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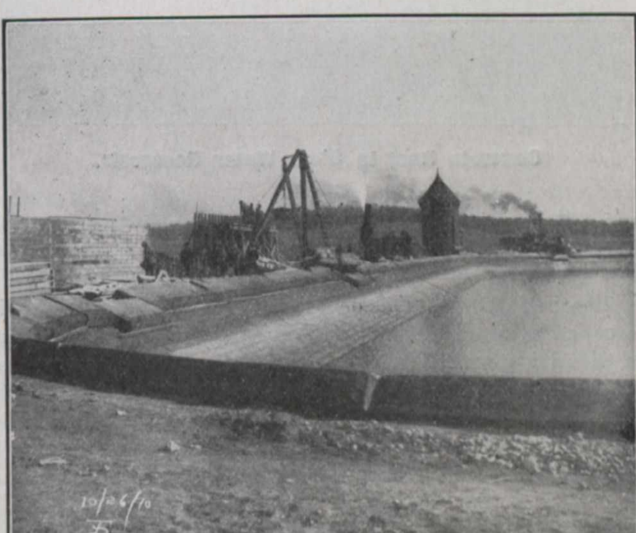
The Canadian Engineer

An Engineering Weekly

MINNEAPOLIS MECHANICAL WATER FILTRATION SCHEME.

The city of Minneapolis, Minn., U.S.A., is constructing a large mechanical water filtration scheme at Columbia Heights, Onoka county, Minn., that will cost in the neighbor hood of one and a half million dollars. The situation of the plant on Columbia Heights will give the city a water pressure by gravitation of about 90 pounds per sq. inch.

The water is pumped up to the reservoirs from the Mississippi river by an eighty million gallon pump at the north pumping station through a sixty-inch main for seven miles.



North Wall to Settling Reservoir.

The big valves are controlled from the gate houses Small cylindrical structures of red stone with tile roofs of a lighter shade of red that gives an ornamental touch to the layout.

The method of filtration is as follows: The water will first flow into the raw water reservoir, and receive part of the chemical treatment. It will then pass through the sixty-inch main at intake to controlling chamber No. 1 to the mixing chamber, flowing against long wooden baffles, through controlling chamber No. 2 into the coagulating basins, from thence into the filter beds. The filter beds are rectangular boxes 28 ft. by 53 ft. A thirty-inch layer of sand at the top is supported by three layers of gravel, increasing in coarseness down to the strainer plates beneath.

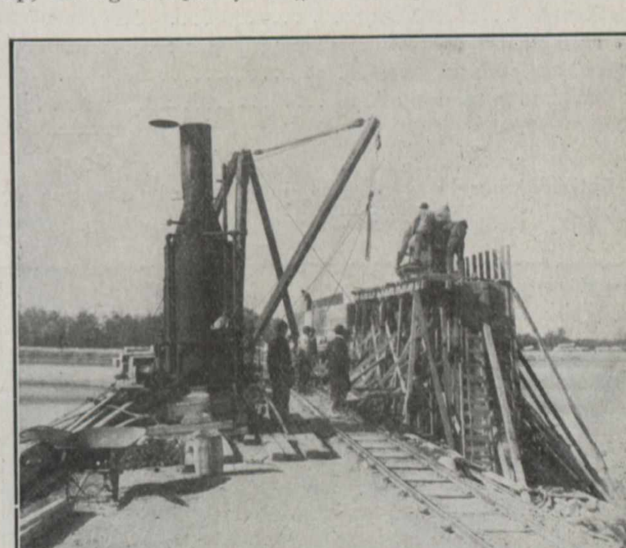
The water is forced through these filters and passes through a controller to the clear water basins, absolutely safe, and clear as crystal. The filters are also fitted with automatic controlling valves, so that when they become dirty the water is forced up with great rapidity, the top brass screens serving to keep the gravel and sand down. The sediment is then carried away by the wash water drain.

The chemicals used are as follows, sulphate of aluminia, two grains per gallon to take out the sediment and collect the organic matter; hypo-chloride, to kill germ life; alum and lime, to assist in the coagulation process, for, when combined, these chemicals make the soluble, insoluble matter suspended in space. It is sometimes necessary to add material to the water, when clear, to assist in coagulating.

This matter, dead germicidal, vegetable, color and other impurities, together with the chemicals that have been used in this purifying process, is collected by the sand filters and entirely eliminated from the water. The whole of the system is fitted with Venturi meters, which measure the quantity of purifying materials for the quantity of water passing through the valves.

The layout of the plant is as follows: The raw and clear water basins are two immense concrete shells, each half a mile in circumference, and having a capacity of 122 million gallons. The raw water or receiving basin is the old reservoir. Its walls have been built ten feet higher to give head to the plant. These additions have increased the dimensions forty feet each way.

The clear reservoir is an immense covered dish, supposed to be the largest covered clear water reservoir in the world. The dimensions are 900 ft. long, 413 ft. wide, 24 ft. deep, having a capacity of 47 million gallons. The roof is



Heavy Wall Between Reservoirs.

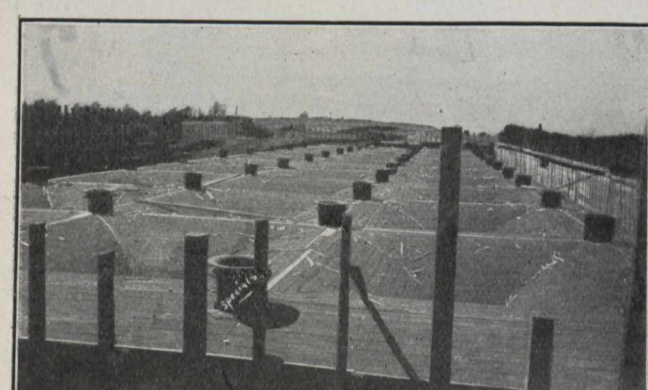
supported by 960 concrete columns, and these columns from a pedestal base of 6 ft. by 6 ft. at 18 ft. centres. The roof is of the groin arch construction and the forms for these are made in sections of four to the bay. These sectional forms have been taken down after ten days and used twenty times with little expense as to repairs. This works out as the cheapest method for groin arch form work. The groins cost per set of four to construct, $50; but when used twenty times the cost was fairly low, being 2c. per sq. foot. Across this reservoir, at the south end, is a 42-inch conduit through which the water passes upon leaving the filters, and is distributed in a manner into the clear water reservoir to prevent all possibility of stagnation. The roof serves to keep out the dust, dirt, sunlight, and also to prevent vegetable growths which are common in most filtered water. This concrete roof is then covered with 3 ft. of earth, which will be planted and laid out in an artistic manner.

Forms Removed from Pedestal Bases in Clear Water Reservoir.

The approximate amount of concrete in the columns, pedestals and roof of the clear water reservoir is 15,000 cubic yds. and was put in at the following prices per cubic yd.:—1—3—6 mix.

Cement	$2.00
Crushed stone	1.35
Sand	28
Mixing, transporting, placing concrete	82
Form building, 2c. sq. ft.	10
Wrecking and placing	1.40
	$5.95

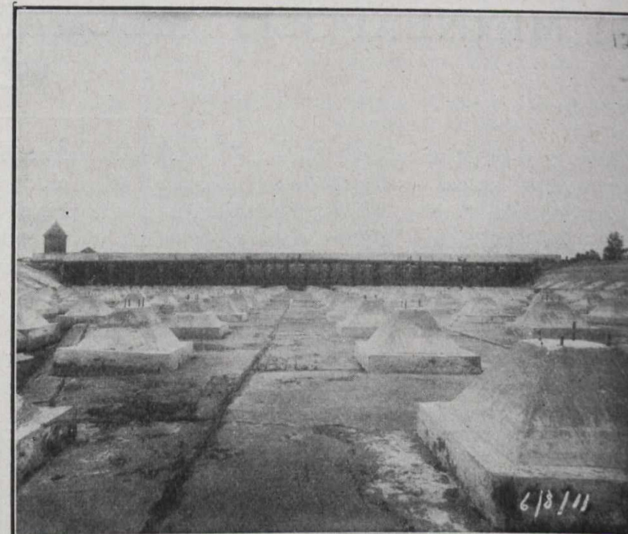
Between these large basins, in a westerly direction, are located the filter beds, coagulating basins and head house.



Groin Arch Forms, No. 1 Filter.

The filters are of concrete. They are of a similar construction as the roof to the clear water reservoir, except that the columns that support the floor to the filters are supported upon inverted groins instead of pedestal bases. The under portion of this concrete work is clear water storage, so that the water can be sent direct to the city's distribution mains or to the clear water reservoir, as the case may require. The upper portions are the filters, consisting of screens, sand and gravel, as already described, the water passing through specials below into a piping arrangement and out through the pipe gallery walls through a rate controller and back again into the lower portion of the filter construction.

The cost of the form and concrete work to this portion of the work, including the setting of reinforcement, will be

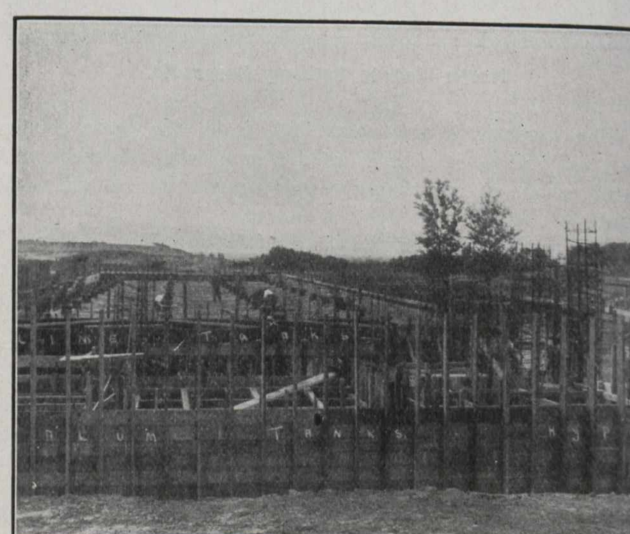


Concrete Roof to Clear Water Reservoir.

$5.65 per cubic yd. Mixing, transporting and placing this concrete was 52c. per cubic yd., as against 82c. in the clear water reservoir, owing to the shorter haul of concrete.

The head house is also of concrete, in which are built the concrete, alum and hypo-chloride tanks, bins, solution and dissolving retainers, engine and boiler rooms, stores and workrooms, also three large iron lime tanks 12 ft. in diameter, 16 ft. high.

The amount of concrete in this portion of the work is approximately 20,000 cubic yds. Above the filters and part



Forms for Alum and Hypo-chlorite Tanks.

of head house and coagulating basins will be offices, laboratories and operating rooms.

The laboratories will be equipped for making bacteriological and chemical tests of the water, and will be a model of its kind. Adjoining and extending out over the coagulation basins will be another building 200 ft. by 30 ft., which will be used for heating purposes to prevent the filters from freezing.

The estimated quantities of this work are as follows:—

35,000 cub. yds. of concrete.
500,000 cub. yds. of excavations.
250,000 cub. yds of fill and embankments.
900,000 lbs. of reinforcement.

The cost of excavations were about 65c. per cub. yd.

Fill and embankments watered and rolled, 85c.

This work is being done by the city of Minneapolis, and carried along at a lower cost than the lowest tender submitted, thus saving the city all there is to be derived from this work, and a right at any time to alter, add, or subtract, without the usual complications that follow.

The constructional part of this work is being supervised by Mr. A. W. Ellson Fawkes, C.E.

The estimated consumption of water for Minneapolis is about 30 million gallons, so in laying down this extensive filtration plant the city is taking care of future possibilities.

The accompanying photos show the work in various stages of construction.

PURIFICATION OF SEA WATER.

While much has been said concerning objections to polluting salt water in bays and channels on account of the danger of contaminating oysters and other bivalves, we do not recall having heard of any instance in which it was seriously contemplated to purify salt water so polluted, until the presentation on Sept. 13th before the New England Water Works Association of a paper by R. Spurr Weston describing plants employed for this purpose in the city of Gloucester, Mass. These were for the purification of water drawn from Gloucester harbor by the packers of cod and other salt-cured fish for washing the fish and making the pickle; investigation having demonstrated that the polluted water of the harbor, when used for this purpose, was responsible for the subsequent decaying of fish cured at this place. While the purification of salt water for this purpose is not a municipal matter, the pollution which rendered this purification necessary was largely caused by municipal sewage, and thus calls attention to an additional reason for preventing the pollution of certain bodies of salt water.

Incidentally it is of interest to those who have to do with the filtration of water to learn that slow sand filters operating at the rate of 4,000,000 to 5,000,000 gallons per acre per day have proved very effective in reducing the bacterial contents of this water, and especially the B. Coli. The filter described by Mr. Weston was put into operation in May of this year, and the results obtained have steadily improved as the filter has aged. Tests for B. Coli were made at intervals of from one to three weeks, and since the second or third week of operation have all been negative, although the tests of unfiltered water have always been positive for B. Coli.

The filter consists of a wooden tank containing 3 feet of sand supported upon a 1-foot graded gravel layer. The capacity of this is 5,000 gallons per hour. Two other filters are under construction, each 21 feet square which, with a clear water basin and a pump house, are constructed of reinforced concrete and covered, the filters and regulating chambers with a wooden house and the clear water basin and the pump house with a concrete slab roof. These filters contain 4 feet of sand supported upon 1 foot of graded gravel, underdrained with split tiles.

PRINCIPLES OF FLIGHT.*

By Algernon E. Be.r.man.

One of the greatest services that can be rendered to the science of aeronautics at the present time is to attract towards it the serious interest of minds that have matured in other departments of the world's work. With this object in view an attempt will be made to give a résumé of the more interesting problems as they are understood by the majority of students, in the hope that those taking part in the discussion may thereby be enabled to direct their remarks along such lines as shall add most to the sum total of our little knowledge in the short space of time available.

The present predominance of the military aspect in the perspective view of the immediate future of aeronautics serves also to draw a dividing line between different forms of aircraft; such as to group all systems essentially possessed of the ability to ascend vertically and hover stationary in the air on one side, and all those that can neither stand still in the air nor get up from anywhere, on the other.

Balloons and Kites.—Thus, the captive balloon and the man-lifting kite both perform useful work, although neither navigates the air at large. The free-moving aeroplane, on the other hand, is frequently criticized because it does not at present possess the potential qualities of the as yet unsuccessful helicopter.

The Helicopter.—It seems necessary to pay some attention to the problem of the helicopter, therefore, in order to see how far an elementary investigation of its principles supports the likelihood of realizing the possibilities frequently assumed in its favor. It has been suggested that some insects fly on the helicopter principle.

It may be demonstrated that the very small helicopter is a remarkably successful toy, although the large helicopter is as yet an unsuccessful machine. A mathematical ratio (see the "two-thirds power law" in summary of formulæ) indicates that the application of increased power to a given screw is an insufficient method of increasing the lift. It is suggested that the ratio of the essential dead-weight to effective lifting area may also increase so disproportionately in large machines as to prevent the practical success of the helicopter class. Inasmuch as the largest screw for a given load is the most efficient, it is argued that the aeroplane is the helicopter of maximum efficiency, inasmuch as it represents a blade element flying on the straight-line periphery of a circle of infinite diameter.

Dirigibles.—Under the assumed division dirigibles and aeroplanes have to be compared as alternative machines for fulfilling the same purpose. Both navigate the air, but the dirigible, in addition, can ascend vertically and hover stationary above any given spot. Windy weather adversely affects both types of machines. In the aeroplane the gust is inimical to stability; in the dirigible a high wind exerts an enormous drifting force. Comparatively large sizes are necessary in dirigibles if they are to have a wide range of action. The more important disadvantages of dirigibles result from the permeability of the fabric to hydrogen, the costliness and inconvenience of using this gas, and the distributing influences of sunshine and shadow on buoyancy.

Aeroplanes.—The aeroplane is the more interesting machine of the two in the eyes of the majority of students, owing to the popularity of flight as sport. A broad treatment of the problems relating to this section divides them under two heads, one dealing with the lift and resistance of the cambered plane, the other dealing with stability, which has

*Paper read at the joint meeting of Sections A and G of the British Association at Portsmouth, September 4.

always been the most important factor making for progress in aviation.

Calculating Lift.—In the mathematical section, an hypothesis that aeroplanes are supported in flight by the inertia of the air leads to the necessity of finding plausible expressions for mass and acceleration.

Two dimensions of the mass of air deflected are plausibly functions of the span and chord of the plane; the third, which defines the depth of the stratum, and is known as the "sweep," is taken as an empirical function of the chord; but this connection needs discussion. Acceleration is obviously a function of the angle of the plane, but difference of opinion exists as to how that angle should be measured. A suggestion is put forward in favor of the "angle of deflection" measured at the point of intersection of tangents drawn to the leading and trailing edges of the plane, which needs discussion. From the assumed premises a rough-and-ready formula for lift has been evolved (see summary of formulæ).

Skin Friction.—In order to extend the premises to cover a plausible expression for the resistance to flight and the power expended thereon, it is necessary to adopt a value for skin friction. Zahm's experiments have been accepted as data (see summary of formulæ), but the whole subject needs discussion. Skin friction is of such fundamental importance in aerodynamics that it is imperative to put it upon an accepted basis analogous to the position occupied by normal pressure.

Coefficient of Flight.—The coefficient of flight, representing the resistance per unit load, may be shown to be independent of speed, but to depend on the angle of the plane, and to have a minimum value depending on the coefficient of skin friction. On the present hypothesis, the minimum coefficient of flight obtains with planes of a very small effective angle (about 5 deg.), such as would necessitate flying at much higher speeds than have hitherto been realized. The existence of an angle of least resistance is very important in connection with the problem of variable speed machines.

Body Resistance.—Body resistance in a practical aeroplane is a supplementary resistance to that of the planes, and should always be considered as such. It stands in the way of realizing the higher speeds that would lead to the use of more efficient planes, but by enclosing all the principal masses in casings of stream-line form a plausible means is afforded of considerably reducing this quantity. A comparison of the coefficients of normal pressure and skin friction indicates a very large possible saving in this direction. In bodies of stream-line form the advantages of a hemispherical head are worthy of consideration.

Stability.—Stability in a flying-machine is either natural as a result of form, automatic as the result of self-acting mechanism, or controlled by human intelligence. No particular progress has been made along the lines of automatic stability, although the use of gyroscopes and wind-vanes to operate relay mechanisms has frequently been suggested. Natural stability has, however, been realized to some extent, and, coupled with modern expert control, the combined result has reached an extraordinarily high degree of perfection, considering the short period of evolution.

