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The Canadian Engineer

An Engineering Weekly

THE POWER PLANT OF THE SPANISH RIVER PULP AND PAPER MILLS, LIMITED.

In the issue of *The Canadian Engineer* of June 6th, 1912, there appeared a general description of the plant of the Spanish River Pulp and Paper Mills, Limited. This plant is located at Espanola, on the Soo branch of the Canadian Pacific Railway, forty miles west of Sudbury and one hundred and thirty-eight miles east of Sault Ste. Marie. We herewith present some further data descriptive of the hydraulic and steam power equipment of the plant.

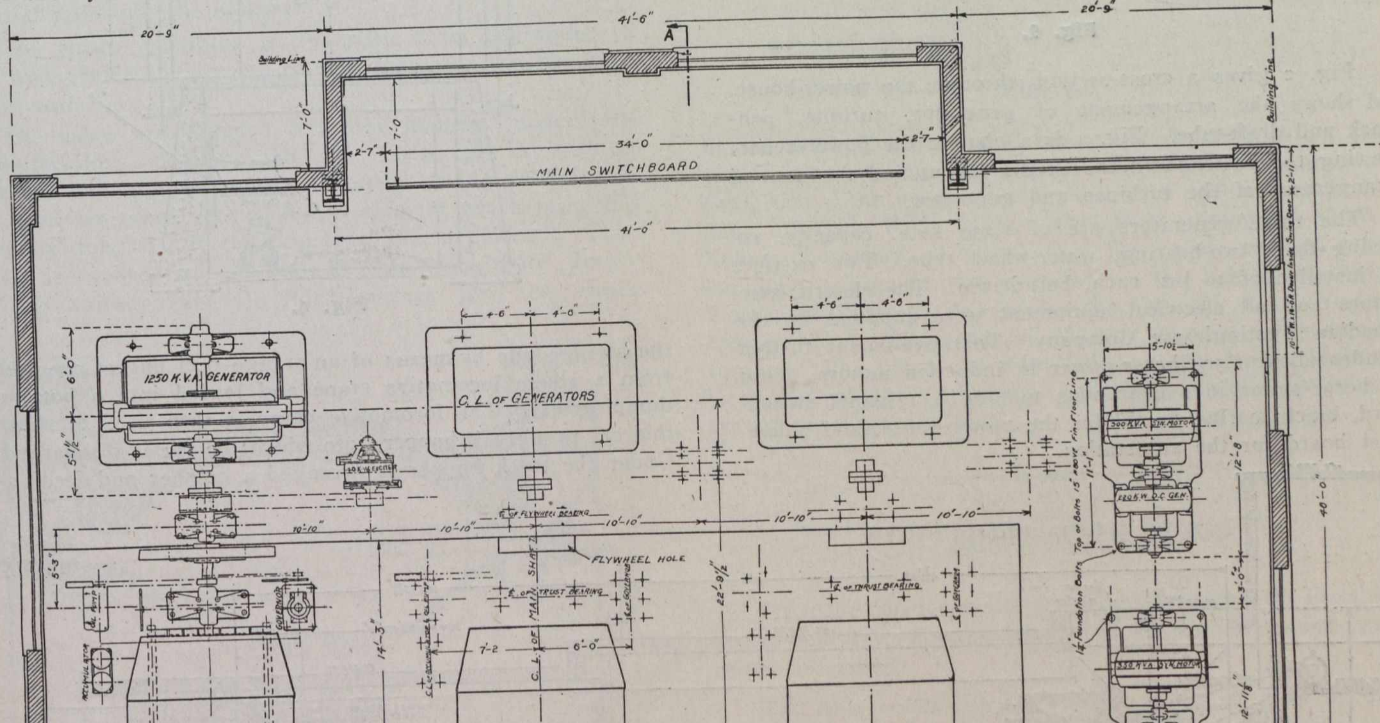


Fig. 1.

The Spanish River runs through the heart of the timber limits owned by this company, which comprise some 6,000 square miles. At Espanola the river runs between two promontories, creating a favorable location for the dam, which is built of concrete, flanked by natural rock formation on either side, and providing a 60-foot head of water. The storage thus provided serves not only to regulate the water supply, but also creates the necessary storage capacity for some 40,000 cords of wood, which it is necessary to prepare during the winter months for supply throughout the year.

Five large penstocks convey water from this dam to the turbines, which supply power for grinding the wood to pulp. A sixth penstock supplies water for three other smaller turbines direct-connected to generators, which supply current for operating the numerous motors used in the various parts of the plant. The five grinder turbines have 2,200 horse-power capacity each. The single penstock, which feeds the turbines driving the generators, is 14 feet in diameter, and on reaching the power-house divides into three sections, one supplying each unit. These three turbine units each consist of two 30-in. diameter Hercules water-wheels, 1,650 horse-power capacity, 360 r.p.m. when operating under the 60-foot head.

The penstock is 275 ft. long, the first 25 ft. being made from 5/16-in. plate, and the rest of 3/8-in. The intake is

12 ft. 2 in. wide and 14 ft. 9 in. high, with arched top. There is a 16-in. vent pipe to prevent collapsing of penstock when emptying, and an expansion joint is placed about half-way down to take care of expansion and contraction due to changes of temperature. Two 6 in x 6 in. angle iron rings are rivetted on the pipe at each end; between these angles a 3 in. x ½ in. anchor stay, ends of which are embodied with the angles in large concrete anchor piers. The upper part of the penstock is carried on cast-iron brackets, which are rivetted to the pipe, and set on concrete piers. The lower section is carried on structural steel, the saddles being carried on a trestle.

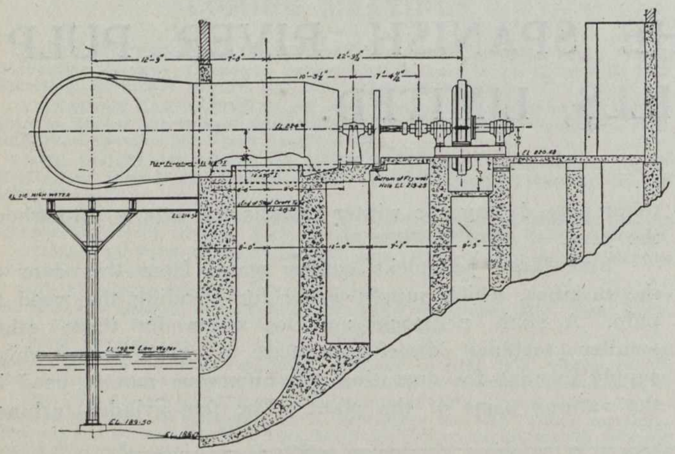


Fig. 2.

Fig. 2 gives a cross-section through the power-house, and shows the arrangement of generator, turbine, penstock and draft-tube. Fig. 1 is a plan of the power-house, showing the switchboard, the exciter layout, and the general arrangement of the turbines and generator.

The three generators are of 1,250 kv.a. capacity, revolving field, two-bearing, water-wheel type. Two exciters are installed of 40 kw. each, belt-driven. The electric generators and all electrical equipment were supplied by the Canadian Westinghouse Company. This equipment further includes about 2,500 horse-power in induction motors, about 700 horse-power in synchronous motors, a 17-panel switchboard, black marine finish, for the power-house, and a five-panel board for the sub-station.

ground can thus be covered as will ensure a sufficient supply over any desired period of time. For taking coal out of storage and placing it in the furnaces, mechanical handling has been adopted throughout. The coal is first dug from

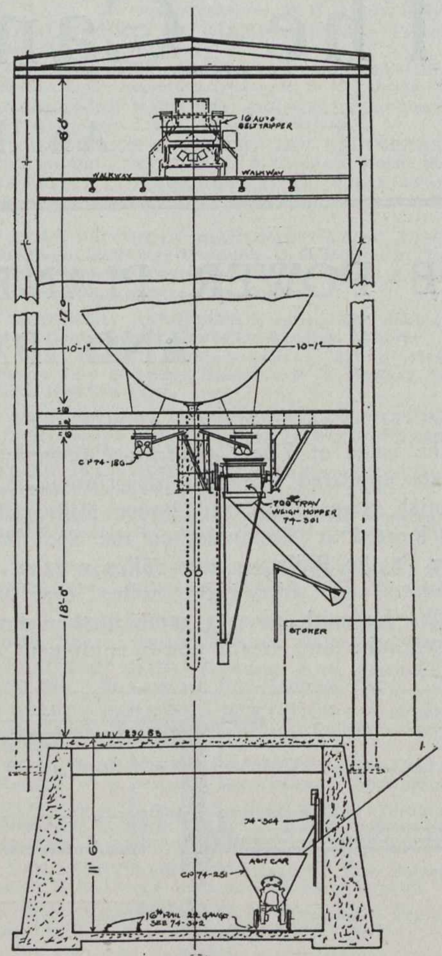


Fig. 4.

the storage pile by means of an orange peel bucket operated from a steam locomotive crane and loaded into a bottom-dumping car. The locomotive crane is then used to shunt this car to a track hopper, into which the car is discharged. Under the track hopper is arranged a crusher and feeding-

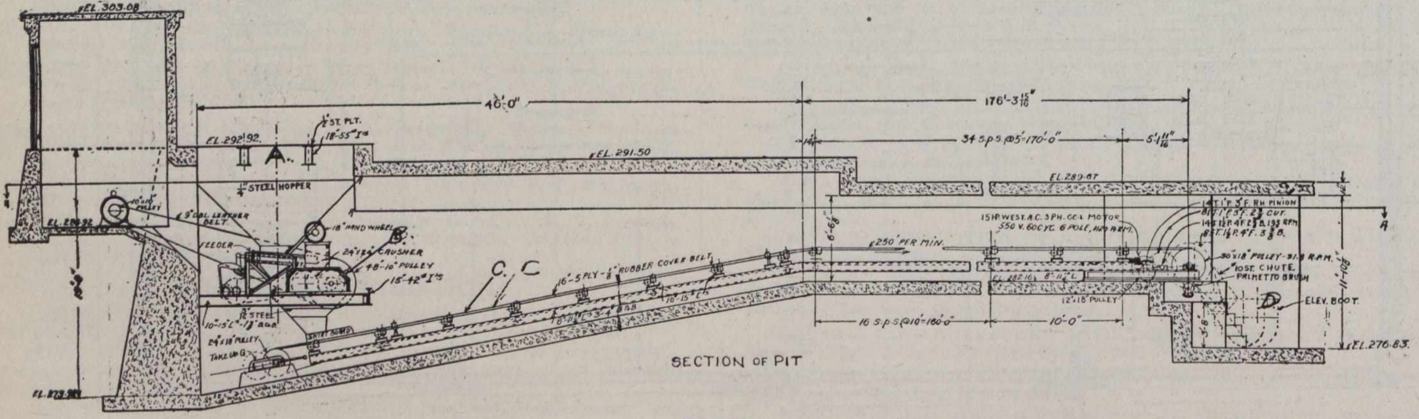


Fig. 3.

The steam plant equipment has been very carefully designed with a view to the most economical handling of the fuel and the ashes. The arrangements for handling the coal were influenced largely by the necessity of storing sufficient fuel to meet the requirements of the mill during the winter months. A convenient area of ground adjacent to the railway tracks has been taken, and a spur track laid in a manner that will permit placing this spur on top of the coal pile as fast as the pile is made. As much area of

gate, which feeds the coal to a belt conveyer. This conveyer carries the coal from the track hopper to a point at the end of the boiler-house, where it is elevated by means of a bucket elevator to a belt conveyer, which distributes it in a steel coal bunker over the boilers. Here there is capacity for storing approximately one week's supply of coal for the boilers.

The coal bunker is placed at an elevation suitable for drawing coal by gravity to the Murphy stokers attached to the boilers. In its passage from the bunkers to furnaces the coal is weighed and daily records kept of the consumption.

For the handling of ashes a tunnel has been constructed under the boiler-house, into which ashes can be drawn by gravity from ash hoppers under each grate. Industrial cars are used to collect the ashes from each of these ash hoppers and transport them to the end of the tunnel, at which point they are dumped into a skip hoist. The skip hoist consists of a sheet steel bucket, which is raised on an inclined track, dumping its load into a large storage bin for ashes and returning to its position in the tunnel automatically. The storage bin for ashes is supported on a steel tower at a suitable height to permit drawing off into railway cars when a sufficient quantity has accumulated.

The coal is dumped from railway cars into a receiving hopper (Fig. 3) (a), and is fed into the crushers by an automatic feeder, where it is crushed to stoker size (b), and then flows on to a belt conveyer (c), and then conveyed with the same belt conveyer through a tunnel to an elevator (d). From there it is elevated to the top of the steel tower and led on to a belt conveyer, which leads over the coal storage bunkers in the boiler-room. It is distributed into this bunker by an automatic travelling tripper (Fig. 4), The coal is then drawn from the bunkers into one traveling weighing hopper, and is accurately weighed. From there the coal falls into the stokers.

The entire apparatus is automatic from beginning to end, and avoids the use of manual labor for the handling of the coal.

The ashes are dropped from the hoppers underneath the boilers into side-dump ash-cars. These cars are pushed by hand, and are very easily operated, having roller bearings, and are taken out through a skip, at which place the ashes are dumped into the skip hoist into a bunker. This bunker is carried in a steel tower, and from there drawn into the railway cars. In this instance also the entire

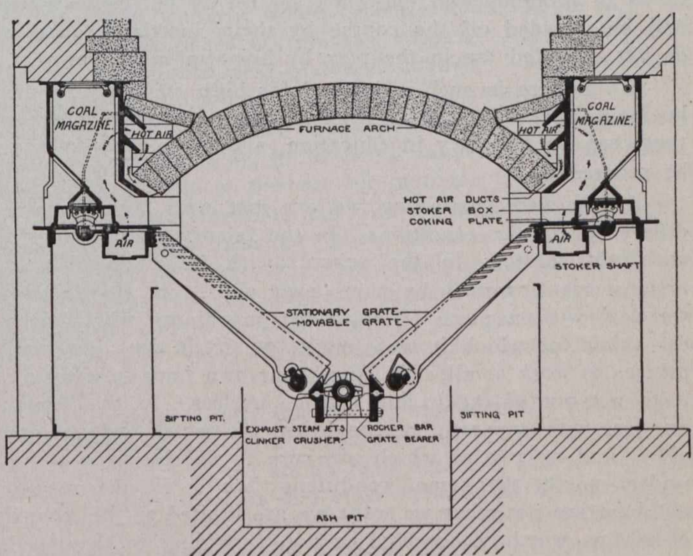


Fig. 5.

apparatus is practically automatic, and only requires the attention of one man to touch the button in order to operate the apparatus.

