Railway Light & Power Company's plant.

## A NEW USE FOR SEWAGE WASTE.

Distillation of dried sediment from sewer water has been found by Prof. Honig to yield gas, as with coal or peat, and Brunn, Austria, is about to try this novel method for obtaining a supply of illuminating gas for the town. The heating value is claimed to be even greater than that of coal gas.

## THE DESIGN AND MANUFACTURE OF CONCRETE PILES.

In a paper presented at the eighth annual convention of the National Association of Cement Users, Mr. Robert A. Cummings stated that all concrete piles of the cast-and-driven type must be reinforced with longitudinal rods, on account of the method of handling them by a line from the pile-driver fastened at or near the butt. Consequently, the pile has to sustain its own dead weight by being raised, as well as shocks and impact against obstacles, before reaching its position in the leads of the pile-driving machine. For this reason the pile must act and be designed as a beam capable of supporting its own dead weight and resisting outside shocks. The ratio of the depth or thickness of the pile to the unsupported beam length determines the tensile and compressive stresses and deflection that result from such handling.

It has been observed that when handling a pile of this type it rarely fails from compression in the concrete, but cracks are usually discovered on the tension side. These cracks may be accounted for, Mr. Cummings said, by the slipping of the usual longitudinal rods used in the concrete while the pile is being hoisted. While such cracks are not sufficiently serious to condemn the pile, they may affect the permanency of the reinforcement. In order to overcome this defect the author recommends that all longitudinal rods should be anchored at the ends, those at the butt opposite each other being bent over into a loop and welded together, while those at the point should be all brought together and electrically welded into one piece. Twisted and deformed rods are advantageous for longitudinal reinforcing, as their allowable bond stress is higher than that of plain rods.

The uniform circumferential spacing of longitudinal rods is very important, in Mr. Cumming's opinion, because any side of the pile may be subjected to tensile stresses, and whichever side is in tension, there must be sufficient steel in position to take the strain. The circumferential spacing of the longitudinal rods may be secured by means of a special spacing device placed at intervals of about 5 ft. throughout the length of the pile. The hooping of the concrete adds greatly to its ability to resist axial loads. Therefore, longitudinal reinforcing should have a helical wrapping of wire throughout the length of the pile, the pitch of which must not exceed 3 in. This wire wrapping assists in taking care of diagonal stresses resulting from the handling of the piles

Practical experience has shown that the butt end of the pile which receives the impact of the hammer should be especially reinforced. This has been done by means of a special reinforcement consisting of a unit cage of flat bands, held 2 in. on centres by a spacing bar for a distance of 2 ft. In the plane of each band a flat wire spiral is fastened to the cage. The embedment of this unit cage in the butt of the pile forms a resilient cushion to receive the impact of the hammer. In no case, in the driving of thousands of piles with this cushion, has the butt itself been broken.

**Methods of Driving.**—Piles of the cast-and-driven type are handled and driven by means of an ordinary pile driver. The ability to vary the fall of the drop-hammer is of great utility in overcoming the variable resistances to be met with in the driving. It has been found advisable to increase the weight of the ordinary drop-hammer as compared with the weight of the pile in the ratio of 2 or 3 to 1, so that the weight of the drop-hammer for driving the concrete piles will vary from 7000 to 12000 pounds.

Steam hammers are not as efficient or desirable for driving concrete piles as are drop-hammers. This last has been shown in a test made between a No. 2 Vulcan steam-hammer and a heavy drop-hammer, under the same conditions, using the same kind and size of concrete pile. The heavy drop-hammer did not break a single pile, whereas the steam-hammer broke several below the cushion. Further, the steam-hammer did not drive as many piles in a given time as did the drop-hammer.

The following explanation is offered by the author, as it applies also to the driving of the heavy steel casings or cores used in the making of the cast-in-place type of pile. He states that the limited fall (3 ft.) and light ram (3000 lb.) of the steam hammer, while delivering twice as many blows per minute as the drop-hammer, loses a large part of its energy in overcoming the proportionately greater inertia of the pile, steel casing or core. He states that an analytical treatment by Mr. Barton H. Coffer, M.E., of New York, confirms and justifies the practice of using hammers as heavy as 12,000 lb. for driving concrete piles, and, in his opinion, if penetration is to be the gauge for measuring the supporting power of a pile, the ratio of the weight of the hammer to the weight of the pile or core that is driven must be taken into consideration.

**Manufacture.**—The procedure in constructing cast-and-driven piles commences with the preparation of the moulding bed. This, of course, will vary with the site, but it is desirable to select a flat and convenient location near the place of driving. It is very important that the bed shall be stable, so that the settlement due to he weight of the piles may be avoided. Where the ground is soft and yielding 2 × 4-in. pine stakes 3 ft. long, pointed at the ends, are driven to a solid bearing. These stakes are located at intervals of about 4 ft. in each direction and the tops cut to a uniform level. Then 4 × 4-in. pine sills are toe-nailed to the top of the stakes in longitudinal rows about 4 ft. on centres. Upon these sills a 2-in. solid wooden floor is placed, which forms the moulding bed. It is desirable that this bed shall be uniformly level to receive the forms for the piles.

The forms are made of two pieces of 2 × 8-in. dressed pine battened together and placed on edge to form the sides of the pile. The bevels or angles for tapered or octagonal piles are made by placing loose pieces of bevelled wooden strips at each end of the form. The steel reinforcement is delivered on the work in factory-made-units, so that it can be placed in the forms at once. When a reinforcing unit is suspended and centred in position, concrete of a wet consistency is depositeed and carefully puddled. As soon as the concrete of a pile has solidified, the forms are stripped and used for making other piles. The number of forms required will vary with the quantity of piles to be made and the prospective salvage in the lumber.

The curing of concrete in the normal manner delays the driving of the piles for a period of not less than three weeks, although a greater length of time is desirable, especially in cold and damp weather. Therefore, unless a stock of cured piles is always on hand it frequently occurs that this type of pile cannot be used at all, and resort is had to the use of the cast-in-place type. This practice is open to question on account of the inability of plain concrete to resist even moderate tension. In fact, it is almost axiomatic that all concrete piles must be reinforced. Every concrete pile is subjected to strains that induce very serious tensile stresses in the pile. Such stresses may result from superimposed loads or a lateral strain from the soil. Further, the making and storing of concrete piles for use at any time necessitates a large financial investment.

In order to avoid the above-mentioned objections, the writer has adopted the method of steam curing cast-and-driven piles. This enables such piles to be made and driven within 3 or 4 days and places the speed of driving on the same basis as that of the cast-in-place type.

The means used for steam curing will vary with circumstances, location of the work, speed required for delivery of the piles, the number needed, etc. During the past winter the writer has used concrete piles made and driven within 10 days, and as a result of this experience confidently recommends that such piles can be made, cured and driven immediately.

On this work the piles were allowed to set in a normal manner for 5 or 6 days, and were then gently hoisted from the moulding bed by a derrick, using an equalizing spreader and bridle, the chains of the bridle being fastened so that the pile was balanced. They were then placed in stacks of 25 or 30 and separated from one another by wooden blocks, particular attention being given to securing a solid bearing for each pile.

A light wooden shed, practically steam tight, was built entirely around the stack of piles. The steam was conducted direct from a boiler through a 1-in. pipe to three branch openings inside the shed. The steam pipe valve was opened and the piles were exposed to live steam for two or three days, when they were found to be ready for driving. On being first exposed to steam, the moisture condensed on the surface of the piles and remained until absorbed by the concrete when the temperature of the steam was reached. This steam treatment should be distinguished from heat applied indirectly or baking, in accelerating the set and hardening the concrete. The writer sees no reason why boiling water should not be used for the same purpose if the conditions are favorable for adopting this method. Precautions should be exercised in making sure that the concrete has solidified and that it has received its initial set before its exposure to steam treatment.

Attention is directed by the author to the publication of the tests of the Structural Materials Laboratory of the United States Geological Survey, an abstract of which is published in the Engineering Record of March 16, 1912, wherein it is conclusively shown "that a compressive strength considerably (in some cases over 100 per cent.) in excess of that obtained normally after aging for six months may be obtained in two days by using steam pressure for curing cement mortar."

## BUILDING AND MUNICIPAL WORK IN WELLAND, ONTARIO.

**Building Permits, 1912.**

| | Number of permits. | Total value of permits issued. |
|---|---|---|
| January | 6 | $ 7,735.00 |
| February | 8 | 8,615.00 |
| March | 16 | 34,870.00 |
| Total for the three months | 30 | $51,220.00 |

The building conditions and general trade prospects show signs of great activity for this year. During this month the council let contract to pave two miles of the main streets, work to commence on the first of May. The street railway are making preparations to extend their lines on West Main, North Main, East Main and South Main immediately the weather is suitable. These extensions will exceed four miles of new track.

## WATER METERS FOR REDUCING WATER WASTE.*

By F. H. Ruthrauff.

As to the effect of installing water meters at Decatur, Ill., I simply state the facts as I have found them during my 22 years' experience in the Water Department in Decatur.

The first five years I served as water inspector and worked faithfully in an effort to stop the waste, which was enormous, due to carelessness on the part of the consumers and to defective plumbing. In 1896 I employed four assistants, with the avowed intention of stopping all leaks. I again went over the city in 1898 with four assistants. I had citizens by the score brought into our police courts and prosecuted them for wilful waste.

After about five years' labor along this line I began to get discouraged. I found that a great many of our citizens believed we had an inexhaustible supply of water, and could not see any good reason why I should be so extremely anxious about this matter.

Consequently, I began to look for some other plan, believing that if this waste were allowed to continue, taking into consideration our rapid increase in population, we would in a short time find our supply short, or be at an unnecessary expense for additional machinery, mains and enlargement of our reservoir and filter plant in handling water merely to be wasted.

In 1901, I recommended to the council the adoption of the water meter on all services, but no action was taken. Again in 1902 I urgently recommended the same plan, and was then ordered to have all livery stables, hotels and laundries install meters. In the spring of 1908, the council ordered all services metered by July 1, 1908. The results are as follows:

April 31, 1904, the end of our fiscal year, we had 2,112 services recorded; five consumers for each service gave us 10,560 consumers; 987 of these services were metered. (There was no record kept of water pumped prior to 1903.) However, with 10,560 consumers, 4,935 of them metered, there was pumped for this year 1,023,180 gal., which gave us a per capita consumption of 266 gal.

For the fiscal year ending April 30, 1911, we had 4,939 services in use; 4,933 of them being metered. (The six services unmetered are large consumers.) This gives us, on a basis of five consumers to the service, 24,695 consumers. There was pumped during this year 1,124,212,338 gal., which is 100,749,158 gal. in excess of that for 1904.

With an addition of 14,135 consumers, we now have a per capita consumption of less than 125 gal. (as against 266 gal. in 1904). It is my belief that if the six consumers previously mentioned were metered, this consumption would be less than 100 gal.

We have accomplished by the enforced use of meters at least a 30 per cent. reduction in the average householder's bill. Under the old flat-rate system a seven-room modern house would cost him $17 per year, and under our present system the yearly bill should not exceed $12. We have also cut the per capita consumption from 265 gal. to 125 gal., saving an unnecessary pumpage of 1,270,928,175 gal. each year.

*Abstract of a paper read at the annual meeting of the Illinois Water Supply Association, March 5-6.

In describing the Dionic Water Tester in last week's issue of The Canadian Engineer we omitted to mention the fact that the agents in Canada for this instrument are Messrs. Vandeleur & Nichols, Dineen Building, Toronto.

# ENGINEERS' LIBRARY

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

## BOOK REVIEWS.

**The American Transportation Question.** By Samuel O. Dunn, editor of the Railway Age Gazette. Published by D. Appleton & Co., New York. Cloth; size, 5 x 7½; 209 pages. Price, $1.50 net.

This volume is a compilation of a number of recent addresses by the author in his course on Transportation at Northwestern University, and includes additional chapters on the regulation of railways and inland waterways in their relation to rail transportation. The first two chapters cover the fundamental principles of rate making. Railway valuation and profits occupy two chapters, and embody a sane and sound exposition of this phase. Throughout the volume the three important factors of the transportation problem, namely, rates, service and financial return, are not considered as separate and unrelated elements, but as closely inter-related problems. One would gather from the volume that the author thinks it highly desirable that the Interstate Commerce Commission should confine their activities to rate regulation.

**Applied Methods of Scientific Management.** By Frederick A. Parkhurst. Published by John Wiley & Sons, New York; Canadian agents, Renouf Publishing Co., Montreal. First edition. Cloth; 6 x 9. 326 pages, including index. Price, $2.00.