Natural stability in its elementary form may be readily demonstrated by means of paper models. In practical aeroplanes natural stability in the longitudinal vertical plane is mainly based on the principle of the dihedral angle. Natural stability in the vertical plane is also commonly based on the same principle, but alternative systems, one of which is the arched wing, have been tried. The arched wing and the dihedral being apparently diametrically opposite in principle, attention is drawn to two orders of stability—"stiff" and "rolling." The relative possibilities of successful development along each line is well worthy of discussion.

The acentric centre of gravity, in which the principal masses are placed well below the centre of pressure, is frequently suggested as a stabilizing principle; but the permanent existence of a couple between the centre of gravity and the centre of pressure indicates liability to pronounced oscillation, and the system does not find general favor. In connection with the under-carriages of aeroplanes, the advantage of landing direct on skids is urged; and in connection with the power plant, the possible disturbing influence of the gyroscopic force of heavy revolving masses is worthy of notice.

Conclusions.—Apart from the question of stability, progress in flying-machine design is mainly a problem of increasing the efficiency of the machine, just as it is in every other branch of mechanical engineering. It follows, therefore, that the need for further information on such subjects as the effective angle of a plane, sweep, skin friction, and other similar problems that come within the province of research work in physical science, is all important. If the aeroplane of the future is to carry heavy loads and to fly far and fast without interrupting its journey, it must be more efficient than the aeroplane of to-day. The air, like the ocean, permits of full speed ahead all the time, and a speed of 60 miles per hour through the air would halve the present latest crossing of the Atlantic. Before an uninterrupted journey across the 1,700 miles that separate the nearest adjacent points of land could be accomplished by a machine carrying only two men, it would have to be shown that an aeroplane could be built capable of carrying at least 1,500 lb. of useful load at 60 miles per hour, with a gliding angle more nearly in the order of 1 in 7 than the angle of 1 in 4 or five, which at present represents the efficiency of a good modern flyer.

Except so far as a pilot might be able to economize power, as soaring birds do, by taking advantage of favorable air-currents, skilful control has nothing to do with the theoretical possibilities of the aeroplane in undertakings of this order, which may be investigated by the aid of simple arithmetic. In matters affecting the use of machines in bad weather, for dangerous purposes, and under difficulties generally, nothing in the world gives any clue to the future except the present state of the art, for which the intrepid practice of pilots and the care of those who build machines is wholly responsible, and deserving of the utmost credit.

Summary of Formulæ.

The Two-Thirds Power Law.—If thrust $\propto V^2$ and power $\propto V^3$, then thrust $\propto H.P.^{2/3}$.

Mathematics of the Cambered Plane.—

$$\text{Lift} = \frac{V^2 \tan \beta}{200}$$

where V = flight speed miles per hour.
β = angle of deflection.

Skin Friction.—Zahm's formula—

$$R = 0.0000316 l^{.93} V^{1.85}.$$

Where R = resistance of double surface lb./ft. of span.
l = chord.
V = velocity miles per hour.

Approximation (1 to 90 miles per hour and high aspect ratio).

$$R = 0.000018 V^2.$$

Coefficient of Flight.—

$$\text{Pounds thrust per lb. loading} = \left(\frac{\tan^2 \beta + 0.0072}{3 \tan \beta} \right)$$

Minimum value obtains when $\beta = 5$ deg. approximate, and gives least coefficient of flight = 0.085.

GRAPHITE IN PROVINCE OF QUEBEC.*

The beginnings of the graphite industry in the Province of Quebec dates back a great many years. In the Geology of Canada, published in 1863, it is mentioned that a mine had been worked in Grenville previous to that year and that prospecting had been carried on extensively in Lochaber and Buckingham townships. Since then several mines have been opened, and mills erected in various places, but results have not always been satisfactory; some of these have only been operated spasmodically, while others have been abandoned.

Tunnel at the Bell Mines.

The principal cause of failure seems to have been the difficulty of concentrating the graphite, which occurs disseminated in complex rocks.

The industry seems to be now on a more solid basis, and it is likely that the production will henceforth progress steadily.

The prices obtained for the Quebec graphite are satisfactory, and as the deposits are very large, the development depends on the successful means of concentration.

During 1910 only two mines were in actual operation in the Province of Quebec, viz.: the Buckingham Graphite Co., and the Bell Graphite Co., both in the township of Buckingham. Other mines expect to be on the producing list in 1911, and a great deal of prospecting has been carried on.

The Buckingham Graphite Co., which succeeded to the Anglo Canadian Graphite Co., owns lot 28, range VI., Buckingham Tp., and the workings are at present confined to this lot of 200 acres. The mill is erected on the northern part of the lot, near a creek from which the supply of water is derived. The building is 160 feet long by 60 feet wide. The ore is dried in a stone kiln near the mill, which is connected with the mine by a long trestle and tramway. The process of concentration in this mill is dry throughout. The ore is dumped into the kiln, wood being the fuel used, and it is next passed through a Blake crusher, screens and through a second crusher. The concentration is then effected by passing through a series of rolls, screens and bolts. The flake graphite then undergoes polishing in buhrstone mills. The milling plant has a daily capacity of 60 tons of ore yielding between 3 and 4 tons of finished products. Three qualities of graphite are produced, of which the highest quality is flake graphite, containing 96% pure graphite. This mill was in operation during the greater part of the year.

Workings have been opened in several places on this lot, the most extensive of which are in the immediate vicinity of the mill. At this place, in the side of a low hill, a tunnel has been driven towards the south for a distance of 300 feet. Two shafts have been sunk from the surface of the tunnel. The workings are in a hard bluish quartz rock which is much fissured, and which weathers to a rusty color owing to the presence of iron pyrites. The graphite is disseminated through a sillimanite gneiss, in a belt or zone the width of which varies considerably and which reaches ten feet in places. The strike is south and the dip is 600 to the east.

Other workings have been opened a short distance to the south and all are connected by the tramway which runs mainly on a trestle. The latest of these workings consists in a pit measuring 50 feet N. W. and S. E., and 30 feet in the other direction. This excavation was full of water when seen, but steps were being taken to pump it out. On the S. W. side of this pit a vein of disseminated graphite was observed, striking N. E., dipping 80° S. E. and about one foot wide. The hanging wall is a very dark micaceous gneiss, which passes into a hornblende and biotite gneiss. The contact between the graphite zone and the gneisses is very sharp. The foot-wall is said to consist of a bluish quartz rock, similar to the rock through which the tunnel was driven. The pit is said to be 52 feet deep, and from the bottom a drift has been driven 42 feet to the east. At this depth the vein is said to have widened to 15 feet and to have yielded good ore.

Tramway and Mill of Buckingham Graphite Co.

The property is about eight miles from Buckingham, the road between these two points being comparatively good for hauling.

The Bell Graphite Company owns lots 1, 2, 3, range V. and lot 4, range X. of Buckingham Township, but operations are at present restricted to the southern half of lot 2. The mill is erected about the centre of the lot, on the south bank of McNaughton creek from which the supply of water is obtained. The property is situated four miles east of Buckingham.

*Abstracted from Report of Dept. of Mines, Que.

The mill comprises two adjacent buildings, called X. and N½ 11, range IX., of the township of Buckingham, formerly worked by the Diamond Graphite Co. The mill is built on N½ of lot 14, range X. The mill building is 78 by 42 feet and the adjoining boiler and engine house measures 27 by 70 feet. The drying kiln is built on a rise of the ground to the N. E. of the mill and the ore is sent from it to the mill by gravity.

The concentration process is dry throughout. The ore passes through a Jenckes jaw crusher, followed by two sets of rolls. It is then subjected to a series of rolling, screening and bolting. Three different grades are produced, No. 1 being crucible graphite. The mill has a daily capacity of 40 tons of ore.

Comparatively little mining work has been done on the lot on which the mill has been erected. There are only a few openings to the N. E. of the mill on graphite bearing outcrops in which the mineral is disseminated in a rusty micaceous gneiss. These openings have been abandoned. The main supply of ore for the mill is from a deposit situated on lot 12, range IX., distant 1½ miles from the mill. The workings here consist of an opening 100 feet long, 70 feet deep, on a vein which may average a width of six feet. The graphite is disseminated in a feldspathic gneissic rock which yields 8% graphite in the mill. The ore is hauled by team from the mine to the mill.

The foot wall of this vein, which dips north at an angle of 70, is a micaceous gneiss, grey in color, cut by veins of coarsely crystalline feldspar and quartz. The contact between the wall and the vein is usually sharp, but in places a gradation from one to the other is noted. Prospecting has been carried on in other places on this lot, notably at 600 feet east of the main pit, where stripping has uncovered workable graphite.

MOTOR HAND CARS FOR SECTION USE.*

During the past few years there has been considerable progress made in new appliances and devices in almost every branch of railroading except the hand car which is practically the same now on most railroads as it was 25 years ago. In most cases we are still propelling the old-fashioned pump hand cars and it is different now because when I first started railroading there was a class of laborers who took interest in their work, took pride in getting on a hand car and going at a good, reasonably fast rate of speed so as to get started to work. But in most cases these laborers have vanished from the track service in one way or another and they are replaced by foreign laborers, who, in most cases, cannot even speak or understand the English language, and in almost all instances the chief aim is to get the money, whether it be $1.25 or $1.50 per day. Track men are paid the lowest rate of wages of almost any class of laborers, consequently we get the inferior class of men. But it is simply a case of using these men or do without any, and any man in charge of maintenance of way work knows what that means.

There is enough time lost in getting men to work with hand cars to warrant spending the amount of money required for motor hand cars.

I have been in charge of double track territory and realize that a motor hand car is not as necessary as on single track and branch lines, as the sections on double track are usually shorter, and in many cases the facilities are better for taking care of the men.

One of the first things to be considered in recommending motor hand cars for adoption is simplicity of construction. Our foremen are not skilled mechanics and what is desired is a car that is simple enough in construction so that the average section foreman can make any adjustment necessary for operation of the car.

Another important item to be considered is sufficient power. A motor hand car for section use should be so constructed that 20 miles per hour would be the maximum speed and geared so that a reasonable speed can be maintained on heavy grades and against a strong wind. In cases of heavy rain storms it is necessary to patrol track before trains are allowed to run over track and in these cases we should have a car that could be depended upon so that all the men who would be needed would be enough to handle the car.

The hand car has served its time and there is no question but that if motor hand cars were furnished we could get a better class of labor, as the average laborer, after pumping a hand car six or eight miles up grade or against a strong wind, if he does his part, is practically tired out when he reaches the work, instead of reaching the work fresh and in shape to do a day's work.

On this road we have the Fairbanks-Morse power hand car in use since December, 1909, which has given good satisfaction. Before this motor hand car was put in service at this point, we had two sections with two foremen and paid them at that time $65 each per month. We cut out one foreman at $65 a month and cut the force practically in two and the sections were each six miles long, and we gave one foreman the 12 miles with motor hand car since that time, and he is doing the work easier and giving better satisfaction with the 12-mile section and motor hand car than he was able to do before with the six-mile section and an ordinary hand car. Not figuring the laborers, as section force is increased or reduced as necessary in all cases, the railroad company has saved, in this one particular case alone, on the wages of section foreman since time that motor car was put in service to the present time, or September 1, of this year, $1,365. This car is a No. 12 model equipped with handles, in addition to the motor, so that in case of a failure of the motor, the handles can be put into commission.

I would recommend a combination car for section use that can be propelled either by hand or motor, and the manufacturing company that will manufacture a car simple in construction and one that can be operated successfully in cold weather with sufficient power to operate successfully on 1 to 3 per cent. grades, should be adopted by railroads as a matter of economy. The first cost of installation would appear large, but the amount of additional work that could be accomplished would make larger dividends each year for the stockholder than if the old-fashioned pump cars are kept in service.

I have had considerable experience with a Fairbanks-Morse No. 26 and they give good satisfaction and can be operated in cold weather successfully; they are very simple in construction and air cooled. A water cooled motor car cannot be operated successfully in a cold climate, as there is too much danger of them freezing up.

I have also had some experience with the Rockford, but the one I had was more complicated and would freeze up if left out over night when 20 degrees below zero.

I do not wish to condemn or recommend any particular make of car at this time, but give the facts as near as I can and they are as above.

D. E. Lynch, Chairman

*Presented at convention of the Roadmasters' and Maintenance of Way Association, held at St. Louis, Mo., September 12 to 15, 1911.

EARTH ROADS--CONSTRUCTION AND MAINTENANCE.*

By MAJOR ROBERT GIBBES THOMAS.

The desirability of good roads needs in this day no extended advocacy. Their desirability, if not their necessity, is generally acknowledged. The agitation of the subject during recent years has called forth from various sources full and convincing expositions of the advantages of good roads to the citizen, to the state, and to the nation.

I shall, therefore, proceed at once to my immediate subject, Earth Roads—Construction and Maintenance.

In regard to good roads, as to most good things, there are obviously degrees of excellence.

While the best may be beyond our means of attainment, surely it is the part of wisdom to improve conditions where practicable, to get better roads, when the cost of the best is prohibitive.

While it is to be hoped that the roads, over which there is heavy traffic in the vicinity of the cities and towns of the state, will be macadamized, gravelled, or otherwise improved in the not distant future it is evident that in the main the public roads of the state must of necessity be composed of earth for many years to come. Such being the case, it is fortunate that under favorable conditions, when well drained and free from ruts, the earth road is the most satisfactory for pleasure and for light traffic.

The statement that an earth road is as good as any other kind of road, if kept well drained and free from ruts, reminds one writer of an old saying that a certain bronze eagle in Salt Lake City "flies down to get a drink every time it hears the town clock strike." The writer holds that the statements are true in both cases, but the conditions are equally impossible of fulfillment. No, the claim is not made that under all conditions the earth road is as good as any other type of road. It is held that with proper construction and maintenance the earth road is a good road, and it may serve a community well until the increase of traffic makes a more unyielding surface imperatively necessary.

It is to be remembered that when the time comes to build a macadam or other pavement, it will have to be built upon an earth bed, so much of the work of making an earth road may be utilized in the future, when it becomes necessary and practicable to have a paved surface to the road. The condition of the common roads is so bad at certain times that it is desirable that every interested citizen should know something about the location, construction, drainage, and maintenance of earth roads—and under the term, earth roads, are incluled those with an admixture of sand and clay.

Everything connected with the construction, use and maintenance of roads was, in times past before the introduction of railways, the subject of exact observations and experiments, many and varied in character. On this account old engineering works that treat of road-making are excellent reading to-day. This is true not only of the construction but of the need of better legislation.

It is held that many of the evils as to bad common roads that we suffer from at the present time are inherited from the antiquated legislation of the past.

Now that we have the results of a great number of years of experience in older countries, it seems that there is little to invent but much to learn in this branch of construction.

Yet there have been improvements in roadmaking and especially in road-making machinery and tools—notably the stone crusher and the steam roller.

It must be acknowledged that conditions in this country are in many respects different from those that obtain in the older and more thickly settled countries of the old world Nevertheless, the fundamental principles of good road construction are the same everywhere, and once they are understood, can hardly be forgotten.

The most economical location of a road is that for which the sum of the cost of transportation, the cost for maintenance, and the interest on the cost of construction is a minimum. The cost of transportation is affected by the rate of grade, the rise and fall, and the length. The rate of grade is important, because it limits the loads that can be hauled or determines the number of loads, and it fixes a limit to the speed of travel. The rise and fall affects the expenditure of power to haul a load over the road. The length of the road has an effect upon the amount of work of hauling, the time required for a trip, and the cost of maintenance. The cost construction depends upon the accuracy with which the line of road is fitted to the surface of the ground, as determining the amount of earth work and cost of bridges and culverts, and, upon the character of the ground over which the road is to be built, as that affects the cost of the work and the expense of drainage.

In location the grade of the road is the most important factor. In the effort to make the road along the most direct line between two places, the grade is often made much steeper than there is any necessity for. The fact is overlooked that the distance half-way around a hill or valley may be little, if any, longer than the distance over the hill or through the valley. The aim in location should be to make the road the easiest and most economical and the shortening of the roads should be subordinated to these considerations. The difference in length between a straight road and one that is slightly curved is less than many suppose. It has been shown that if a road between two points 10 miles apart were made to curve so that the eye could see no farther than a quarter of a mile of it at once, its length would exceed that of a perfectly straight road between the same points by only 150 yards. The value of straightness for a country road is frequently very much over-rated. Considerable deviations from the straight line may often be made with but slight increase in length. While straight roads are the best for traffic, often things being equal, in hilly country straightness should be sacrificed to lower the grade; and for pleasure the curved road gives a greater variety of scenery

Many roads have been made on such steep grades that the cost of cutting and filling to bring them to a proper grade would be greater than to relocate and make the roads anew.

Distinct from and independent of the rate of grade is the amount of rise and fall on the vertical height through which a load must be lifted in passing in each direction over the road. The minimum amount of rise and fall is found where the rise is all in one direction and the fall in the other, each being equal to the difference of elevation of the terminal points. Any increase in the rise and fall beyond this amount is represented by the rise encountered in passing from the higher to the lower terminus. It affects the traffic equally in each direction, and requires a certain

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*Paper read to South Carolina Good Roads Association at the mid-summer convention.

expenditure of power to lift the load through the given rise in each direction. The rise and fall may be evaluated in terms of distance. Thus an ordinary earth road whose resistance to traction where level is 100 lbs. per ton, the distance a ton may be moved on the level surface in developing 2,000 foot-pounds of work is 2,000 divided by 100, and equals 20 feet.

As the work of lifting one ton through a rise of 1 foot is 2,000 foot-pounds, 1 foot of rise or fall may be considered as equivalent to 20 feet of level distance. So far as expenditure of power is concerned, the elimination of unnecessary rise and fall is thus equivalent to shortening distance. Of course when the termini of the road are at different elevations there is a certain amount of rise and fall that must necessarily be encountered. The proper grade for any particular road must be determined by the conditions and requirements existing on that road.

The ideal is the level road with no rise or fall, but as the level road can seldom be obtained in roling country, it is well to consider the greatest allowable grades for country roads.

It has been found that for a short time a horse can double his usual exertion, and that he can draw only about one half as much on a 4 per cent. grade as he can on a level road.