Two 600 horse-power steam engines of the Corliss type supply power for running the paper machines, and the exhaust steam from these engines is used for the drying of the paper.

Fig. 5 shows a transfer section through the Murphy stoker. Fig. 6 is a longitudinal section of the same.

Joseph H. Wallace & Company, Temple Court Building, New York, designed the plant. The water-wheels were manufactured by the Holyoke Machine Company, of Worcester, Mass.; the generators and switchboard by the Canadian Westinghouse Company, Hamilton, Ont.; the boilers

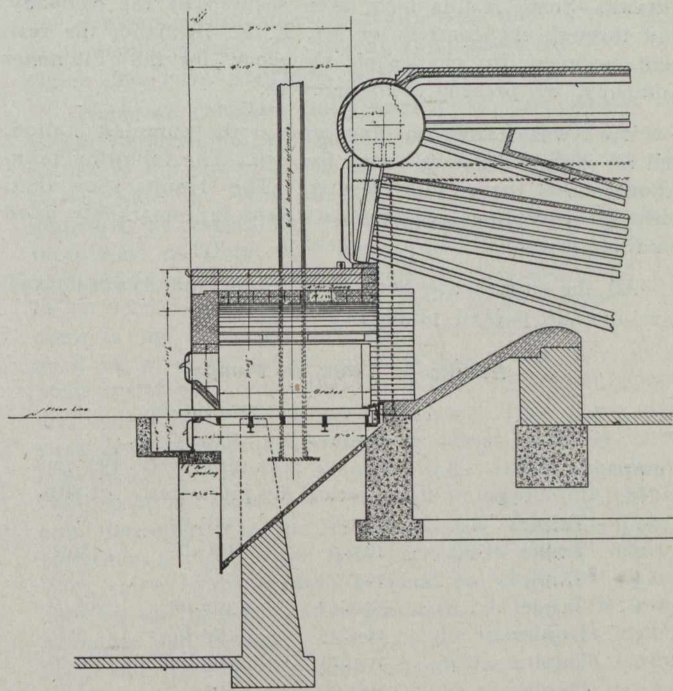


Fig. 6.

by the Robb Engineering Company, of Amherst, N.S.; the steam engines by the Goldie-McCullough Company, of Galt, Ont.; the economiser by the B. F. Sturtevant Company, of Hyde Park, Mass.; the steam piping by M. W. Kellogg Company, of New York. The entire coal and ash-handling equipment was installed by the Exeter Machine Works, of Pittston, Pa., while the Murphy Iron Works, Detroit, Mich., furnished the Murphy automatic, smokeless furnace. The penstocks were built by the Jenks Machine Company, of St. Catharines, and the hydraulic governors are of the Lombard type.

FIRE TESTS WITH GLASS.

From the conclusions of the recent fire test with glass of the British Fire Prevention Committee, the following excerpts are taken:

Too little account is often taken of the effect of an external fire on a fire-resisting building, and the protection of the vertical enclosure seems to be more often than not forgotten or neglected.

We have in fire-resisting glazing, if properly applied, a very valuable ally, and the report of the tests shows that such a material will afford a most useful amount of protection from the exposure risk.

It would seem that the maximum protection is afforded by fixing the glazing into metal frames or into masonry direct.

It seems regrettable that often the value of such a useful article as the type of glazing may be seriously discounted by inefficient fixing. It thus behoves the officers of the local authorities concerned to be on their guard in this respect.

A WATER SURVEY OF OTTAWA.

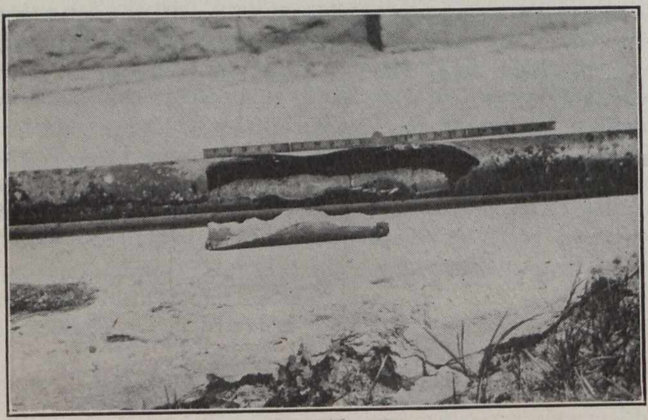
Some months ago we noted in *The Canadian Engineer* that the Pitometer Company, 220 Broadway, New York, were starting work on a pitometer survey of the water mains of Ottawa. Some results have been secured by the company, and through the courtesy of Mr. E. R. Howland, the resident engineer in charge of the work for the Pitometer Company, we present them herewith.

Work was started on May 22nd at the pumping station, and all the pumps were tested for slip. The following tabulation shows the results secured. The results show that, with few exceptions, the pumps were in remarkably good condition.

All the pumps are horizontal, crank and flywheel, and have outside packed plungers.

Results of Tests on Pumps.

Pumps, No.	Type.	Discharge per revolution in gallons per 24 hours. Theoretical.	As measured by pitometer.	Per cent. of slip.
1	Triple	127.9	127.9	0
2	Triple	127.9	126.8	0.9
3	Triple	127.72	118.5	7.2
4	Triple	342.42	303.02	11.5
5	Duplex	103.25	97.6	5.6
6	Duplex	103.25	102.5	0.7
7	Duplex	106.06	105	1.0
8	Duplex	106.06	101.4	4.4



View of Three-Inch Broken Main to Foundry.

As may be seen from the above table, generally speaking, the pumps were exceptionally efficient. The pitometer survey of the distribution system was started in the first week in June, and up to the present about half the city has been covered. A large number of underground leaks have been found, the most important being the following:—

Description of leak.	Loss in imperial gals. per 24 hrs.
Five-inch fire service to lumber yard badly split and discharging into a sewer	1,050,000
Five-inch main on Earnscliffe Avenue split and discharging into sewer	225,000
Three-inch service to disused foundry badly broken and discharging into a sewer full bore One-inch service to same foundry split and discharging full bore into a sewer	2,100,000
Leak on eight-inch main under tail-race. This crossing has now been abandoned and the main blanked on both sides of the water	350,000

A number of leaks have also been found on abandoned and fire services, bringing the total leakage, discovered to date, and repaired, up to about four million gallons per day. Many of the mains in Ottawa are laid in rock cut; the waste water, therefore, easily finds its way into the sewers without giving any surface indication. It is stated that some of the leakage discovered was undoubtedly caused by the exceptional depth reached by the frost last winter.

The illustration shows the break in the three-inch service to the foundry, mentioned in the above description of leaks.

EFFICIENCY IN EDUCATION.*

By Dr. George A. Hoadley.

We are living at a time in which the question of securing the highest efficiency in every form of business enterprise has become a dominant one. No man would undertake a business unless he could assure himself at the very outset that every department of it could be conducted both economically and efficiently.

For a man to take such precautions is not only an evidence of good common sense, but the stand is one that must be taken as a matter of self-protection.

There have been times in the progress of almost any kind of business when it was possible to keep it alive, and even prosperous, in spite of the careless and wasteful methods employed; but at the present time, when our excellent systems of communication have brought all parts of our country together and when manufactured products can be quickly delivered to the places where they are needed, however remote any manufacturer is almost as keen a competitor of another a thousand miles away is though they both lived in the same city.

Space and time have been annihilated, from the business standpoint, and the man who does not meet the standards of economy and efficiency set up by his competitors will be crowded off the course by their inertia of motion or left stranded far in the rear by his own inertia of rest.

Since there is such a demand for high efficiency in the business world, it may be well for us to enquire whether there can be efficiency in education, and, if so, how it may be secured.

At the very beginning we are met with fundamental differences in the conditions. In the factory one has to do with inert matter; in the school, with individuals whose actions are governed by their own wills. In the factory we deal with a piece of automatic machinery which does the thing for which it was made, or, if it does not and refuses to work at all, it is largely our own fault in allowing it to get out of repair and become useless. In the school we deal with separate personalities, no two of which are alike, and no two of which are sure to do the same thing under exactly the same conditions; while, if the results obtained are not what we want, we are limited to the giving of advice, which is accepted or not, according to the mood or fancy of the one who receives it.

It would seem, then, by this comparison of the material with which we have to deal, that the problem becomes a much more difficult one when we bring it into the field of education.

When a man designs a piece of automatic machinery he must, in order to be at all successful, have very definitely in mind the purpose for which the machine is being designed: what it is that the machine is to do. To take any

* Address delivered at the meeting of the Alumni Association of the Franklin Institute, March 23rd, 1912.

other course would stamp the attempt with failure from the start.

To secure efficiency in education, should there not be the same clear-cut, definite knowledge of the result to be obtained? There is in both cases a groundwork of that which is fundamental. In the case of the designer it is his knowledge of the physical qualities of the materials to be used. He must know what the limit of elasticity is of the material that he proposes to use in every part. He must know whether it will be able to stand the strains that will be put upon it in the work that it has to do. He must know whether there is a choice in this material, and he must make choice of the very best, or the next man who takes up the problem and who can profit by what he has done will so far surpass him in his design that the work will be a failure through the very competition that it invited, by not being the best machine that could be made. Not only must the designer have this fundamental information, but this fundamental strength, this fundamental elasticity, this fundamental adaptability must have been put into the material by the maker, or the machine will be a failure through his lack of this fundamental knowledge.

The same thing obtains in efficient education. There are, first of all, the fundamentals to be obtained and to be made such a part of the every-day life of a child that they seem to him things that have always been known.

At the very foundation of these fundamentals I would place the ability to think straight. Perhaps you think that I am beginning at the wrong end, and that the ability to think straight is the aim and end of education and cannot be had at its beginning. Well, there may be some reasons for your opinion, but I really believe that in order to secure efficiency in education it must be founded upon the ability to think straight, to have the moral sense of what is right and what is wrong; and, moreover, I believe that this ability is common to most men and women.

To the man who does not think straight, or who will not, an education brings at most the ability to succeed in things in which it would be better if he should fail. There is another phase of thinking straight, and that is to have one's thoughts clear and well defined. This, too, seems to me to be one of the fundamentals in education.

If we are to have any hope whatever of being of service to those about us, or of being influential among them, we must be able to present our opinions to them in a clear and forceful manner, and this we cannot do unless we are able to think them out clearly to ourselves. It is a pleasure to listen to a man who has a definite purpose in his mind, and also has the ability to express that purpose in fitting words, and so I would include, as another fundamentally important thing, an ability to use one's native tongue forcefully.

Too frequently, none of the things that I have mentioned are considered as a necessary part of an education at all. In addition to the ability to understand and use the English language, there is one other department of knowledge that lies at the very foundation of daily life, and that is mathematics. Now, do not think of the kind of mathematics that delights the mathematician, for what I mean is the fundamentals—that is, the elementary mathematics, such as arithmetic, algebra, and geometry. If we consider for a moment that the great discoveries of Nature were most of them made with just these branches of mathematics applied to the questions in hand, possibly adding trigonometry for the use of the astronomer, we shall see that the essentials are elementary.

No one can live in our times, surrounded as we are by the most striking applications of science, without feeling that a study of the natural sciences is required in order to consider that we may be entitled to the name of educated people. Here, again, the fundamentals are of the greatest importance. Take, for example, electricity, which has so general an application in lighting, heating, and furnishing us a means of transportation. As a matter of fact, the essentials are few. It is in the applications that there is so great a divergence. Let a man be thoroughly grounded in the elementary principles of magnetism and electricity: it is a simple matter of diligent application of these principles that solves the most intricate problems to be met.

When we calculate the efficiency of an electric generator, for example, we find that it is the ratio of the power output to the power output plus the **losses.** How are these losses made up? Why, there is the loss in the shunt field, and this we expect and are willing to allow, because if there were no shunt field there would be no lines of magnetic force for the armature wires to cut, and there would be no voltage generated for delivery at the brushes. Then there is the armature loss, and this we expect, for there must be wires to cut the lines of force, and they all have some resistance; hence there is a heat loss in the armature that increases as the current increases. Then there are the stray losses—those heart-breaking losses that the designer tries to cut down, and generally fails: losses that have no compensation; that have no redeeming feature; that are only detrimental to the machine, and that cut down its efficiency ten per cent. How are these losses made up? Why, there is the friction between the shaft and bearings, between the brushes and commutator, between the rotating armature and the air. There is the time-lag or hysteresis loss, and there is the eddy current loss, which is due to currents set up by the cutting of the magnetic lines by the armature core or the pole pieces, and which only serve to heat up the machine and increase its resistance. Now, how does this apply to education? What I would say is that if we wish to increase efficiency in education we must cut down the losses. Perhaps there are some of them that are really so connected with the system or method that they cannot be avoided. But there are certain others—the stray losses—that are wholly harmful, and these should be eliminated. The friction losses between teacher and taught should disappear. The system should be so changed that friction between both teacher and taught and the system should not be possible. And greatest of all, the eddy currents, those vampires that destroy uselessly, caused by inattention, lack of interest, lack of enthusiasm should be themselves destroyed.