The main portion of this work appeared in a series of articles in Industrial Engineering during the year 1911. An appendix contains much new matter which was not included in the original. Many instructions and forms, which show substantially the medium employed to incorporate the principles of the science of management, into an efficient organization suitable for plant under the specific conditions illustrated, are given. The author states that he believes in adapting all details to meet each existing condition as found, and that an existing plant should be developed to its highest possible efficiency before making large outlays for extensive alterations or additions. This volume is a decided addition to the already extensive list of books dealing with scientific management, for theories and generalities have been avoided and the subject treated from a practical point of view, intensified by the many years of experience of the author along these lines.

**Tests of Columns.** An Investigation of the Value of Concrete as Reinforcement for Structural Steel Columns, by Arthur N. Talbot and Arthur R. Lord, has just been issued as Bulletin No. 56 of the Engineering Experiment Station of the University of Illinois. Price 25c.

The bulletin gives an account of the investigation of the strength of a type of column which has been used recently in the construction of reinforced concrete buildings. Structural steel angles are tied together by bent plates, making a form known as the Gray column, and this steel structure is itself filled with concrete and covered with a shell of concrete for fireproofing purposes. Such a column requires less space than the ordinary reinforced concrete column. Whether in such a column the steel and the concrete act together to give a strong stiff column has been a matter of some doubt. In the investigation described, tests were made on unconcreted steel columns of various lengths to determine the strength of the steel columns and the effect of length upon strength. Tests were then made on similar columns filled with concrete. This enabled the action of the steel and of the concrete to be compared. The breaking loads were determined and the shortening of the concrete and of the steel was carefully measured. Tests were also made upon columns having a fireproofing shell and upon columns reinforced with spiral hooping. It was found that the column strength is approximately equal to the ultimate strength of the steel column of the same length plus the strength of a short concrete column of the same quality of concrete. For loads approaching the ultimate, the shell of fireproofing concrete clung to the column without spalling. The columns tested possessed the qualities of a good structural member and seem adapted to more general use in building construction. Copies of Bulletin No. 56 may be obtained from the European sales agents, Chapman & Hall, Ltd., 11 Henrietta Street, Covent Garden, London, W.C., England.

**Starting Currents of Transformers,** with special reference to transformers with silicon steel cores, by Trygve D. Yensen, has just been issued as Bulletin No. 55 of the Engineering Experiment Station of the University of Illinois. Price, 25c.

This bulletin gives the results of tests upon five commercial transformers, showing the rush of current upon closing the primary switch, at various points of the impressed e.m.f. wave, and with a residual magnetism of various magnitudes, with the secondary open-circuited. The phenomenon is illustrated by means of oscillograms. Three of the transformers tested are of recent manufacture, with silicon steel cores, and the other two are old types. The test shows that the starting current for the silicon steel cores may rise to more than seven times the full load current, while for the old types the maximum rise is not above four times the full load current. The complete theory is given for calculating the starting currents, also for calculating a resistance or aircore inductance for limiting the starting current to safe values. In the appendix is recorded a series of tests on the permanence of the residual magnetism of transformers, and it is shown that under ordinary conditions the residual magnetism does not decrease with time, while the decrease due to severe shocks is very small. Copies of this bulletin may be obtained from the European sales agents, Chapman & Hall, Ltd., 11 Henrietta Street, Covent Garden, London, W.C., England.

**Constructing Concrete Porches.** By A. A. Houghton. Published by the Norman W. Henley Publishing Company, New York. Paper; 5 x 7; 60 pages. Price, 50c.

This book forms No. 9 of the Concrete Worker's reference books, and is explanatory of the construction of monolithic concrete and concrete block porches together with the moulding of columns, balusters, lattice and railings, as well as plain and reinforced types of porch floors. Many details of moulds and ideas that are not covered by patents, such as may be easily and cheaply constructed, are given.

**Practical Chemistry for Engineering Students.** By A. J. Hale; published by Messrs. Longmans, Green & Co., London. Canadian agents, Renouf Publishing Company, Montreal. Size, 5¼ x 7¾; 192 pages, including index, many tables and figures. Price 90c.

This treatise is intended for the use of students in the various branches of engineering. The program of practical exercises makes no claim to have introduced any fundamentally new principle. Its distinctive feature is the teaching of the subject with a bias towards the use of materials familiar in constructive industry. This is entirely proper and will be much more successful in arousing the interest and fixing the attention of the students. This manual is intended to give a little broader outlook on chemistry for the engineer than the mere dexterity in making analyses.

**Precise Calculations of Pipe Drain and Sewer Dimensions.** By. C. E. Housden. Published by Messrs. Longmans, Green & Co., London. Canadian agents, Renouf Publishing Company, Montreal. Size, 5 x 7¼; 53 pages. Price, 75c.

This little volume is called the "Precise and Therefore Economic Calculation of Pipe Drain and Sewer Dimensions for use in Water Supply, Drainage, etc.," and is a collection of tables based on the author's experience in this subject. Some of the tables have been framed and are applied on the same principles as the author's "Practical Hydraulic Tables and Diagrams," to which they are a self-contained, independent supplement. The tables are of special use in the precise and economic determination of drain and sewer dimensions, the calculation of which is by no means a simple matter, when, as is usually the case, only the required discharge and the available slope in the water surface are known. Numerous working examples are given and the work concludes with a collection of useful hydraulic tables. The simplicity of the formulae used, with their accuracy, will be a strong factor in recommending this book to engineers.

**Concrete Bridges, Culverts and Sewers.** By A. A. Houghton. Published by the Norman W. Henley Publishing Co., New York. Paper; 5 x 7; 58 pages. Price, 50c.

This is No. 8 of the series of Concrete Worker's Reference books, and illustrates and explains the various types of solid and reinforced arches, slab and girder concrete bridges, with notes on construction; also the moulding of concrete culverts, drains, and sewers, and forms for their construction. This little book, with the preceding one, is intended for the small contractor or builder.

**Elementary Principles of Reinforced Concrete Construction.** By Ewart S. Andrews. Published by Scott, Greenwood & Sons, London. Size, 4¾ x 7½; 196 pages; 57 illustrations; numerous tables. Price, $1.00.

This volume forms No. 1 of the Broadway series of Engineering Handbooks, and is intended to furnish an inexpensive treatise on reinforced concrete. It is written from an elementary standpoint in an explanatory method, without the use of advanced mathematics, and is at the same time in accordance with modern theory. The theoretical treatment is illustrated by numerous examples which enable the reader to follow the reasoning easily. The notation of the British Concrete Institute is used throughout.

## PUBLICATIONS RECEIVED.

**Report of the Ohio State Board of Health, 1910.** Being the 25th annual report. C. O. Probst, secretary, Columbus, Ohio.

**Collection and Disposal of City Waste in Ohio.** Being a supplement to the 25th annual report of the State Board of Health of Ohio, and including a report of a study of the collection and disposal of city wastes in Ohio.

**Statistics of Railways in the United States.** 23rd annual report of the Interstate Commerce Commission, for the year ending June 30th, 1910. Prepared by the Division of Statistics, Washington.

**25th Annual Report of the Interstate Commerce Commission.** Dated December 20th, 1911.

**Department of Public Works, Saskatchewan.** The annual report of the Department of Public Works of the Province of Saskatchewan, for the year ending February 28th, 1911.

**James Bay Surveys.** A report on the James Bay surveys, exploration Cochrane to James Bay, June 9th to Sept. 12th, 1911, by Sydney C. Ells, for the Temiskaming and Northern Ontario Railway Commission.

**The Smoke Problem at Boiler Plants.** A preliminary report by D. T. Randall, for the Department of the Interior, Bureau of Mines, U.S. A reprint of the United States Geological Survey, Bulletin 334. Revised by S. B. Flagg.

**Highway Bridges and Culverts.** By Chas H. Hoit and Wm. H. Burr. Bulletin No. 43, of the Office of Public Roads, U.S. Department of Agriculture. Being a revision of Office of Public Roads, Bulletin No. 39.

**The Principles of Specification and Agreement Writing.** By C. R. Young, being a reprint of a series of articles in The Canadian Engineer. Copies may be obtained from The Canadian Engineer, Toronto. Price 25c.

**Signal Installation.** Bulletin No. 127, of the General Railway Signal Company, Rochester, N.Y., describing the signal installation on the Chicago and Northwestern Railway terminal, by J. A. Peabody.

## CATALOGUES RECEIVED.

**Lead Wool.** The lead wool method of jointing, a pamphlet by The Lead Wool Company, Ltd., Snodland, Kent.

**The Prescot Welder.** A pamphlet describing electrical spot and seam welding, issued by the British Insulated and Helsby Cables, Ltd., Prescot, Lancashire.

**Sewerage, Water and Sewage Disposal.** Pamphlet issued by The Adams Hydraulics, Limited, York and London. Canadian agents, Francis Hankin & Company, 231 Coristine Building, Montreal.

**Block System.** A pamphlet describing the A. P. Block system for single track steam railroad, by F. L. Dodgson. Issued by the General Railway Signal Company, Rochester, N.Y., being their bulletin No. 128.

**Tarvia.** A pamphlet illustrating different installations of tarvia pavement, issued by The Barrett Manufacturing Company, New York.

**Steam Wagons.** Pamphlet describing Foden steam wagons, manufactured by Fodens, Limited, Sandbach, England. Canadian agents, Jones & Glassco, 201 St. Nicholas Building, Montreal.

**Products of the Damascus Bronze Company.** A very handsome catalogue issued by the Damascus Bronze Co., of Pittsburg, describing the uses of their product.

**Hayward Buckets.** Catalogue No. 39, of the Hayward Company, New York.

**Gasolene Tractors.** The International Harvester Co., of Canada, forward catalogue illustrating their Titan kerosene-gasolene tractors.

**Steam Turbines.** The DeLaval Steam Turbine Co., Trenton, N.J., forward advance copy of Catalogue D, illustrating their multi-stage type of steam turbines.

## Metallurgical Comment

T. R. LOUDON, B.A.Sc.

Correspondence and Discussion Invited

# THE CARBONIZATION OF COAL.*

**Professor V. B. Lewes.**

The whole end and aim of carbonization is to obtain as much as possible of the energy stored in coal in the condition most applicable to uses for which it is to be employed, and as these vary over a wide range, practical experience has led to the destructive distillation of coal being carried out mostly under two distinct sets of conditions—the first aiming at obtaining the maximum result from the gaseous products, the second at obtaining the best possible coke, whilst in a third, applied chiefly to shales, it is the liquid products to which most attention is paid. Of late years many attempts have been made to bring the two great industries of gas making and furnace coke production, both dealing with the destructive distillation of much the same class of coal, into line, but in most cases a lack of appreciation of the principles underlying the complex actions taking place during carbonization has proved an obstacle to any important advance, each industry viewing the problem from its own particular standpoint, and failing to grasp the wide differences which exist between substances made as the result of a process designed for their special production and the same bodies when made as a by-product. Furnace coke, as an example, must have certain characteristics to fit it for metallurgical work, which cannot be obtained in the ordinary processes of making good illuminating gas, whilst if the gas is to satisfy the parliamentary requirements laid down for most large town supplies, it is useless to expect to obtain the same volume of it from a coke oven that one would from a gas retort, so that whilst the gas manager hankers after the economies incidental to carbonization in bulk, he is constrained to work with much smaller charges in order to obtain the necessary quality and quantity of gas, and although he uses temperatures quite as high as the coke-oven manager, he misses the factors that are necessary for a good furnace coke.

In regard to the composition of coal, twenty years ago I came to the conclusion that the most satisfactory view to take of the composition of coal was that it consisted of an agglomerate of the solid degradation products of vegetable decay, together with such of the original bodies as had resisted to a greater extent the actions to which it had been subjected, and all the experience of wood, peat and coal carbonization which I have had since confirms me in the opinion that this is in the main correct. The evidence seems to point to the presence in all bituminous forms of coal of degradation products of the original vegetation of a humus or ulmic character, and which is probably the portion carrying the nitrogen.