If full loads are to be hauled, this would make a 4 per cent. grade the maximum.

One authority states from his own observation and from tests made by the U.S. Agricultural Department, that a team can exert four times as much tractive energy going up a short hill as its average pull upon the level. As the load that can be hauled continuously up a 10 per cent. grade has been found to be one-fourth of that drawn upon the level, this shows that the full load might be carried over a ten per cent. grade for a short distance—say 200 feet.

Most road builders prefer 3 per cent. grade to those of 4 per cent. where they can be secured without additional expense. A 3 per cent. grade is one down which a horse with vehicle can comfortably trot.

On all public highways which are travelled by heavily loaded vehicles, the aim should be to keep the grade down to 3 or 4 per cent. and not to exceed 5 per cent. In mountainous regions steeper grades are often unavoidable, and even in ordinary hilly country it is good engineering not to reduce grades where much earth work is necessary, as it is generally a few short deep cuts that add so greatly to the cost of a road.

In most parts of the state the roads are in the main already located and the problem of location consists for the most part in the relocation of portions of old roads, so as to reduce the grades and render the roads more convenient and pleasant for the use of travel. When the road must be constructed out of the material over which it passes, it is often possible to select a route where the soil is better adapted for the purpose than that found where first located. Upon one side of a valley the surface may be clay, upon the opposite side gravel, and in the bottom of the valley the soil is usually alluvial—higher up the ground is generaly far more fit for road purposes.

In starting the construction of any road the width and shape of the cross section has necessarily to be determined. The practice is too common of designing a uniform cross section for a road regardless of the character of the soil and the drainage area that the ditches must serve. A uniform cross section for all parts of the road should not be adopted.

The depth of the ditches should be made to vary with the character of the soil—very shallow in sand and on steep grades and deep in flat soggy land, but ordinarily not much more than a foot below the general ground level. The width of the road will depend upon the requirements of the case—sometimes 12 feet is sufficient, but 18, 24 and 40 feet are the usual widths for country roads. The surface should be formed with a crown at the middle sufficient to shed the water that falls upon it and prevent it from standing upon the road surface. The slope necessary to shed the water readily is about 1 in 20—a fall of 5 per cent. each side from the middle. The most desirable section is usually that composed of two planes of equal inclination rounded off in the middle. Such a surface can be constructed and repaired with the road machine and a roller can be used to advantage. Deep, narrow bottomed ditches at the sides are to be avoided. Wide, shallow ditches are best generally and they are favorable to the use of drag and wheel scrapers—the wheel scraper being regarded by one authority as the greatest labor saving device for moving earth ever invented. Sometimes the only ditches necessary to carry off the surface water are those made with the road machine. The side ditches should have a fall of at least half a foot in every 100 feet—in fact the road itself would be better to have that slope longitudinally than to be level, so as to secure drainage of any incipient ruts that may form in the road surface. As noted before, the problem immediately before the people of this state is generally the improvement of existing roads, and enough progress in this direction has been made in recent years to show how much improvement can be effected.

The improvement in the surface of the earth road has been most marked. The method of improvement of the surface depends upon the nature of the material of which it may be composed. When the material is loose sand, the surface will be more firm if the sand be damp and more unstable in dry weather. In such cases a small admixture of clay in the surface layer may give cohesion to the surface when dry, or a layer of clay six or eight inches deep may form a hard and comparatively durable surface, as it is easily drained when upon a sand road bed.

Clay used alone is the least desirable of all road materials, but roads composed of clay may be treated with sand or small gravel, from which quite a hard compact mass is formed, which is nearly impervious to water and but little acted on by it. Material of this character found in the natural state, known as "hard pan" or "cement gravel," makes, when properly applied, a very solid and durable road. In soil composed of a mixture of sand, gravel, and clay, all that is necessary to make a good road is to crown the surface, keep the ruts and holes filled and the ditches open and free.

Drainage is especially important upon earth roads, as the material of the surface is more susceptible to the action of water and more easily destroyed by it than are the materials in the better class of roads.

It has been said that the whole problem of the improvement and maintenance of ordinary country roads is one of drainage. Drainage, more drainage, better drainage, should be the cry. Surface drainage is mainly effected by making the surface of the road slope from the middle to the side ditches. When the road is on a steep grade the inclination of the slope to the side should be greater than when on a level, so as to prevent the water from following the wheel tracks.

The side ditches can be prevented from being washed into deep gullies by paving the bottom and sides with brick or field stones. When water has to be carried under the road, sewer pipe or culverts of concrete, stone, or brick will be in the long run more economical than those of wood. In very wet ground sometimes under-drainage must be resorted to in order to get a dry road bed. The maintenance of a country road in good condition requires constant care and watchfulness. Any small breaks in the surface should be immediately repaired, and ruts filled and smoothed before they become serious. Earth roads are especially difficult and expensive to maintain under the common system of repairing once or twice a year or at long intervals.

The only way to keep an earth road in good condition is by the employment of men whose business it shall be continually to watch the road and make such small repairs as may be necessary from time to time. Ruts and holes should not be filled with stones unless a considerable section is to be so treated. They should be tamped full of some good material like that of which the road is constructed. When work is needed over a considerable area, earth roads can be rapidly repaired by the use of road machines and road rollers. In case the roadway is sufficiently high, the work should begin in the middle of the road and the loose dirt should be gradually pushed to the ditches and finally shoved off the roadway or placed where it will not be washed back into the ditches by rain. The advantage of this method is that a smooth, firm surface is at once secured—a surface which will stand wear much longer than one composed of loose worn out material thrown up from the ditches. When, however, the crown is worn down and the roadway low, it is

Macadam Object Lesson Road Built in 1904 by United States Office Public Roads, Near Lebanon, Mo.

desirable to work from the sides, scraping the material lightly toward the middle until the proper crown is obtained, and then the surface compacted by the roller. It is claimed that two good men with two teams can build or repair more road in one day with a roller and road machine than many times that number can with picks, shovels, scoops, and plows, and do it more uniformly and more thoroughly.

As soon as possible after long continued rains, the roads should be gone over with the scraper and put in proper form, and then rolled down hard.

While earth roads should be generally repaired in the spring and fall of the year, if they receive daily attention, they will require no extensive repairs. The old adage, "a stitch in time saves nine," finds application here.

A system of common road maintenance, introduced in Vermont, has been so successful in operation that "much better roads are secured at less expense and the tax rate for highways has been reduced each year."

This system is like that applied to railway maintenance—the roads are divided into certain lengths and each length allotted to a section man, care-taker, or farmer. It is suggested that our important country roads could be divided into sections varying in length from one to five miles, and a good road man who lives on the section put in charge. It should be his duty to devote a few hours each week to the filling of small ruts or holes and to the protecting of the road from running water. He would have plenty of work to do in keeping the road clean, free from loose stones and rubbish—in cutting weeds and clearing drains and side ditches. The efficiency and economy of this plan of maintenance have made the roads of France and other European countries deservedly famous.

THE EFFECT OF PIGMENTS ON LINSEED OIL.

Mr. H. A. Gardner, of the Institute of Industrial Research, Washington, D.C., in the September issue of the "Journal of Industrial and Engineering Chemistry" of the American Chemical Society, reports a series of studies into the chemical activity of pigments ground in linseed oil. Mr. A. H. Sabin, Consulting Chemist, National Lead Co., has described (Journal of Ind. and Eng. Chem., vol. 3, p. 84) the peculiar action of various pigments in accelerating the drying of linseed oil. He accounted for the action as due to the hindering of peroxidation processes. Mr. Gardner cites his experiments as showing that several pigments in question, such as barytes and china clay, are really inert and have no chemical action, the stimulation of oxidation being accounted for by catalytic or contact effects.

Five-gram samples of various common pigments, including inert crystallized and amorphous types, were each ground separately in an agate mortar with five grams of raw linseed oil. Each of these pastes was placed in a marked beaker and allowed to stand for one month in a dustless atmosphere. The paste from each beaker was then extracted with benzine to remove the linseed oil. The oil solutions were heated to remove the benzine and the residue was burned to ash. The ash from each paste was weighed and if it ran above the percentage of ash determined on a blank sample of linseed oil (0.003%), the ash was analyzed qualitatively for metals. The following table shows the results:—

Pigment.	Per cent. of ash in extract.	Analysis of ash.
Raw linseed oil without pigment	0.003	....
Barytes	0.003	....
Blanc fixe	0.003	....
Silica	0.003	....
Asbestine	0.005	....
China clay	0.007	....
Whiting	0.008	....
Chrome yellow	0.025	Lead oxide (PbO)
Lithopone	0.031	Zinc oxide (ZnO)
Prussian blue	0.032	Iron oxide (Fe_2O_3)
Sublimed white lead	0.033	Lead oxide (PbO)
Zinc oxide	0.105	Zinc oxide (ZnO)
Corroded white lead	0.116	Lead oxide (PbO)
Red lead	0.2112	Lead oxide (PbO)

The slight increases with asbestine and china clay are explained by the carrying over of traces of pigment mechanically into the oil extract, these pigments being difficult to separate completely from the oil. Slight chemical action was apparent in the case of whiting and greater action in the still more alkaline pigments. The raw linseed oil used in the tests had a very low acid value, but the neutralization by alkaline pigments is held to account for a portion of the increased percentage of ash. It seems evident from these figures that the lead and zinc pigments are chemically active. The resulting saponification of the vehicle is apt to result in early disintegration. Mr. Gardner recommends the use of a moderate percentage of inert pigments in paints made of chemically active varieties, so that marked saponification would not take place.

REINFORCED CONCRETE PIPES.*

By Arch. Currie, C.E., City Surveyor, Westmount.

To a French gardener, M. Monier, must be given the credit of having first employed reinforced concrete, for in 1867 he constructed large flower pots of cement concrete with a reinforcement of metal.

Reinforced concrete was undoubtedly known before that date; a patent having been taken out in England for a suspension reinforcement in 1854, an exhibit of this material being shown at the Paris Exhibition of 1855, and several methods of its application having been proposed by a French engineer, M. Francis Coignet, as early as 1861.

No further progress seems to have been made till about 1855, when German and Austrian engineers took the question up. England and America quickly followed, but it is only in very recent years that the problem of the construction of reinforced concrete pipes has been seriously taken in hand.

In this age of improvement of all kinds, but more especially with regard to those of sanitation and water supply, improvements that are necessarily of a costly character, municipal bodies are frequently debarred from carrying out such owing to:—

(1) The initial cost; (2) The cost of repairs owing to corrosion in iron or steel pipes; and (3) The additional burden placed upon the taxpayers. But it can be claimed that reinforced concrete pipes have the following advantages:

(1) Reduced initial cost; (2) There being no corrosion or leakage, repairs are reduced practically to nothing; and (3) The tax rate under these conditions would be considerably less.

The above advantages appeal largely to the public, but there are other advantages which commend themselves to the engineer who acts as advisor to the public.

As is well known, the principal duty of the metal in a water main is to withstand the tensile stress set up in it by the internal water pressure. Now, if a cast iron main is designed simply to resist this stress, the result is that a thin cylinder of cast iron is designed which is almost too thin to cast with accuracy, and iron being a metal adapted to resist compressions and not tension the result does not instill confidence, and a certain percentage of metal is boldly added to cover irregularities in manufacture, unequal bedding in trench, water hammer, road traffic, etc., and, after all, a metal has been used which is not well adapted for its duty, but is used almost universally, being both cheap and convenient. If a sheet steel main is designed simply to withstand the internal pressure, the result would probably be a sheet so thin as to cause doubt as to its power to resist collapse from the weight of the material filled in the trench or from road traffic; the thickness of metal is therefore increased to cover this and the weakness of joints; and this addition to an expensive metal is costly, and although the body of the pipe is of an excellent material and well adapted for its duty and would give more confidence than the more uncertain cast iron pipes, yet both of them are subject to corrosion, which will in time destroy them, the steel pipe first because it is thinner, and the rate of decay practically the same for both metals with pure water. It is therefore necessary to protect both the cast iron and the steel main from corrosion, and for this purpose the pipes are treated with an application of bitumen or other preventive. How long this preventive coating will last under the best conditions it is not possible to say, but it is probable that its effect is simply to defer the time of commencement of the attack by corrosion for a few years, and that once this sets in little assistance is obtained by the coating.

It is only during the past few years that the various valuable properties of cement in combination with steel have been thoroughly realized; it has been vaguely known that when the space between the outer and the inner skins of the hull of an old iron or steel ship have been filled with liquid cement and a portion of this structure is cut into after 30 or 40 years, the metal is found to be perfectly preserved; this experience of ship builders was not generally or widely known by engineers or architects, or if known has not been acted upon. It is on record that a bar of iron after being embedded in concrete for about 400 years was perfectly preserved.

The principal features of value in adopting reinforced concrete for pipes that are to be put under pressure are: (1) Strength—this can be made sufficient to deal with any pressure to which the pipe may be subjected; (2) If steel is well surrounded by cement the metal is protected for a very long period, much longer than any rust preventive will increase the life of a metal pipe. The adhesion of cement to metal excludes all air and prevents rust, thereby allowing the metal to maintain its original strength. As to the cement covering it is well known that cement concrete increases in durability with age and particularly so when impregnated with water.

The following description of the manufacture, laying and jointing of one of the many systems of reinforced concrete pipe, and carried out under the writer's supervision may be of interest:

The pipe consists of an interior tube or sheet of mild steel, varying in thickness from 1/32 in. to 1/8 in. according to the pressure to which the pipe is to be subjected, built up in sheets manufactured locally. The jointing of the steel tube sheets is effected by means of oxy-hydrogen blow pipes, which make autogenous welds. The oxygen and the acetylene, or other heating gas, may be so regulated at the blow pipe as to give either a fusing flame or a burning or oxydizing flame. With this latter flame iron or steel can be cut to any shape; with the former it can be fused or welded together with no waste.

The circumferential joints in the tube are made by turning up the edges of the sheets and welding the adjoining edges, whereas the longitudinal joints are butt joints. The ends of each tube are turned up and a collar made of sheet steel is turned up to form a stop and for the external cement coating.

Outside this steel tube is placed the external reinforcement consisting of bars of the section of a Latin cross wound in helical form around longitudinal parallel bars of smaller cross section, all the crossings of the tube being wired together.

The external reinforcement and the steel tube only are taken into consideration in calculating the strength of the pipe, and the distance apart of the helices is varied to suit the pressure in the main. An internal reinforcement constructed with a lighter section of bar is constructed in the same manner. The only duty of this internal reinforcement is to support the inner portion of the cement, and is not taken into account in the calculations of the strength of the pipe. When the three portions of the steel skeleton are completed, the inner reinforcement is placed inside the tube and the outer reinforcement outside; they are then placed vertically on curved wooden curbs made to the shape necessary to centre them and preserve the correct thickness of the cement coating.

The next operation is the moulding or casting of the pipe. A collapsible core made much on the principle of an

*Paper delivered before Convention of Union of Canadian Municipalities, Quebec, August 30, 1911.

umbrella is lowered into position in the inside and sheet steel moulds outside, the space between the core and the mould being then run with mortar consisting of two parts of clean, sharp river sand to one part of Portland cement, mixed on an elevated travelling platform to the consistency of thin mortar, so that it will flow readily and completely surround every portion of the inclosed steel. During the process of running the cement, the outer steel mould is sharply struck with wooden mallets to facilitate the escape of air bubbles and assist in consolidation.

This portion of the work may appear simple, yet great care has to be exercised in its execution; before the cement is run into the moulds they should be well rubbed with a mixture of soap and oil, so that when they are withdrawn they will leave the finished concrete clean.

A somewhat difficult point is to determine exactly when the concrete has set sufficiently to enable the core and external moulds to be removed, the time of setting, of course, varying with the temperature, mixture, quality of cement and various other conditions. The writer has known cement set sufficiently in forty-five minutes to enable moulds to be removed, whereas in other cases six hours have elapsed.

When the moulds are taken off, the pipes are allowed to stand vertically for four or five days to harden, after which they are lowered and left in a drying yard until required. They should be allowed to dry for about a month before being laid and when ready for laying will stand quite as much rough usage as a cast iron pipe.

The next operation is laying and jointing the pipe. At the ends of the pipes a rebate of about two inches long and 1½ inches deep is left, the ends of pipes are laid hard up against each other, the rebate filled with bitumen on the outside of the pipes thus joined together, a reinforced concrete collar, made similar to the body of the pipe, is constructed and thus forms the main joint.

Bends and specials are made on much the same principle as the straight pipe, except that the cement concrete moulding is done by hand moulding and not by steel shields. This system has considerable advantage over either cast iron or steel pipes, as the angle of splay or radius of the bend can be executed by the workmen to suit the actual conditions and is not dependent on a stock pattern.

As regards testing, the writer was engineer on several works where this system was used and made many experiments during the process of making and laying the mains as to strength and water tightness.

The first testing was made on the welded steel tube before any of the reinforcing rods were fixed, in order to detect any pin holes in the welding and, if necessary, repair before the pipe was concreted. Every tube was placed in a specially designed proving frame and subjected to a test of 50 feet static head.

The finished pipe was placed in the same testing frame, about one month after being moulded, and subjected, as a rule, to a test of 1½ times the working pressure, which varied from 350 to 900 feet static head; or in other words, from 152 to 391 lbs. per square inch. One special tube was tested to a static head of 1,500 feet or 651 pounds per square inch, and showed no sign of fracture.

These pipes can be made for all diameters above eighteen inches and are essentially for trunk mains.

Where junctions have to be made for stop valves, air valves, scour valves or branch services, a specially made steel casting is usually welded on to the internal steel tube, then heavily reinforced and surrounded with concrete.

Having generally described the use of these pipes for water mains, the question of their use for main sewers need only very briefly be touched upon, as it is only a question of designing the reinforcing to suit the pressure. In one sewer made for the Corporation of Belfast, Ireland, the steel tube was entirely omitted, the only reinforcing being the spiral rods. This pipe stood a pressure of 50 pounds per square inch.

These pipes are usually made in about ten or fourteen foot lengths, where the diameter does not exceed two feet, the total thickness of the shell being from two and one-half to three inches.

As regards cost, the writer found in Great Britain on the works he was engaged on, that these pipes were manufactured, laid and jointed at about three-quarters of the price of steel and slightly more than one-half the cost of cast iron.