To ensure efficiency in education there must be a greater saving in another great loss, and that is in the loss of time. This requires that one shall know without question what it is that he wants to inform himself on, and not flounder along helplessly for months or years with no definite goal in view. You who have the opportunity of taking the courses that the Franklin Institute offers have had the advantage of knowing definitely what it was you wanted to study. You have had the opportunity placed before you of applying yourself directly to the problem in hand, and if you have taken advantage of these opportunities you have the consciousness that the education so secured has brought with it something that has been of real and lasting value. I believe we should never look upon our education as a thing of the past. I greatly admire the point of view of the centenarian who had completed his hundredth year in this year 1912 who went to a shoemaker to have a pair of shoes repaired, and who was very insistent that they should be made strong enough to last a long time. The shoemaker said to him: "Why, you are a hundred years old, and still you seem to be as anxious that these shoes shall last as though you were to live another hundred years." "Well," said the old man, "perhaps I shall. I am a great deal stronger than I was when I started out in 1812." That is the kind of optimism that I like.

3000 KW. VERTICAL ROTARY CONVERTERS.

Two 3000 kilowatt, vertical, synchronous booster, commutating-pole, rotary converters have just been built and tested by the Westinghouse Electric and Manufacturing Company in its East Pittsburg works. These two machines, which are of unusual interest because they are the largest vertical rotary converters ever constructed and because they are the only vertical converters ever built involving the synchronous booster and commutating-pole features, are for the New York Edison Company for installation respectively in its Clinton and its Crosby Street sub-stations.

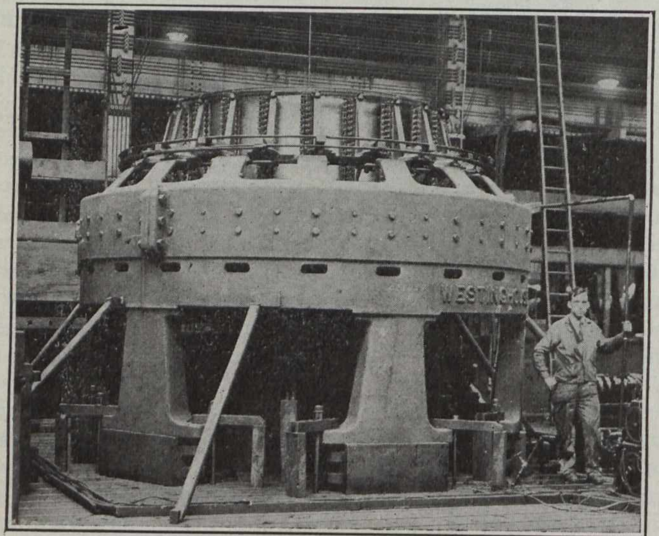


Fig. 1. 3000 kw., Vertical, Synchronous Booster, Commutating-Pole, Rotary Converter on Test.

The converters deliver a normal direct current voltage of 270, and are for 25 cycle, 6-phase operation. The direct current voltage variation obtained by virtue of the booster feature is 15% buck and 15% boost from the normal voltage, giving a total direct current voltage variation of 30%. These machines were made of the vertical type to conform in general construction to the other converters in the sub-stations, all of which are vertical machines.

Fig. 2, a sectional drawing, shows the detail construction of the machines. The converter armature and frame are mounted above the booster armature and frame. The commutator is at the top of the machine and the collector rings at the bottom. The armature consists of a rotary converter of the usual construction mounted on the same shaft with the smaller booster armature, which is connected in series with the converter armature so that when the booster field excitation is varied, the alternating current voltage impressed on the converter armature will be decreased or increased accordingly.

The main or converter poles are shunt wound. The commutating-poles which lie between the main poles have been so wound that variations in armature reaction introduced by the booster are taken care of. The copper grids imbedded in the main pole faces do not extend from pole to pole as in ordinary machines but are cut off flush with the sides of each main pole. This construction is used on all commutating pole converters, which forms the most effective starting and damping winding. The booster poles are shunt wound, and the booster field is arranged for hand regulation. Provision is made for effectively cooling the commutator by the insertion of copper heat-radiating vanes in the upper end of each commutator bar. Ample space is provided between commutator necks which extend from the commutator bars to the armature coils, and through these spaces the cooling air is forced by the rotation of the machines. A commutating pole converter which is to be started from the alternating current end must be provided with a brush lifting device, but inasmuch as these machines are to be started from the direct current end, a brush lifting arrangement is not necessary.

Some of the mechanical constructional features are unique and different from any heretofore used for vertical electrical machines. The pedestal on which the armature rotates, and which is plainly shown in Fig. 2, is a one piece, hollow steel casting having a large area of base. With this construction a much more rigid structure results than with the usual one wherein a steel pedestal with flange on its lower end is bolted to a cast iron base. The pedestal is tapered so that the upper bearing is smaller in diameter than the lower one. This facilitates assembly. The bearings proper are babbitted and cast in a sleeve which can be readily taken out of the converter spider for re-babbitting.

A roller thrust bearing is arranged at the top of the pedestal to take the weight of the revolving element. The bearing rests on a plate which has a spherical seat carried on the pedestal so that perfect alignment is assured. The roller bearing can be taken out by removing the top plate of the machine. To assume the weight of the rotating part at times when it is necessary to remove the top plate, six 1¾ inch bolts are provided that turn through the lower portion of the pedestal flange. When it is necessary to take off the top plate, these bolts are screwed up until they raise the rotating element a trifle and assume its weight.

Lubrication is effected with a gravity oiling system. The oil is drawn from the reservoirs and forced up through the oil pipe in the centre of the pedestal. At the top of the pedestal, the oil discharges through a nozzle into a cylindrical chamber within the roller bearing. The pressure on the oil forces it from this chamber out between the bearing rollers into an annular pan surrounding the roller bearing. Oil

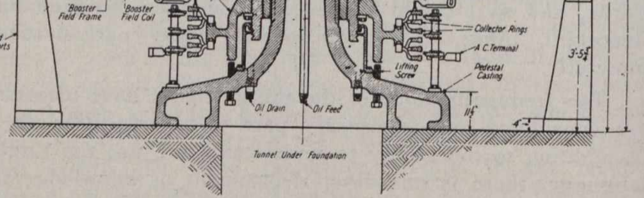


Fig. 2. Sectional View of 3000 kw. Vertical Converter.

cannot leave the chamber except through the bearing, and the height of the outlet nozzle and the oil pan rim are such that the bearing rollers always travel in a bath of oil. When the oil overflows from the pan around the roller bearing it passes into an annular chamber just above the upper pedestal bearing. From this chamber its only exit is through oil grooves in the pedestal. While it is passing through these grooves, the rotating babbitt bearing surfaces take up oil. From the upper pedestal bearing the oil flows down through the chamber around the shaft to oil grooves for the lower bearing similar to those above described. From the lower oil grooves, the oil discharges into an annular reservoir to the lower part of the pedestal from which it drains into a storage reservoir to be circulated again through the lubricating system. An effective oil thrower arrangement is provided at the upper part of the oil space and around the lower part of the pedestal which effectively prevents oil creepage up the shaft.

EFFECT OF INSTALLING METERS AT DECATUR.*

By Harry Ruthrauff.†

As to the effect of installing water meters at Decatur, Illinois.—First let me say I do not wish to claim the title of an expert; but simply wish to state the facts as I have found them during my twenty-two years experience in the water department at Decatur.

I believe it important for every community to obtain and conserve, without unnecessary waste, a water supply ample and suitable for all purposes. The question with me from the beginning of my experience was,—"How to Stop Unnecessary Waste?"

I was first employed as a laborer in this department; later as foreman and finally in the year 1894 was appointed water inspector. I therefore knew of the great waste of water upon entering the duties of my office.

The first five years I served as water inspector I worked faithfully in an effort to stop the waste, which was enormous, due to carelessness on the part of consumers and defective plumbing. I used every honorable means along this line, always looking after this work personally. In 1896 I employed four assistants with the avowed intention of stopping all leaks, and thereby preventing waste in the city. I again went over the city in 1898 with four assistants, looking after this waste, giving the matter personal attention.

I brought into our police courts citizens by the score and prosecuted them for wilful waste. After about five years labor along this line, I began to get discouraged. I found that a great many of our citizens believed we had an inexhaustible supply of water, therefore could not see any good reason why I should be so extremely anxious about this matter. Consequently, I began to look for some other plan. I believed, if this waste were allowed to continue, taking into consideration our rapid increase in population, we would in a short time find our supply short, or be at an unnecessary expense for additional machinery, mains and enlargement of our reservoir and filter plant to handle water merely to be wasted.

In 1901 I recommended to the council the adoption of the water meter on all services. The recommendation was filed, but no action taken. Again in 1902 I urgently recommended the same plan and was then ordered to have all the livery stables, hotels and laundries install meters. I was then able, by comparison, to prove the water meter would be beneficial both to the city and the consumer, and each year thereafter I strongly recommended the placing of all meters on all services, and finally in the spring of 1908, the council ordered all services metered by July 1st, 1908. The results are as follows:

April 31st, 1904, the end of our fiscal year, we had 2,112 services recorded; five consumers for each service gave us 10,560 consumers; 987 of these services were metered. I wish to say here that there was no record kept of the water pumped prior to the year 1903. However, with 10,560 consumers, 4,935 of them metered, there was pumped for this year 1,023,463,180 gallons, which gave us a per capita consumption of 266 gallons.

Revenue for this year was		$32,812.99
The operating expenses at plant for this year were	$17,100.84	
The operating expenses, outside of plant, such as laying mains, repairs, etc., were	5,899.16	
The total expense		23,000.00
Leaving a balance of		$ 9,812.99

The plant was operated at this time with two shifts with coal costing $1.50 per ton.

For the fiscal year ending April 31st, 1911, we had 4,939 services in use, 4,933 being metered. I will say the 6 services unmetered are large consumers. This gives us, on a basis of 5 consumers to the service, 24,695 consumers. There was pumped during this year 1,124,212,338 gallons, which is 100,749,158 gallons in excess of that for the year ending April 31st, 1904. With an addition of 14,135 consumers, we now have a per capita consumption of less than 125 gallons. It is my belief that if the six consumers previously mentioned were metered, our per capita consumption would be less than 100 gallons. This may yet seem excessive to some, but we have some very large consumers for a city of our size, having 6 consumers using annually about 300,000 000 gallons.

The operating expenses at the plant for the year ending April 31st, 1911, were	$30,657.23
The operating expenses outside of plant, laying mains and miscellaneous were	26,960.01
Making the total expense	$57,617.24
The revenues for this period were	52,577.00
Leaving a deficiency of	$ 5,040.24

We now have three shifts at the pumping station, with coal costing us $2.15 per ton. The lowering of the water rates a few years ago and increased cost of operation are the causes of the deficiency, which has been overcome by a slight raise in water rates effective July last.

We have accomplished by the enforced use of meters at least a 30 per cent. reduction in the average householder's bill. Under the old flat rate system a 7 room modern house would cost him $17.00 per year and under our present system, his yearly bill should not exceed $12.00.

We have also cut the per capita consumption from 265 gallons to 125 gallons,—thereby saving, at the present time, an unnecessary pumpage of 1,270,928,175 gallons each year. Therefore, the benefit derived from a complete metering of any city is very clear to me.

*Paper delivered before Illinois Water Supply Association, March 5, 1912.

†Commissioner of Public Property, Decatur.

General passenger agent W. P. Hinton, of the Grand Trunk Pacific Railway, says that such good progress is being made with the construction work that the line will be completed from Winnipeg to Prince Rupert by the end of 1914. There is at present a gap of 300 miles between the western end of the line in Yellowhead Pass and the eastern end of the completed line from Prince Arthur. Mr. Hinton says the Grand Trunk Pacific will do its share in the movement of this season's grain crops. He estimates that the Western farmers should have $75,000,000 more to spend from this year's crop than they had from the yield last year.

MAINTENANCE OF ROADS AND PAVEMENTS.*

By James Owen.†

The writer of this article would have preferred that the title of this paper should have been the economies of roads and pavements, as he sees that at this stage of road development the financial question is paramount. But as finally the maintenance problem is the one with which to deal, the discussion of that feature will of necessity include the money end, so it is hoped that undue stress upon what is sometimes too apt to be ignored in engineering in the means of construction as well as the methods will be pardoned.

In discussing the pavement problem in such an extensive country as this, with its varying climate, topography, materials to be used and habits of the people, it would seem impossible for any one individual to cover the whole ground, as, of necessity, each man's environment and experience are limited. Yet, the aggregate of such experience will be of value to all. So, if in these remarks statements at variance with the ideas and experience of other members of this convention are made it is hoped that prompt repudiations of the statements will be evolved, as by such means will accurate data be accumulated.

To properly consider the subject in its entirety it may be wise to indulge in a classification of the people, the pavements and the pay. The traveling people may be divided into urban, suburban and rural and it may be confidently stated that the requirements of the pavements differ in character practically in accordance with this division, except that there may be a certain overlapping due to special conditions. This covers two heads. The ability to pay varies spasmodically with climate, topography and the energy of the community.

Now enters into consideration the character of vehicles which there are to-day two, self-propelled and horse-driven. Both of these may be divided into fast and slow moving, the heavy wagon, the light buggy, the motor truck and the automobile, these introducing still other items, the iron tire of the wagon, the solid rubber of the buggy, the corrugated tire of the motor truck and the pneumatic tire of the automobile. All these factors vary in weight and speed and their effect on the surface of the pavement is of vital importance.

Another point, which has not yet arisen, is the effect of different pavements on the tires of vehicles. So far, the owners of such vehicles have been so busy trying to get something smooth to ride upon that they have been content to pay their bills for new tires and new wheels ungrudgingly, yet in the future it will be an important economic factor.

There is still another factor which to-day is the most important in road construction, viz., the suppression of dust. Also, there enters in, to a lesser degree, the suppression of noise in cities.