It has been shown by Muck and other observers that it is not always the coal containing the largest amount of volatile matter that evolves gas most rapidly, or is the richest in hydrocarbons, and this naturally follows from the fact that those coals which have the highest oxygen percentage are mostly those giving high volatile matter, and as these are rich in the humus bodies which yield most of the diluting gas and but little tar or rich hydrocarbon gases, they cannot give the high result of a coal in which the oxygen content is about 10 per cent., or rather lower, and which contains a large percentage of resin bodies. Observers have differed as to the nature of the binding material in coke, some holding that it was the residuum of the semi-fused constituents of coal, whilst others, chief amongst whom was Wedding, consider that it is carbon shed off by the decomposition of heavy hydrocarbon vapors, which is undoubtedly the cause of the carbon hairs found in coking. My own opinion is that the cementing material is due to liquid products, the most volatile of which go off as vapors, leaving pitch, which carbonizes and binds the mass into coke, and in considering the actions taking place during carbonization ample proof of this will be adduced. It is clear that the binding material is formed below 450 deg. C., as if we take a good coking coal and carbonize it at 450 deg. C. we obtain coke which, although not strong, is perfectly luted together; but if we now powder this low-temperature coke and again carbonize it, a large yield of poor gas is evolved, but no coking of the residue takes place. There is no doubt in my mind that it is the resin bodies and their derivatives, the hydrocarbons in the coal, that form the tar, which yields the pitch which lutes the coke, and also that the resin bodies play a very important, if not the chief, part in the weathering of coal.

Experience shows that the weathering of coal is a phenomenon which is dependent upon the absorption of oxygen from the air, and this weathering is fatal to the coking of some coals, the slacks of which are so susceptible to oxidation that a few days' or weeks' exposure destroys their coking power. Now, the avidity of oxygen for some vegetable resins is well known, the rapidity with which copal will absorb oxygen from the air may be taken as an example; common resin has itself been formed by the oxidation of turpentine, and countless ages under conditions tending to reduction may well have whetted anew the resinic appetite for oxygen. In any case the resin bodies are the compounds present in the coal most likely to possess this property, and it is the chemical actions so caused which lead to slow combustion and, when accelerated by any rise in the surrounding temperature, is capable of generating sufficient heat to lead to the spontaneous ignition of masses of broken coal large enough to prevent the escape of the heat as it is developed. Coal exhibits to a lesser extent the same property of absorbing gases that charcoal does, and the least absorbent will take up one and a quarter times its own volume of oxygen, whilst many bituminous coals will absorb more than three times their volume of gas. This action, at first largely physical, presents the oxygen in a probably active condition to the resin bodies in the coal, and leads to the rapid "weathering" and destruction of the coking properties found in some kinds of coal.

The lines of research intended to throw light on the composition of coal have been either to distil the coal at various temperatures and to draw inferences from the products of the nature of the original substance, or, to directly attack the coal by means of solvents. The early attempts to isolate definite bodies from coal by solvents were none of them very successful, but Bedson made a great advance in this line of research when in 1899 he pointed out the solvent power of pyridine bases, extracted from coal tar, which dissolved 16 to 18 per cent. of a Durham coal, but had no action on anthracite. In 1901 Baker experimented upon the action of this solvent on several coals, and found that from Durham coal (Hutton seam) 20.4 per cent. could be extracted with pyridine, and that after extraction the residue had lost the coking properties of the original coal.

*Abstract of a paper read before the Royal Society of Arts.

This observation was confirmed by Anderson and Henderson in 1902, who tried the action of pyridine in a research upon the coals of Bengal and Japan, and also upon some Scotch coals, the coking powers of which were known. They found that the extraction of a strongly coking coal by pyridine weakened the coke, whilst with inferior coking coal the property is entirely destroyed. In 1908 Professor Bedson read a paper before the society of Chemical Industry, in which he gave the results of experiments upon six coals obtained from the Redhaugh gasworks, which seem to show that with some gas coals an amount equal to practically the whole of the volatile matter capable of being driven off by heat can be extracted by pyridine.

| | Volatile matter. Per cent. | Pyridine extract. Per cent. | Gasworks yield. Per ton. | Candle power. |
|---|---|---|---|---|
| I. | 34.10 | 32.36 | 11,381 | 16.63 |
| II. | 33.28 | 33.39 | 11,392 | 16.30 |
| III. | 31.91 | 24.58 | 11,646 | 16.40 |
| IV. | 31.7 | 22.81 | 11,108 | 16.00 |
| V. | 33.66 | 29.77 | 10,913 | 16.39 |
| VI. | 30.87 | 22.63 | 10,730 | 16.76 |

Now, from these figures the inference is that in a coal like II., everything beside the fixed carbon and ash has been dissolved—that is, humus, resin and hydrocarbon bodies—and it would have been of the greatest interest had Professor Bedson made an analysis of the residue, or at any rate had shown that no volatile matter was left in it.

It appears probable that in a feebly coking coal the coking property is due almost entirely to the soluble form of resin constituent, and can therefore be entirely removed by extracting the coal with pyridine; whilst on the other hand, in strongly coking coals the property is due partly to soluble resin bodies, but to an even greater extent to other hydrocarbons of resinic origin, which resist the solvent action of the pyridine, so that the coking property is weakened but not destroyed by extraction. A similar conclusion was arrived at by Anderson and Roberts in 1898, from an entirely different point of view. Dr. Percy, more than fifty years ago pointed out the fatal effect of weathering upon certain coals and slacks, and showed that if a fairly good coking coal was kept at a temperature of 300 deg. C. for a few hours, and is afterwards heated to redness, it does not swell and coke. Anderson and Roberts, in trying this with various Scotch coals, found that, although it was true for a coking coal of medium power, a really strongly coking coal had the power only weakened, and they found also that the same phenomenon could be brought about by treating the two coals with sodium hydrate. The conclusion is that although resinous bodies which can be saponified or oxidized contribute largely to the coking, yet there are also present non-saponifiable bodies which in breaking up under the influence of heat, yield enough luting to form coke. I think the action of pyridine shows that these non-saponifiable bodies consist of substances very probably akin to those found in shale and some cannels. Burgess and Wheeler, in a paper read before the Chemical Society this year, took a Silkstone coal containing 33.4 per cent. of volatile matter, and succeeded in extracting 30 per cent. by means of pyridine, leaving a cokelike residue, which on distillation at 900 deg. C. yielded hydrogen and oxides of carbon—they would have found methane as well if they had looked for it—whilst the extract on destructive distillation yielded a mixture of the paraffin hydrocarbons and hydrogen. At first sight this looks as if pyridine was a solvent which could be used to separate the humus and resin constituents, but Messrs. Burgess and Wheeler are careful to point out that they hesitate to identify absolutely the paraffin-yielding constituents of coal with that portion extracted by pyridine, and they are wise in being cautious, as there are several anomalies to be cleared up. I have found several times that after extraction the residue contains as much volatile matter as the original coal, and sometimes more, in spite of repeated washings with acid, drying in vacuo and other forms of treatment intended to eliminate all pyridine, whilst the composition of the extract also shows anamalous results, and after the most careful measures have been taken to free it from pyridine, it will sometimes still contain more nitrogen than did the original coal.

Coal always contains a certain proportion of water which appears to be partly mechanically held and partly in some form of combination. In this it resembles wood, which after long air-drying still retains an average of 20 per cent. of moisture, which, if got rid of at an elevated temperature is reabsorbed from the air. The mechanically-held portion in coal is generally known as "pit-water," and represents ordinary wetting, which can be got rid of by air-drying, but the so-called "hygroscopic water" is driven out only by drying at 103 deg. C., and as this heating for some hours causes oxidation of the resin bodies, it also tends to destroy the coking properties of the sample. This result has led some observers to conclude that hygroscopic water is essential to coking, which is manifestly incorrect, as the tertiary coals, which contain the largest quantity of hygroscopic moisture, will not coke owing to the proportion of humus derivatives being largely in excess of the resin bodies.

Many classifications of coal have been suggested, some based on their chemical, some on their physical, and others on their coking properties, and of the latter the most generally adopted is that suggested by Gruner, in which he tabulates bituminous coals into five classes; although Schondorff, Muck and others have shown that it is not applicable to all kinds of coal, still this criticism applies to all classifications that have been proposed.

| | | Carbon. Per cent. | Hydrogen. Per cent. | Oxygen. Per cent. |
|---|---|---|---|---|
| 1. Dry Coal | Long flame and non-coking | 75—80 | 4.5—5.5 | 15.0—18.5 |
| 2. Fat gas coal | Coke porous and brittle | 80—85 | 5.0—5.8 | 10.0—13.2 |
| 3. Semi-fat or furnace coal | Good coke but porous | 84—89 | 5.0—5.5 | 5.5—10.0 |
| 4. Coking coal | Best coke | 89—91 | 4.5—5.5 | 4.5— 5.5 |
| 5. Lean Coals and anthracite | Non-coking | 90—93 | 3.0—4.5 | 3.0— 4.5 |

This arrangement shows not only the coking properties, but also the changes in composition which the coal undergoes—the concentration of carbon and reduction in highly oxidized bodies. In the first class we have the dry coals, yielding large volumes of gas and liquid products on distillation, and these coals—as might be expected—most resemble the lignites, and share with them the property of non-coking or binding together of the residue on carbonization. This is due to the fact that the humus-like bodies are still present in much larger quantities than the resinic compounds and hydrocarbons, and as on disillation they leave no binding material in the residue the resinic bodies cannot supply enough to give more than a friable mass. In the second class of coals altered conditions of temperature, pressure and time have led to further decompositions of the humus bodies, and the resinic constituents and hydrocarbons having increased in ratio by concentration, a point is reached at which coking takes place, although not of a satisfactory character. In the third class the action still has continued with further concentration of the resin bodies, hydrocarbons and residuum, with the result that the former bodies are so increased in comparison to the humus and residuum that a good coke results. In the fourth class the proportion of resin and hydrocarbon bodies has reached the right ratio as compared with the humus and residuum, and the best coking coal is obtained. Bituminous coals of the kind classified by Gruner may, therefore, be looked upon as an agglomerate of humus and the degredation products of these bodies down to carbon, luted and protected by resin bodies and their derivatives; steam coal and anthracite as the degradation products of humus which has nearly completed its decomposition owing to the small quantity of resin bodies in the original vegetation; and cannel coal as consisting mainly of resin bodies, which having been in a semi-fluid condition, have mingled with the earthly matter in contact with it, so obtaining the high ash found in many kinds. In putting forward this theory as to the composition of coal, I wish it distinctly understood that by the terms "humus" or "resin" bodies, I do not imply any one definite compound, but merely bodies of this character, the humus bodies all containing a percentage of hydrogen from 5 per cent. downwards, whilst the resin bodies all contain a percentage of hydrogen above 5 per cent. If it is once admitted that coal is a conglomerate of the kind I have indicated, it explains all those obscure points which no other theory touches—such as why with two coals of almost identical composition and of high oxygen content, one should be a coking and the other a non-coking coal; the reason being that in the one the high oxygen content is due to humus bodies, which will not coke owing to the low pitch-forming nature of the hydrocarbons, whilst with the other the oxygen is due to resin bodies, which are essential to good coking.

All the evidence that can be adduced shown that when a coal undergoes destructive distillation all the hydrocarbons, together with the resin and humus constituents, undergo decomposition at a temperature certainly well below 700 deg. C., and that as the liquid and gaseous products distil out they leave behind their less volatile residues as a pitch, which lutes together the carbon particles and forms soft coke, whilst as the temperature rises above 750 deg. C., he pitch residue decomposes, yielding hydrogen, carbon monoxide and methane as gases. The carbon residue from the pitch binds the residual mass into coke, and it is this residual pitch that Burgess and Wheeler have mistaken for a primary constituent of coal. It is clear, however, that (putting detail on one side until our knowledge has been broadened by experience) the answer to the question as to what is the composition of coal—whether the answer is derived from a consideration of the actions taking place during its formation and of the substances from which it was derived, or is obtained from analytical data, as was done by Anderson and Roberts, or from the products of distillation as has been attempted by Burgess and Wheeler—must be that coal is a conglomerate of humus and its degradation products with the resinic bodies and their derivatives.

## THE EFFECT OF VARIOUS SUBSTANCES ON THE RATE OF CORROSION OF IRON BY SULPHURIC ACID.*

**By Oliver P. Watts.**

In Vol. 8 of the transactions of this society, C. F. Burgess called attention to the remarkable reduction in the corrosion of iron by sulphuric acid, brought about by the addition of a small amount of arsenious oxide to the acid. Later he explained the protective action as follows: "The explanation which has been offered for this phenomenon is that the iron receives, by contact with the solution, an extremely thin coat of arsenic which resists the action of the acid and protects the underlying metals." He also gave experimental proof that the iron was coated with arsenic.

It has long been known that by dipping clean iron into solutions of suitable composition and concentration thin coatings of gold, silver, platinum, copper, and several other metals may be deposited on the iron. It is generally conceded that such coatings are not sufficiently continuous and impervious to protect the underlying metal from corrosion, even though the metal forming the coating may itself be thoroughly resistant to the corrosive agent. Instead of being a protection, such coatings are usually considered to be stimulators of corrosion.