In the city of Grenoble, in the south of France, the city authorities arrived at the following conclusions on a line of reinforced concrete pipes which had been laid for fifteen years:—

(1) The irreproachable state of preservation of the pipes, in which there was found a slight calcareous deposit about 1/16 inch thick. They did not show the least fissure, either internally or externally.

(2) There existed no trace of oxidation from the metal. The binding-in wire which connected the longitudinal rods was absolutely free from oxidation.

(3) The adherence between the metal and the cement concrete constituting the body of the pipe was such that, despite the thinness of the concrete (1-3/8 inches), they could only be separated by heavy blows from a sledge hammer.

(4) When struck with a hammer, these pipes evinced remarkable sonority, such as might be obtained from a sound cast iron pipe.

(5) The detached fragments of the cement concrete showed very sharp angles.

(6) No repairs had been executed on these pipes from the time they were laid until the time of examination, a period of fifteen years.

A great advantage in reinforced concrete pipes is that with the aid of a few experienced men local and other authorities can carry on the manufacture themselves. This appealed to the writer very much where city councils in other countries had to deal with the great unemployed problem and provide relief work. In Johannesburg, South Africa, after the Boer War, the municipal council provided considerable relief work to the unemployed by undertaking the manufacture of reinforced concrete for the main outfall sewer.

In Scotland, about two years ago, the writer engaged a number of unemployed men on manufacturing, laying and jointing the pipes already described, which to some extent aided the corporation in alleviating the relief problem, a problem which, it is hoped, will never require solving in this country.

CONCRETE AND STEEL TIES.*

As has been said many times, it may be in the near future it will be impossible to procure wood for ties and something will have to be substituted in place of wood. Quite a number of roads are commencing to use, to some extent steel or concrete ties, and a great many roads have been and are experimenting with both concrete and steel ties of every conceivable shape and make.

Owing to the fact that some of these ties now being tried are comparatively heavy and hard to handle, this necessarily makes them quite expensive not only as far as the first cost is concerned, but in regard to their maintenance cost also.

*Presented at convention of the Roadmasters' and Maintenance of Way Association, held at St. Louis, Mo., September 12 to 15, 1911.

Some of the new designs of steel, as well as concrete ties, are so constructed as to make them hard to apply in track where automatic signals are in operation on account of the difficulty of getting proper insulation; some of them are so constructed that it is hard to apply the rail to them with anything but a bolt and nut, which by some railroads is not considered a satisfactory fastening.

Again, owing to the salt brine that comes from refrigerator cars, as well as to the fact that the nuts may be hard to keep tight, and also in case of a derailment of a heavy engine or car, the fastenings might become so damaged that new ties and fastenings would have to be applied before the track could be made safe or put in usable condition, the problem is a hard one to solve.

There are a great many things that should be taken into consideration before we make up our minds:

First, we should consider how much the first cost of the new tie would be.

Second, we should consider how much more it is going to cost to handle the tie, on account of its weight, shape, kind of fastening, etc.

Third, we should consider the safety of the appliance by which the rail is fastened to the tie.

Fourth, we should consider how much labor it is going to require first to fasten the rail to the ties and how much labor it is going to require to keep them in proper shape.

Fifth, we should consider how durable and efficient the contrivance is for proper insulation in all kinds of weather, on all kinds of roadbeds and under all kinds of traffic.

Owing to the fact that the time has come, as we have said before, when it seems as if we would have to begin to figure on something to substitute for wood ties, should we not stop and take into consideration whether or not a steel or concrete tie, made a little wider and not quite so deep would answer the purpose of a tie. If a tie made a little bit wider and not quite so deep would answer the purpose of a tie, it would not require so many ties for a mile of track and we would get the same amount of bearing on our rail and on our roadbed as we have now, and it would not take so much material to make the ties; therefore, the ties would not cost so much. And if the tie was not so deep as the tie we are using at present, it would require less labor to put the tie in, as well as less labor to tamp the tie, which would be quite a saving. This is very important, as a number of trunk lines are ballasting their roads with stone, slag, or some other hard material which is more expensive to handle in every way.

If a tie could be constructed so that we could narrow up the shoulders and still have the same amount of ballast up against the end of the tie, this would be another saving, and a tie made thinner than the ties we are now using would not require so much ballast to fill in between the ties, which would be another saving.

During the past six or eight months we have received illustrations of concrete ties, on which at present there are patents. We have become quite interested in them, and while some are not the same shape as the ties we have always been used to using, some of them look to be practical for railway use. It is a fact that the first cost of them would be considerably more than our present tie, but the amount of labor saved in handling them and putting them in the track, etc., tamping them after they are in the track and the amount of ballast saved owing to their peculiar make-up would almost enable a railway company to tie up their tracks at the same expenditure it is costing us now to put in wood ties.

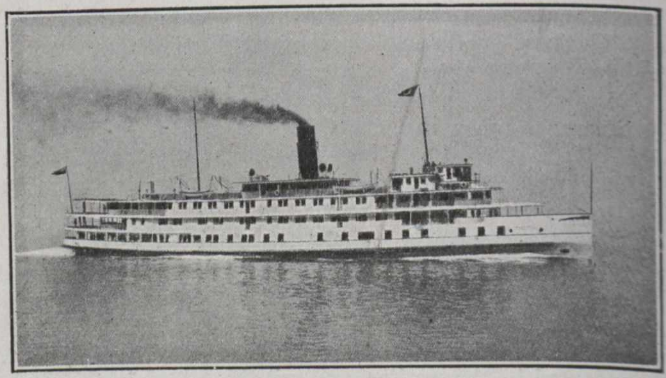
L. C. Ryan, Chairman; P. J. McAndrews, John O'Leary, F. R. Laying, John D. Boland, F. D. Harrigan.

A NEW STEAMER.

A somewhat novel type of steamer, recently described in Engineering, built for the Richelieu & Ontario Navigation Company, by the Fairfield Shipbuilding Company, of Scotland, named the "Saguenay," has just entered service.

The dimensions of the ship had, of course, to be restricted to suit the special service of the St. Lawrence River, and thus the length is only 275 ft., the breadth 54 ft. 6 in., while the depth to the hurricane deck is 40 ft., the only structures above this being those associated with the navigation of the vessel. The vessel has been classed at Lloyd's, and the scantlings have been made light, to minimize the draught, but in all cases strength has been carefully considered. A notable feature is the heavy "guard," to act as a fender along each side above the water-line; this guard is reinforced by beams below, secured to the shell-plating and framing, and assists greatly in giving longitudinal stiffness.

As regards the machinery, it follows the usual merchant-ship practice of the Fairfield Company. The two sets of engines have each four cranks, with four cylinders, arranged for triple compounding, and on the Yarrow-Schlick-Tweedy balanced system. The screws are of the built-up type, with bronze blades. The engines are designed to run at high



The "Saguenay".

speed, the revolutions being 180 for 2,100 horse-power. Special care has been taken in the design of the valve-gear to ensure quiet running, as well as to eliminate vibration. As is the case with all Canadian and American river passenger-steamers, the starting-platform, from which the main propelling engines are controlled, is situated at the level of the main deck, within the engine-room casing. The whole of the gear is conveniently arranged here, and from this position both sets of engines can be easily manipulated by the engineer on watch. The three boilers supply steam at a pressure of 175 lb. per sq. in., and are worked on the Howden system of forced draught, for which there have been fitted two large steam-driven fans, located in the main engine-room. Each fan is sufficient for all the boilers when running at full power, so that one is a stand-by. The auxiliary machinery is very complete, including two powerful electric-light engines and a refrigerating machine.

The vessel before leaving the Clyde ran her steam trials on the measured mile at Skelmorlie, when under service conditions, a speed of 16 knots was attained. This was regarded as specially satisfactory, the conditions of trials being arranged and carried out, like the design and construction of the ship, under the personal supervision of Mr. A. Angstrom, the consulting naval architect to the Richelieu and Ontario Navigation Company.

The Canadian Engineer

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

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CONTENTS OF THIS ISSUE.

THE TORONTO HYDRO-ELECTRIC COMMISSION.

The thought strikes us as we pass along some of the ill-lighted streets in Toronto, what have the Toronto Hydro-Electric Power Commission been doing since their appointment? This commission of three, one appointed by the city, one by the Hydro-Electric Commission of Ontario, and the Mayor of Toronto, ex-officio a member, were expected to do something towards quickly installing and getting in operation the new electrical system in Toronto to compete with the Toronto Electric Light Company. Toronto, however, has repeated here the mistake made so many times before. Neither of the Commissioners has the qualifications which fit him for organizing and pushing this work. Each Commissioner, too, has so many other interests that as a result he has had no time to devote to this work.

The Commission at present is composed of Mr. P. W. Ellis, Mr. H. Drayton, and Mayor Geary. A short time ago, during the Coronation in England, the whole Commission were absent from the city for some time, and this, too, when it was most essential that some of their number should be constantly there to look after the work.

Is it any wonder, then, that the work of the City Hydro-Electric Department is proceeding so slowly, with a Commission at its head composed of a business man, who is looking after his own business, and is chairman of another Commission (the Queen Victoria Niagara Falls Park Commission); a lawyer, the corporation counsel for Toronto, with its attendant duties, and the Mayor of the city?

It certainly appears that a very little judgment could have secured a more balanced Commission.

Here is an expenditure of two and a half million of dollars of the people's money, and the work is dragging along so that it will be years before the system is complete. In the meantime, interest charges are accumulating and new contracts with the Toronto Electric Light Company must be signed, contracts in which the city will certainly be mulcted.

What has the city received so far to show where the money has been spent? Work is being done in practically all parts of the city, and even up in North Toronto. This work, however, has been too scattered to be effective, and as a result little new private business can be taken on. At the same time, the Toronto Electric Light Company is continually taking on new business and making itself stronger each day.

The city of Toronto must bestir themselves or they will find themselves in a very bad predicament. They are buying power from a commission who are in turn buying from a private company, and they are installing a new system to compete with a plant already in operation with the equipment complete, a company which generates, transmits and sells its own power.

With this danger staring them in the face, it would appear that the $8,000 a year paid to this Commission in salaries would be much better spent by appointing a new Commission who are unencumbered with other work, and who will devote their whole time to the work of the Commission.

We would suggest that the Commission be reorganized at once, and that the Mayor and the Corporation Counsel be dropped. This Commission should be composed of men who will devote time and energy to this work. The new street railway system of the city might then be placed under the control of the new Commission.

GRAND TRUNK PACIFIC CONTRACTS.

We note in one of the Western papers that the steamers "Prince Rupert" and "Prince George" will shortly be converted into oil burners, and that the work will be done in Seattle. The "Victoria Colonist" in its editorial columns refers to the fact that a few months ago the steamer "Prince Rupert" was taken to Seattle to have repairs effected on her boilers. The "Colonist" adds that during the time the repairs were going on the Victoria and Vancouver shipyards were practically idle, and rightly takes issue with the principle of taking this work out of the country. The Grand Trunk Pacific is a heavily subsidized Government road, and is not in the same position as a private company. Aside from the question, which is open to doubt, whether the work can be done cheaper in Seattle or in British Columbia shipyards, the people of Canada have a right to ask that in so far as it is possible to handle work here, all expenditure should be distributed in this country.

The Grand Trunk Pacific, however, are not the only offenders in this respect. In the matter of employment of engineers, far too often our municipalities go outside the country for men when Canadian engineers as competent, if not more so from a knowledge of local conditions, are ready to handle the work.

THE APPOINTMENT OF A CITY ENGINEER.

Kingston is about to appoint a city engineer. The city council advertised for applications for the position, and eighteen have applied. After the applications had been received letters were sent out to the different men asking them to appear before a committee in Kingston and state their qualifications for the position. Four did so, paying their own expenses to Kingston. After the interview they were told that the matter of the appointment would be laid over for a week or so.

These men left Kingston with the impression that the committee were trying to shelve them, and that the appointment was practically settled. Their impression was that a local man, who was not an engineer, would receive the city engineership.

We would be sorry, indeed, to believe that a city council whose duty it is to find the best man for the position would make the appointment on personal or political grounds. Kingston has many problems coming up in the near future for solution, problems which will require the services of an experienced engineer, and it would be a grave mistake on the part of the city officials to take any other than the very best man they can secure for the salary offered.

The city engineership is a position which is peculiarly difficult to fill, and the less the local affiliations of the appointee, the less will he be handicapped in his work. The position should be filled by a man with technical qualifications, and the salary question should not enter too strongly, as a capable man will save the city far more than the extra remuneration required to obtain him.

Therefore, we reiterate that the appointment should be kept clear of political or personal grounds, and that the man among the applicants best fitted by reason of training, education and general qualification should be placed in this position.

INDIANS AND THEIR PLACE IN CANADA.

Something for consideration is provided by Archdeacon Renison, of Moose Fort, James Bay, who has charge of Anglican mission work in the Moosonee district with 6,000 scattered population. He tells it briefly, not to say bluntly, and deserves sincere attention. Why, he asks, should our government desire to teach the red man a trade, and "civilize" him according to the civilization of the whites, when they can with less trouble and more success train him for what he can do infinitely better than he can on a farm or in a factory? The fact is overlooked that Indians are already skilled workmen of the highest type, fitted for their work by heredity and centuries of environment. "The Government is bringing white men into the northland for the purposes of surveying, prospecting and geological work, very often university men, who barely know the difference between a frying-pan and an axe, and by so doing ousting the Indian from the country which is his very life, and for which he and none other is specially adapted."

Employ these skilful woodmen, he urges, in all surveying and like pioneer work. Employ them, too, in fire-ranging and game wardenship. Speaking of conservation in the north country, he says: "No man can assist in and, indeed, carry out the work of conservation as well as the Indian, for the woods are his home, and conservation is work in which he has no equal."

Portages should be cut between the vast band of lakes which fills New Ontario, and an Indian should be settled by every lake. The Government might allow him to erect a home and to cultivate what land he liked. His work should be the keeping open of the portage routes, and the guidance of such white men as should pass through his territory. In addition, he could hunt within his limits, and, in fact, live his own life and at the same time be of immense use to Canada.

Testimony comes from Port Arthur and other parts of Ontario as to the successful employment of Indians in directions like those indicated. At a mission on Lake Nepigon is a group of temperate, trustworthy Indians whose great services to the railways, to settlers, and explorers have been testified to most strongly. Where the lily-fingered work of clerking and other indoor avocations has been tried in vain, the Indian has been found trusty as guide, motor-boat man, chain-man—all occupations appealing to his nature and keeping him out of doors. He has been found to be a good boat-builder as well.

EDITORIAL COMMENT.

The Waterworks Department of London, Ont., are considering the use of the ultra-violet ray in sterilizing their water supply. The ponds at Springbank have been giving trouble. Inquiries are now being made in France and Germany, where the ultra-violet method of sterilization is being used.

* * * *

We have much pleasure in drawing attention to the article in this issue on the Minneapolis filtration system. The constructional part of this work is being installed by Mr. A. W. Ellson Fawkes, who is a Canadian by birth. This work reflects great credit on the city of Minneapolis and the engineer in charge, as the work is being done at a lower cost than the lowest tender submitted.

The authorities of the University of Toronto must be careful or they will have a tragedy staring them in the face very shortly. At the football game on October 14th in the new University Stadium the bleachers were seen to sway over a foot under the synchronous movements of the crowd. A bad accident will certainly be the result unless measures are immediately taken to stiffen the structure and prevent in future the repetition of Saturday's performance.

* * * *

Since last week's issue there has been another failure of a dam in the United States, and, while in this case no lives were lost, still a tremendous amount of damage was done. Little excuse can be found for failures of this kind. With careful inspection of the materials and the construction of the work, and with care and conservatism in design, dams can be built with assurance of safety. We repeat what we said in our last issue, that Government supervision of the designs, foundations and construction, where a failure means loss of life, is required.

* * * *

The City Planning Association of Winnipeg appointed a permanent secretary last week who will hereafter be an active force in laying out and planning the growth and development of the city, so that the costly errors of older communities may be avoided.

The new secretary, Mr. F. J. Cole, of the Garden City Association of England, is a man of much experience in city planning, and thoroughly competent by training and experience to do the work he has been engaged to do for Winnipeg.

Winnipeg is a city that has done splendid work in laying out parks, streets and other features of the city beautiful, but there was a feeling among the progressive men of the city that there was no expert information available, and the City Planning Association was formed, Mr. Cole's appointment following the organization of that body. We wish every success to the new organization and the new secretary. It is a department which will, if handled rightly, do good work in advancing the æsthetic side of the city's development. Toronto made such a departure some time ago, and, while as yet the results obtained by the Guild of Civic Art there have not been very great, still they have done something towards educating the people.

PROGRESS OF THE GRAND TRUNK PACIFIC.

It was not stated at the adjourned annual meeting of the shareholders of the Grand Trunk Pacific Railway at Montreal this week when the new transcontinental would be completed from coast to coast. Mr. Charles M. Hays, president, told, however, of the progress of construction and stated that during the year the track laying on the main line of the western division had been extended from Wolf Creek to Fitzhugh, west of the Athabaska River in the Rocky Mountains, which is 1,027 miles west of Winnipeg and will be the divisional point for that section; that the construction work is under full headway, with night and day forces to Tete Jaune Cache, on the Fraser River, beyond Yellow Head Pass, on the western slope of the Rocky Mountains, and it is expected that the track laying will reach this point, which is 1,094 miles west of Winnipeg, before the close of the year.

On all portions of the line which have been sufficiently completed trains are at present in operation, and a daily through freight and passenger service is established on the line between Winnipeg, Edmonton and Edson. From the stage to which construction has advanced, we should judge that the line should be completed at least by the end of 1914.

For the purpose of establishing suitable hotel accommodations throughout the country, which will be traversed by the company's lines, it is proposed to construct a chain of first-class modern hotels.

The company has been granted a subsidy by the Canadian Government for the construction of a floating dry-dock at Prince Rupert, at an approximate cost of $2,200,000, on which work has already been commenced, and tenders have also been called for the construction of terminals and a station in that city.

The steamer Prince John has been added to the company's fleet on the Pacific Coast, and placed in service between Prince Rupert and the Queen Charlotte Islands.

Good progress has been made in the construction work on the eastern division and the present condition of that work shaws a total of 1,223.45 miles of main line track, and 136.50 miles of side track laid, and the remaining portions of this section are all under contract.