Taking all the factors outlined heretofore, the problem is to furnish a pavement that is smooth, durable, dustless and cheap; and that problem is to-day facing the civilized world. It is not my intent to dilate very extensively on the paving of cities, as practice in that branch is being slowly crystallized and the principles governing it are giving good results. Classify city traffic into business trucking, arterial communication and purely local distribution, with the use of the following standard pavements, wood block, granite block, Medina sandstone, brick, asphalt and the tar compounds, and with proper care in the selection and manufacture of material and a conscientious disposal of it in place, and in most cases a smooth dustless pavement will be secured. But here enters the question of maintenance and also the traveling factor. At the same time there arises a controversy between drivers of horse and motor vehicles on the question of smooth pavements, the horsemen claiming that the smooth pavements, like wood block or asphalt, are impassable and useless at certain periods for heavy hauling and should not be tolerated. That at seasons their slipperiness is detrimental is not doubted. However, this point is one for purely local consideration and cannot be generalized upon.

Cobbled and old-fashioned granite block are certainly permanent but not desirable. The close jointed grouted granite block and the Medina sandstone would seem to be ideal. They are smooth, and once down relieve the maintenance department from attention for a generation. Wood block as now laid is desirable, smooth, and, at times, slippery, but its permanency is unknown.

The brick pavements of to-day are desirable and appropriate, especially in districts where there are no stores. Here it is proper to make the statement that many paving brick manufacturers are setting an example to the community in concentrating their efforts on making and delivering the best possible brick, relying more on the character of the material than on their profits for future prosperity. The writer suggests this example to other industries. Brick pavements as now constructed also relieve the maintenance department, if proper care is used in discriminating on certain character of travel. Where there are extraordinarily heavy loads and dense vehicular travel, it is not wise to use brick.

We now come to the mastic propositions in which the maintenance department sooner or later takes an interest. The asphalt and tar preparations give a smooth, dustless and serviceable road, and are desirable for residential sections and in many cities are universal. Their maintenance is carried on in different municipalities in different ways, some owning their own repairing plant, others contracting the repairs, and still others neglecting them altogether. It is safe to say, however, that after five years' use of these pavements the item of repairs begins to be a factor, although the writer has one asphalt pavement which has been in use for nearly ten years without repairs or apparent necessity for them.

Interjected into many cities is the use of cheaper pavements for purely residential streets of both high and humble character. Sanitary precautions in some cases cause their existence before the demand is made by the residents who often are not able or willing to pay. In other instances they are laid at the desire of the property owners, and in these the maintenance problem soon appears, and the practice there can be considered the same as in suburban communities.

In street development in suburban communities or small towns there are new factors to be considered. Except in main thoroughfares the travel is light. The unwillingness to pay large assessments and also the suppressing of dust has opened the field to endless inventions with varying materials to privide cheap, smooth and dustless pavements. All kinds of panaceas have been promoted and enormous sums of money have been expended in experiments, and it is to be hoped that in the near future a practice may be adopted available to all within their means. This same idea extends, to a degree, to rural highways, and it would seem desirable to discuss the problem as common to both classes of communities.

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* Paper read before American Road Builders' Association, Nov. 14-17, 1911.

† County Engineer, Essex County, New Jersey.

To properly appreciate conditions it would be well now to consider what these pavements, so-called, have to endure. With horse-drawn vehicles and steel tires, the roads were constructed to be available for such use and the standard generally adopted where material was convenient was the macadam or telford pavement, using the local rock if possible, but in many cases bringing it from 200 to 250 miles by water or rail. Where rock was not available, other natural materials were used, such as gravel, shale, chert, sand and clay, and in the arid sections, clay and oil. The success of these pavements when properly constructed and maintained gave an enormous impulse to automibile travel, in some cases causing it to supersede horse travel. The rapid increase of automobile travel, however, speedily began to impair the surface of the highways and pavements, and also created volumes of dust. This condition started new ideas and new investigations, of which we are now in the throes.

Careful comparison of the effect of iron tires and shoes and rubber tires on road surfaces shows a marked difference in their action. Under the old order of things, if a coating of broken stone or gravel were placed on a highway it was confidently expected that the surface would soon be consolidated. It was probably wearing out the patience of the traveler, but showing that a consolidatory effect was obtained. The writer has made experiments with automobiles, at low and high speeds, both on macadam and gravel surfaces and finds that their action is disturbing, the higher speed the greater the disturbance created. There are, therefore, two opposing factors in the maintenance of present highways and the resultant is determined by the preponderance of certain kinds of travel. Where the wagon travel is universal the old conditions exist and the old practice may prevail, and where the automobile is universal, an entirely different system of maintenance has to be followed. But where there are equal volumes of the two kinds of traffic the greatest difficulty exists. The question of the future must now be considered. Will automobile travel entirely supersede wagon travel or will the travel still be mixed? It is well accepted that there is a great growth of automobile use and a great diminution of horse-drawn vehicles and the decision of such a factor is purely local.

Another very important factor is the suppression of dust, and here the writer wishes to enunciate the fact that the automobiles themselves are not the creators of the dust, as is generally considered. The steel tire with its grinding action creates the dust and the automobile, with the wind, disturbs and scatters it. As a proof of this a coating of screenings laid in late spring on a road carrying only automobile travel will still be in the same condition in the fall, merely disturbed, but not consolidated. And there will be no dust.

Taking these facts as axiomatic, the maintenance of all pavement surfaces liable to wear must be considered as a purely local problem governed entirely by the local travel. The dust question has this peculiarity: It may be more troublesome on a less traveled highway. This question, while of somewhat recent origin—that is to say, while there was always plenty of dust, the public for some occult reason did not complain of it—is really the governing source of all new efforts at road making, and is just as much of an economic problem in rural communities as it is in urban. The impairment of the value of crops, especially fruit, is an accepted fact and the demands for suppression are insistent and imperative. In the effort at dust palliation a large amount of gray matter has been expended and a great many expedients have been devised. Setting aside the experience of the French engineers at Algeria where the first experiments in dust suppression were made with the oil of Massat, the California practice was really the first that did not use water. But we all understand that water was the first material used for dust suppression, whether by rain or the watering cart. In southern California there is little or no rain and the heavy mineral oil was used, first by surfacing the adobe soil with clay and then sprinkling the oil. This gave good results and an application twice a year proved satisfactory.

This idea spread and the practice of using crude oil for surfacing came into vogue. The smell in the houses and the ruination of carpets and clothes stopped its use and then oil, without the smell, was manufactured, and with some of the stickiness eliminated. These oils, generally with asphaltic bases, gave general satisfaction and are now in general use. The idea, however, was prevalent that a dustless, smooth, permanent surface could be devised that would be cheap and effective, and such surfaces have been provided, but the question of cost then becomes the vital point.

The original experiments made by Mr. Blanchard of Rhode Island in resurfacing roads with asphalt or tar mixtures and the reasonable low cost with good results after a limited period of use encourage the whole country, as well as the writer to be up-to-date and do likewise. It must be understood that those experiments were made by a competent engineer with selected help. When, as is often the case, communities do not employ a competent engineer nor have selected help, however, very different conditions prevail.

The writer started on the unknown path and resurfaced miles of road with heavy asphalt oils by the penetration method, and also drew specifications for new roads to be built by the same methods. The results, however, were so unsatisfactory that the practice both in old and new work was quickly abandoned. Subsequently contracts were made for work by the mixing method both by cold and hot application and results from them have been satisfactory. The final practice arrived at by the writer is to build his roads by the old water bound method and then apply a light surfacing oil at the proper season to allay the dust. This is found to give the smoothest pavement for the least money on an average country road in New Jersey where there is a large automobile travel.

The experiences in the penetration method were peculiar and there was also a curious case from the fact that the engineer was compelled to rely upon the chemist for his data, accepting such data even though based on meager procedure. The question of manipulation by the labor available became more of a factor than the chemical data. Men of experience in the old practice were at sea in the new methods, and in one case, even though an expert was called in and special men were employed, the result was unsatisfactory, from an engineering standpoint. It is true a certain percentage showed good results, but forty per cent. efficiency is not ideal.

In one instance a section of newly built road a mile in length was finished in the fall and presented a good, smooth surface. In the spring, however, the surface broke to pieces over the entire length and had to be renewed. In other cases the rolling of the surface mixture into waves practically put an embargo on travel and the surface had to be entirely removed. In another case a rut six inches deep and a half a mile long appeared with no apparent cause. With such experience the writer may be excused from indulging in any more surfacing escapades.

With the mixing process better results have been obtained. In one case, with a hot mixture, the surface, after being rolled and having cooled, was a series of waves.

Curiously enough, after eighteen months of travel these waves disappeared and a smooth surface now exists with no appearance of wear.

The cold mixture gives excellent results, producing a surface that is smooth and equal to asphalt.

A few experiences in surface oiling may be interesting. In maintaining a system of 150 miles of road with city and suburban travel a complete system of repairs is obligatory and breaking the continuity of such a system leads to complications. As the demand in the writer's section for the suppression of dust was in the spring it was considered desirable to find an oil that would last the season. It did last the season in most local cities, but such an oil ruins the surface of a pavement, creating a pitting which is very objectionable. This heavy oil of course prevents the ground particles of the road from being blown away but when it rains an emulsion is formed which is of great local objection. Therefore it was found advisable to use a lighter oil with more frequent applications, and with such practice no impairment of the surface is presented. With the practice of repeated applications of dust preventives the use of materials not containing oil may be advisable, depending of course on the system in vogue and the cost of the material itself. Some of these the writer has tried but so far not with the success anticipated. In residential localities these preparations are of advantage as no oily particles of dust are carried into the houses or on the clothes of wayfarers.

There is one other point that the writer wishes to emphasize, and that is that with the growth of automobile travel the character of the mineral aggregate in any mixture is of secondary importance. Under the old conditions, hard trap rock was ideal and was used wherever available, even when long hauls were necessary. Such an insistence is not now necessary as it is found that with the grinding eliminated and the use of surface oils, good gravel gives as excellent results as the trap rock. Granite can be used with impunity, and such natural materials as chert and shale can also be used. The sand and clay roads of North Carolina can, with oiling, be made into perfect roads, as is shown in California. A full appreciation of such a fact will reduce the cost of thousands of miles of roads in the future.

The writer now wishes to allude to the financial problem in road construction, and it might be well to note the varying channels from which money comes. Taking my own State as an example, these are as follows:

City street paving.—A part, say about 80 per cent., on property, balance on the city at large. Maintenance a city charge.

Suburban towns.—Streets macadamized 16 feet wide. A general tax; extra width local assessment.

Rural towns.—Mostly developed by either state roads or county roads.

County roads.—Main arterial highways paid for on bond issue of the county; maintained by the county. County road repair system abandoned when state roads came into use.

State roads.—State pays 33 per cent., county 56½ per cent., town 10½ per cent. Maintained by the county with contributions from the State of automobile money, say 20 per cent.

With such varied methods of pavement for original construction it is to be noted that the maintenance cost is defrayed by either the county or municipality, with the addition of a small amount from automobile taxes. Now enters the important part of the whole question of road and street maintenance and that is the ability and willingness to pay.

As to ability, that is a condition hard to gainsay. As to willingness, that can be overcome by education. To properly educate a community to higher ideals and standards, those ideals and standards must first be crystallized on a permanent basis and then set before them.

In too many cities of the United States there are rough and unsightly pavements tolerated by educated people and traveled over with repugnance, yet there they are. In country districts where good roads have been made they have been allowed practically to disappear through neglect. In other communities the desire for the ideal and also the willingness to pay are both present yet the supply of talent and material is deficient.

So, in this question of road surface maintenance the practice in cities is fairly conceded to be beyond controversy. Only the money is required.

In suburban and rural highways this problem confronts us: In days before the automobile, with wagon travel alone and with a system of roads in cities, towns and country, the average cost of macadam repairs was three cents per square yard per annum. This, by increased travel, increased cost, and automobile, has now raised the cost to six cents, and the oil at one cent brings it up to seven cents per square yard per annum for having and keeping a smooth oil surface.

Rejecting the penetration method as erratic and uncertain and applying the mixing process the cost runs from 80 cents to $1.10 per square yard. Consequently the mixture has to last ten or twelve years to be equal in actual cost to the oiled macadam. Another item enters in. The renewal by mixing, or 150 miles of road 16 ft. wide at, say, 90 cents, would cost $8,300 per mile or a total of about $1,245,000. As this would have to come out of the annual appropriation, whatever money was expended in the mixing should be made a separate item, otherwise the maintenance account of the balance of the roads would show a shortage and deterioration would ensue. This has been the experience of many communities and great dissatisfaction has been the outcome.

In conclusion the writer hopes that in the near future the mistakes and experiences of different men in different sections may bring the practice of road repairs into some definite shape, both as to construction and financing. The community, including the road wearers and taxpayers, want good roads at the lowest cost and are willing in most cases to furnish the money if good results can be obtained. It is the province of this association to supply the demand.

MANUFACTURES IN CANADA.

The census of manufactures of Canada taken last year for the calendar year 1910 as now compiled by the Census and Statistics Office, gives the following comparative statistics, compared with those of the census of 1901 for the calendar year 1900, viz.:

—	1910	1900	Increase	Increase p.c.
Establishments	19,202	14,650	4 552	31.07
Capital	$1,245,018,881	$446,916,487	$798,102,394	178.58
Employees	511,844	339,173	172,671	50.91
Salaries and wages	$240,494,996	$113,249,350	$127,245,646	112.36
Materials	$600,822,791	$266,527,858	$334,294,933	125.42
Products	$1,164,695,032	$481,053,375	$683,641,657	142.11

The capital employed in manufactures increased during the decade by 178.58 per cent. and the value of products by 142.11 per cent. The number of establishments employing five hands and over last year was 19,202, being an increase of 4,552 in the decade.

EMERGENCY WELDING OF BROKEN PARTS OF DREDGES.*

By S. E. Lawrence.

The continuous operation of dredging plants, day and night, and the extreme usage that some of the machinery is subjected to are conducive to many break-downs, which are very expensive both in repair cost and more especially in delays and crew costs while parts are being repaired.

Such accidents are provided against as far as they can be ordinarily foreseen by keeping on hand such duplicate parts as may be expected to give way under usual conditions, and each plant in this district is equipped with a small machine and blacksmith shop to handle emergency repairs. Such precautions do not, however, provide for the larger breaks and the extraordinary accidents, and it is in this particular field that the Thermit welding process has been of service in several instances.