Since all metals which thus deposit upon iron when it is immersed in a solution of the metallic salt are electro-negative to iron, a short-circuited voltaic cell is formed, of which the iron is anode and the metal deposit is the cathode. So long as any iron remains in contact with the electrolyte, it would seem, except for certain considerations which will be presented later, that the corrosion of the iron ought to be stimulated by this condition, and that the only way in which such a coating could afford good protection would be by covering the iron completely, so that no electrolyte could come in contact with it.

Speaking of the effect of other metals in contact with iron, W. H. Walker says: "Tin is a metal which, like copper, accelerates the corrosion of iron by aiding in the oxidation of the hydrogen set free by the reaction." M. P. Wood calls attention to the injurious action of metals, "The use of anti-corrosive, or anti-fouling paints, containing salts of any metal, is attended with the greatest danger to the coated (iron or steel) structure. These pigments are extremely sensitive to the presence of saline elements in moisture, their action being to rapidly dissolve portions of the iron, and to deposit the metal which they contain upon the surface of the plates, and these deposits, exciting energetic galvanic action, cause corrosion and pitting to go on with alarming rapidity. Both mercury and copper salts are offenders in this way."

It appears then, that arsenic is unique among the metals which precipitate themselves upon iron from solution, for arsenic protects iron almost completely from powerful corrosive agents, while the other metals are generally considered to aggravate corrosion and rusting. The protective action of arsenic cannot be due to any superior power of resisting attack by sulphuric acid, for silver, platinum and gold are even more resistant, and yet accelerate the corrosion of iron. It is evident that these other metals do not form continuous and impervious coatings over the iron, else they would protect it. It is difficult, perhaps even impossible, even with the aid of the electric current, to deposit from solution a thin coating of one metal upon another, so perfectly as to protect the underlying metal from corrosion by an acid ordinarily capable of attacking it. It is almost incredible that a thin yet perfect and non-porous metallic coating should be deposited by a process which depends for its operation upon the dissolving of the underlying metal. The protective action of coatings of copper, silver, etc., thus deposited on iron is about as effective as would be expected from a knowledge of their method of formation. They are continually being undermined by the corroding of the iron anode at points not yet covered, until the copper or silver becomes detached, to have its place taken by a new coating, and so on, as long as any of the salt of the depositing metal remains in the solution. If the coated metal be removed to an acid, the corrosive action is similar, except that the renewal of the coating can take place only at a rate not greater than that at which the detached metal redissolves in the acid.

If the coating of arsenic is so porous and imperfect as the action of acids shows the coating of copper, for example, to be, how can the arsenic protect the iron any better than copper does? It occurred to the writer that the ex-

* Abstracted from a paper read before the Am. Electro-Chem. Soc., April 20th, 1912.

planation lay in a high overvoltage or excess potential of hydrogen on arsenic, and the experiments which follow were undertaken to discover whether this is the explanation of the singular and mysterious protective action of arsenic. If the above explanation is correct, among the metals which deposit upon iron when it is immersed in a solution of their salts those having overvoltage for hydrogen should protect iron, and those of very low overvoltage should aggregate corrosion.

If an electrode of platinum coated with platinum-black be immersed in normal sulphuric acid the electrode will be electro-negative to the solution by about 1.14 volts. If now a small but slowly increasing electromotive force be applied between this electrode and an insoluble anode it will be found that the platinized cathode becomes progressively electronegative with regard to the solution. When a certain difference of potential between the cathode and the solution is reached, bubbles of hydrogen begin to appear on the cathode. If a cathode of smooth platinum is used, hydrogen will not appear on this until it has become 0.09 volts more positive than the other cathode was when hydrogen first appeared on it. Similarily zinc must be 0.70 and mercury 0.78 volts more positive than the platinum-black before hydrogen appears upon them. This excess of potential required to cause a visible liberation of hydrogen upon a cathode of any particular metal, over the potential required for the liberation of hydrogen upon platinum coated with platinum-black, is known as the overvoltage of hydrogen upon that metal. In Table I. are given the single potentials in normal solutions of the sulphates of the metals, and the overvoltage of hydrogen as stated by different observers.

**Table I.**

| | | Overvoltage in normal sulphutic acid | | | in 5 per cent. KOH, |
|---|---|---|---|---|---|
| | Single Potential | Caspari[4] | Foerster[5] | Harkins[6] | Nutton and Law[7] |
| Mercury ........ | —0.98 | 0.78 | 0.43 | 0.74 | |
| Zinc ............ | +0.524 | 0.70 | | 0.71 | 0.70 |
| Lead ............ | —0.095 | 0.64 | 0.35 | 0.62 | 0.57 |
| Tin ............. | —0.085 | 0.53 | 0.43 | 0.55 | 0.61 |
| Cadmium ....... | +0.162 | 0.48 | 0.48 | | 0.52 |
| Arsenic ........ | —0.550 | | | 0.39 | |
| Bismuth ........ | —0.490 | | | 0.38 | |
| Iron ............ | +0.093 | | | | 0.15 |
| Copper ........ | —0.515 | 0.23 | 0.10 | 0.25 | 0.41 |
| Cobalt .......... | —0.019 | | | 0.22 | |
| Nickel .......... | —0.022 | 0.21 | 0.10 | 0.15 | 0.37 |
| Silver ........... | —0.947 | 0.15 | | 0.13 | |
| Platinum ........ | —1.140 | 0.09 | 0.07 | 0.07 | |
| Gold ............ | —1.356 | 0.02 | 0.055 | | |

On the theory that the protection of iron by a deposit of arsenic is due to the high overvoltage of hydrogen on the latter the action would be as follows: Iron dissolves and by so doing deposits arsenic upon the surface of the iron. Since the arsenic is deposited simultaneously with the dissolving of the iron, and only as a result of this dissolving, it is hardly possible that the iron should be perfectly covered by arsenic, but here and there holes will exist, allowing the iron to make contact with the electrolyte. Voltaic cells are thus formed. From the single potentials of iron and of arsenic, + 0.093 and —0.550, these cells should have an electromotive force of 0.64 volts, and the corrosion of the iron ought to be very vigorous. It is here that the overvoltage of hydrogen comes in play. The iron is anode and the arsenic cathode, and, just as in any other primary cell with sulphuric acid as electrolyte, hydrogen is deposited on the cathode. But when hydrogen is liberated on arsenic the potential of the latter is raised 0.39 volts higher than —0.277, the potential at which hydrogen is liberated on platinum-black. This would rise the potential of the arsenic to + 0.113 volts, or higher than the potential of the iron anode. This means that in our iron-arsenic cell there can be no visible evolution of hydrogen on the arsenic, for before this can occur the potential of the cathode has become equal to that of the anode, and corrosion of the iron ceases, in other words, this particular primary cell polarizes so badly that after a few seconds of action its electromotive force has fallen to zero.

If the above explanation is correct, protection should be afforded by those metals which plate out on iron by immersion, and whose overvoltage for hydrogen is great enough to raise their potentials to at least equal the single potential of iron. The potentials of the following metals are far enough below that of iron to expect that they will deposit on iron even in moderâtely strong sulphuric acid: antimony, arsenic, bismuth, gold, lead, mercury, platinum, silver and tin. Potential measurements made by students in the writer's laboratory indicate that chromium should be included in the list. Omitting lead, on account of the insolubility of its sulphate, mercury, tin, and arsenic show the highest overvoltage; compounds of these metals were therefore used in a preliminary experiment, by A. C. Shape.

From the experiments certain definite conclusions can be drawn and other generalizations now appear profitable, but may require revision or rejection in the light of future experiments.

The writer's hypothesis, that the protective action of arsenic is due to its high overvoltage, has been in a general way confirmed. Other metals of high overvoltage have had a protective influence, while all metals of low overvoltage which deposits on iron are accelerators of its corrosion. So far as overvoltages are known, bismuth alone fails to conform to the hypothesis. Theoretically it should retard corrosion; actually it is an accelerator. Unless redeterminations of the overvoltage of bismuth and the single potential of iron shall reconcile theory with fact, the writer's hypothesis fails. The overvoltage of bismuth was presumably measured on a solid electrode. Bismuth deposited as a powder. If there is the same difference in overvoltage for bismuth as between smooth and spongy platinum, this correction would put bismuth in the list of accelerators.

The statements which follow are intended to apply only to the corrosion of iron by sulphuric acid.

Tin, chromium and mercury retard corrosion; of these, tin alone is as effective as arsenic. The protective action of mercury is very slight.

In studying the effect of different reagents on corrosion it is necessary to consider both the metal and the non-metal or acid radical, since each may have an effect of its own.

The binary salts and acids of the halogens are very good protective agents when used in considerable amounts. To combine most effectively the protective effects of a metal and a halogen, e.g., tin and chlorine, much stannous chloride should not be added, for a large amount of the salt of any metal which precipitates on iron in an acid solution is likely to act as a corrosive agent; only a small amount of stannous chloride should be added, and the extra chloride added as sodium chloride.

Oxidizing agents are in themselves accelerators of corrosion by acids, although in dilute solution this may be masked by a protective action which supervenes when the oxygen has been used up, as might happen with chromates.

Reducing agents should show more or less protective action, but this fact remains to be confirmed by further experiment.

In general, the whole subject as here presented is but a preliminary study which opens many possibilities for future investigation. It is hoped that the data appended may prove of service to those wishing to pursue the subject, and that the writer's conclusions may meet with confirmation from independent sources.

For convenience in comparing the effects of different reagents, an index is appended.

**Retarders of Corrosion.**—Acid, hydrobromic; acid, hydrochloric; acid, hydrofluoric; arsenate of sodium; arsenic sulphate; bromide of potassium; chloride of ammonium; chloride of manganese; chloride of mercury; chloride of sodium; chloride of tin; chrome alum; chromium sulphate; fluoride of potassium; hydroquinone; iodide of potassium; mercury chloride; mercury sulphate; resorcine; stannate of sodium.

**Accelerators of Corrosion.**—Acid, chromic; bismuth sulphate; chromium chloride; copper sulphate; gold chloride; mercurous nitrate; platinum chloride; potassium chlorate; potassium chromate; potassium dichromate; potassium nitrate; potassium permanganate; silver nitrate; silver sulphate.

**Of no Effect or Doubtful.**—Ammonium sulphate, antimony, sulphate, boric acid, citric acid, potassium sulphate.

## THE PRESERVATION OF POWER TRANSMISSION POLES.*

**By W. R. Wheaton.**

The following account deals with an experiment which is complete and covers a long period:—

In March, 1908, the San Joaquin Light & Power Corporation set a line of Western yellow pine (pinus ponderosa) poles. The line is about thirty miles long and contains approximately 600 poles. These poles were cut in the Sierras above Fresno at an elevation of about 4,000 ft., and thoroughly seasoned before treatment. A portion of the poles were given a brush treatment with carbolineum and with creosote, and the balance were treated in the open tank with creosote, zinc chloride and crude oil. The butt only was treated. Western yellow pine is very susceptible to a preservative treatment. Some of the butts were thoroughly penetrated with creosote and with zinc chloride, the average penetration at the ground line being 3 in. The penetration with crude oil averaged about 1½ in. The crude oil used was a heavy oil of asphaltum base supplied from the Kern River fields. In order to get a comparative life of the wood treated and untreated, stubs of untreated timber were set along the line about a mile apart. The writer inspected this line in June, 1910, at which time it had been set for 27 months. The untreated stubs set along the line were completely rotten. Of the poles given a brush treatment with creosote, 27 per cent. showed signs of decay and 29 per cent. of the poles given brush treatment with carbolineum. Of the poles treated with crude oil 45 per cent. were slightly attacked, and of the poles treated with zinc chloride, 28 per cent. showed attack. The poles treated with creosote in the open tank (over 50 per cent. of the entire line was treated in this way) were all perfectly sound and showed no signs of decay.

In August, 1911, two of the poles in this line which had received a brush coating of creosote fell over, due to the decay of the butt. During August and September, 1911, the line was gone over and all of the poles which had been given a brush treatment of creosote and carbolineum were so badly decayed that they were strapped to a creosoted cedar stub.

Since the erection of the plant by the San Joaquin Light & Power Corporation Western red cedar has been treated. The butts only are treated by the open tank process. There is no necessity for treating the top, since the top is not subject to decay. With this process it is attempted only to fill the outer ring of sapwood with creosote, and if the timber is thoroughly seasoned there is little difficulty in accomplishing this. The penetration varies with the width of the sapwood from ½ in. to 1 in. with an absorption of from 7 to 9 lb. to the cubic foot. There are treated and untreated cedar poles in the lines which have been set for four years. The creosoted poles are still perfectly sound, while the poles set untreated have decayed through the sapwood and into the heart.