The names of the following directors were proposed for re-election—Mr. Hugh A. Allan, retired; Alfred W. Smithers, Sir Henry Mather Ackson, Geo. Von Chauvin, Col. Frederick Firebrace, Chas. M. Hays, E. J. Chamberlin, Wm. Wainwright, E. H. Fitzhugh, W. H. Biggar, E. B. Greenshields, the Hon. R. Dandurand, the Hon. Geo. A. Cox, E. R. Wood, and J. R. Booth.

THE NEW MINISTER OF PUBLIC WORKS.

Honorable F. D. Monk, K.C., B.C.L., D.C.L., Minister of Public Works, comes of old Devonshire stock on his father's side, the family having settled in New France under the French regime. On his mother's side he is French. He was born in Montreal in 1856. He occupied the position of recognized representative of the French Conservatives in

HON. F. D. MONK,
The New Minister of Public Works.

the House of Commons up to the time the Nationalist movement became strong in Quebec, when he formed an alliance with Henri Bourassa. He broke with the English-speaking Conservatives on the autonomy bill and on the naval question. Mr. Monk is a lawyer and a professor of constitutional law in the Montreal branch of Laval University.

Metallurgical Comment

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

Correspondence and Discussion Invited

THE VALUE OF A MISTAKE.

At the recent meeting of the American Electrochemical Society, the course taken by one of the members in reading a paper on an experiment that proved unsuccessful brought forth very favorable comment as to the value of thus making public such data.

It is only too true that a great deal of information made public on scientific matters is pure "theorizing," and the reader in search of information is often at a loss what to accept, especially after he has had one or two "experiences." How valuable, then, is any such information dealing with an unsuccessful experiment, especially when it come from an authoritative source. In recommending such a procedure it would have to be done advisably, for, of course, objections will at once be raised that to make public all such information would be disclosing the material that constitutes the large portion of one's experience. This, no doubt, is to a certain extent very true; but let us look at the matter in another light.

The greater portion of one's time in any research work is taken up in finding out "ways and means," and it goes without saying that a great deal of this time would be saved if there were at one's disposal the whole record of other experiments, which, while not of the same nature, are distinctly allied so far as the method of attack is concerned. Now when we say the whole record, there would necessarily be included an account of unsuccessful attempts, the mistakes that are so often glossed over.

It is often said that the wise do not contemplate failure. Would it not be very much to the point to say, rather, that they avoid the mistakes of others? Following the argument still further, it is easily seen that mistakes would occur less frequently if more attention were paid to discussing the difficulties of problems. There would undoubtedly be a larger percentage of "commercial successes."

THE ANNIVERSARY OF A NOTABLE EVENT.

The fortieth anniversary of the first heat of Bessemer steel made at the Cambria Works, Johnstown, Pa., was lately celebrated, after having been postponed from July. The first blow was made on July 10th, 1871, under the direction of Capt. Robert W. Hunt, now of Chicago. It is a matter of common knowledge that the first successful heat of Bessemer steel was made at Wyandotte in the fall of 1864.

In an address to the gathering, Capt. Hunt, among other things, said:—"It is no doubt hard for Bessemer steel men of to-day to realize or even appreciate the conditions which surrounded our early work. All the pig iron had to be remelted in cupolas which could only be run a few hours before it would be necessary to drop the bottom and repair the tuyeres. Spiegel was melted in a reverberatory furnace. The tuyeres in the converter were of very uncertain life; turning down the vessel and blanking them in the middle of a heat was a common occurrence. We have seen the annual production of Bessemer steel in the U.S. grow from almost nil to 12,275,830 tons per year, and the number of works from 5, in 1871, to 71 in 1910.

THE INSTITUTE OF METALS.

The Failure of a Brazed Joint.

Professor H. Louis, M.A., B.Sc., Assoc. R.S.M.

The Paper gives a brief account of the investigation of the cause of a failure in the braze of a steam pipe on a steamer, undertaken at the instance of the Board of Trade. The author shows that the failure was due to corrosion following certain well-defined lines in the brass, and he traces the cause of these lines to the presence of small quantities of lead and tin in the original brazing spelter. The lead-tin alloy separating out between the crystals of brass formed planes of weakness that gave access to the corroding solutions, and this brought about the gradual corrosion of the entire brazing material.

The Corrosion of Brass, with Special Reference to Condenser Tubes.

Paul T. Bruhl, M.Sc.

It is urged by the author that so important a subject as the corrosion of brass by sea water, the neglect of which must mean no slight expenditure, should induce steamship companies to keep records bearing on the subject. It has been this lack of data that has hitherto retarded the solution of the corrosion problem. All the companies with whom correspondence was opened possessed "no definite information."

The corrosion of brass condenser tubes may conveniently be classed under four heads:—

1. Corrosion proper; where the metal is uniformly removed over the whole surface.

2. Dezincification; where the zinc being preferentially more rapidly removed than the copper, the surface of the metal becomes copper-rich in places. The action does not usually extend much below the surface, although it may occasionally be so marked as to result in copper "plugs."

3. Pitting. This is by far the most serious form of corrosion, as it considerably curtails the life of the tube. It is due to galvanic action between the deposit on and the metal of the condenser tube. It may occur in any portion of the tube, that is to say, in the roof and sides as well as along the floor. It most often occurs in the lowest portion of the tube because of the natural downward gravitation of any extraneous sediment, or of any insoluble product of corrosion.

4. Erosion. Here the mechanical influence of the stream of cooling water comes into play. Its effect is small and, under ordinary circumstances, uniform:—

The conclusions arrived at by the author are:—

(1). That the presence of air or an increase of temperature up to a certain point accelerates corrosion.

(2). That iron, nickel, and small amounts of lead are injurious; tin up to about 1 per cent., large amounts of lead, and aluminium are useful in diminishing corrosion.

(3). That the inlet pipe and the condenser plates should preferably be made of brass.

(4). That the condenser should be protected against stray currents.

(5). Protective coatings are not recommended.

(6). The importance of "spills" cannot be exaggerated.

(7). That the tubes should be flushed with clean water after use.

THE DIRECT PRODUCTION OF MOLYBDENUM STEEL IN THE ELECTRIC FURNACE.*

By E. T. Dittus and R. G. Bowman.

The desirable properties of molybdenum steel and the expense involved in its manufacture by the methods at present in use led the authors to search for some reaction upon which could be based a process for its direct production from its most common ore. Without such a process any extended use of molybdenum steel, instead of tungsten steel, is very improbable. The reaction described by Becket appeared the most simple and was, therefore, made the subject of the investigations.

The production of steel direct from ore in the electric furnace is easily accomplished where the ore is pure. Certain impurities, particularly sulphur, are, however, very difficult to remove from the metal. Small amounts may be removed by the use of a basic slag but this method is limited in its application since the fusibility of the slag decreased rapidly with increasing basicity. For the reduction of molybdenite in the presence of molten iron it is necessary to have present some substance which has a greater affinity for sulphur than either molybdenum or iron. The compound formed by the desulphurizing agent and the sulphur must either pass into the slag or be volatilized as soon as formed. The two metals which seem best adapted for use as desulphurizers, under these conditions, are manganese and silicon.

Manganese in the form of metal or as the ferro alloy reacts with sulphides at high temperatures according to the following reaction:

$$2\,Mn + RS = R + 2MnS.$$

The managnese sulphide forms a slag resembling iron sulphide. If the above reaction takes place in a bath of molten steel or iron the resulting metal is apt to contain small included masses of manganese sulphide. Sulphur in this form has little effect on the properties of steel. This reaction might be applied to the production of alloy steels, such as molybdenum steel, by adding a mixture of molybdenite and ferro-manganese to the bath of molten steel just before tapping. This would result in the formation of ferro-molybdenum and manganese sulphide; the former alloying with the steel and the later passing into the slag.

Silicon reacts with sulphides to form silicon sulphide SiS_2 and liberates the metal of the original sulphide. This is the reaction described by Becket.[1] The reaction has been investigated by Fielding[2] who produced a yellow powder which sublimed at 1,500°C and which decomposed water with the formation of H_2S and silicic acid. This compound did not correspond to the formula SiS_2. Sabatier[3] describes a somewhat similar compound and suggests the formula Si_2S_4. The heat of formation of SiS_2 is given by Sabatier[3] as + 40.4.

This reaction might be applied to the production of molybdenum steel in the same manner as the manganese reaction described above. The silicon, in the form of ferro-silicon, and the molybdenite should be reduced to powder, intimately mixed in the proper proportion to produce the reaction and added to the steel in the furnace before tapping. The mixture might be added in a soft iron tube or in small briquettes made up with a binder of sodium silicate. Addition in the ladle during tapping would probably result in raising the sulphur content of the metal on account of the absence of slag, which in the furnace would remove small amounts of sulphur which might tend to pass into the steel.

The experimental work was undertaken with a view to determine the feasibility of applying the Becket process to the production of molybdenum steel direct from iron ore molybdenite in the electric furnace.

To accomplish the results desired it was necessary that the furnace fulfil the following requirements: the crucible walls should be of neutral or basic material, free from carbon; the furnace should be easily charged and operated. Since the best method of heating could be determined only by experiment, it was thought best to design a furnace capable of being operated as a Girod, or with slight alteration as a Heroult furnace.

A detailed description of the design illustrated in Fig. 1 will suffice, since this was the furnace finally adopted and used in the investigations.

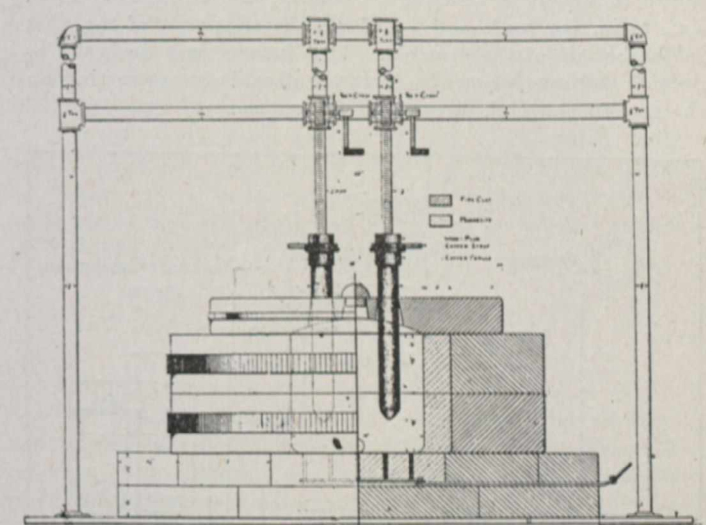

Fig. 1.

The crucible is elliptical in cross section and measures 6 in. by 9 in. by 8 in. (15 x 23 x 20 cm.) deep. The total volume of the crucible is about 360 cu. in. (5.5 litres), the volume of the smelting zone is about 90 cu. in. (1.4 litres). The walls have a slight bosh to effect a concentration of heat at the base of the crucible. The crucible lining is of burned magnesite obtained by crushing magnesite brick to pass 10 mesh (2.5 mm.). The magnesite was mixed with tar to form a paste and rammed in hot around a central wooden form. The tar was burned out in the heating up of the furnace.

The walls are biult up of eight fire-brick sections of special design, luted together with fire-clay and encircled by steel bands. These rest on a foundation made up of two courses of standard fire-brick, with the joints filled with fire-clay.

The cover for the crucible is a solid elliptical fire-brick section 17 in. x 20 in. and 2½ in. (43 x 50 x 53 cm.) thick, encircled by a steel band. The electrodes enter through the slot in the centre of the cover. This slot admits of considerable lateral or angular movement of the electrodes. The under side of the cover is slightly concave. An asbestos gasket is placed under the cover where it rests on the top of the furnace, and small asbestos washers encircle the electrodes where they pass through the cover.

The tap-hole is 1¼ in. (3 cm.) in diameter, and is well rounded at its point of entrance to the crucible. A small hole 1 in. (2.5 cm.) in diameter extends diagonally from the top of the outer wall to the smelting zone for the purpose of pyrometer readings and for the escape of gases.

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*Abstracted from a paper read before the American Electro Chemical Society.

1 Elec. Chem. & Met. Industry, Aug., 1909.

2 Bul. de Soc. Chem. Paris 2, 38, 153.

3 Comptes Rendus, 90, 819.

The hearth electrode consists of six ½-in. rods of swedish iron screwed into a ⅜-in. (0.9 cm.) plate of the same material. The plate is embedded in the lining of the bottom of the crucible in such a position that the upper ends of the roads are flush with the inner surface. A copper strap 3-16 in. (0.5 cm.) thick and 1.5 in. (4 cm.) wide, bolted to the plate, extends outside the furnace for connection to the source of current.

The two movable electrodes are supported on a frame above the furnace. The supporting frame is entirely independent of the furnace proper and is therefore unaffected by expansion or contraction of the walls. The electrodes are cylindrical graphite rods 1.25 in (3 cm.) in diameter and 11 in. (28 cm.) long.

Ordinary pipe fittings were used as much as possible in the construction of the frame and supports, since these give a light, strong construction, and require no special castings or forgings.

Another Furnace constructed differs from that described above in having a crucible or double the depth described, i.e., 16 in. (40 cm.), and a different arrangement of the rods in the bottom of the crucible. This furnace was designed to operate continuously with a column of cold charge resting on the molten material, as in a shaft furnace.

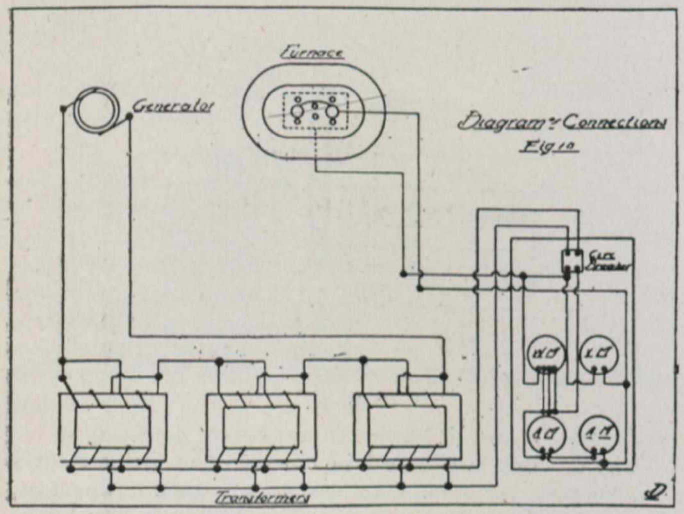


Fig. 2.

This type of furnace may be operated as a Girod steel furnace by connecting the two movable electrodes in parallel with one side of the circuit and the hearth electrode with the opposite side. The movable electrodes may then be placed parallel vertically, thus forming two arcs, or set to converge to a single central point forming but one arc. To operate the furnace as a Heroult steel furnace, the points of the rods in the hearth electrode are covered with a layer of magnesite, and the two movable electrodes are connected in series with the circuit. The magnesite covering for the hearth electrode need not be of any great thickness, since there is but a slight tendency for the current to cross through the iron plate after the charge becomes molten.

The furnace is charged at the beginning of a run by removing the cover and distributing the charge with a trough or funnel. Additional material may be added through the opening in the cover while the furnace is running.

The small amount of coke in the charge used was found to be sufficient to make the cold charge slightly conducting, the resistance rapidly decreases with rise of temperature, and the furnace may thus be readily started on a cold charge, providing the walls of the crucible are hot. The electrodes are forced down through the charge to within a short distance of the bottom of the crucible at starting. As the charge becomes hot, the electrodes are gradually raised until the charge is reduced and the arcs play between the ends of the electrodes and the surface of the slag. With the current available it was found impossible to maintain arcs below both electrodes simultaneously for any length of time. The best results were obtained by raising and lowering the electrodes alternately at intervals of two or three minutes, which caused the arcs to alternate from one electrode to the other.

The capacity of the furnace as described is about 1,000 gm. of metal per charge, or approximately 2,000 gm. of raw charge. A charge of 1,000 gm. was employed in several runs. This yielded 500 gm. of metal, but this amount is too small to make clean tapping possible.

Single-phase alternating current at 60 cycles, 25 volts, was employed. The amperage varied throughout the run, but averaged 250 with the arcs running steadily.

The connections of the various pieces of apparatus are illustrated in the accompanying diagram, Fig. 2.

The iron ore employed was a good grade of hematite from the mines of the Colorado Fuel and Iron Co. at Sunrise, Wyoming. Two separate lots were used, the analyses of which were as follows:

Fe	66.06	per cent.
Al_2O_3	1.52	"
SiO_2	4.12	"
P	0.04	"
S	0.04	"

The ore was crushed to pass eight mesh (3 mm.) and the fines were retained.

A quantity of very pure molybdenite from Yorkés Peninsula, Australia, was obtained from the Foote Mineral Co.

Analysis showed the material to be practically pure MoS_2 with only a trace of impurity in the form of copper sulphide.

Two lots of ferro-silicon were used, the analyses of which were as follows:

Fe	49.70	per cent.
Si	50.00	"
S	0.005	"
C	0.20	"

The ferro silicon and molybdenite were ground to pass thirty mesh and intimately mixed in the proper proportions to bring about the reaction:

$$MoS_2 + Si = Mo + SiS_2.$$

The proper amount of this mixture to give the desired molybdenum content in the steel was enclosed in a small paper tube and added to the bath of metal just before reduction was complete.

The coke used was from Trinidad, Colorado, and was obtained from the North American Smelting Co., of Golden, Colorado, from whom the analysis was also obtained.

The coke was crushed to pass eight mesh and the fines retained.

Ordinary builders' lime was used as flux.

The lime was crushed to pass eight mesh and the fines retained.

A description of six runs was given in the paper, the following being one of them:

Charge.—Iron ore, 3,025 gm.; coke, 660 gm.; lime, 412 gm.; calculated iron content, 2,000 gm.; length of run, 1 hr. 30 min.; mean amperes, 200; mean volts, 25; K.W., 5; metal obtained, 1,700 gm.; calculated molybdenum, 25 per cent.

Iron turnings were spread over the bottom of the crucible and covered by a layer of coke, lime and silica to form slag and protect the iron. The metal melted in 25 minutes but was kept molten in the furnace for 15 minutes after fusion in order to burn out the tar from new portions of the lining. This metal was tapped cleanly and a charge sufficient for 500 gm. of metal was added. This reduced in 20 minutes. Molybdenite-ferro-silicon mixture sufficient to give a content of 5 per cent. Mo. in the metal was added in a paper tube just before reduction was complete. The tap hole was opened but the metal was level with the tap and only slag flowed out. The tap hole was again plugged and a charge sufficient to give 1,000 gm. of metal was charged.