The first time this method was employed by this office was in the repair of the low-pressure connecting rod of the 550-h.p. triple-expansion engine directly connected to the dredging pump on the 20-in. U.S. pipe-line dredge "Col. A. M. Miller."

This fracture was an example of the sudden development of an invisible flaw made in the original forging of the part. This engine had been in constant operation for several years and no precaution had been thought necessary to keep an extra rod on hand.

As it would delay the dredge for an indefinite time to secure a new part from the factory, and also several days at least to machine one in a local shop, it was determined to try and reweld the broken fork. Only fair results were obtained, and it was not thought advisable to use the rod. Then it was that the Thermit process was resorted to. About 1 in. of metal was removed and the parts fastened to a bedplate in as perfect alignment as possible. The weld came out of the sand in good condition and, after removing gate and riser, the part was placed in the engine without further machining and was so used with best of results.

The second instance in which this method of repair was made use of was in the repair of one of the propeller shafts of the seagoing hopper dredge "Galveston." This was hardly a weld in the common acceptance of the term, as there was no uniting of several parts, but it served as an illustration of the varied uses that this method can be put to.

While at work at the mouth of Galveston Harbor a wire cable became entangled about one of the shafts in such a way as to wear a groove in it about 1¼ in. deep and 4 in. wide. This weakening of the 10-in. shaft necessitated its removal, a spare part being substituted. The local shops did not afford a lathe of sufficient size to handle the removed shaft, and other methods of repair other than the conventional ones had to be resorted to.

Two processes suggested themselves, the oxy-acetylene process of autogenous welding and the Goldschmidt Thermit process, and representatives of both methods were asked to submit proposals for the filling of the groove cut by the entangled cable.

Upon receipt of the proposals, the oxy-acetylene bid proved the lower and a contract was awarded for the filling in of the cut with new metal by their method.

To facilitate matters the shaft was raised on concrete piers, the top of the piers forming a socket in which to turn the shaft more easily. This turning was accomplished by means of a tackle and rail.

The apparatus was put in place and the shaft preheated with charcoal and covered with asbestos to retain the heat as much as possible. The work was done under extreme physical conditions, the great heat requiring frequent relays and changing of men, it being almost impossible for a man to stand close enough to the cut to operate the burner for very long at a time. When the circle was at last complete and inspected, the ring of the metal melted into the cut was found to be separated from the metal of the shaft in places, the bond was insufficient to strengthen the weakened place, and the material so placed was easily removed. The failure was due mainly to the large radiation and conducting of the heat from the particular part where a bond of metal was desired, and to the severe physical strain. Smaller parts have been successfully handled here.

The Thermit exponents were then given a chance to fill in the worn place. The groove was carefully filled with wax and an adjustable flask placed around the worn part and the mold. Air was supplied from a derrick car, the derrick also being utilized to suspend the crucible containing the charge. The preheating was accomplished by gasoline blow torches and the wax was carefully removed and the mold cleaned by compressed air.

The reaction was perfect, and the result was a complete welding of the new metal into the groove. Precautions had been taken to provide a large riser and gate to cover the shrinkage and to insure solid metal in the worn part, as the top metal may be in some cases more or less porous. When the mold was removed, very satisfactory results were found. The removal of the extremely tough surplus metal was the most difficult part of the work. The gate and riser were finally removed, and outside of a few marks the weld was unnoticeable. Some concern was felt about the chances of warping the shaft when such an intense heat was suddenly applied in a comparatively short length, but such fears were dispelled when no appreciable change in the alignment was evident.

No machine finishing was necessary in this case, as the portion of the shaft affected did not come upon any bearing surface. Herein consisted the efficiency of this particular method, as there was no machine of sufficient size to handle this length of shafting available in this immediate locality, which would have barred the ordinary schemes of repair.

The third incident of interest in this district was the repair of a crankshaft of the main engine of the U.S. Engineers pipe-line suction dredge "Captain C. W. Howell."

The crankshaft of this 12x22x14-in. compound engine, directly connected to a 12-in. dredging pump, was 5½ in. in diameter. A crack was discovered in the low-pressure crankpin, and a careful investigation showed that instead of the characteristic fracture the crack ran into the web and back again around the pin. This precluded all the ordinary schemes of replacing the broken pin by shrinking in a new one, as the web did not have sufficient remaining metal to make such a repair safe.

The dredge was operated until arrangements could be made for a Thermit weld, and on the repair day the plant was shut down and the shaft removed to a shop. It was found to be entirely broken off. Part of the pin was machined off, leaving about an inch of space between the web and pin when the parts were aligned and fastened to a bedplate.

The mold was repaired in the usual way, and the ends to be united heated to as high a temperature as was safe. There was no hitch in the pouring of the crucible and, after

*From "Professional Memoirs, Corps of Engineers, U.S .Army and Engineer Dept. at Large," July-Aug., 1912. Vol. 4. No. 16.

cooling over night, the mold was removed in sections to prevent uneven contraction.

When the gates were removed and the complete shaft placed in a lathe the nice allowance for shrinkage, etc., was evidenced by the fact that scarcely any refinishing was necessary on the thrust collars of the shaft. The pin was turned up and the surplus metal removed and web reshaped to original dimensions without changing the balance of the shaft.

A total of four days was lost by the plant because of this repair, most of the delay being due to the distance of the dredge from the shop. This shaft continued in constant use without any evidence of the repair whatever, and was in use when this dredge was lost a year after on the Texas coast.

An idea of the saving effected in this instance may be obtained from the fact that a new shaft ordered rushed at once from the factory at a cost of $465 was not ready for shipment 90 days after receipt of order, as compared with a charge of $150 and a delay of four days for the Thermit weld.

The necessity of skilled handling and placing of parts to be welded cannot be too forcibly emphasized, as the chances for ruining a part are greater from mishandling than from failure of the weld, and much unnecessary finishing work is prevented by careful attention to the mold conforming exactly to the desired shape of the part to be repaired.

The hard-driven machinery of dredging plants, with their interdependent individual machines, offers an excellent field for economic employment of this method, and it will very likely play an important part in cutting down long delays brought about by extraordinary accidents.

THE MELTING POINTS OF FIRE BRICKS.*

By C. W. Kanolt, Assistant Physicist.

We are accustomed to thinking of a melting point as a temperature at which a substance changes from a rigid to a fluid condition, but a melting point can be precisely and rationally defined only as the temperature at which a crystalline or anisotropic phase and an amorphous or isotropic phase of the same composition can exist in contact in equilibrium. While this definition is satisfactory for pure substances, so complex a mixture as an ordinary fire brick usually has no single definite melting point according to this definition, since several anisotropic phases may be present, all differing in composition from the isotropic phase produced by fusion. We can then only select the temperature at which the transition from a rigid to a fluid state seems most distinct, and can call this the melting point only by apology. In the case of fire bricks, the transition temperatures so found are, fortunately, sufficiently distinct. I have taken as the melting point the lowest temperature at which a small piece of the brick could be distinctly seen to flow.

The experiments were conducted in an Arsem graphite resistance vacuum furnace. The samples were usually inclosed in a refractory tube made of a mixture of kaolin and alumina in the proportions to form sillimanite, to protect them from the small amount of reducing gas in the furnace, although the action of this gas was slight. The samples were observed through a glass window in the top of the furnace.

*Abstract of forthcoming Technologic Paper to be issued shortly and published in the Journal of the Franklin Institute.

The temperatures were determined by means of a Morse optical pyrometer of the Holburn-Kurlbaum type, which was sighted vertically downward through the glass window. The carbon-filament pyrometer lamp was calibrated by two methods. In the first calibration it was sighted into a platinum resistance furnace in which black-body conditions were obtained, and the temperature of which was measured by platinum, platinum-rhodium thermocouples. These thermocouples had been calibrated against the freezing points of pure metals. In the second calibration the lamp was calibrated against the freezing points of metals directly, without the intermediation of thermocouples. The metals used were copper, silver, and the copper-silver eutectic, which freeze at 1083 deg., 961 deg., and 779 deg., respectively. The metals were melted in the vacuum furnace in graphite crucibles, the pyrometer being sighted into a thin-walled graphite tube inserted in the metal. The pyrometer readings corresponding to the freezing points were determined by means of cooling curves. With silver and copper, heating curves were also obtained.

As the melting points to be measured were above the working limit of the pyrometer lamp, an absorption glass was interposed between the pyrometer and the furnace.

The true temperatures were then found from the apparent temperatures measured through the glass, by means of the equation

$$\frac{1}{T_2} - \frac{1}{T_1} = A,$$

where T_1 is the absolute temperature of the furnace, T_2 is the apparent temperature observed through the glass, and A is a constant. The value of A was determined by calibrations at various temperatures. A small correction was also applied for the absorption and reflection of the glass window of the furnace.

The samples, which were from one to two centimetres in diameter, were heated at the rate of about ten degrees per minute when near the melting point. It was found that in the case of certain bricks made of heterogeneous material of relatively low melting points were slightly higher after six hours' heating to 1550 deg., apparently as the result of the gradual running together of dissimilar particles to form a mixture having a higher melting point than the most fusible of the original materials.

The results are summarized in the following table:

Material	Number of Samples.	Melting point, Centigrade.
Fire clay brick	41	1555° to 1725° mean 1649°
Bauxite brick	8	1565° to 1785°
Silica brick	3	1700° to 1705°
Chromite brick	1	2050°
Magnesia brick	1	2165°
Kaolin	3	1735° to 1740°
Bauxite	1	1820°
Bauxite clay	1	1795°
Chromite	1	2180°
Pure alumina	..	2010°
Pure silica	..	1750°

The value 1750° given for silica is not the true melting point, but represents approximately the temperature at which the silica flows distinctly. It was found that silicon carbide does not melt below 2700°; it becomes unstable at much lower temperatures.

THE PRESERVATION OF REINFORCED CONCRETE IN SEA WATER.*

By Lieut. Edward Burr, Engineer Corps, U.S.A.

There still remains much doubt in the minds of engineers as to the reliability and permanence of reinforced concrete immersed in sea water or exposed to its effects. This doubt arises primarily from uncertainty regarding the effect of sea water upon the Portland cement or other binder employed in the mortar of the concrete, since, if the concrete is properly proportioned and put into place, and if it continues sound and intact, little remains to be done for the preservation of the steel. The problem, therefore, in its essential features, resolves itself into the employment of a cement or mortar unaffected by sea water, and its utilization in such a manner as will prevent access of sea water to the interior of the concrete and to the steel, with such additional precautions as experience may show to be efficacious. This short statement of the case is simple in terms, but its solution rests upon the determination of the most suitable cement and mortar to produce permanent results when used in concrete placed in sea water, which question has for years been before engineers for solutions and now has increased importance through the advent of reinforced concrete. In one respect, however, the problem is less difficult than would otherwise be the case, since it is only in rare instances that reinforced concrete cannot be seasoned before being exposed to sea water, and methods for its preservation can be employed under these circumstances that are not available for subaqueous work, with its attendant difficulties and possible defects.

The above concise analysis represents your general reporter's view of the problem involved in the determination of the best means for insuring the preservation of reinforced concrete in sea water. If it is correct in its general terms, the relatively long experience already had with plain concrete in sea water is available as a basis for drawing conclusions as to the reliability of reinforced concrete in maritime works, and we are not dependent alone on our short experience with reinforced concrete for the formulation of opinions and conclusions thereon.

The hydraulic mortars of lime and pozzuolana used by the Romans have through the centuries proved their worth for the conditions under which they were used in the Mediterranean. Portland cement is, through its universal availability, the material upon which modern engineers generally rely for hydraulic construction. While comparatively a modern product and subject to much suspicion in its earlier applications, it has been developed and perfected until it is now accepted by the profession as reliable for all purposes when selected and used with good judgment, and to this fact must be credited many of the most noted accomplishments in maritime works. In its application to such works, some failures have resulted, particularly in the earlier structures, but the failures chargeable to the material, in contradistinction to those due to other causes, have become notably less. Many successes with it have been had for decades, and of this fact no other evidence is needed than that supplied by its continued wide application to maritime works. The question, therefore, is not whether Portland cement mortar and concrete are reliable in such works, but is merely the determination of the conditions necessary to its most successful utilization. The conditions necessary to success appear to have been attained most generally when the concrete has, for various reasons, been seasoned in air to a greater or less extent before being placed in the work, and this is almost invariably the practice in reinforced concrete structures. Such success as has been secured with good examples of plain concrete, seasoned before placing in sea water, may therefore be expected with reinforced concrete, provided the precautions leading to that success are followed, together with such others as are peculiarly necessary to reinforced concrete construction, by reason of its design. The deteriorating effect of sea water on mortar and concrete is due to two general causes, physical and chemical. Physical effects result especially from the action of frost in the severe climates of northern latitudes and are largely localized to the areas between low and high-tide planes, where alternate freezing and thawing occur with each tidal oscillation. Effects of this class are to be found on the northern Atlantic coast of the United States, and require for their avoidance the application of methods that are not practicable in the general case, when the concrete is placed in the green or plastic state.

Chemical effects resulting from the action of sea salts on Portland cement are well known in their general aspects, and the general reporter will not enter in detail on this part of the subject, deeming it to be outside the scope of this report. It may be stated, however, that while engineers and chemists are, as a rule, agreed as to the general principles involved, there still exists some differences of opinion in regard to the desirability of having in the cement or mortar an excess of free lime, alumina or iron oxide.