Creosote is used in preference to chloride of zinc or other treatment which might be effective in an arid climate because after the installation of the irrigation systems the poles are often in the middle of irrigated fields, where zinc is washed out of them, so that they have to be replaced after a brief service. A 50-ft. creosoted pole placed in the line means an investment of about $25, while the use of chloride of zinc would cut this cost to about $24.25. The saving is too small to be considered against the possibility of the loss of the preservative in one or two years.

*Abstract of paper presented at Annual Convention of Wood Preserver's Association, Chicago.

## LIGNO-CONCRETE.*

**By Gerald O. Case (Member).**

In the introductory remarks, the author refers to the use in America and Australia of concrete in combination with timber, and points out that, while the concrete effectively preserves the timber, it is not used to the greatest advantage. The object of the author's investigations was to ascertain if it were possible to reinforce concrete with timber rods. Roughly speaking, steel is about eight or nine times stronger than timber, but ten to fifteen times as expensive. The efficiency of timber, as a reinforcing material, depends on whether there is sufficient adhesion between the timber and the concrete, and whether the difficulties of the absorption of moisture by the timber from the wet concrete, and the splitting the latter, can be overcome.

The paper describes the experiments made by the author to ascertain (a) the amount of water absorbed by eighteen kinds of timber immersed in fresh water, along the grain and through the end grain respectively; (b) the relative absorption by the timber of fresh and sea water in the same period; (c) the relative amount of water absorbed by timber embedded in 6 to 1 concrete and neat cement blocks; (d) the effect of applying wood preservative, creosote, varnish, etc., to the timber before insertion in the concrete or cement blocks; (e) the effect on the adhesion between the timber and the concrete of soaking the rods before insertion. Examples are given to show that concrete effectively preserves timber embedded in it.

Particulars are given of the construction of twenty-five concrete beams reinforced by timber rods. Three ligno-concrete beams, 8 in. deep by 4 in. wide, were tested with a central load on a 4 ft. span, the average ultimate load producing fracture about three tons. The results of these tests are compared with the tests on ferro-concrete beams recorded by Mr. E. Marburg in the Proceedings of the American Society for Testing Materials (1904, Vol. IV.). It appears that for the same ultimate strength of beam it is necessary to use 9 per cent. of sectional area of pitch pine

*Abstract of paper read before the Society of Engineers, London. April 1st, 1912.

tensile reinforcemnts as against 1 per cent. steel reinforcements. A comparison of the prices of steel and pitch pine shows a saving in favor of ligno-concrete.

As the author points out, in cases where more than about 1.2 per cent. of steel reinforcement is required, ligno-concrete cannot compete with ferro-concrete, because the required size of the timber bars would be too large for convenient use. There appears, however, to be a big field for it for use in constructing bungalows, buildings for small holdings, floors, piles, posts, fencing, coast and river works, etc. It has already been used for making fence posts and for building a short length of sea wall. The ligno-concrete fence-posts cost about two shillings per cube foot. They are about 20 per cent. cheaper than creosoted deal, and about 40 per cent. cheaper than Engish oak. In Canada four bungalows have been built with ligno-concrete slabs, and the Pacific Coast Construction Company, of Victoria, British Columbia, now have contracts in hand for twenty buildings in which this material is to be used.

## ENGINEERING NOTES.

**Regina, Sask.**—There is a probability that the position of city engineer will be vacant owing to the present incumbent, Mr. Thornton, being appointed works commissioner.

**Lethbridge, Alta.**—The fire rangers of the Rocky Mountain reserve will meet in this city and consider the question of installing a telephone line throughout the forest. Mr. S. J. Gilling, telephone expert for the provincial government, has prepared a report on the subject.

## PERSONAL.

**Mr. James G. Lindsay** has been re-appointed engineer for the municipality of Belleville, Ont.

**Mr. W. H. Sullivan** has been appointed to the position of chief engineer of the Welland Ship Canal.

Announcement is made of the appointment of **Mr. J. L. Weller** to the position of charge of the Welland Ship Canal.

**Mr. J. C. Gardner** has been appointed engineer-superintendent on the construction of the good roads of Welland County, Ontario.

**Mr. I. F. Willsie** has taken charge of reconstruction work on the Canadian Pacific Railway. Until recently Mr. Willsie has been assistant engineer for the city of London, Ont.

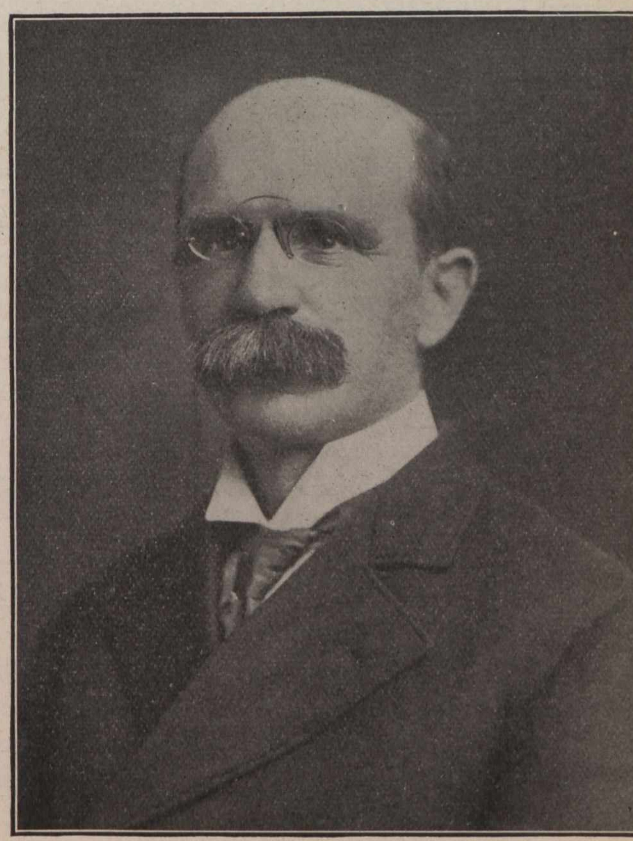
**Mr. H. H. Adams** has been appointed to the position of president of the Kansas City terminals. Mr. Adams was formerly manager of the Toronto, Hamilton and Buffalo Railway.

**Mr. R. W. Heafield,** 264 Reid Street, Peterboro', Ont., was the author of an article on "The Material List Method of Store-Keeping," which was published in The Canadian Engineer of April 11, 1912. Mr. Heafield will be glad to furnish further details of the method to any one sufficiently interested to enquire.

**Mr. Gunni Jeppesen,** who was for many years designing engineer of The Strauss Bascule Bridge Co., of Chicago, Ill., has been appointed managing engineer of the same company. Mr. J. R. Hall, who was formerly chief draftsman, has been appointed designing engineer, and is succeeded as chief draftsman by Mr. A. O. Walker.

**Mr. W. W. VanEvery** has just been appointed city engineer of Sault Ste Marie, Ont. Mr. VanEvery graduated from the School of Practical Science, Toronto, thirteen years ago, and since then has been continuously engaged in different kinds of engineering work, both in Canada and in the United States. While in the United States he was construction engineer with the Lackawanna Steel Company during the construction of their new plants at Buffalo, N.Y., and Lebanon, Pa. Later he was sales engineer for the Allis-Chalmers Company, of Milwaukee, Wis. In Canada he has been connected with the construction of the following new plants: The Canada Car & Foundry Co., at Turcot, Montreal; M. Beatty & Sons, Welland, Ont.; The Tallman Brass & Metal Co., Hamilton, Ont.; extension to the Canada Screw Company's plant at Hamilton, and extensions to the Harris Abattoir plant, Toronto. He has also done considerable consulting work besides, and previous to taking the city engineership of the Soo, was engineer for the Algoma Steel Company of the same city. Mr. VanEvery is an associate member of the Canadian Society of Civil Engineers.

**Mr. C. H. Rust,** M. Can. Soc. C.E., M. Am. Soc. C.E., has tendered his resignation as city engineer for Toronto. Mr. Rust was born in Essex, England, December 25th, 1852; was educated at Brentworth Grammar School, and began professional work under the late Mr. Frank Shanley. In



the year 1877 he entered the employ of the city of Toronto as rodman; in 1881 he was appointed assistant municipal engineer, and during the year 1892 took charge of the city's work, but it was not until February, 1898, that Mr. Rust was appointed city engineer. Mr. Rust was elected a member of the Canadian Society of Civil Engineers in 1887, and in the year 1901 was honored by the position of vice-president of that body. In 1911 he was elected president of this organization. He was interested in other engineering and municipal societies, having been elected a member of American Society of Civil Engineers, the American Society of Municipal Improvements, and the American Waterworks Association.

## OBITUARY.

Through the "Titantic" disaster Canadians lost a prominent metallurgical and chemical engineer in the person of **Mr. Ernest Sjostedt.** He had been connected with the erection of many important steel and metal plants, among which are the reduction plant and the water gas plant at Sault Ste. Marie, and the Standard Chemical works. He was a native of Sweden and a graduate of the School of Mines, Stockholm. When he met his death he was returning from a business trip in the interests of The Lake Superior Corporation and the Dominion Government. He was sixty years of age.

The engineering fraternity recently lost one of its members in the person of **Charles Beresford Fox,** of the firm of Fox and Wragge, Toronto. He was the eldest son of Mr. Francis Fox, a member of the firm of Sir Douglas Fox and Partners, civil engineers, London, England. Mr. Fox has been a resident of Toronto for the past three years. Prior to coming to Toronto he had been engaged in many important engineering works, having passed some years in South Africa on the Rhodesian railways, and at the construction of the bridge over the Zambesi River at Victoria Falls. He was also engaged for about two years at the building of the Assiout Barage on the Nile in Egypt, and for a time at the Simplon Tunnel. His death occurred on April 15th last.

## COMING MEETINGS.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—413 Dorchester St. W., Montreal. Meeting of the Mechanical Section. Thursday, April 25th, at 8-15 p.m. Paper on "Distribution of Stress in Certain Tension Members," by Mr. C. Batho, A.M. Can. Soc. C.E.; Secretary C. H. McLeod

CANADIAN INSTITUTE.—198 College Street, Toronto. Saturday Evening Lectures, 8 p.m. April, 27th—"Early Economic History of Canada," S. A. Cudmore, Toronto University. Nominations. May 4th—Annual Meeting and Election of Officers.

ONTARIO MUNICIPAL ASSOCIATION.—Annual convention will be held in the City Hall, Toronto, on June 18th and 19th, 1912. Secretary-Treasurer, Mr. K. W. McKay, County Clerk, St. Thomas, Ont.

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

## 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, W. Alan, Kennedy; 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, Chas. Hopewell, Mayor, Ottawa; 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.

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, Mayor Mitchell, Calgary.; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

### CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, G. M. Lang Secretary, L. M. Gotch, Calgary, Alta.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, J. L. R. Parsons, Regina; Secretary-Treasurer, M. B. Weeks, Regina.

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

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CANADIAN FORESTRY ASSOCIATION —President, John Hendry, Vancouver. Secretary, James Lawler, Canadian Building, Ottawa.

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

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

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ONTARIO LAND SURVEYORS' ASSOCIATION.—President, T. B. Speight, Toronto; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

REGINA ENGINEERING SOCIETY.—President, A. J. McPherson, Regina; Secretary, J. A. Gibson, 2429 Victoria Avenue, Regina.

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, F. S. Baker, F.R.I.B.A., Toronto, Ont.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Louis B. Stewart, Toronto; Secretary, J. R. Collins, Toronto.

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WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, 115 Phœnix Block, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

# CONSTRUCTION NEWS SECTION

**Readers will confer a great favor by sending in news items from time to time. We are particularly eager to get notes regarding engineering work in hand and projected, contracts awarded, changes in staffs, etc. Printed forms for the purpose will be furnished upon application.**

## PLANS AND SPECIFICATIONS ON FILE.

The following Plans (P.) and Specifications (S.) are on file for reference only unless otherwise noted at the office of The Canadian Engineer, 62 Church Street, Toronto:—

| Bids close | | Noted in issue of |
|---|---|---|
| 4-30 | Tunnel sewer, Edmonton, Alta. ..........(S.) | 4-4 |
| 4-30 | Trunk sewer, Edmonton, Alta. ............(S.) | 4-11 |
| 4-30 | Subway, Moose Jaw, Sask. ..........(P. & S.) | 4-18 |
| 5-10 | One diesel oil engine, Vernon, B.C. .....(S.) | 4-25 |

(Saskatoon plans and specifications are on file at The Canadian Engineer Office, 820 Union Bank Building, Winnipeg).