Reduction was rapid and the charge was entirely reduced in 30 minutes. Molybdenite mixture sufficient to give a molybdenum content of 2.5 per cent. in the metal was added just before final reduction of the charge. Since the bottom of the crucible appeared to be sinking constantly, another charge equivalent to 500 gm. of metal was added and reduced in 15 minutes. This gave a total of 2,000 gm. of metal (calculated) in the furnace, with sufficient molybdenum to yield 2.5 per cent. in the total.

The tap hole was opened and slag flowed out freely but no metal was obtained. The current was shut off and the furnace allowed to cool. A solid mass of metal level with the tap hole was found in the bottom of the crucible.

The furnace was taken down and the entire lining and bottom electrode removed. A solid mass of metal weighing 1,700 gm. was obtained. The metal was malleable and tough, and was broken with great difficulty. When broken across the centre the fracture was very fine grained and dense at the centre of the mass and coarsely crystalline and full of small blow holes at its outer edges.

A section of the central portion of the mass, polished and etched with picric acid showed a network of a bright white constituent, probably a double carbide of molybdenum and iron. A section in the coarsely crystalline portion of the mass showed a coarsely granular structure.

Analysis:

C	0.62	per cent.
Si	0.91	"
Mo	1.15	"
P	0.08	"
S	0.37	"

Since the results of the experiments herein described were qualitative rather than quantitative, further experiments would be necessary in order to determine the loss and distribution of molybdenum.

Since no analyses were made upon the slag, it is impossible to determine what proportions of the sulphur were removed by the ferro-silicon and the slag. However, the following conclusions were gathered:

(1) Molybdenum steel can be made in the electric furnace by the direct reduction of iron ore and the addition of molybdenum in the form of molybdenite, MoS_2.

(2) Molybdenum steel of low sulphur content can be produced from molybdenite by the use of ferro-silicon as a desulphurizer.

(3) Molybdenum steel of low sulphur content can be produced from molybdenite in the form of low grade concentrates by the use of ferro-silicon as a desulphurizer.

With regard to the design of a furnace for small scale operations, the foregoing experiments would indicate that:

(1) The Girod principle as used was superior to the Heroult.

(2) A tilting furnace would be more effective than a stationary furnace.

(3) The tap hole on a stationary furnace should be made short, with a steep inclination. Ample provision for heating the tap hole should be made.

(4) Tar does not make a satisfactory binding material for crushed magnesite.

In the discussion following this paper, it was pointed out by Mr. Fitzgerald that it was rather dangerous to draw conclusions from small laboratory experiments. The objection was also raised to designating the two types of furnaces Heroult and Girod.

TESTS OF RIVETED JOINTS UNDER IMPACT.

Tests of riveted joints under impact are reported by E. Preuss in "Der Eisenbau" of September, 1911, and appear in a recent copy of Engineering News. Two-rivet connections of three small rectangular plates were tested. The plates were superimposed, the middle one being offset upward so that it could be struck by a falling ram while the outer plates rested on an anvil block. The slip of the middle plate with respect to the others was measured, for blows of different heights and for various repetitions of the blow. Static pressure tests were also made and slip measured, for comparison with the impact tests. The conclusions reached by the author are:—

The slip produced by a blow of given striking energy is only slightly increased by repeating the blow.

The slip is, roughly, a linear function of the energy of impact. In contrast herewith, in static tests the slip is a higher function of the loading.

For the same impact energy per square inch of rivet-shear section, the slip was greater for larger (1-in.) rivets than for small (11/16-in. and ⅞-in.) rivets.

To produce a given amount of slip, the required static load in pounds is 8,000 to 22,000 times as great as the required impact energy in foot-pounds. This figure is greater for large rivets than for small, and is smaller for a great amount of slip than for a small amount of slip.

WELDED STEEL PIPES.

With reference to the article on "Welded Steel Tubes," which appeared in our issue of October 2, and to the statement as to the absence in Great Britain of any fully equipped concern for their manufacture, the British Welding Company (Limited) write to say that some three years ago they installed at Motherwell, England, a complete plant of the most modern description, with water gas producers, special fixed and portable welding machines, and auxiliary machinery, for the production on a large scale of the highest quality of welded pipes up to 6 ft. diameter in the longest lengths, with all forms of joints, receivers, cylinders, and other welded work.

NEWS ITEMS.

It is the intention of the Atikokan Iron Company to double the capacity of their furnace plant at Port Arthur, and to establish a foundry.

* * * *

The Rolling Mill Department of the Canadian Steel Foundries, Limited., at Welland, Ont., which is undergoing improvement, will most likely be in operation some time in December.

* * * *

The pig iron production in the United States shows a decided improvement. Steel works furnaces have made the greatest gains, and the Merchant furnaces have turned the tide and now show a large daily gain.

Chemical changes are accomplished by either the absorption or evolution of heat. When heat is absorbed the reaction is called endothermic; and when heat is evolved the reaction is called exothermic.

THE CARE AND USE OF EXPLOSIVES.

The following synopsis of Miners' Circular No. 1, Bureau of Mines, Washington, D.C., is published here for those who may be called on to use explosives.

Miners' Circular No. 1, the first of a series to be written in plain, non-technical language for the benefit of the miner, has just been issued by the Federal Bureau of Mines. It contains the names of the permissible explosives tested by the bureau at its Pittsburg station up to November 15, 1910, and gives precautions as to their use. Permissible explosives give a short and relatively cool flame that is less likely to ignite inflammable gas or coal dust than is the longer and hotter flame of dynamite or the longer and much more lasting flame of black powder. Because they can be used with greater safety, permissible explosives have taken the place of other explosives in many coal mines in the United States during the last two years and their use is increasing rapidly.

To reduce the risks in storing, thawing, and handling explosives at coal mines, the following precautions are urged by the Bureau of Mines:

Don't store detonators with explosives.

Don't open packages of explosives in a magazine.

Don't open packages of explosives with a nail puller, pick or chisel.

Don't store explosives in a hot or damp place.

Don't store explosives containing nitroglycerine so that the cartridges stand on end.

Don't repair a magazine until all explosives are removed from it.

Don't use permissible explosives or other explosives that are frozen or partly frozen.

Don't thaw frozen explosives before an open fire, in a stove, near a boiler, near steam pipes, or by placing cartridges in hot water.

Don't put hot water or steam pipes in a magazine for thawing purposes.

Don't carry detonators and explosives in the same package.

Don't handle detonators or explosives near an open flame.

Don't expose detonators or explosives to the sun for any length of time.

Don't open a package of explosives until ready to use the explosive, then use it promptly.

Don't handle explosives carelessly.

Don't use more than 1½ pounds of any permissible explosive for one shot in a coal mine.

Don't use a detonator (blasting cap) or electric detonator of less strength than No. 6.

Don't crimp a detonator (blasting cap) around a fuse with the teeth.

Don't economize by using a short length of fuse.

Don't use in a gaseous coal mine any fuse or other device which emits flame or sparks.

Don't use coal cuttings or "slack" or any combustible material for stemming.

Don't use a metal tamping rod. A copper tipped rod is not to be recommended. Wooden rods are safer.

Don't use two kinds of explosives in the same drill hole.

Don't return to the face until at least 5 minutes after a shot has been fired.

Don't breathe the gases from the shot.

Don't return to the face after a misfire for at least one half hour.

Don't attempt to draw the charge in case of a misfire.

Don't leave any detonators or explosives in a mine over night.

Don't charge or load any hole which has not been properly placed or has been drilled "on the solid."

Don't light the fuse of dependent shots at the same time the first shot is lighted.

Don't expect to get satisfactory results with a permissible explosive or anv explosive when a miner uses it for the first time.

Don't think the use of permissible explosives can take the place of other safety precautions in mines and thus neglect those precautions.

COMBUSTION OF FUEL.

In the Conference of Sanitary Inspectors in England an informative paper on "The Smoke Nuisance and Its Abatement," was read by Mr. John Macaulay, A.M.I.Mech.E., from which the following extract is taken:—

"In a fire ready for firing, i.e. for a fresh supply of coal, we see a bed of fuel in a more or less incandescent condition, consisting of the carbon of the coal in the form of coke. When the fresh supply is thrown upon this glowing mass, the intense heat causes the release of the volatile or gaseous constituents of the coal, which burst into luminous flames above the fire and which consist chiefly of a series of hydrocarbon compounds playing an important part in the production of heat.

"With an ample supply of air admitted to the furnace in fine streams so as to thoroughly intermix with the hydrocarbons and a sufficiently high temperature, these gases will burn in the upper part of the furnace with a heat producing flame, resulting in the formation of CO_2 and steam.

"The liberation of these hydrocarbons is simply a process of evaporation, therefore, as during that process heat is absorbed and the furnace cooled to some extent, it will be understood how necessary it is to maintain a high temperature, i.e. not to allow too long an interval to elapse between the periods of firing, or, in other words, not to allow the fire to burn low.

"If we note what takes place with any of the hydrocarbons, e.g. methane, which is represented by the chemical symbol CH_4, and has an ignition temperature of 667°C. or 1201°F., when sufficient air is added at this temperature the result is represented by the formula

$$CH_4 + \text{Air} = CO_2 + 2H_2O + xN.$$

From this it will be understood that the hydrocarbons are decomposed at high temperatures, and if there is an inadequate supply of oxygen, or air, the carbon separates as soot which is not consumed; again, should the temperature of the furnace be too low, the particles of carbon will be deposited unburnt in the form of soot, even in the presence of an excess of carbon.

"Therefore the formation of visible smoke is chiefly caused by the liberation of these hydrocarbons at a low temperature or by the insufficient supply and admixture of the quantity of oxygen which is requisite for their complete combustion at the temperature of ignition.

"But the visible smoke, though bad, is an indicator of something worse, which is being generated in the furnace and emitted from the chimney in the form of the poisonous gas CO, the flame of which is readily distinguished in the fire by its well-known violet-blue tint. If the conditions necessary for the proper combustion of this gas are absent, it will be emitted as CO and will result in a corresponding loss of heat and furnace efficiency. Those conditions are, as in the case of the hydrocarbons, high temperature and adequate air supply.

"The ignition temperature of amorphous carbon is about 700°C or 1,260°F, and if this, the minimum temperature, is maintained, with an ample air supply, the carbon will be burnt to CO_2. No excess of air or admixture of the air and gases, however effective, can remedy the failure to maintain this minimum ignition temperature within the furnace.

"Besides the effect of the air supply on smoke, let us for a moment consider its effect upon the economical working of the furnace. Under the most favorable conditions, as in a calorimeter, when every particle of the oxygen of the air is completely used, and there is no waste oxygen to carry heat away, 1 lb. of coal will require for its combustion 11.5 lbs. weight of air, equal to 150 cubic feet.

"In practice, these conditions are unattainable, much more air being required, but the excess air may be considerably reduced by using fuel which has been previously broken into small lumps.

"If 1 lb. of carbon is completely burned to CO_2, it will give out about 14,500 British thermal units, whilst if partially burned to CO, it will give only 4,500 British thermal units, showing a loss of about 10,000 units. It is therefore obviously necessary, for the sake of economy, that the carbon should be thoroughly burned.

"The incomplete combustion of the hydrocarbon gases also causes a further loss, the carbon, as it separates out in a finely divided condition as soot, covers the heating surface of the boiler flues and acts as a non-conductor of heat.

"The best indication of the quantity of air being used per 1 lb. of coal, is that give by an analysis of the gases being collected at suitable places in the flues, and the analysis made by means of one of the forms of apparatus used for the purpose. On analysis of the products of combustion, the following gases are likely to be found, viz., CO_2, extreme figures 5 per cent. to 15 per cent., more usually 7 per cent. to 14 per cent., free oxygen, usually 4 per cent. to 12 per cent.; CO 2.5 per cent. to 0 per cent. (in an efficiently worked furnace, nil); hydrocarbons, if existing unburnt, are a source of loss; traces of sulphur compounds; nitrogen about 79 per cent.

"It is now usual in up-to-date boiler plants to have CO_2 recorders installed. These recorders give a fairly accurate idea of the conditions, as to air and fuel supply, under which the furnaces are working during each hour of the day, and to that extent act as a check on the firemen.

"The check is a useful one, because, when the boiler has been carefully set, by regular and systematic stoking and proper air supply, the recorder will show 12 per cent. to 14 per cent. CO_2 in the flue gases, and any deviation from that will denote a corresponding irregularity of the air and fuel supply to the furnaces, which can only be accounted for by bad stoking, except when cleaning fires.

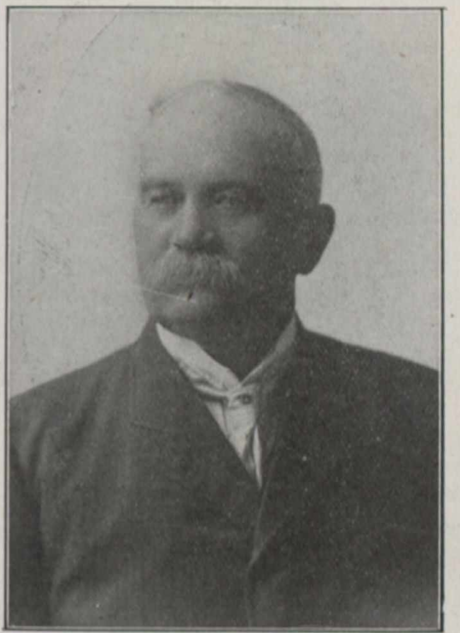
"With hand-firing, the best results follow from what is known as 'ribbon-firing,' i.e. throwing the coal along one side of the fire, the full length of the furnace, and after a short interval repeating the operation on the other side.

"When forced draught is produced by steam jets injudiciously used, a waste of heat is caused and volumes of smoke are produced. A waste of heat is caused because steam at a pressure of say 50 lbs. per. sq. inch, the temperature of which is 298°F., introduced into a furnace whose temperature is at a minimum of 1,300°F., has a cooling action on the fire; and volumes of smoke are produced because the hydrocarbons are cooled and driven off and their mixture with the oxygen of the air at the proper temperature cannot take place."

CANADIAN MANUFACTURERS' ASSOCIATION

The annual convention of the Canadian Manufacturers' Association at Toronto this week was very successful. The entertainment features were largely deleted with the result that this year's gathering was perhaps the most businesslike ever held. Mr. Rowley, the retiring president, in his address discussed tariff questions and pointed out that he did not advocate a higher tariff. The association and the individual members who composed it would be ill-advised to ask for material increases in the rate of duty. The vote of the people could not be distorted into a building permit to heighten the tariff wall. It endorsed the principle of reasonable protection.

"Other industries need protection just as manufacturing needs protection, and we should see to it that they get it," said the speaker. "In using the word 'protection' I mean far more than mere tariff protection. The protection the ordinary tariff affords is well enough so far as it goes, but like a cofferdam, it is intended only as a temporary aid to



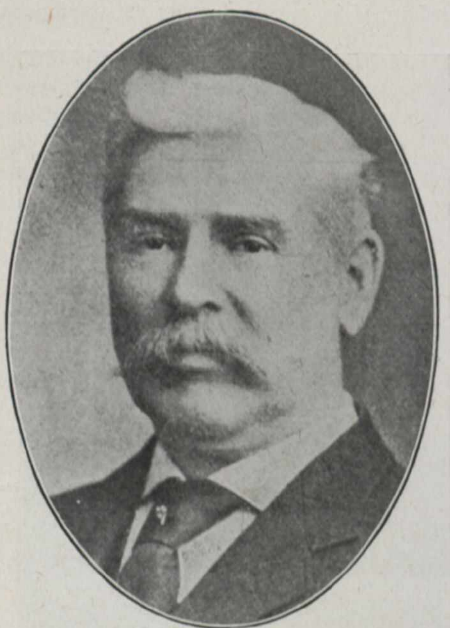
MR. N. CURRY,
Elected President of the Canadian Manufacturers' Association this week.

permit the solid work of construction to go forward. We need to study German methods to know what practical protection really means.

"Reforestation, conservation of all our natural resources, experimental farms, seed inspection, elevators, cold-storage, transportation, biological stations, fish hatcheries, geological surveys, fire ranging and research of every kind, are as essentially a part of a comprehensive, practical protective policy as the tariff ever was or ever will be. These are the kinds of practical protection we should strive most earnestly to secure and to extend, because these afford the only safe and sane basis upon which to build for the future. Our competitors to the south are realizing this, and have already outdistanced us in progressiveness of this practical policy, we must speedily follow their example or suffer the consequences of our inaction."

The Canadian Manufacturers' Association was pleased with the prospect of the early appointment of a permanent tariff commission. Tariff-making was a science, and could be mastered only after long and patient study. In appointing a commission he thought Mr. Borden would insure a "square deal" to merchants, manufacturers and consumers. "No matter what the cost may be, no matter whose toes may be trodden upon, let us first get our tariff right and fair, then let us insure its stability, making from time to time only such slight modifications as the changing conditions of the country demand."

On the subject of transportation Mr. Rowley pointed to the importance of extending and improving east and west communication, and to keep as far as possible the movement of all business in Canadian channels. Every ton of freight carried over a Canadian railway or in a Canadian vessel gave work to Canadian crews. The sight of nineteen United States feeders stretched along and across the border confirmed this view, and the rapid construction of new lines and double-tracking of old ones was necessary to keep Canadian tonnage on this side of the border. Great as the expenditure on subsidies had been, none could regret it, for that policy had brought the provinces together and had opened up the fertile plains of the west for settlement.



MR. R. S. COURLAY,
Elected Vice-President of the Canadian Manufacturers' Association this week. Mr. Courlay is also President of the Toronto Board of Trade.

Winnipeg could not always expect to be the great distributing centre of the west. Other centres were springing up to challenge its supremacy. With the building of the Hudson Bay Railway, Georgian Bay Canal and Panama Canal the growth of other centres would be hastened, and a readjustment of freight rates would follow as a matter of absolute necessity.