It may be well at this point to refer to the opinions held by some engineers that mortars are inevitably destroyed in time by immersion in sea water. Such views were advanced at the St. Petersburg Congress in 1908 by some reporters and general reporters upon the questions of the application of reinforced concrete to hydraulic and maritime works, but were not sustained by the congress, which found sufficient grounds for believing that first results were encouraging if certain precautions were observed. Your general reporter concurs in that action and is of the opinion that further experience confirms it. He bases his opinion more broadly, however, upon the longer experience with plain concrete in sea water, and numerous specific instances may be cited where concrete has continued sound and unaffected after immersion from twenty to forty years or longer, in latitudes extending from the tropics to the severe climate of the north Atlantic. With these facts before us we can only confirm the opinions expressed sixty years ago that laboratory experiments are not conclusive in this matter, and only by immersion in the sea in the locality where it is to be used can the reliability of a cement for maritime works be absolutely determined. Long experience has shown that with sound cement and properly proportioned mortar and concrete, excellent results may be had if the materials are mixed and placed in position with all the care and precautions demanded by good workmanship in maritime works. Concrete, when used intelligently, has proved itself to be the best of handmaidens to the modern engineer, but in the hands of engineers or workmen unskilled in its application, manufacture and placing, it has, by its failure, often exhibited their inefficiency. The failure of concrete in some maritime works cannot be held to prove it to be unsuited for such works, but, in view of its many successful applications, merely shows that some of the conditions necessary to success have not been met. It is believed, therefore, as a result of past experience, that good Portland cement concrete may be accepted as a reliable material for maritime works under suitable conditions, and may be expected to be reasonably permanent.

Both the physical and chemical effects of sea water on mortar and concrete result from their porosity, and if per-

* Abstract of report to International Congress on Navigation.

colation can be prevented, these effects can be avoided or retarded through the denial of access by sea water to the constituents subject to its action, if such there be in the concrete. A dense compact mortar is therefore essential to success, and is obtainable throughout the entire mass of reinforced concrete. While engineers are agreed upon this point, there are differences of opinion as to details in regard to materials, proportions of mixtures and other factors.

A sound, finely-ground cement, with limited percentages of sulphates and magnesia, is the first requisite. A minimum of free lime is generally agreed to, but opinions differ on this point and in regard to iron oxide and alumina. A rich mixture is necessary. It should not be leaner than 1:2:4, and some engineers recommend 1:2:3 or 1:1:1⅔. Opinions differ between fine and coarse sand, but, to the writer, this matter resolves itself merely into the question of a sand so graded as to have the minimum of voids, bearing in mind that a very fine sand makes, as a rule, a weak mortar. The gravel of broken stone should be small and well graded to secure a minimum of voids. The addition of pozzuolana or trass is strongly advocated by some, who hold that it combines chemically with the free lime of the cement, but this is denied by others, who maintain it to be an inert material, and opinions differ as to whether it strengthens the mortar. Others advocate the addition of anhydrous colloidal clay, or similar materials, finely ground and intimately mixed with the cement at the factory. Numerous proprietary compounds for improving the impermeability of mortar and concrete are in the market and are recommended by some maritime works, but they should be used with great caution until their stability in sea water is established.

The consensus of opinion is favorable to the use of salt water in gauging, but, since there remains some doubt on the subject, it is believed that fresh water is safer and should be used if reasonably available. The general tendency in modern practice is toward the use of a wet mixture for concrete either in mass or reinforced. The writer's practice goes back to the period when dry mixtures, in accordance with the theory of the times, were almost universally recommended, but experience has demonstrated to his satisfaction that the practical conditions of actual work can only be met by wet mixtures if the best results are to be secured with a minimum of defects. He also has a preference for small gravel or pebbles in lieu of broken stone, since sufficient adhesion for all practical purposes is found between the gravel and mortar, and since the gravel, through the shape of its particles, better lends itself to compacting in the mold, particularly in small work.

Under the conditions just given, a dense, compact concrete is obtainable, if it is manipulated and placed with care. Precautions particularly should be taken to secure a dense surface and to compact the concrete thoroughly about the steel bars, through care in selection and manipulation. It has been the writer's practice, also, to finish the surface of the concrete with two coats of neat cement wash, well brushed, in order to reduce still further the surface permeability, and concrete structures built and finished as described have resisted excellently well the severe climate of the northern United States. Other water-resisting materials similarly applied are recommended by some reporters and may be considered as an additional precaution if so applied as to secure intimate contact with the concrete, but doubts may exist as to their permanence in sea water.

A good sound cement mortar appears in itself to be a sufficient protection to the imbedded steel—so long, at least as the mortar remains sound. The general reporter is of the opinion that a well-applied coat of cement or cement mortar is one of the best of preservative coatings for steel or iron, even when exposed to continual of intermittent immersion in water, and instances can be cited in support of this opinion. Some fifteen years ago a composite water main made of thin sheet iron, coated inside and outside with cement mortar, was removed from the streets of the city of Washington, where it had been buried and in service for nearly forty years. The mortar coating was about three-quarters of an inch thick and the sheet iron was absolutely in as good condition as when the pipe was made. It is recognized that such examples hold only so far as concerns exposure to fresh water, but they confirm the opinion as to the protective value of sound mortar, and numerous cases may, no doubt, be found of similar protection when the exposure was to salt water. A case is cited ([1]) where reinforcing chains in a concrete-in-situ sea wall at Bridlington showed no signs of corrosion after being twenty-five years in place, although at points they were but one inch from the face of the wall, of which the lower half was covered by the sea at each tide. Further arguments and citations of facts appear unnecessary, since if protection can be and has been shown to have been secured in specific instances, it merely remains for engineers to reproduce in their own works the conditions necessary to secure like protection.

In this connection it may be added that short-time experiments in the United States of concrete exposed to sea water indicate the desirability of coating the steel bars with neat cement, well brushed on, before imbedding them in the concrete, and Mr. Luiggi, in his report upon this communication, recommends such a coating to be applied immediately, before the concrete is placed. The general reporter has prescribed this practice in all reinforced concrete work under his charge in recent years. To secure the best adhesion between the steel and the mortar for the development of the full strength of the work and for the protection of the steel from corrosion, the bars should be thoroughly cleansed of all oil, grease, rust and mill scale before the cement coating is applied.

While doubt remains in the minds of some engineers as to reliability of cement mortar immersed in sea water, and while other engineers maintain that it will be destroyed in a relatively short time, there is no difference of opinion in regard to the desirability of permitting concrete to harden or season in air or in sand for as long a time as the circumstances of the work will permit, before exposing it to the sea. Like views are held in regard to protecting concrete in place from the action of sea water, when the necessities of the case expose it to such action before it has fully hardened. Concrete that has thoroughly hardened in air before exposure to the action of sea water has fully established its greater reliability than concrete placed in sea water in a plastic state, and the subject requires no further comment here.

Earlier in this report a passing reference has been made to the excellent results obtained with concrete in the hands of skilled engineers and workmen. Every engineer is familiar with failures, more or less complete, of concrete when misused in incompetent hands. Even in skilled hands, care and watchfulness from the selection of the cement to the final completion of the work, are necessary to the best results. This is true of works in the open, and is all the more true for maritime works, where added adverse conditions prevail, and where the sea will inexorably prove the quality of the work in time. Therefore, a requisite to success is the unremitting exercise of every precaution needed to secure good workmanship at all stages of the work.

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[1] Page 17, Reinforced Concrete Construction, by Adams and Mathews; Longmans, Green & Co., 1911.

Mr. Voisin reports that the works described by him have generally behaved well, and the oldest of them (piles and sheet piling on the sands of Olonne) were nearly thirteen years old in 1911. He recommends a rich mixture for submerged work, a brush finish of cement on the outside mortar surface and one or two coatings of coal tar, and a minimum protective coating of from 0.025 to 0.03 metres (1.0 to 1.2 inches) over the steel bars. He refers to the promising use of ceresite in mortars, and sums up by expressing his opinion that the conclusions reached by the 1908 congress have been confirmed and can now be more precisely stated.

Mr. Luiggi advocates the use of certain proportions of pozzuolana or trass to counteract the effect of any free lime in the cement, and refers to the lime-pozzuolana mortars that have continued sound in the maritime works of the Romans. In addition he sets forth four conditions necessary to success that may be summarized as follows: (1) A sound, finely-ground cement containing the minimum of sulphuric anhydride, magnesia and, especially, of free lime; (2) a rich mixture with a liberal excess of cement and mortar above that necessary to fill voids; (3) great care in the manipulation and placing of the concrete and the coating of the reinforcing bars with cement; (4) plenty of time for the concrete to harden in air. If his instructions are followed, Mr. Luiggi is of the opinion that "there will be obtained a practically impermeable concrete, and one, so to speak, unchangeable in sea water, in the interior of which the completely protected iron will last under good conditions for centuries.

"The reinforced concrete used with the precautions stated above will give excellent results when used for works in salt water, and may be adopted, therefore, with full confidence."

Mr. van Kuffeler is of the opinion that the covering over the steel bars should be not less than 0.02 metres (0.8 inch). He cites instances of the better performance of air-hardened concrete in comparison with concrete placed in sea water in a plastic state, and recommends a richer mixture under the latter conditions. Little objection is seen to the use of sea water in gauging, but a watertight concrete is considered a necessity. He advocates the use of trass or pozzuolana with the cement to increase the density and strength of the concrete, and refers to the tests of German special committee. Mr. van Kuffeler's conclusions, briefly stated, are: (1) Use only slow-setting Portland cements of the best quality; (2) mix thoroughly and place carefully the concrete in watertight forms; (3) the addition of trass or pozzuolana is desirable; (4) use a watertight concrete having 1 of cement and 1½ of trass to 3 of sand, or 1 of cement to 1½ of sand; (5) harden in the air if possible, and otherwise use a richer mixture.

Your general reporter is of the opinion that in good, sound concrete, plain or reinforced, the engineer has a most valuable device adaptable to meet any conditions in maritime works; that if designed with good judgment and applied with discretion, it will permit of the execution of works that might otherwise be financially or physically impracticable, and will ordinarily permit of economy in permanent works; that it is reasonably permanent in sea water if applied with all the precautions that experience to the present time has suggested, and that further experience may provide additional means for increasing its reliability; but that no precaution should be omitted in its application. He would not, however, be considered as advocating the use of concrete under any and all conditions, and recognizes that in some situations other materials, alone or combined with concrete, give better or more economical or more permanent results.

It is evident from the reports before the congress, and more especially from the current literature upon this subject, that experience with reinforced concrete in sea water has not to the present time covered a period sufficiently long to permit of laying down conclusions in detail as to the best methods to be followed for its preservation. With longer experience, such conclusions might be so formulated as to meet the approval of the Congress and some of them might be put forward at this time. It would seem, however, to be wise merely to refer to the experience heretofore gained in the matter of such details, as contained in the reports before the congress or as found elsewhere, and to defer action by the congress on such matters until conclusions thereon may be supported by such further experience as will enable the congress to adopt them with greater assurance as to their efficiency.

Only the following general conclusions are therefore submitted for the action of the congress:

1. Further experience tends to confirm the conclusion of the congress of 1908 that the earlier results of the application of reinforced concrete to hydraulic and maritime works are encouraging, and to indicate that reinforced concrete may be expected to be reasonably permanent in sea water if the precautions necessary to secure that end are intelligently and unremittingly exercised in accordance with the best experience in such works.

2. In view of the comparative novelty of this type of construction, its increasingly wide application, and the rapidly growing experience in its use, this subject should again be made a question for consideration at the next congress.

THE LIFE OF COTTON ROPES.

In a paper by Mr. Edwin Kenyon, delivered recently before the Canadian Society of Civil Engineers, on "The Transmission of Power by Ropes," it was stated that as to the life of cotton driving ropes, much of course depends upon their size and the conditions under which they have to work. All things being equal durability may be gauged by sectional area, and the most economical diameters range from 1½ inches to 1¾ inches more of the latter being used than any other size for textile work.

A remarkable case of longevity may here be quoted where twenty-four cotton ropes 1¾ inches in diameter are employed to transmit 820 horsepower at a velocity of 4,396 feet, direct from the engine fly wheel 28 feet in diameter to the various rooms of a Lancashire cotton mill. These were fixed in September, 1878, and all the ropes driving the card room have been running from then till now, a period of over thirty-three years. Another set has been working an average of twenty hours per day and appear to be little the worse for their twenty-three years' service.

The lives of other cotton driving ropes similarly circumstanced have extended over periods little short of this, while others again fixed from eleven to fifteen years ago though working without cessation, week-ends excepted, are still doing good service. A good example is to be found at a large paper works near Glasgow where cotton ropes have been working night and day for nearly fifteen years. Such cases of longevity lead to the conclusion that fatigue of material is due to constant activity does not readily manifest itself in well made cotton driving ropes.

Their quick recovery from driving strain is suggested as the cause, seeing that they pull down on the working side but bulge out to their normal diameter immediately they pass to the trailing or slack side of the pulleys.

ROADS ADAPTED TO LOCAL CONDITIONS.

At the last convention of the American Road Builders' Association, held at Rochester, Mr. Nelson P. Lewis gave a paper on "The Adaptability of Roads and Pavements to Local Conditions." Mr. W. A. McLean, the Ontario Provincial Engineer of Highways, in discussing the paper, said that a study of road conditions in various countries of the world will show a remarkable similarity in their several stages of road improvement, and in the problems which have confronted each. Throughout all, certain general principles are apparent, although local circumstances may require or permit a considerable variation in detail. These variations are, in general, more superficial than otherwise, and the underlying principles are in most cases of universal application. Thus on this continent we say, "Too many cooks spoil the broth," but in China they say, "Too many cooks spoil the dog." The general truth that too many cooks are an evil is taught in either case, and "broth" or "dog" are merely the local details. General truths are the same the world over, and it is important that, on the one side, we do not deny the usefulness of the general principle because of varying local applications; and on the other hand, that we do not render a failure the general truth by neglecting to adapt details to local conditions.

Let me emphasize a matter alluded to by the previous speaker—the selection of paving material for particular streets and roads, according to the preferences or prejudices of some of the abutting owners, "judiciously accelerated" by the enterprise of a salesman representing some particular kind of pavement. Most emphatically, "Too many engineers will spoil the pavement." It is a basic truth in all good business management, that responsibility should be centralized in order that full credit or blame may be placed where due. How can this be possible when paving materials are selected by the people or by councillors in opposition to or without the recommendation of their engineer? This is an evil in Canada as well as in the United States, and one which, solely in the public interest, should be strenuously combated. It is right that the preferences of the people should be made known; it is right that the taxpayers should express their views, and that these preferences and views should be given impartial and wise consideration by the engineer. But the engineer is employed as an expert, and as regards paving, the selection of the most suitable material for a given street or locality, should be one of his most important functions. Responsibility should be fixed upon him in this regard, and if he is inefficient and his selections are plainly unwise, another engineer should be sought. But the public, in its own interest, should be the last to relieve the engineer of this most important duty—the final selection of the most suitable paving material for each street under his jurisdiction.