## TENDERS PENDING.

### In Addition to Those in this Issue.

Further information may be had from the issues of The Canadian Engineer referred to.

| Place of Work. | Tenders Close. | Issue of. | Page. |
|---|---|---|---|
| Arborg, Man., school house | May 1. | Apr. 11. | 59 |
| B·y View, N.S., lifeboat house and dwelling | Apr. 30. | Apr. 11. | 60 |
| Calgary, Alta., timber structures | May 15. | Apr. 18. | 76 |
| Calgary, Alta., concrete structures | May 1. | Mar. 28. | 70 |
| Calgary, Alta., designs for aqueduct | May 1. | Feb. 22. | 70 |
| Edmonton, Alta., tunnel sewer | Apr. 30. | Apr. 4. | 72 |
| Edmonton, Alta., trunk sewer | Apr. 30. | Apr. 11. | 72 |
| Fort William, Ont., garbage incinerator | May 15. | Apr. 18. | 74 |
| Fredericton, N.B., school building, St. Mary's Reserve | May 2. | Apr. 18. | 60 |
| High River, Alta., laying water mains, etc. | Apr. 30. | Apr. 18. | 59 |
| Kerrisdale, B.C., outfall sewer, etc. | Apr. 29. | Apr. 18. | 59 |
| Little Pines, Sask., school house, etc. | May. 6. | Apr. 4. | 60 |
| Macdonald, Man., grading | Apr. 24. | Apr. 11. | 59 |
| Moose Jaw, Sask., subway | Apr. 30. | Apr. 18. | 74 |
| Moose Jaw, Sask., public library building | Apr. 24. | Apr. 18. | 59 |
| Muncey, Ont., alterations to Industrial School | May. 1. | Apr. 4. | 60 |
| Ottawa, Ont., steel tug | Apr. 22. | Apr. 11. | 60 |
| Ottawa Ont., designs for monument | Oct. 1. | Apr. 18. | 60 |
| Ottawa, Ont., fishing protection vessel | June 17. | Apr. 18. | 74 |
| Ottawa, Ont., improvements to Lock 15 | Apr. 26. | Apr. 11. | 60 |
| Port of Quebec, Que., proposals for drydock | July 2. | Apr. 18. | 60 |
| Point Grey, B.C., plans for university | July 31. | Feb. 7. | 60 |
| Prince Albert, B.C., sidewalks | Apr. 30. | Apr. 18. | 60 |
| Regina, Sask., electric supplies, Sec. 6 to 9 | May 15. | Apr. 11. | 72 |
| Saskatoon, Sask., superstructure 23rd Street subway | May 17. | Apr. 18. | 76 |
| Sault Ste. Marie, Ont., widening lower entrance channel-way | May 10. | Apr. 18. | 60 |
| Selkirk, Man., bridge, Gunn's Creek | May 7. | Apr. 18. | 60 |
| Vancouver, B.C., pumping engine, hose wagon, etc. | May 2. | Apr. 11. | 60 |
| Winnipeg, Man., twelve additional rooms to Britannia School | Apr. 30. | Apr. 18. | 60 |

## TENDERS.

**Berlin, Ont.**—Tenders will be received by the town of Southampton until May 1st, 1912, for the laying of 500 ft. of 15-in. sewer pipe along the lake shore road. Full particulars may be had on application to Messrs. Bowman & Connor, Civil Engineers, Berlin, Ont.

**Berlin, Ont.**—Tenders will be received up to April 27th, 1912, for the construction of a new bridge over the River Nith, one mile north of New Hamburg, bridge consisting of (a) 110-ft. steel span; (b) concrete abutments. Specifications, etc., at the office of Messrs. Bowman & Connor, Civil Engineers, Berlin, Ont.

**Brantford, Ont.**—Tenders will be received by Geo. W. Alderson, Secretary-Treasurer, S. S. No. 3, Grandview P.O., until April 30th, 1912, for the erection and completion of an eight-room school house at Grandview. Plans and specifications at the office of the architects, Messrs. Taylor & Taylor, Hope Chambers, Brantford, Ont.

**Denfield, Ont.**—Tenders will be received by E. R. Barclay, clerk of Lobo Township, Poplar Hill, until Wednesday, May 1st, 1912, for concrete abutments and steel superstructure for a bridge over the Sydenham River at Ivan P.O., Lobo Township. Also for three small concrete bridges. Plans, etc., may be obtained either from F. W. Farncomb, consulting engineer, London, Ont., or James McNair, commissioner, Denfield.

**Exeter, Ont.**—Tenders will be received up to Monday, May 6th, 1912, for about 6,000 feet of 4" and 6" cast iron waterworks pipe, also about one dozen hydrants and valves. F. W. Farncomb, consulting engineer, London, Ont. (See advt. in Canadian Engineer.)

**Exeter, Ont.**—Tenders for the construction of about 3,000 feet of vitrified sewer pipe will be received up to noon of May 10th, 1912. Plans and specifications at office of F. W. Farncomb, consulting engineer, London, Ont., and T. B. Carling, town clerk, Exeter, Ont. (See advt. in Canadian Engineer.)

**Guelph, Ont.**—Tenders will be received until May 3rd, 1912, for the laying of 3,000 feet of track on the York Road, in the city of Guelph. Plans and specifications at the office of the City Engineer or the Guelph Radial Railway Company. (See Advt. in Canadian Engineer.)

**Lebret, Sask.**—Tenders for the erection of a brick veneer school building will be received up to May 31st, 1912. Plans and specifications may be seen at the office of W. Crossley, Lebret, Sask, or at secretary-treasurer, J. Z. Lafleur's office, Lebret, Sask.

**Moose Jaw, Sask.**—Tenders will be received by the City Commissioners until May 15th, 1912, for the laying of approximately 34,000 square yards of pavement. Plans, etc., at the office of J. Antonisen, City Engineer. (See Advt. in Canadian Engineer.)

**Moose Jaw, Sask.**—Tenders will be received by the City Commissioners, Moose Jaw, up to May 1st, 1912, for the laying of approximately 4-5 mile of sewer and water mains. Plans and specifications may be obtained from J. Antonisen, city engineer.

**Montreal, P.Q.**—The management of the Cedar Rapids Power Co. are inviting tenders for the construction of a dyke and a portion of the power house. This work will cost about $2,000,000.

**Montreal, P.Q.**—Mr. L. N. Seneca, secretary Board of Commissioners, will receive tenders up to noon, April 30th, for the construction of retaining walls around the ponds in Lafontaine Park.

**Orangeville, Ont.**—Dr. Riddell, mayor of this municipality, will receive tenders for reinforced concrete bridge to be erected on the West Roadway. The tenders are to be in by 7.30 p.m., May 6th.

**Oshawa, Ont.**—Mr. John Bale will receive tenders for the work of erecting a new church and Sunday School building up to noon, May 4th next.

**Ottawa, Ont.**—Tenders will be received until May 6th, 1912, for the construction of Azimuth Mark and Stellar Camera Huts, Royal Observatory, Ottawa. Plans, etc., at the office of R. C. Desrochers, Secretary Department of Public Works, Ottawa.

**Ottawa, Ont.**—Tenders will be received up to May 6th, 1912, for dredging required at the following places:—

Prince Edward Island—Vernon River.

Nova Scotia—Cheticamp, Margaree Harbor, Sydney Harbor, D'Escousse, Digby, Musquodoboit, Mill Cove.

Full particulars, specifications, etc., can be obtained from R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

**Ottawa, Ont.**—Corporation of the city of Ottawa, Municipal Electric Department, calls for tenders on fifty (50) ornamental iron lamp posts together with globes and fittings for same. Tenders to be by noon of April 30th, 1912. Specifications may be had at the office of the Electrical Superintendent, J. E. Brown, 75 Laurier Avenue W., Ottawa.

**Ottawa, Ont.**—Tenders, addressed to the Board of Control, will be received up to noon of April 30th, 1912, for the supply of 2,000 feet of 2½-inch double jacket-rubber-lined fire hose complete with couplings (Higbee thread). Also for the supply of two 55-gallon chemical tanks, to be constructed in accordance with specifications to be seen at the office of the Chief of the Fire Department, City Hall.

**Ottawa, Ont.**—Tenders will be received up to May 14th, 1912, for the supply and installation of two electrically operated pumping units each having a capacity of 2,000 imperial gallons per minute. Newton J. Ker, City Engineer, Ottawa. (See Advt. in Canadian Engineer).

**Ottawa, Ont.**—Tenders will be received until May 13th, 1912, for dredging required at the following places in the Province of Ontario:—South Lancaster, Gananoque, Kingsville, Blind River, Cobourg, Honey Harbor, Port Hope, Trenton, Deseronto. Combined specifications and form of tender can be obtained on application to R. C. Desrochers, Secretary, Department of Public Works, Ottawa.

**Ottawa, Ont.**—Tenders for interior fittings, post office, Hillsborough, N.B., will be received up to May 6th, 1912. Plans and specifications to be seen on application to Mr. B. Steeves, clerk of works, Hillsborough, N.B.; Mr. D. H. Waterbury, clerk of works. St. John, N.B., and at the office of R. C. Desrochers, secretary Department of Public Works, Ottawa.

**Ottawa, Ont.**—Tenders addressed to Chas. Macnab county clerk, Court House, Ottawa, for the following road machinery, will be received up to May 6th, 1912: Two ten ton road rollers, three rock-crushers, two twenty ton bins with screen attached, and nine two-yard spreading wagons.

**Ottawa, Ont.**—The Board of Control will consider tenders for asphalt pavements. The tenders are to be in the hands of the secretary by 4 p.m., April 30th next.

**Port Arthur, Ont.**—J. J. Hackney, Commissioner of Utilities, will receive tenders for the construction of sewer and water mains to be laid on St. Paul Street. The tenders are to be in his hands by 5 p.m., April 29th.

**Prince Albert, Sask.**—Tenders for the various works in connection with the two four-roomed brick schools to be erected in Prince Albert for the Public School Board, will be received up to noon of April 30th. Plans and specifications can be seen at the office of the Architect, O. Albrechtsen, Prince Albert.

**Scotland, Ont.**—Tenders will be received until April 29th, 1912, for the construction of a reinforced concrete bridge for the Township of Oakland. Plans and specifications can be seen at the office of Fairchild and Webster, Civil Engineers, Brantford, or at the residence of Percy M. Button, Township Clerk, Scotland, Ontario.

**St. John, N.B.**—Tenders will be received at the office of the Common Clerk, City Hall, up to noon of April 26th, 1912, for birch or oak planking for ferry dept. Estimated quantity required is:—20,000 superficial feet 6-in. x 6-in. x 35-ft. long. Geo. H. Waring, Superintendent, Adam P. Macintyre, Comptroller, St. John, N.B.

**Stratford, Ont.**—The branch manager of the Canadian Bank of Commerce will receive tenders for the erection of a new bank building. He has the plans and specifications. Tenders are to be in by noon, May 6th next.

**Toronto, Ont.**—Plans are being prepared and tenders will be called for immediately for the erection of a ten-storey warehouse on Wilton Avenue, near Yonge Street, for the Imperial Optical Company. Building will be of reinforced concrete, and the cost will approximate $70,000.

**Vancouver, B.C.**—Tenders will be received up to noon of May 15th, 1912, for 2,000 lineal feet of 18-inch lap welded wrought steel water pipe and 13 double gate valves with flange ends. Specifications, etc., can be obtained from James Stuart, Purchasing Agent, Vancouver.

**Varna, Ont.**—Tenders will be received up to May 15th, 1912, for drainage work of by-law 11, 1911, estimated at 30,500 cu. yards. For particulars apply to John E. Harnwell, Clerk of Stanley Township, Varna.

**Vernon, B.C.**—Tenders will be received until May 10th, 1912, for the supply and erection, on foundation supplied by the city, of one 200 B.H.P.; 257 R.P.M. diesel oil engine for direct connection to 125 K.W., 3-phase, sixty cycle, alternating current generator with excitor. D. G. Tate, city clerk, Vernon, B.C. (See advt. in Canadian Engineer.)

**Winnipeg, Man.**—Tenders will be received by M. Peterson, Secretary, Board of Control Office, until April 29th, 1912, for the supply of labor and materials required in the erection of a building over the weigh scales at the Central Market. Plans, etc., at the office of City Engineer, 223 James Avenue.