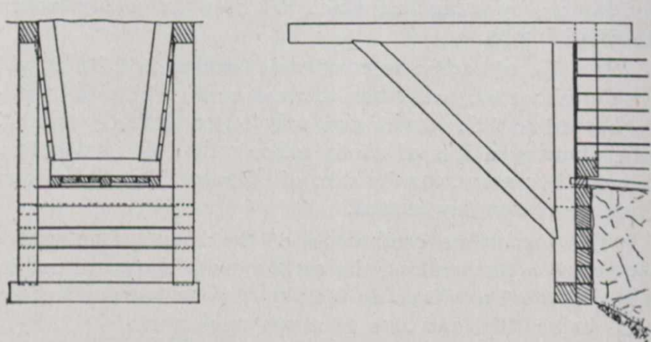
Referring to interprovincial trade, Mr. Rowley protested against the system of licensing extra-provincial corporations now in vogue. It was contrary to the spirit of Confederation. It was disintegrating in its effect and would engender a policy of exclusion and isolation.

Discussing the British preference, Mr. Cyrus S. Birge, of Hamilton, after quoting the clause of the Grain-growers' resolution in which they asked for an increase in the preference to 50 per cent. from 33 1-3 per cent., said.—"I favor preference, but I contend that the British preference as it stands to-day is the extreme limit to which any Canadian Government should go. Any increase in existing preference with Great Britain would be an evil to the industries of Canada."

TIMBERING PORTAL OF TUNNEL.

The following description and cut of the method of timbering the portal of a tunnel, abstracted from the Mining and Engineering World, is of interest:

In most cases the rock at the mouth of a tunnel is loose and falls readily, particularly that portion over the back of the opening. The accompanying sketches illustrate a means of holding such ground in place at small expense, while giving the portal of the tunnel greater permanence, and being cheaper in the end than the usual expedient of shovelling the debris away after each fall of rock, as well as replacing the timber loosened by the cave. If necessary, lagging may be placed behind the timber frame at the sides of the cut. as well as over the back of the tunnel entrance. The timber required is indicated in the sketches, which show a front and side view of the portal of an ordinary mine entrance. If the



Timbering Portal of Tunnel.

cap be mortised to receive the legs these latter can then neither spread nor come together. The sills should be mortised in similar manner for the foot of the uprights. All the timber used in a frame of this sort should be treated with a preservative of some sort, if it is expected to last a length of time that will justify the expense. These timbers should be set up after the tunnel is in some distance but before caving has commenced. It is a good idea to cut out the ground for a foot back of the frame, if it be soft, or largely composed of earth, and fill in with rock from the tunnel, placing it between the timber and the ground, for timber will not rot nearly as fast when in contact with rock as it will when next to soft earth. The size of the timber to be used must be determined by the size of the opening and by the pressure that it is likely to have to sustain. Ordinarily 6 by 8-in. timber will be heavy enough, though 8 by 8 would be better.

TO REPAIR CONCRETE AFTER FREEZING.

Considerable trouble has been experienced in repairing concrete which has been exposed to freezing weather before acquiring final set. The following method has been used quite successfully:—

Chip off with a pick and bull point the concrete which has been affected by frost, and then thoroughly wash the exposed surface with water, using a stiff scrubbing brush, until entirely clean. A 1 : 3 solution of muriatic acid is then applied with a brush, and the surface is again washed. As soon as possible after this is done a very wet mixture of new concrete is applied. Where the old surface has been thoroughly cleaned, and the new concrete kept damp for a week, it bonds nicely with the old surface, making it appear as solid as if the entire mass had been placed at the same time.

SEWAGE DISPOSAL BY GASIFICATION.

A. T. Cowper-Smith.

Owing, it must be supposed, to the fact that sewerage engineers are not, as a rule, conversant with the processes of gas manufacture, and that gas engineers are seldom interested in the subject of sewage disposal, the destruction of sewage, and of city garbage, by the simple, effective, and cleanly process of gasification, has not received the attention which it deserves from engineers.

Gasification must not be confused with ordinary incineration. The use of Refuse Destructors, besides often causing much annoyance because of smell, is more costly than is necessary, on account of the fact that the products which might be evolved and put to use, are run to waste.

By the method of gasification, a considerable amount of gas, tar, and ammonia is produced, all of which may be recovered easily, and turned to account.

Few people are aware of the amount of these products contained in the organic constituents of common sewage. Some years ago, the writer conducted a large number of experiments for the corporation of a big English town with a view to proving what gas-making properties were possessed by ordinary sewage.

The sewage was precipitated, pressed until it contained about 50 per cent. of moisture, and further dried, by waste heat, until the moisture had been reduced to about 33 per cent. The "cake" was then subjected to dry distillation in ordinary gas retorts, with surprising results.

The composition of the sludge was as follows:—

On a Wet Basis.		On a Dry Basis.	
Moisture	32.41	Volatile matter	50.40*
Volatile matter	33.74*	Fat (by extraction)	5.20
Mineral (ash)	33.85	Mineral (ash)	43.93
		Ammonia	0.47
	100.00		100.00

The results of gasification were as follows:—

Gas produced (per short ton)	8,538 cu. ft. (average)
Candle power of the gas	5.605
Calorific value of the gas	335 B.T.U. per cu. ft.
Tar per short ton (spc. gr. 1096)	2.6 Gallons.
Ammoniacal liquor (spc. gr. 1020)	26 Gallons (9 oz. strength by Willis' test).

The composition of the gas varied greatly, as it must when made from such a varying substance as sewage, but a fair average was as follows:—

CO_2	10.20
CO	24.88
O	2.12
Hydrocarbons other than Methane	22.09
Methane, Hydrogen, and Nitrogen	40.71
	100.00

The candle power given is much below the actual, but the writer had to adhere to the absurd and unscientific method of burning the gas at the fixed rate of 5 cubic feet per hour, in a burner which was designed for gas of a higher candle value, a method which only gives correct results when gas of approximately a predetermined value is being tested.

* Volatile matter includes everything that can be driven off by the application of heat.

It will be noted that, although the candle value of the gas produced from sewage is not high (unless burned in incandescent burners, when it gives good results) the heat value of the gas is more than double that of average Producer gas; and that the horse-power value of the sludge is approximately 280 horse-power per hour, per ton of "cake."

The foregoing does not deal with the precipitation of the solids from sewage, but with the sanitary, and useful, disposal of those solids. The cost of producing sludge containing 50 per cent. of moisture should not exceed a range of about 36c. to 55c. per short ton of "cake" produced, or about 3c. to 6c. per ton of wet sludge. But whatever that cost may prove to be, the disposal of the solids is the question that demands attention.

The provision of sewage farms may be satisfactory for cities which have large tracts of cheap land, at a suitable level, within easy reach, and revenue may be obtainable from sludge-nursed cabbages and effluent-fed fruits, but it is a matter for consideration whether or not a much more satisfactory return could be made by fertilizing farm lands with the ammonia compounds produced direct from the sewage.

Lake-shore cities are not usually favored with suitable land in their vicinities, and the pollution of water supplies is becoming a very serious matter. The destruction of sewage and garbage by gasification requires comparatively little land, causes no pollution whatever, affords the most complete and efficient destruction of germ life, and further, affords products which have commercial value.

The final "disposal" is reduced to that of a little harmless inorganic dust. The disposal of sewage and garbage is bound to cost money, and of course it is money well invested. But if revenue can be made by the recovering of useful products, the cost is reduced, to say nothing of the great advantages of cleanliness, absolute destruction of disease germs, and the great reduction of operating room required in the gasification method.

The agreement between the Burrard Inlet Tunnel and Bridge Company and Vancouver in regard to the building of the Second Narrows bridge, which the electors endorsed at plebiscite held last January, has been signed by the directors of the company and by the Mayor and City Clerk. By the agreement the city will take stock in the company to the extent of $200,000, and will, with other municipalities interested, control the company. The company was incorporated by a private act of the Dominion Parliament in February of 1910 for three million dollars. The provisional directors then appointed were Messrs. E. W. MacLean, Edward Mahon, James P. Fell and P. Lambert Band, all of the city of Vancouver, and Mr. John Y. McNaught, reeve of the municipality of North Vancouver, and Mr. J. C. Keith of North Vancouver.

The commission which will deal with navigable conditions on the St. Lawrence River is composed of:—Professor C. H. McLeod, of McGill University, and Messrs. W. I. Gear, and Arthur Surveyor, of Montreal. The appointment was made by an order-in-council dated August 29th, and will be known as the St. Lawrence River Commission. The duties of the new organization will be to examine conditions prevailing in the river and to report upon the many power schemes now before the federal authorities and the effect of such works upon the navigation of the river. Its jurisdiction will extend from the head of Lake St. Francis to the port of Montreal. The commission will also study the improvement of the river channel and the feasibility of deepening the water highway to the sea to a depth of 22 or 25 feet.

A DESIGN OF MIXER OUTFIT THAT REDUCES PLANT CHARGES.

There is evidence that some concrete machinery manufacturers have produced a concrete mixer outfit of such a design that it may be readily adapted for other work than

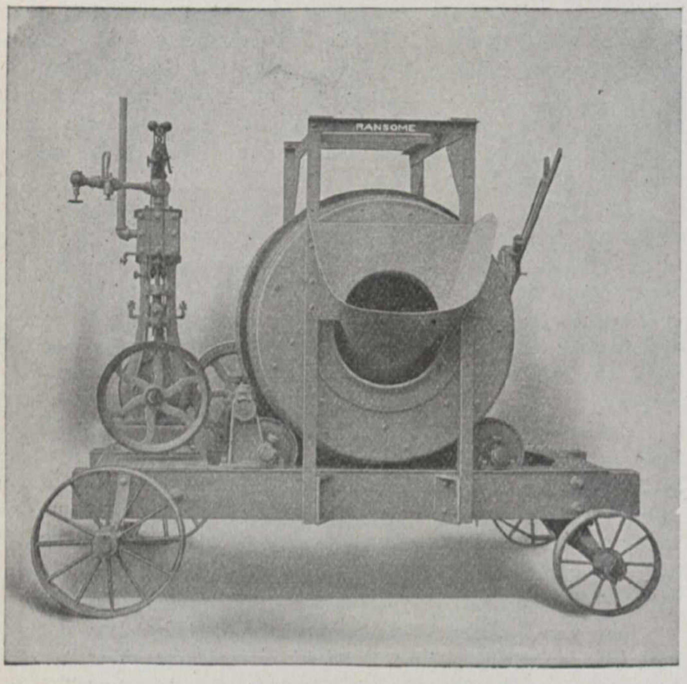


Fig. 1.—A portable steam driven concrete mixer outfit showing mixer with uprights on which is attached removable feed chute that may be taken off and substituted with a fixed batch hopper.

that for which it was purchased by simply changing part of the equipment. In former times when a contractor purchased a mixer with a feed chute and later desired a mixer with a

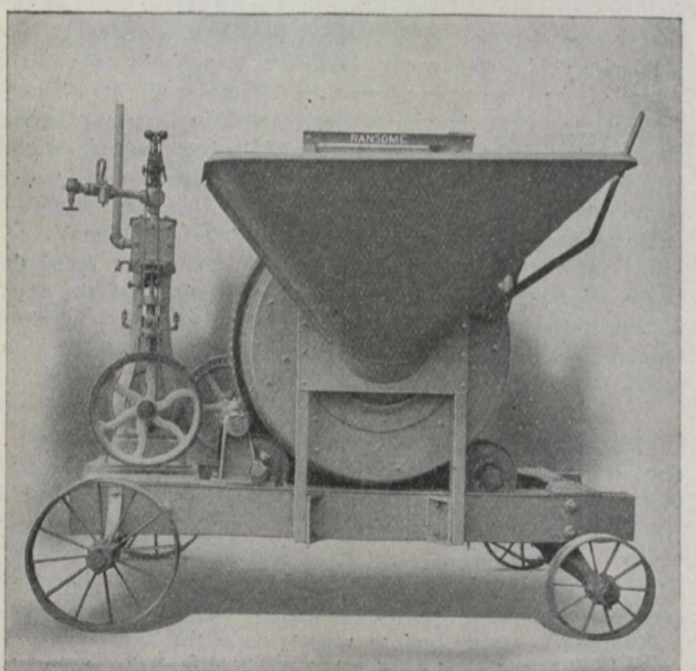


Fig. 2.—Portable concrete mixer outfit as in Figure 1, but equipped with fixed discharge hopper.

pivot charging hopper it was necessary for him to go to considerable expense in alteration and in some cases it was cheaper to purchase a new mixer outfit. However, this expense in the future can be avoided by the type of mixer that has built around it a simple upright frame made up of angles. With this model holes are so drilled that a change may be made from a feed chute to a fixed batch hopper by simply removing the feed chute in the field and substituting a fixed batch hopper. If a mixer that is purchased with a feed chute is desired to be changed to a pivot charging hopper it is only necessary to purchase a small triangular steel frame work that can be mounted on the upright frame together with a hoisting mechanism. Thus there is absolutely no necessity to buy a new outfit, as all holes are drilled previously, and the change can be made on the job.

Further, if it is desired to change a mixer with a feed chute to one with a fixed batch hopper and also to load it by means of a skip car, by building up the upright frame of the original mixer it is possible to secure this result.

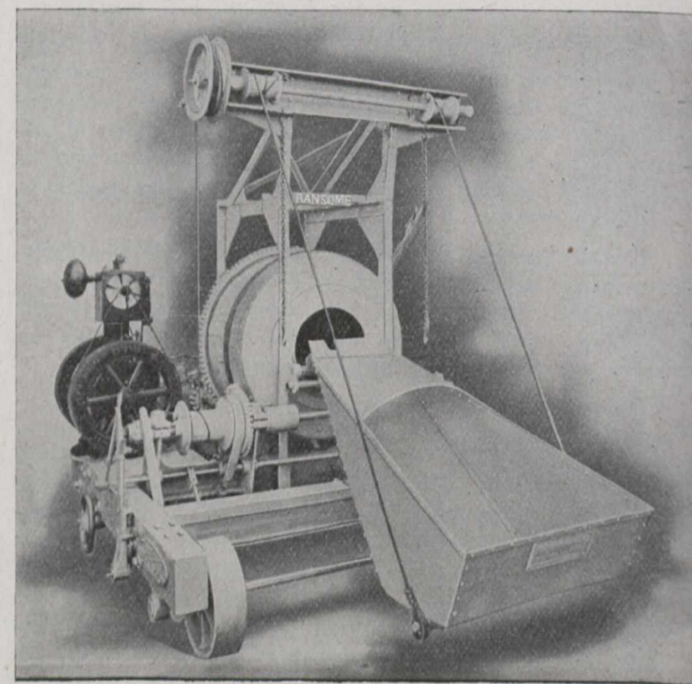


Fig. 3.—A portable motor driven concrete mixer outfit showing the upright frame with the triangular piece attached to frame and with the necessary hoisting mechanism and pivot hopper. Note that this outfit is easily built up from the frame shown in other cut.

Another advantage of this upright frame is the fact that when a contractor purchases a mixer without a water tank and then finds he wishes one, all he has to do is to order the water tank and it can be placed on the top of the frame where it is out of the way.

It is evident that a convertible mixer outfit of this type means a big saving in plant charges and makes one mixer outfit a multi-service affair.

Mention has been made in these columns of the project of the Coteau Power Company to construct an electric line in the Okanagan district, with branches, the power to be obtained from Shuswap Falls. This was proposed first some years ago, and recently the charter of the company has been acquired by Sir William Mackenzie, Sir Donald Mann and associates. When in the West, they visited the district to inspect the possibilities, and also to consider in a general way the route for a line which will link up the Okanagan with the Canadian Northern, thus giving the railway a feeder for a large fruit producing section of the province.

THE ELECTRICAL PRODUCTION OF NITROGEN.

At the meeting of the British Association at Portsmouth, Mr. E. Kilburn Scott read a paper on "The Manufacture of Nitrogen Compounds by Electric Power," and described various methods of fixing the nitrogen of the air with the help of cheap electric power, which were started on a commercial scale in Norway and Italy six years ago. These enterprises, said the writer, were now well established, the principal products being artificial manures, nitrate of lime, containing 12¾% nitrogen, and calcium cyanamide, with 18% nitrogen. These were now being made at prices which compared favorably with the older artificial manures such as nitrate of soda and sulphate of ammonia when calculated on the nitrogen contents. For actual delivery to farmers, prices were perhaps not so favorable, because the quantities handled were small and the selling organization was not so complete.

In the nitrate of lime process, as introduced by Birkeland and Eyde, the nitrogen is fixed directly from the air in the electric furnace, and nitric acid made from this fixed gas then acts on carbonate of lime. In the calcium cyanamide process, first introduced by Frank and Caro, the nitrogen is first isolated from the air and then absorbed by carbide of calcium, itself an electric furnace product. The principal difference between the two processes is that the cost of raw materials for nitrate of lime is low, whereas in the case of calcium cyanamide the nitrogen has to be specially prepared by the Linde process, and the carbide of calcium, by which it is absorbed, costs about £6 a ton. The nitrate of lime process was certainly unique among industrial processes in using a raw material—nitrogen—that cost nothing; but, on the other hand, more electric energy was required for a given amount of nitrogen fixed. The nitric acid made by the nitrate of lime process can be concentrated to any value, and sold for manufacture of explosives, such as gun-cotton, dynamite, smokeless powder, etc. Ammonium nitrate, the main constituent for the manufacture of safety explosives and laughing gas, is made by the simple process of mixing the weak nitric acid that came from the absorption towers of the Birkeland-Eyde process with ammonia liquor obtained from English gas-works. The solution is crystallized and dried, and the resultant, containing 35% of nitrogen, is sold freely in England at £27 a ton. This material is also made from calcium cyanamide, and the Loteringen Works at Gerthe produce about 2,000 tons per annum, which was presumably all taken by the German Government as a substitute for nitroglycerine.

At the present time this country is largely dependent on overseas supplies for the manufacture of explosives, and we should be in an extremely serious position in case of war. There is no reason whatever why a factory should not straightway be established in this country for the manufacture of nitric acid from the nitrogen of the air. Even if the product could not at first compete in price with existing supplies, the fact that it was a necessary addition to our national insurance against war would justify its establishment. The question of manufacturing these products here depended, from a strictly commercial point of view, on whether power could be obtained cheaply enough. Electrometallurgical works had usually a 100% load factor, and there was good reason to suppose that waste heat power stations in Great Britain could produce as cheaply as Niagara for such a load factor. If a steam electric power plant of 10,000 kw. was erected at a cost of £10 per kw., and on a 33% load factor the energy was sold for 0.25d. per kw.-hour, then on a 100% load factor the energy could be sold at 0.168d. per kw.-hour. A waste heat station using waste steam from, say, rolling mills, would cost £6 5s. per kw. installed, and the figures for a waste heat station using gas from blast furnaces or coke ovens would probably be about the same. If the initial cost of the plant could be brought down to £6 per kw., the cost of electric power should fall to a figure that was comparable with the most favored hydro-electric plants.