Somewhat allied to this is a rule of procedure in English practice, that, in letting contracts, purchasing material, and making appointments, the tenders and applications can be made only in open council or in open committee, and any agent or company or applicant personally approaching a councillor, or official of the council, is absolutely disqualified. This is an ideal toward which it is to be hoped public opinion will tend in all parts of the world.

Climate is an extremely important factor in selecting a paving material or determining the details of construction for any given locality. While most paving materials are of universal use, if properly employed with due regard to local conditions, these varying local conditions should be carefully studied and compared. The lack of scientific data in this regard is a serious deficiency on this continent.

Climatic differences of temperature, moisture and wind in all combinations, materially influence the amount and method of drainage to be adopted. For example, if the subsoil and situation of a road are such that the natural soil is saturated and filled by the autumn rains and the melting of snow during the winter, and if this is acted upon and expanded by frost during the winter to a depth of three or four feet, as in Canada and the northern States, it is manifest that a very weak condition of the subsoil must exist when the spring thaws and freshets come. The foundation of the road may in this way become a quagmire for two or three weeks in the spring, during which time traffic will break through or partially disrupt any stone surface that could reasonably be applied. Under such climatic conditions, the need for careful underdrainage of the subsoil is manifestly much greater than in such a climate as that of England, where the frost penetrates only three or four inches into the ground. A mild climate having long periods of heavy rain may develop very similar conditions, though without the added difficulty of expansion by frost, or an impervious stratum of ice below the surface.

In the use of bituminous binders we have much to learn from other countries, particularly England, France and Germany, but any deductions should be made with full consideration of climatic and other differences. Thus in England tar is widely used for road purposes by spraying, by penetration, by the matrix, and by the mixing processes. But the extremes of temperature and the dry atmosphere of this continent present influences which do not exist in the more uniform and moist climate of Great Britain. Experience with tar in Canada has shown that it will resist successfully the climatic conditions, but the numerous failures have as clearly shown the necessity for a more scientific use with a view to climatic differences, demanding a careful study of methods of manufacture, of distillation, of proportioning the tar, pitch and creosote oil, and of selecting and grading the mineral aggregate. More frequent surface painting and gritting may also be one of the means for overcoming the influence of hotter and dryer climatic conditions.

First cost is often, necessarily, a determining factor, but as pointed out by Mr. Lewis, the ultimate cost at the end of the life of the pavement should, if possible, for true economy, be the most considered. The cost of pavements varies greatly according to locality, and an economical material in one district may be extravagant in another, owing to relative difference in price. In Cleveland, vitrified brick (an excellent paving material for many situations) cost $8 per M, while at Toronto the cost is $18 per M. Roads of local gravel, with short haul, may in cases be had for one-third of the cost of broken stone brought by rail; so that a gravel road, even if it has to be heavily resurfaced every four or five years, is probably, under such circumstances, a more truly economical road than broken stone would be.

The local cost and efficiency of labor is a factor which may favor or cause the rejection of an otherwise suitable paving material, which elsewhere can be economically laid. There is often a considerable range in this regard in short distances, while as between separated countries or regions the variation may be exceedingly marked. Wages are generally higher in the cities than in the country; are lower in Europe than on this continent, and are usually lower in southern than in northern countries, so that methods and materials should be varied accordingly.

Road construction has been criticized from time to time because of large bond issues, and the economic value of large expenditures has been questioned. Very great care must be taken in the local adaptation of road making materials in order that this criticism may not be justified. The use of heavy foundations, bituminous binders and other first-class materials is no doubt justifiable and essential on heavily traveled suburban and main interurban highways—the class of road which is or should become of national, or state, or occasionally of county importance. But this will ordinarily apply to a comparatively small percentage of the total highway system, and a road that is too good, and too costly, for the amount of traffic, is as much an economic blunder as bad roads. But all roads of the country need improvement. It is as necessary that the 90 or 95 per cent. of less traveled township and country roads be made proportionately good by grading, draining and surfacing, as that the 5 or 10 per cent. of trunk roads be built, but care must be taken that costly design suitable only for the latter, be not carried into the division where cheaper construction would be satisfactorily serviceable. Construction adapted to location and traffic, with proper regard to future requirements, is of vital necessity.

SOME TEST CURVES OF TURBINE-DRIVEN CENTRIFUGAL PUMPS.

A complete line of turbine-driven, low-pressure centrifugal pumps have recently been placed on the market by McEwen Bros., of Wellesville, N.Y. These pumps have been developed after over two years' careful investigation from designs made by Mr. C. V. Kerr, chief engineer of the company. They represent an advance in turbine machinery, as the speeds used conform to exceptional turbine economy. The usual type of centrifugal pump cannot run at turbine speeds for low-pressure work, and so the steam consumption is sacrificed.

Fig. No. 1 shows the calibration curves for a well-known small turbine. It will be noted that the curves are lines of constant steam conditions, and also constant steam flow. At, for example, 150 lbs. steam pressure and atmospheric exhaust, with the same total steam flow, the horse-power increases from 21 at 1,500 r.p.m. to 36½ at 3,000 r.p.m.

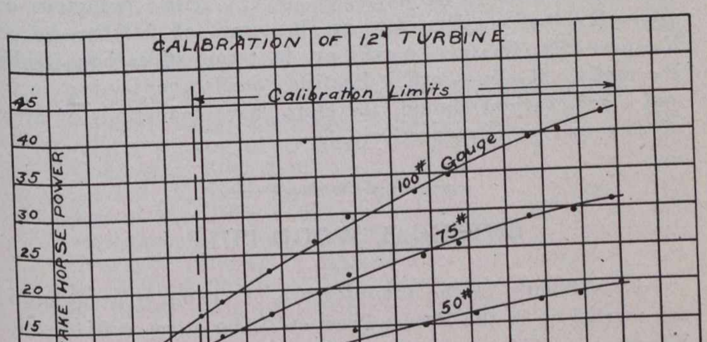

Fig. 1.

The advantage of high speed will at once be evident. A smaller turbine may be used in most cases, and the water rate is greatly improved.

Fig. No. 2 shows test results obtained on a standard 30-in. pump. It will be noticed that the maximum pressure occurs at no discharge. This gives best conditions for starting and general service. At constant pressure the horse-power at no discharge never exceeds 40 per cent. of the normal, and may be less than 30 per cent. The horse-power decreases at discharges greater than normal when the speed is kept constant. As the horse-power increases at higher speeds or pressures, the pump of itself forms a highly efficient governor, and service conditions are maintained over variable operating possibilities. At the same time, under variable speed control the horse-power curves

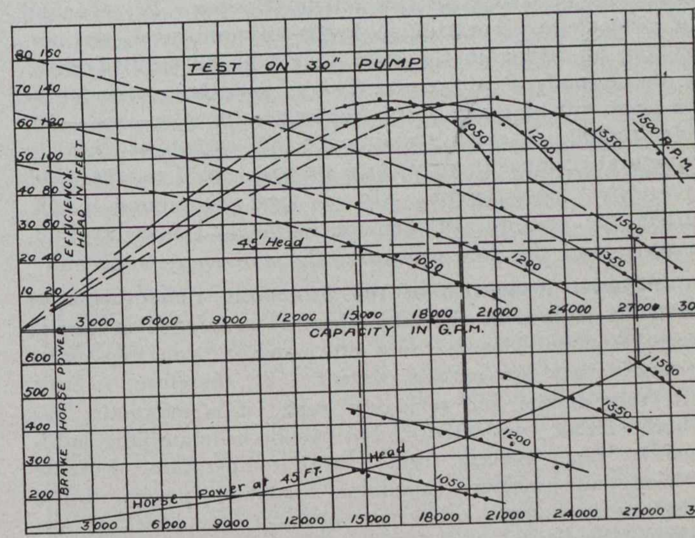

Fig. 2.

vary about as the quantity delivered at constant pressure. The gain in efficiency and horse-power used under these circumstances enable the turbo pump to further encroach on the field of the plunger type.

STRUCTURAL COMPOSITION AND PHYSICAL PROPERTIES OF STEEL.

The following is abstracted from an interesting article by Albert Sauveur in the May Journal of the Franklin Institute:—

Bearing in mind that hypo-eutectoid steel is composed of free ferrite (pure metallic iron, magnetic and stable below 850 deg. C.) and pearlite (an alloy of carbon and iron, of lamellar structure), and that hyper-eutectoid steel consists of free cementite (iron carbide, formula Fe_3C) and pearlite, and knowing the proportion of carbon in pearlite and cementite, the structural composition of any steel may be calculated, provided the percentage of its carbon content is known.

For hypo-eutectoid steel, $F + P = 100$, and $0.01EP = C$, in which F is the percentage of free ferrite present, P the percentage of pearlite, E the percentage of carbon in the pearlite, and C the percentage of carbon in the steel. For hyper-eutectoid steel, $P + Cm = 100$, and $0.01EP + 0.0667Cm = C$, in which Cm is the percentage of free cementite.

The exact carbon content of pearlite is not known, and it varies somewhat both with composition and treatment; in commercial steel it is probably not far from 0.85%. For simplicity in calculation it is warrantable to assume that pearlite contains 1 part by weight of cementite to 7 parts by weight of ferrite; or

$$12.5\% \text{ cementite} + 87.5\% \text{ ferrite} = 100\% \text{ pearlite},$$

and since cementite contains 6.67% carbon, 12.5% of cementite will contain $(6.67 \times 12.5 \div 100 =)$ 0.834% carbon. With this assumption and the fact that the carbon in the steel produces exactly 15 times its own weight of cementite, the calculation of the structural composition of any steel becomes extremely simple.

From the foregoing considerations it may be shown that the percentage of pearlite in hypo-eutectoid steel (i.e., steel containing less than 0.834% carbon) is equal to 120 times its carbon content, or P = 120C, the remainder of the steel consisting, of course, of free ferrite (F = 100 — P). To find the percentage of pearlite in hyper-eutectoid steel, the percentage of carbon in the steel should be substituted for C in the formula P = (800 — 120C) ÷ 7, and the remainder of the steel will be made up of free cementite (Cm = 100 — P). For example, a steel containing 0.50% carbon will have a structural composition of (120 × 0.50 =) 60% pearlite and (100—60 =) 40% ferrite. In a steel containing 1.25% carbon the pearlite will amount to [800 — (120 × 1.25)] ÷ 7, or 93%, and the free cementite Cm = 100 — 93 = 7%.

Physical Properties of the Structural Constituents of Steel.—It is evident that the physical properties of ferrite must resemble closely those of wrought iron and steel having a very low carbon content. It, therefore, is very soft, very ductile and relatively weak; it is magnetic, has a high electric conductivity, and cannot be materially hardened by rapid cooling from a high temperature. Pearlite is hard and possesses maximum hardening power. Little is positively known as to the physical properties of cementite, excepting that it is exceedingly hard and brittle, and that it possesses no hardening power. The properties of these constituents of steel in its normal condition are substantially as follows:—

	Tensile strength, lb. per sq. in.	Elongation in 2 in., %.	Hardness.	Hardening power.
Ferrite	50,000*	40*	Soft	None
Pearlite	125,000*	10*	Hard	Maximum
Cementite	5,000 (?)	0	Very hard	None

* More or less.

Tenacity of Steel vs. Its Structural Composition.—It is reasonable to make the assumption that these constituents impart to the steel their own physical properties in a degree proportional to the amounts in which they are present. The tensile strength (T) of any hypo-eutectoid steel may, therefore, be expressed by the formula

$$T = (50{,}000F + 125{,}000P) \div 100,$$

or, simplifying, T = 500F + 1250P; or, in terms of pearlite alone (since F = 100—P), T = 50,000 + 750P; or, finally, in terms of carbon, since P = 120C, T = 50,000 + 90,000 C.

According to this simple formula, steels containing 0.10, 0.25, and 0.50% carbon have tensile strengths of 59,000, 72,500, and 95,000 lbs. per sq. in., respectively. These values agree closely with our knowledge of the average tenacity of such steels when in a pearlitic condition. Steels forged and finished at a fairly high temperature are practially in this condition. The formula cannot be used for steel forged until its temperature is quite low, and especially if it be cold-worked—the tensile strength is generally increased in such cases. Neither can it be used for hardened steel, nor for steel castings unless properly annealed. The formula is of value only in the case of commercial steels containing the usual proportions of impurities, and in which the percentage of manganese varies roughly with the carbon content from some 0.20 to 0.80%. A greater percentage of manganese would materially increase the tenacity.

The tensile strength of hyper-eutectoid steel cannot be calculated so closely, because of lack of accurate information as to the tenacity of cementite. Assuming it to have a tensile strength of 5,000 lbs. per sq. in., the tensile strength of a hyper-eutectoid steel = T = (125,000P + 5,000 Cm) ÷ 100 = 1,250P + 50Cm, or, in terms of pearlite (since Cm = 100 — P), T = 5,000 + 1,200 P. As P = (800 — 120C) ÷ 7, the foregoing may be further simplified to T ÷ 142,000 — 20,600C. Applying this formula to steels containing respectively 1.25 and 1.50% carbon, the respective tensile strength are found to be 116,250 and 111,100 lbs. per sq. in., which are fair values for the average tenacity of pearlitic steels of those degrees of carburization.

Steel of Maximum Strength.—From the preceding considerations it seems evident that eutetoid steel must possess maximum tensile strength, since the influence of the presence of ever so small an amount of free ferrite in hypo-eutectoid steel or of free cementite in hyper-eutectoid steel must necessarily be a weakening one, because of the relative weakness of free ferrite and free cementite as compared to the strength of pearlite. Most writers state that a slightly hyper-eutectoid steel, containing about 1% carbon, possesses maximum tenacity. It seems probable, however, that the steels to which they refer were in a sorbitic rather than in a pearlitic condition; it may well be that when in a sorbitic condition maximum strength corresponds to a higher degree of carburization—i.e., 1%—because sorbite may, and indeed often does, contain more carbon than it does pearlite.