**Winnipeg, Man.**—Tenders received by R. H. Smith, Secretary-Treasurer, Winnipeg Public School Board, up to Monday, April 29th, 1912, for the erection of a stone and brick school on Ruby and Lenor site. Plans, etc., with J. B. Mitchell, Commissioner of School Buildings, School Board Office, Winnipeg.

**Winnipeg, Man.**—Tenders for the plumbing, heating and ventilation fixtures required in the Dormitory Building at the Agricultural College, St. Vital, will be received up to April 27th, 1912, by Colin H. Campbell, Minister of Public Works, Winnipeg. Plans, etc., at the office of the Provincial Architect, 261 Fort Street.

**Winnipeg, Man.**—Tenders will be received until April 29th, 1912, for the construction of a permanent pavement, 24 feet wide, on the north side of Portage Avenue, extending from the western limits of the city of Winnipeg to the western limit of Lot 20, St. James. Plans and specifications at the Engineer's office at the Municipal Hall, St. Charles. Frank Ness, Secretary-Treasurer, Rural Municipality of Assiniboia, Kirkfield Park P.O., Man.

**Board of Highway Commissioners, York County.**—Tenders for the construction of Dundas Street from the city limits west to the Humber River, will be received up to Tuesday, May 7th, 1912. E. A. James, engineer to the Board. (See advt. in Canadian Engineer.)

## CONTRACTS AWARDED.

**Belleville, Ont.**—The tender of Messrs. J. Lewis Company for water pipes was accepted by the municipal council. Their prices were lowest.

**Grand Forks, B.C.**—Contracts have been let for an additional 25 miles of grading on the Kettle Valley Railway west of Carmi. C. H. Williams & Co. secured a six mile contract; Milligan, Dussault & Co., nine miles; and Porter & Connelly, ten miles.

**Lethbridge, Alta.**—The city council have let various contracts as follows:

Sidewalk, curb and gutter, Forest City Paving Co., $22,500.

Sanitary sewers, Hotson, Leader & Goode, $26,000.

Grading, Marquard Construction Co., $25,273.

For sewer pipe, 6in., Western Supply and Equipment Co.; 8in. to 12in., J. B. Turney & Co.; over 12in., Western Supply and Equipment Co.

For steel pipe, 6in., 8in., 10in. and 12in., Western Supply and Equipment Co.; 4in., 20in., and 24in., J. B. Turney & Co.; 14in. and 18in., General Supplies Co., of Calgary.

Galvanized iron pipe, Western Canada Agency; J. B. Turney & Co.; Metals, Ltd.; the contract being divided for various sizes.

Moving crane, J. B. Turney & Co.

Special piping, Crane Co.

Cement, Western Supply and Equipment Co.; price, $2.97 f.o.b., stores.

**Moose Jaw, Sask.**—Contract for installation of sewer and water mains has been awarded to Messrs. Patrick Kilkenny, Limited, Moose Jaw, for $19,544.59. Other bidders and prices are as follows:—Navin Bros., $22,828.23; McManus Construction Co., $22,873.60; Hurst Construction Co., Ltd., $24,058.92; W. Manders, $24,060.61. W. H. Greene, Assistant City Engineer.

**Moose Jaw, Sask.**—The contract for the supply of 1,000 k.w. turbo-generator set has been awarded to the Canadian General Electrical Company.

**New Westminster, B.C.**—The contracts for the Seventh Avenue school have been awarded as follows: Main building, Mr. William Forrester, for the sum of $32,150; plumbing work, Mr. James McMurphy; electrical work, the Parker Chase Company.

**Port Arthur, Ont.**—The contract for the construction of a warehouse for the Fitzsimmons Fruit Company, to be erected on the corner of Ambrose and Wellington Streets, has been awarded to Mr. Geo. Otta. Estimated cost about $30,000.

**St. Catharines, Ont.**—Messrs. Hitch and Company, Montreal, have been awarded the contract for the erection of the new building of the Sterling Bank in this city.

**Vancouver, B.C.**—Contracts for the construction of two city stables were awarded to F. J. Palo, at $3,950 each.

**Vancouver, B.C.**—The El Oso Paving Company have received the contract for the erection of an eight-room modern fireproof school building to cost $63,000.

**Victoria, B.C.**—The contract for the erection of a new municipal hall at Oak Bay has been awarded to Mr. A. H. Mitchell, for $10,500.

**Welland, Ont.**—Contracts for road machinery have been awarded as follows:—

One road roller, Waterous Engine Cc., $2,650.

Two road rollers from Sawyer-Massey Co., $5,300.

One crusher from Sawyer-Massey Co., $1,150.

Three Champion graders, Hamilton Machinery Co., $220 each.

Three plows, Canada Foundry., $22 each.

One 25-h.p. International Harvester Co. gasoline engine (on trial), $2,000.

Five two-yard wagons, Sawyer-Massey Co., $135 each.

One six-yard spreading dump car, Port Huron Engine Co., $580.

**Windsor, Ont.**—Contracts for the construction of approximately 20,000 yards of paving on May and Hall Avenues, at a cost of $27,184.50, has been awarded to Messrs. Geo. Caldwell & Company.

## RAILWAYS—STEAM AND ELECTRIC.

**Belleville, Ont.**—The municipal council have ordered tender forms prepared for 500 feet of best quality hose. J. G. Lindsay, Engineer.

**Medicine Hat, Alta.**—The ratepayers voted against the street railway by-law.

**Montreal, P.Q.**—The municipal council have received a request from the Canadian Pacific Railway that they be granted permission to erect elevated lines in several streets.

**Regina, Sask.**—A large water tank in the yards of the Canadian Pacific Railway will be moved to the round house. At present the tank interferes with the handling of baggage.

## LIGHT, HEAT AND POWER.

**Fredericton, N.B.**—The Public Utilities Commission held a meeting for the purpose of fixing the power rates of the Fredericton Gas Light Company.

**Moose Jaw, Sask.**—The names and prices of the various firms tendering on the supply of a 1,000 k.w. turbo-generator set for the municipal power house are given as follows:—William Robinson, $25,200; Siemens Bros, $27,830 for Fraser-Chalmers combination; Siemens Bros., $27,660 for Bellis-Morcom combination; Bellis-Morcom, for the Siemens combination, $26,000; Allis-Chambers with Lancashire combination, $28,350; Bellis-Morcom, with general electric combination, $25,000; Allis-Chambers Company, with A. C. B. combination, $26,190; Canadian Westinghouse Co., proposal "A" combination, $28,888; Canadian Westinghouse Co., proposal "B," $30,070; Goldie-McCulloch, Rateau combination, $29,000; Escher-Wyss Zoelly combination, $26,000; Brush Co., $26,505; C. A. Parsons, $29,387.

**Welland, Ont.**—The management of the Welland Electrical Company have rejected the offer of the municipal council to dispose of their plant and property at the figure offered vis. $50,000.00. The company have agreed to appoint arbitrators at any time to confer with the city officials.

## GARBAGE, SEWAGE AND WATER.

**Fredericton N.B.**—The Water and Sewage Committee have ordered the installation of several improvements to the pumping plant and water supply system. A new boiler and filter are included in these changes.

**North Vancouver, B.C.**—The municipal council have made an application to the authorities at New Westminster for the use of Lake Dick for water storage purposes. The lake is estimated to have a capacity of 220,000,000 gallons.

## BUILDINGS AND INDUSTRIAL WORKS.

**Brampton, Ont.**—The new Pease Foundry to be erected here will comprise eleven buildings, which will aggregate a floor space of 137,000 square feet. The plans for the plant are being prepared by Messrs. Ellis & Connery, Toronto and are nearing completion. The buildings will all be of the single storey variety, except the office building, which will be two stories. They include a foundry, warehouse, shipping-room, blacksmith shop, machine shop, core rooms and ovens, rumbling room, pattern shop, pattern vault and dome and tin shop for the manufacture of furnace casings.

**Calgary, Alta.**—The design for the new stores of the Hudson Bay Company is something of a novelty and all stores constructed in the future will follow the same general design. There are twelve great columns across the front and the structures will be six stories in height for the present, although the foundations will be designed for a height of ten stories.

**Calgary, Alta.**—The management of the Winona Pioneer Tractor Company will erect a plant in this city. The site of this plant is in Victoria Square.

**Edmonton, Alta.**—A permit has been issued for the construction of a concrete and veneer brick plant. The plant will cost $10,000, and will belong to Messrs. Kohr g and Konig, Madgeburg, Germany.

**Hamilton Ont.**—A report states that the management of Pratt and Latchworth of Buffalo, N.Y., are considering the question of erecting a plant in this city for the manufacture of steel castings to be used on locomotives and cars. Mr. C. W. Sherman of Buffalo, N.Y., is at present interested in the matter.

**Hamilton, Ont.** — The management of the Canadian Drawn Steel Company will erect a brick extension to their present plant. Mr. Stewart McPhie, Hamilton, has prepared the plans. The cost is to be $5,000.

**Hamilton, Ont.**—Mr. Stewart McPhie has prepared plans for a new church to be erected by the congregation of the Congregational Church. The cost of this work will be $30,000.

**Medicine Hat, Alta.**—The ratepayers voted in favor of granting privileges to three new factories. They are porcelain factory, a glass factory, and a new steel works.

**Moose Jaw, Sask.**—The plans prepared for a new theatre, under the management of Mr. W. B. Sherman, show a building with a seating capacity of 1,500, and the cost of erecting the same is estimated at $100,000.00.

**Moose Jaw, Sask.**—The management of the Canadian City and Town Properties, Ltd., are about to erect a four storey building with foundations capable of supporting a weight of seven stories. It is to cost about $300,000.

**Montreal, P.Q.**—The authorities of Laval University have received a permit to erect a $60,000 dental college.

**Nelson, B.C.**—The Brackman-Ker Milling Company will erect a business building, 2 stories, 70' × 107'. The plans include one electrical hoist, a crusher and a complicated loading platform. The architect is Mr. Alex. Carrie.

**New Westminster, B.C.**—The new mill of the British Canadian Company will be well equipped from a mechanical standpoint; all the machines will be operated by individual motors. Eight boilers and suitable condensers will be included in the programme. There will be about four hundred men employed.

**Oak Bay, B.C.**—Plans for a new municipal hall have been prepared by Messrs. James and James, Victoria. The estimated cost for this work is $10,500.00.

**Ottawa, Ont.**—The municipal council are considering the erection of a market in the western portion of the city. Among the alderman in favor of the project are Ald. Forward and Black.

**Port Arthur, Ont.**—A report states that the Northern Islands Pulp Woods Company will erect a pulp and paper mill in this city.

**Port Arthur, Ont.**—An extension is being built to the Prince Arthur Hotel by the Imperial Construction Company The estimated cost for this work is $45,000.

**Regina, Sask.**—A report states that the management of the firm of Tees and Persse, of Winnipeg, are considering the erection of a warehouse in this city.

**Rosetown, Sask.**—A flax mill will be erected in this town of sufficient size to employ about 75 people. It has been proposed that the mechanical part of the enterprise be so constructed that an electric light plant may be operated from the surplus energy.

**Rosetown, Sask.**—A Presbyterian Church will be erected in this town in the near future.

**Rosetown, Sask.**—The management of the Union Bank are about to erect a brick office building in this city.

**Saskatoon, Sask.**—A company taking the name of the Dominion Sanitarium Company has been formed in this city with Mr. C. W. Underhill as president. The management contemplate erecting in the town of Watrous a large sanitarium and hotel. These will be erected on the shore of Lake Manitou. The cost of the buildings will be about $35,000, and they will be provided with mineral baths, sun rooms, etc.

**Stratford, Ont.**—The ratepayers will vote and decide the question of erecting a new market building and an extension to the present fire hall. Ald. J. W. Alles is interested in the matter.

**Toronto, Ont.**—The management of National Drug Company have had plans prepared for a new plant to be erected at the corner of Beverley and Phoebe Streets. Mr. W. W. Bole is interested in the project.

**Toronto, Ont.**—A report states that the Metropolitan Engineering Company of New York, N.Y., are about to establish a branch plant in this city for the manufacture of electrical meter protective devices. Mr. Noice is to take charge of this plant. This company is a branch of the New York Edison Company.

**Toronto, Ont.**—Mr. D. B. Williams, 124 Baldwin Street, will erect a four storey warehouse on Spadina Avenue. The plans have been prepared by W. C. Mason.

**Toronto, Ont.**—The management of the Imperial Optical Company have had plans prepared for a ten-story building on Wilton Ave. The material of construction will be reinforced concrete 42' × 55'. The cost is estimated to be $70,000.