RAILROAD AND COMPANY EARNINGS.

Railroad earnings for week ended September 14:—

	1910	1911	Increase or decrease
C. P. R.	$2,195,000	$2,325,000	+ $130,000
G. T. R.	951,950	1,026,449	+ 74,499
C. N. R.	257,800	360,300	+ 102,500
T. & N. O.	24,426	40,020	+ 15,594
Halifax Electric	4,521	5,046	+ 524

Railroad earnings for week ended September 21st:—

	1910	1911	Increase or decrease
C. P. R.	$2,029,000	$2,218,000	+ $189,000
G. T. R.	949,506	1,018,506	+ 69,000
C. N. R.	282,300	373,600	+ 91,300
T. & N. O.	26,736	45,421	+ 18,684
Halifax Electric	4,480	5,090	+ 610

The Mexico Tramway Company has net earning of $266,731 in August, an increase of $12,999. Eight months net was $1,920,809, an increase of $158,067.

The Sao Paulo Tramway net for August was $189,759, an increase of $24,425. Eight months' net was $1,423,281, an increase of $219,518.

The Detroit United Railway on September 3 showed a gain for the day of $7,660. This is one of the largest gains on record.

The Rio de Janeiro net earnings for eight months were $4,361,257, an increase over last year of $951,574. For August the net gain was $87,576.

For year ended June 30, 1911, Granby Consolidated Mining, Smelting & Power Company showed a decrease in net profits of $348,421. Net profits for year 1910 were $564,946, the decline being equal to about 38 per cent.

The Montreal Street Railway has issued its statement of earnings for August. The following are the comparisons for August:—

	1911	1910	Increase
Total earnings	$443,107	$398,828	$ 44,273
Net earnings	210,597	182,514	28,064
Total charges	73,633	65,743	7,890
Surplus	136,944	116,771	20,173

The following are the figures for 11 months, ending August 31:—

	1911	1910	Increase
Total earnings	$4,319,819	$3,889,475	$430,344
Net earnings	1,841,094	1,658,644	189,449
Surplus	1,291,487	1,166,354	125,132

The balance sheet of the Kerr Lake Mining Company at August 31 shows cash on hand amounting to $413,755, mining property $55,000 and total assets and liabilities of $588,978. The Kerr Lake Mining Company of New York reports for fiscal year ended August 31 total income amounting to $1,344,545 and a surplus over charges and dividends of $111,489. The profit and loss account showed a surplus on August 31 of $134,428. Cash on hand on the same date amounted to $5,570.

THE GOOD ROADS OF MADISON COUNTY, TENNESSEE.*

By Atwell Thompson, City Engineer, Jackson, Tennessee.

There is no stone of any sort in West Tennessee. There is no gravel either. All road metal must be shipped in. The question, then, was where shall we find the best metal? Investigations were made and, after thoroughly going into details, it was decided to use the material from Tamms, Alexander County, in the southern part of Illinois. Tamms is on the Mobile & Ohio Railroad. The railroad company charges 55 cents per ton for hauling the gravel from Tamms to Jackson, a distance of 130 miles. The quarry company charges 48 cents per cubic yard on board the cars at Tamms. A cubic yard weighs a little more than a ton, and we therefore figure that the cost of this material delivered f.o.b. Jackson is $1.13 per cubic yard.

The gravel from Tamms is known as Novaculite, the name signifying that it is very hard, coming from Latin Novacula, a razor. It is a flinty substance which cannot be scratched with hard steel, and which will easily scratch glass. Deposits of this rock are found in ridges which extend from Mississippi through Tennessee, Kentucky, Southern Illinois, Missouri and Arkansas. The rock is full of seams and fractures very readily. A heavy shot reduces it to the proper sizes, when screened, for road material. It is prepared in four sizes, Nos. 1, 2, 3, and 4.

No. 1 is the largest size, and is about as big as ordinary brick bats. No. 4 is the smallest size, and is what is left when the other sizes are screened out. It varies in size from that of peas to fine dust, and is too fine for roads, but makes excellent material for cheap sidewalks, or for the last coat on park drives. No. 2 is smaller than No. 1, and No. 3 is smaller than No. 2, and is just the right size to finish this sort of water-bound macadam road, varying from the size of a walnut to that of a pea.

In its natural state this gravel has plenty of what is known as "binder" mixed with it, and during the screening process enough of this binder stays in each size to make it bond perfectly on the road. This binder is, of course, the result of heat and pressure, and is simply the rock in powdered form, but its action is so good that the roads never disintegrate in the winter, and very slightly in the dry and prolonged summer season.

The usual difficulties resulting from that curious phenomenon which we call human nature have been met with in our work. Scientific location of highways pays but scant courtesy to the kinks that are common to all old dirt roads. Occasionally these kinks seem to be sacred and very valuable to the property owner, who insists on the improved highway following exactly the line of the old road. It is in such cases as this that the engineer often meets this tantalizing trouble. Let him use tact; it will generally win out. I have found that the "Suavitor in modo" is the most successful method. When it fails, and all tact is useless, then it is time to appeal to the courts.

I now come to the actual road building. It was decided to limit the maximum grade to 6 per cent. It was also decided to straighten the roads. These decisions have been adhered to, and tortuous old roads with steep grades have given way to new roads with scientific alignment and easy grades, and which are splendidly fitted to the topography of our county. The standard road bed is 20 feet wide with three feet on each side for ditches. The gravelled portion of the road bed is 16 feet wide near town, and holds this width for about two miles into the country. From there on it diminishes to 14 feet and then to 12 feet before the road reaches out five miles from the corporation. It will be seen that the shoulders of the road near town are 4 feet wide on each side, increasing to 6 feet farther out. When the road is graded and crowned the width of it to be gravelled is excavated to a depth of about 6 inches. This is locally called "cutting the pit." This "pit" is thoroughly rolled, care being taken to have the bottom surface parallel to the surface of the finished road, and consequently it has the same crown as the finished gravelled surface, that is, the centre is 4 inches higher than the edges in a 12-foot roadway, its cross-section being a setment of a circle. On the bottom of this pit the first layer of gravel is spread uniformly and rolled to a depth of about 4 inches. The next sized gravel is then spread on this to a depth of about 2½ inches and then rolled. Lastly, the finer finishing gravel is spread on this to a depth of about 1½ inches and rolled. The heavy steam road-roller, weighing 10 tons, develops depressions in each course, but these depressions are properly filled as the work proceeds, and when finished the surface of the road is perfectly uniform, showing no depressions at all at any point. The gravel is then 6 inches thick in the centre, diminishing to 4 inches at the edges. The dirt shoulders of the road are rolled with the last coat of gravel so that these shoulders conform perfectly with the crown of the road. Each load of gravel is wetted at a convenient city hydrant as it goes forward from the cars to the spreaders. In case no hydrant is at hand, a small gasoline pump delivers the necessary water from a pond, or a well specially driven for the purpose. A careful perusal of what I have said will show that none of the gravel is wasted (it is too costly to waste, i.e.). If, for no other reason, it is cheaper to roll the graded surface and bring the low places to grade with good dirt rather than put the gravel on before rolling, bury some of it in the soft places, and then fill the depressions with more gravel.

It is marvellous how well this novaculite packs under the roller. It cements together at once, and becomes so hard that heavily loaded wagons make no appreciable wheel tracks on the new surface.

It will naturally be asked how much per mile does this sort of work cost, and it can be answered with accuracy. A summary of the total expenditure during the life of the $300,000 shows the cost per mile has been almost exactly $5,300. The cost of grading the road, together with all drain tile, concrete culverts and bridges has been $1,375 per mile. Engineering cost is figured in this. The cost of buying the gravel, hauling it, and putting it down has been $3,925 per mile, or nearly 75% of the total cost. All the smaller water conduits have been made permanent. Vitrified tile has been used from eighteen inches to 30 inches in diameter, and concrete head and tail walls have been built at each drain. Reinforced concrete box culverts up to 6 feet span have been put in where necessary. These, of course, have wing walls, aprons and parapet walls. Where larger water ways occur stout wooden bridges have been put in, and as these wear out they are replaced by permanent steel or reinforced concrete structures.

If there is anything in the art of constructing good roads that all men who know anything about the subject agree upon, it is thorough drainage. There never was a road built in the past that has endured, and a road never will be built in the future that will endure, except it be thoroughly drained at the time of construction, and kept thoroughly drained ever afterwards. The water conduits must be abundantly large to carry the storm water and the sub-surface water must be well and carefully handled. I know that emphasis on road drainage before a convention of this sort is redundant, but our words will reach beyond these walls and carry

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*Abstract of address before the Fourth International Good Roads Congress and Exposition, Chicago, September 27, 1911.

this message to those who may not understand its necessity so well. I consider it the most important thing in the construction of any class of road. Lead the water away at every opportunity. Don't gather any more water than you possibly can help in the ditches alongside; then get rid of what goes into these ditches as often as possible. It is an unpardonable error to allow the storm water to run along the ditches, accumulating as it goes, for more than a hundred yards before diverting it, if there is any reasonable way to do so. This may apparently mean sacrifice on the part of some of the contiguous property owners, but in reality it is not. It is far more damaging to the contiguous property to have an expensive road ruined than to have a small ditch cut through it to carry away the water that would in a short time destroy the road. Here is another opportunity for the engineer to exercise his persuasive ability on the land owner who may be hard to convince.

It was evident that $200,000 would not extend the system very far if all the roads were gravelled. It would add to each road only a mile and a half. In view of this fact, it was decided to spend the second bond issue on improved dirt roads. The same care has been exercised in the alignment, grade, drainage, and construction of these dirt roads that was exercised in the construction of the gravel roads. At the present moment 80 miles of these dirt roads have been constructed. It was hoped that the farmers living along these dirt roads would haul the road metal free of charge whenever they decided that they wanted their particular road macadamized, and this hope is being realized now to some extent. The commission furnishes the gravel f.o.b. Jackson, or at some nearer switch, if there happen to be any.

Madison county has immeasurable quantities of sand-clay. In fact, nearly all of West Tennessee has a sand-clay stratum close enough to the surface so that it is easily available for road purposes. It is found often on the surface, and almost any ravine shows its outcrop.

Experimental stretches of sand-clay roads have been built and are proving very satisfactory. Of course these roads get a little muddy in the winter time, but the mud is never deeper than an inch. They get exceedingly hard during the summer, and are not near as dusty as the dirt road.

Nature has been kind to West Tennessee in this respect. She has mixed the sand and clay in just the right proportions, about 75% of sand and 25% of clay, or just enough clay to fill the voids in the sand. When this material is put on the road in three layers, each layer being carefully spread and rolled with spuds in the roller, it becomes very dense, especially if a few convenient rains fall during the work. Traffic still further packs and condenses this material so that it is impossible for a muscular man to drive an ordinary pick into it farther than an inch with a powerful blow. As time goes on it becomes harder, and really partakes of the nature of incipient sand rock. Here, then, we have excellent local material which fits in well for a road that is not subject to any very heavy winter hauling. It stays comfortable all the year. Automobiles can speed up to 25 miles an hour on it any time, and as fast as any one cares to drive during dry weather. Whenever ruts or wheel tracks appear the drag can always be used with absolute success. No new material needs to be hauled for repairs, because the drag, when operated, scrapes up enough off the road. In this respect a sand-clay road may be said to be self-sustaining.

Our graded dirt roads are kept in repair by the use of the drag. Each year finds them easier to maintain than the year before, because every time the drag is used after a rain it smears the surface of the road, fills the depressions and subsequent traffic puddles the smeared surface, finally compressing and smoothing it uniformly as the weather dries it. Each dragging adds a dense leaf of mud to the surface, and as time goes on this process forms a laminated crust on top of the road, which resists the absorption of water splendidly. One of the most important functions of the drag is that when used with intelligence and perseverance it crowns the surface of the road after each rain just right, so that it sheds the water at once. This simple little implement, which can be fabricated by almost anyone for the trifling cost of $3, or even less, is serving Madison county well. It is being used with success. It keeps the dirt and sand-clay roads in good order all the year, and at a very trifling cost, so low that if I were a stranger to the drag and the results it produces, I could not believe it. Anyone who wishes to verify the statement that the road drag will maintain properly graded and drained dirt roads for $5 per mile per year can do so by coming to Jackson. I will take pleasure in showing you.

In reading the Red Road Book of the Bureau of Town Highways for the State of New York for the year 1910, I notice that the cost of maintaining dirt roads by means of the drag is less than $6.00 per mile per year. This verifies our experience.

BETTER HARBOR FACILITIES FOR VANCOUVER.

More than the British Columbia coast cities should be interested in the movement to create extensive harbor facilities in the vicinity of Vancouver. Both Portland and Seattle are preparing for the increased trade which will rapidly accrue on the Pacific, and it is felt here that prompt action should be taken to so improve existing waterways that adequate accommodation will be provided shipping. With Burrard Inlet, False Creek and the Fraser River, provision can be made with a reasonable expenditure for all classes and amount of trade and industries. Securing the trade will mean much for the West and British Columbia.

Some time ago the movement for greater harbor facilities was begun, and this week another meeting was held. With frontage on Burrard Inlet high in price, and False Creek land taken up, short leases only being granted, attention is being turned toward the Fraser River. With the dredging of the north arm of the river miles of frontage will be made available for industrial purposes, with both rail and water transportation facilities.

It will have the advantage of being practically in Vancouver, with labor handy, in fact South Vancouver, now being peopled by those who have to pay rent, will be as close to the north arm of the river as to Burrard Inlet. The Liberal Government promised $1,250,000 for this dredging, and it is believed confidently that the Borden administration will implement this promise since the work is such that it will benefit the whole of the West. The dredging of the river also means much for the industries being located at and near New Westminster, sixteen miles from the sea, as a fresh water channel will be provided for shipping.

The meeting held this week took action in deciding to employ an engineer to lay out a plan as a suggestion to the government at Ottawa which can be improved upon if seen fit. This will start the matter going. Action should not be delayed, for the scheme is a large one, and will take a few seasons to consummate.

PERSONAL.

Mr. W. P. Morrison, until recently municipal engineer of South Vancouver, B.C., has resigned his position and opened up as a consulting engineer at 311 Crown Building, Vancouver, B.C.

Mr. Moscrop, of the Campbell Gas Engine Co., Halifax, England, who has been looking over the Canadian field for the past three months, returned to England last week. While in Canada Mr. Moscrop appointed agents at Vancouver, Winnipeg and Toronto.

Mr. S. B. Thompson, who has had charge for several years of the operating department of Messrs. Canderson & Porter, consulting engineers, of New York, has been appointed to the position of mechanical superintendent of the British Columbia Street Railway Company, of Vancouver, B.C. This is a new office for which need has arisen through the growth of the company's business.

Mr. J. G. Sullivan has been appointed chief engineer of the western lines of the Canadian Pacific Railway. Mr. Sullivan first became connected with the Canadian Pacific Railway in 1900 as division engineer in charge of western lines construction, which post he held until 1905, when he was appointed as assistant engineer of construction on the American Isthmian Canal Commission, Isthmus of Panama. A few months later he again entered the Canadian Pacific service, and has held executive rank in the engineering department ever since. He was born in Munroe County, New York, in 1863, and has had long experience in railway engineering, having been connected with several of the larger American lines.

COMING MEETINGS.

THE ENGINEERS' CLUB OF TORONTO.—Oct. 19, 8 p.m. 96 King Street West, Toronto. R. B. Wolsey, Secretary, Toronto.

THE ENGINEERS' CLUB OF TORONTO.—Oct. 26, 8 p.m. Meeting of Toronto Branch of Canadian Society of Civil Engineers, 96 King Street West, Toronto. R. B. Wolsey, Secretary, Toronto.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Oct. 26. General Section Meeting, 413 Dorchester Street West, Montreal. C. H. McLeod, Secretary.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—Nov. 9. Monthly Meeting, 413 Dorchester Street West, Montreal. C. H. McLeod, Secretary.

THE AMERICAN ROAD BUILDERS' ASSOCIATION (150 Nassau Street, New York). Nov. 14-17. Annual Convention, Rochester, N.Y.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION..—Nov. 15. Sixth Annual Convention, Toronto. F. Dagger, Secretary, 21 Richmond Street West, Toronto.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—Nov. 21-23, Montreal. F. C. Douglas, M.D., D.P.H., Secretary, 51 Park Avenue, Montreal.

AMERICAN ASSOCIATION FOR HIGHWAY IMPROVEMENT.—Nov. 20-24. First Annual Convention, Richmond, Va. Logan Waller Page, President, United States Office of Public Roads, Washington, D.C.

ENGINEERING SOCIETIES.

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

QUEBEC BRANCH—
Chairman, P. E. Parent; Secretary, S. S. Oliver. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, H. E. T. Haultain, Acting Secretary; E. A. James, 57 Adelaide Street East, Toronto. Meets last Thursday of the month at Engineers' Club.

MANITOBA BRANCH—
Secretary E. Brydone Jack. Meets every first and third Fridays of each month, October to April, in University of Manitoba, Winnipeg.

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 319 Pender Street West, Vancouver. Meets in Engineering Department, University.

OTTAWA BRANCH—
Chairman, S. J. Chapleau, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

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

UNION OF ALBERTA MUNICIPALITIES.—President, H. H. Gaetz, Red Deer, Alta.; Secretary-Treasurer, John T. Hall, Medicine Hat, Alta.

THE UNION OF CANADIAN MUNICIPALITIES.—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, Mayor Reilly, Moncton; Hon. Secretary-Treasurer, J. W. McCready, City Clerk, Fredericton.

UNION OF NOVA SCOTIA MUNICIPALITIES.—President, Mr. A. E. McMahon, Warden, King's Co., Kentville, N.S.; Secretary, A. Roberts, Bridgewater, N.S.

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Bee, Lemberg; Secretary, Mr. Heal, Moose Jaw.

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.

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

BUILDERS, CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary Treasurer, J. H. Lauer, Montreal, Que.

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

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

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

CANADIAN ELECTRICAL ASSOCIATION.—President, N. W. Ryerson, Niagara Falls; Secretary, T. S. Young, Canadian Electrical News, Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, Canadian Building, Ottawa.

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

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