**Vancouver, B.C.**—The management of the Hudson Bay Company are having plans prepared for a $1,500,000 building to be erected in this city. Mr. Burbidge, Stores Commissioner, Winnipeg, Man., will arrange the details.

**Vancouver, B.C.**—The municipal council have had plans prepared for a rock bunker to be erected in the eastern portions of the city. It is estimated that about 100,000 cubic yards of rock and gravel will be required by the city engineer's department during the coming season.

**Vancouver, B.C.**—Messrs. Alexander and Brown have prepared plans for a new church to be erected by the congregation of St. James' parish. It is to cost about $100,000. Rev. Mr. Eteson is interested in the matter.

**Vancouver, B.C.**—The number of tall buildings in this city will be increased by the new structure to be erected for the United Building Corporation. It is to be an eighteen story structure, 120 x 100. Messrs. James Coughlan & Sons are shareholders in this company and will supply the steel work. Tenders for the remaining portions of the work and for the various supplies will be called in the near future.

**Weston, Ont.**—The management of the Gurney Foundry are about to enlarge their plant by the addition of extra warehouse and foundry floor space.

**Winnipeg, Man.**—A report states that a large grain elevator will be erected by the Canadian Pacific Railway in this city.

## BRIDGES, ROADS AND PAVEMENTS.

**Brantford, Ont.**—Work has been commenced on a new steel bridge across the canal near the municipal water works.

**Fort George, B.C.**—The provincial government and the Grand Trunk Pacific have agreed to share the cost of construction of a bridge across the Upper Fraser River near this point. The structure will be so designed that it may be used for vehicular purposes as well as for railway traffic.

**Lethbridge, Alta.**—The municipal council, upon the advice of the City Engineer, are reconsidering the question of pavement for the lanes of this city. The ratepayers are to decide the question of gas supply, and if the by-law is carried all the mains will be buried in the lane-ways.

**Montreal, P.Q.**—Tenders for park improvements amounting to $35,000 will be called by the Board of Control. This work will be carried out on the Champ de Mars. Mr. Todd, landscape artist and the city engineer have revised the plans for this work.

**Montreal, P.Q.**—The local council of the district of Greenfield Park will spend the sum of $23,000 on road improvements.

**Province of New Brunswick.**—The Department of Public Works are preparing to call tenders for the construction of a number of steel bridges.

**North Vancouver, B.C.**—Mr. J. L. Crawford has made an application to the municipal council for permission to erect a cable bridge across Lynn Creek, about a mile south of the municipal bridge.

**Quebec, P.Q.**—The National Battlefields' Commission are planning to construct an important park on the Plains of Abraham near this city. Sir George Garneau, Quebec, is the president of the Commission.

**Revelstoke, B.C.**—It is expected that steps will be taken immediately for the construction of a motor road between Banff and Windermere. The road after leaving Banff will follow up the Bow River to Castle Mountain, thence crossing the Bow will reach the head of Vermilion River, through the Vermilion Pass in the main range of the Rockies, and following the Vermilion to the Kootenay River, will parallel this stream to a point opposite the St. Clair Pass. Leaving the Kootenay, the road will cross the St. Clair Pass, and the descent will be made to the Columbia River via the famous St. Clair canyon and Hot Springs. Mr. W. W. Foster is deputy minister of Public Works for this province.

**Victoria, B.C.**—Ald. Stewart, of the municipal council, has suggested that the Rock Bay bridge be planked and made safe for traffic. If this is carried out the cost will be about $2,000.

**West Belleville, Ont.**—The municipal council have ordered plans and specifications of a sewerage system prepared. James G. Lindsay, Engineer.

## FIRES.

**Hamilton, Ont.**—Fire caused damage to the extent of $10,000 to the plant of the American Can Company.

**Montreal, P.Q.**—The warehouse and contents of Messrs. J. R. Walker and Company was damaged by fire to the extent of $25,000.

## CURRENT NEWS.

**Brantford, Ont.**—The municipal council will secure information with a view of reducing the damage caused by the recent flood. A plan of co-operation with other municipalities along the Grand River for the erection of storage facilities to prevent flooding is being considered.

**Moose Jaw, Sask.**—What might be considered a record in building construction has been performed in this city. The Robin Hood Mills were in operation after less than three weeks construction. The building is a seven story structure, 54 × 112.

**Regina, Sask.**—The municipal board of trade are taking steps to interest local business men in a large coal district in this vicinity. Mr. G. S. Porter, Regina, is interested in the project.

## PATENTS.

The following is a list of patents recently granted to inventors in Canada. The list is furnished by Messrs. Featherstonhaugh & Co., Royal Bank Building, Toronto:—G. F. Brown, capstans; G. E. Goldstein, process of seasoning cigars; N. P. F. Death, illuminated signs; A. Hutchinkins, acetylene gas generating machines; G. Low, jr., push button electric switches; A. J. Lavoie, internal combustion engines; T. G. McGonigle, rotary engines; H. J. S. Martin, universal joints for fluid pipes; W. D. Seale, street indicators; T. M. Stewart, valves; A. B. Surarus, street indicators; A. Warrell, asbestos packing; J. Wright, lanterns.

## THE AUSTRALIAN TRANSCONTINENTAL RAILWAY.

The government of this country will undertake the construction of this great work without the assistance of a contractor

British manufacturers of railway material will probably receive a considerable preference in all iron goods, and makers supplying internal combustion engines should obtain ample opportunities of demonstrating their ability to compete on favorable terms with American enterprises. Tenders are now being invited (in London and Australia only) for 135,000 tons of steel rails. They must reach the high commissioner's office in London by 2 p.m. on May 29.

About 2,000 men will be engaged on the work, 1,000 starting at each end. The two parties will meet in the middle of the route in a desert and will have to be supplied with water at enormous cost. The gangs will need to be accompanied by camel commissariat corps, and will for many months encounter grave risks. The line is to be 1,070 miles long, and in the opinion of Mr. King O'Malley, the Labor minister for home affairs, is the longest that has been ever undertaken as one job.

Within five years, Regina, Moose Jaw, and all the municipalities within the Soo Line district to Weyburn will be securing water in the Saskatchewan River by means of the Government system. Such was the prediction of Mr. T. Aird Murray, Toronto, consulting engineer, who is at present engaged by the Saskatchewan Government in connection with the proposed system of water distribution from the Saskatchewan River. The minimum daily flow of the Saskatchewan River is 1,800,000,000 gallons of water, and of that quantity all that will be required to serve the purposes planned by the Government will be 300,000,000 daily.

## ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

**Each week on this page may be found summaries of orders passed by the Board of Railway Commissioners, to date. This will facilitate ready reference and easy filing. Copies of these orders may be secured from The Canadian Engineer for small fee.**

16304—April 11—Directing C.P.R. to construct a station and appoint an agent at St. Francois de Salle, Que., and to file plans within 30 days showing side track.

16305—April 12—Directing C.P.R. on or before May 1st, 1912, to make Winchester, Ont., regular stop for trains 21 and 22.

16306—April 12—Naming express collection and delivery limits for town of Chapleau, Ontario.

16307—February 15—Approving C.N.O. Railway branch line to Bond St., and spur line into William St., Oshawa, Ontario.

16308—April 15—Granting certificate of correction to G.T.P. B.L. Co, correction location plan Regina Boundary Branch.

16309-10—April 13—Authorizing C.P.R. to reconstruct bridge No. 24.5 on its Macleod Sunbdivision and bridges 33.9 and 103.9 on its Edmonton and Muskoka Subdivisions.

16311—April 15—Approving location of Central Railway Company of Canada from Oka at mileage 31 to south side of highway at Carillon at mileage 45.61 (Montreal to Midland Line).

16312—April 3—Authorizing C.P.R. to cross with additional track, track of Street Railway at Pacific Avenue, Fort William.

16313—April 11—Directing C.N.R. to construct road crossing, etc., and grade roadway to loading platform, elevator and team track by 1st May, 1912, under penalty of $10.00 per day. At Polly, Sask., complaint, Board of Trade.

16314—April 12—Directing that Supp. No. 6 to G.T.R. Tariff C.R.C. No E. 1432 and Supp. 5 to C.P.R. Tariff C.R.C. No. E. 1286 may become effective June 1st, 1912, re Order 15844 January 27th, 1912, Consumer's Cordage Co., Ltd., Mtl.

16315—April 12—Directing C.P.R. to construct suitable farm crossing for F. W. Dodwell, of Austin, Man.

16316—April 13—Authorizing C.P.R. to construct spur for William Davies Co., Ltd., near Front and Overend Sts., Toronto, Ontario.

16317—April 13—Granting certificate of correction to G.T.P. B.L. Co., error in location plan Regina-Boundary Branch.

16318—April 13—Authorizing G.T.R. to construct siding into premises of Ridgeway Milling Co., Ltd., Ridgeway, Ontario.

16319—April 12—Authorizing G.T.R. to construct additional track across Pape Avenue, Toronto, Ontario.

16320—April 13—Approving revised location of C.N.R. (Calgary-Strathcona Branch) mileage 72.58 to 81.75, Alta.

16321—April 15—Approving joint agreement between C.P.R. and C.N.R. for joint facilities at Regina, Sask.

16322—April 15—Approving location of C.P.R. station to be erected at Cutknife, Sask.

16323—April 12—Directing C.N.O. Ry. to install electric bell at crossing, Manvers Road, 1st highway east of Bowmanville Station, Ont. Complaint, James Veal.

16324—April 15—Directing Dominion Atlantic Rly. before 1st July, 1912, to install electric bell a short distance east of Berwick Station, N.S. Complaint, John Buchanan. 20 per cent. from Railway Grade Crossing Fund.

16325—April 11—Approving location of Campbellford, Lake Ont. & Western Ry. Co., Glen Tay, to Cobourg Line, from mileage 88.21 (from Glen Tay) to mileage 106.17, and to take possession of certain portions of G.T.R. right-of-way.

16326—April 13—Approving location of James Bay & Eastern Rly. (C.N.R.) station grounds at Demeules, Que.

16327—April 15—Authorizing C.P.R. to construct additional tracks across highways at Tantallon, Esterhazy and Killaley, Sask.

16328—April 12—Re King St. crossing C.P.R. at Walkerton, Ont., crossing to be widened; bell question reserved for further consideration of Board.

16329—April 15—Authorizing G.T.P. Ry. to construct spur for Edmonton Portland Cement Company, Ltd., near Edmonton, Alta.

16330—April 15—Authorizing C.N.O. Ry. to construct bridge across the Muskegogama River at mileage 94, from Sudbury Jct.

16331—April 18—Amending Order No. 13357 of March 30, 1911, as follows:—"Express Companies are absolved from making delivery under the terms of this Order where the condition of the roads or streets is not in a reasonably passable state for vehicular traffic."

16332—April 17—Authorizing M.C.R. to reconstruct bridge No. 180.62 over Grand River.

16333—April 16—Approving character of work known as "the Hill Drain" across Pere Marquette Ry. being constructed by Twp. of Aldborough, County of Elgin, Ont.

16334—April 16—Approving location of C.N.Q. Ry. station at Cap Sante, Que.

16335—April 17—Approving Plan "B" in connection with grade at Jackson St., Bethany, Ont., C.P.R. (G. B. & S. Ry.), and rescinding Order 16169 of March 13, 1912.

16336—April 17—Approving location of C.P.R. station at Claresholm, Alberta.

16337—April 17—Authorizing C.P.R. to construct 9 spurs for Birds Hill Sand Company near Winnipeg, Manitoba.

16338—April 13—16339—April 15—Approving location of G.T.P. B.L. Co. stations to be known as Bremen and Meacham, on its Prince Albert Branch; and Stony Beach and Keystown, on its Regina-Moose Jaw Branch.

16340—April 17—Authorizing G.T.R. to construct spur for Barber-Ellis, Ltd., in city of Brantford, Ont.

16341—April 17—Directing C.P.R., G.N.W., and C.N.R. Telegraph Companies to deliver telegrams within corporate limits of city of St. Boniface, Man., free of charge.

16342—April 18—Authorizing G.T.R. to construct spur for Connell Anthracite Mining Co., Ltd., Carlaw Ave., Toronto.

16343—April 18—Approving plans of C.N.R. Standard Portable Station for use on Eastern Lines.

16344—April 18—Approving location of James Bay & Eastern Ry. (C.N.R.) station grounds at Chute A. L'Ours, Que.

16345—April 18—Dismissing application of Stockton & Mallinson, Regina, Sask., re Dominion Express rates.

16346—April 18—Authorizing city of Fort William to construct Pacific Ave. across C.P.R.