Ductility of Steel vs. Its Structural Composition.—It should be possible to work out a formula expressing the ductility of any hypo-eutectoid steel in the annealed (pearlitic) condition from the known elongation under tension of ferrite and pearlite (see table). This ductility should be D = (40F + 10P) ÷ 100, or, in terms of pearlite alone (since F = 100 — P), D = 40 — 0.3P; and, since P = 120C, the ductility in terms of carbon would be D = 40 — 36C. Pearlitic steels, for instance, containing 0.25 and 0.50% carbon should have elongations of 31 and 22%, respectively.

Reduction of Area vs. Structural Composition of Steel.—Similarly, the reduction of area of any slowly-cooled (i.e., pearlitic) hypo-eutectoid steel may be calculated on the assumption that pearlite has a reduction of area of 15% and ferrite a reduction of 60%. Then reduction of area = R = (60F + 15P) ÷ 100, or, in terms of pearlite (since F = 100 — P), R = 60 — 0.45P, or, in terms of carbon (since P = 120C), R = 60 — 54C. Pearlite steels containing 0.25 and 0.50% carbon should, therefore, have reductions of area of 46.5 and 33%, respectively.

CHEMICAL WOOD PULP.

Experiments in the manufacture of chemical wood pulp are carried on in the Forest Products Laboratory at Madison, Wisconsin. This is the largest and most complete laboratory of its kind in the world. The building, costing $100,000, was erected by the University of Wisconsin. The equipment, staff and operating expenses are supplied by the United States Forest Service.

The laboratory started work in June of this year. The results of the work have not yet been published, but it is known that a good quality of kraft paper has been manufactured from the saw-mill waste of western yellow pine, that the saw-mill waste of Wisconsin has been found satisfactory for chemical pulp manufacture, that great advances have been made in the manufacture of a good quality of chemical pulp from dead and green tamarack, hemlock and jack pine. The staff at Madison have also examined samples of pulp from practically all the mills in the country, and have worked out satisfactory methods of standardizing, comparing and grading wood-pulps.

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MATERIAL FOR ROAD AGGREGATE

In a paper before the American Road Builders' Association, and printed in this issue of *The Canadian Engineer*, on "The Maintenance of Roads and Pavements," Mr. James Owen places emphasis on one feature of road-making which, we feel, to the present time, has been lost sight of by many road-builders. This fact is that the increase of automobile travel has caused the character of the mineral aggregate in any road mixture to assume a place of secondary importance. Under the old conditions of traffic the ideal material for road metal was hard trap-rock, and this was used, and is being used, wherever available, even at great cost on account of long hauls. Under the present conditions of travel, however, it is found that with the grinding eliminated and the use of surface oils, good gravel gives as excellent results as trap rock. Mr. Owen draws attention to the fact that granite can be used with impunity, and such natural materials as chert and shale can also be used. The sand and clay roads of North Carolina have, with oiling, been made into perfect roads. A full appreciation of this fact will reduce the cost of many miles of road in the future.

LONG DISTANCE POWER TRANSMISSION.

The question of long distance electrical power transmission has assumed vast proportions during the past few years. Voltage and distance of possible transmission has increased tremendously. When the Niagara Falls Power Company began its development in 1891 it was considered a wonderful feat when power was transmitted to Buffalo, a distance of about twenty miles. To-day we find plants operating at a voltage of 140,000 and up to distances of 200 miles. The limiting voltage of power transmission is an interesting point. In discussing a recent paper by Dr. Steinmetz before the American Institute of Electrical Engineers, Mr. F. W. Peek, jr., made some interesting comments on this point. He states that a comparison of the past with the future is of interest in giving a comparison of past difficulties with present difficulties, and limitations of the past with the apparent limitations of the future.

He states that he came across, quite accidentally, an old book of letters by a very prominent engineer—it was not such an old book either, measured in time, but old measured by engineering progress. The writer states in one letter that an operating transformer had actually been built that could stand 15,000 volts, and it was hoped that ultimately a transformer could be built to operate successfully at 20,000 volts. The apparatus at that time was the limiting feature of transmission. Voltages went up by leaps and bounds, and transformers were shortly thereafter operating practically at voltages of from 50,000 to 60,000. At this stage the pin type insulator began to give trouble, so, naturally, the suspension insulator was invented. Voltages then jumped up to 100,000, and another trouble appeared, or what seemed to be a trouble or limiting feature, that is, corona. This led to investigations of corona losses, and it now appears that we still have some margin in the matter of corona limit; for instance, power could be transmitted at 200,000 volts with a conductor about one inch in diameter with 12 to 15 feet spacing. With long lines and high voltages other troubles appear; as an example, suppose we take a line, say, 200 miles long, with a voltage of 140,000. The capacity current may equal the total load current of the whole station. This will mean trouble unless some method is adopted that will take care of this heavy leading current, or the generator units are properly arranged as to size. If part of the load is supplied by part of the generator units and the load is suddenly lost, these units may be over-loaded by the capacity current. Another emergency to be provided against is the rise in voltage at the receiving end (due to capacity current through reactance) when the load is suddenly thrown off. Taking a practical instance, after the comparatively small lighting load is taken on in the evening, the heavy factory loads go off; over-voltage is put on the lamps. Fortunately, the effect of capacity current can generally be well taken care of by shunted synchronous reactance. Now, it is rather interesting, for the moment, to look forward into the future and perhaps ask a question, What will actually be the limiting voltage of power transmission, or limiting distance? Will it really be due to the loss of energy into the air by corona, the line insulator, the apparatus, or will it be an electrical feature after all? Will it not rather be, with some few exceptions, an economic or natural feature? For instance, the power naturally concentrated at a given point, as in a waterfall, will generally be exceeded by the demand before the distance becomes so great that it is necessary to use voltages above the electrical limit.

EDITORIAL COMMENT.

The Western Canada Irrigation Association has just closed its annual convention at Kelowna, B.C. Next year's meeting will be held at Lethbridge, Alta.

* * * *

Ottawa is slow to move on the water supply question, although they have had sufficient warning to warrant immediate action. The mayor is endeavoring to shift responsibility to the shoulders of the city engineer. The public, however, will no doubt remember that it is over a year since the previous typhoid epidemic, and since that time no action has been taken by the city council to improve the water situation.

* * * *

A magazine published in the United States and enjoying a large circulation among persons of a scientific tendency recently sent out a number of letters to scientists of international reputation in order that a vote might be secured and the seven wonders of the modern world tabulated. The result was that wireless telegraphy, telephone, aeroplane, radium, antiseptics and antitoxins, spectrum analysis and the X-ray were given as the seven wonders. A glance over the list at once raises the question of where the high-power microscope stood when the total was ascertained. It is doubtful if any piece of mechanism could be named that has rendered more service to mankind. The high-power microscope is to the waterworks engineer exactly what the compass is to the helmsman of the trans-oceanic liner, and without its discovery and development municipalities that are to-day hazarding their existence by discharging their refuse into lakes and streams and then attempting to secure a satisfactory drinking water supply from the same source would be depleted and devastated without the ability to secure control of the bacillus that was the root of all the evil. The science of bacteriology was unknown before the invention of the oil immersion microscopic objectives. This instrument, that has bridged the gap between disease and the source of disease, and has given sanitary engineers and medical experimenters the power to combat bacteria and observe the results of their labors, is worthy of a place on this list.

* * * *

Many instances could be cited regarding the general laxity of business methods employed by religious denominations in their dealings with architects and contractors. One of the most pointed instances has recently come to light in a rapidly growing city in the Province of Alberta. Tenders were called in the usual manner, the date of expiration mentioned, and the parties tendering were given to understand that their respective prices and offers would receive full attention from the governing body of this particular religious body, which has its provincial seat of control in Edmonton, some miles from the proposed place of work. As the time for the awarding of the contract lengthened, several contractors made enquiries, and were informed that the purpose of calling these tenders was to aid the architect only. When this gentleman (with the assistance of the contractors doubtless fully appreciated) made a report on the probable cost of the structure the building committee would reconsider the matter.

* * * *

The mayor of Ottawa has issued an invitation to citizens at present securing water from private sources, other than that publicly sold, to forward samples to the civic medical health laboratory for free bacteriological examination. The invitation contains an extraordinary statement to the effect that "many wells, particularly those drilled in rock, are contaminated." As a matter of fact, wells drilled in rock as a general rule furnish pure water. Recently in the council meeting of a large Western Canadian city a discussion was under way relative to the merits of the spring which certain parties were urging the authorities to purchase. An analysis of the water had been prepared and a number of the council took issue to the high reading of the chlorine factor. Their objections, however, were overcome by one member of the council, who ventured to impart the valuable information that the chlorine in water "was just what made it hard," and, as he explained, doubtless would be easily removed. The above incidents illustrate the amount of scientific knowledge held by the average member of a city council.

THE END OF A FAMOUS SHIP.

The Canadian Pacific Railway liner, Empress of China, was recently sold to a junk dealer in Yokohama, Japan, for the paltry sum of $63,180. It is just exactly one year since the palatial white liner, sister ship to the present Empresses plying from Vancouver to the Orient, went on the Shirahama reef in a dense fog and during a freak tide. About eight months ago she was floated under great difficulties and taken to Yokohama.

After the big liner had been surveyed it was found that it would cost anything from $170,000 to $200,000 to effect such repairs as would enable her to continue in the Trans-Pacific passenger trade. The underwriters have been negotiating for the sale of the vessel for some considerable time, and several Japanese have been in the field bidding for the wrecked liner. The Empress of China was raised by the Mitsui Bishi Dock Company, of Nagasaki, after the rocks which held the ship fast had been blasted away, and with the help of exceptionally high tides. The Canadian Pacific Railway put in claims for a constructive total loss, and a settlement of the insurance claim was made by the underwriters when the liner was offered for sale. The Empress of China will be broken up for scrap by the Japanese purchaser.

DESTRUCTION OF CONCRETE TRACK FOUNDATION.

A method of breaking up old concrete track foundation is described by Mr. C. B. Vorce, construction engineer for the British Columbia Electric Railway Company, Vancouver, B.C., in an article in a recent issue of Engineering and Contracting, and we reproduce the description herewith.

Granville Street in Vancouver, British Columbia, is a principal business street, over which six car lines, or about 150 cars per hour, pass. The tracks on this street between Robson and Drake Streets, a distance of one-half mile, were riding so badly that their reconstruction was imperative.

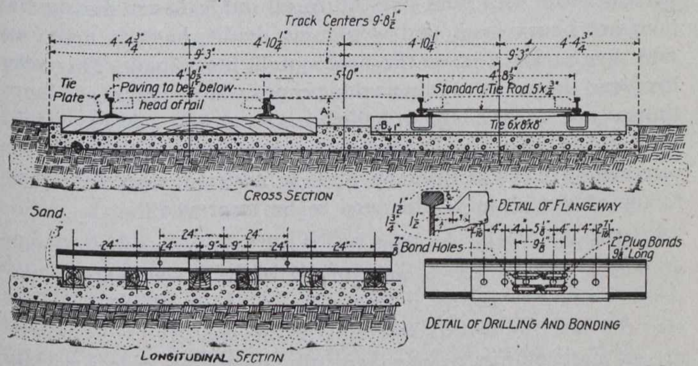


Fig. 1.—Standard Track Construction of British Columbia Electric Railway, Vancouver, B.C.

It was not advisable to rebuild during operation and as there is a double track car line only two blocks away, the Board of Public Works granted the B.C. Electric Railway Company permission to abandon traffic during construction, providing it was restored in 24 days.

The street was paved with wood blocks laid on 6 inches of concrete, and each rail of the double track was carried on a concrete girder 2 feet wide and 15 inches deep. Owing to the nature of the foundation these girders were not heavy enough to carry the weight imposed upon them and on account of this the company adopted the type of construction shown by Fig. 1. This construction consists of a 6-inch concrete slab which is laid over the entire track allowance, 18½ feet wide, upon which 91-lb. T rail 7 inches high are laid on 6 x 8-inch by 8-foot ties spaced 2 feet centre to centre. The track is then surfaced to grade on a sand cushion averaging 1 inch deep and the concrete is brought up to the under side of the pavement.

By referring to the standard cross-section (Fig. 1) it will be seen that the bottom of the concrete slab is 20 inches below the rail grade.

As stated above, the reconstruction of the tracks called for taking out and replacing the following quantities: 5,100 sq. yds. of wood block paving, 10,200 lin. ft. of rail or 5,100 lin. ft. of single track, 1,800 cu. yds. or 5,100 sq. yds. of concrete, 600 cu. yds. of earth and the laying of 2,400 cu. yds. of concrete, one-half mile of double track, 850 sq. yds. of granite flangeway blocks and 4,250 sq. yds. of wood blocks.

As the concrete has to set 10 days before traffic can be turned back on the street, this necessitated the completion of the work above outlined, except the paving, in 12 days, and not 14 days, as two Sundays intervened. The work was carried on day and night, and a schedule (Fig. 2) was prepared showing the rate of progress which must be made on each of the operations in order that the work should be completed within the time limit. This schedule was so closely followed that all the work, except the paving, was finished one hour before the time called for by the schedule, and during the 10 days the concrete was setting the street was repaved, so that when traffic was restored all the work was completed.

The B.C. Electric Railway Company has a large construction force, who do the greater portion of its work, so it was certain of the speed with which the various operations, with the exception of breaking up of the concrete, could be accomplished.

The company had just built a piece of new track which called for the removal of about 300 sq. yds. of concrete of a similar nature, which had been laid by the same contractors. This piece of concrete was removed by hand and it took 15 men 6 days to do the work. As the schedule called for the removal of about 32 sq. yds. of concrete per hour, it was seen that some mechanical means must be used, and the following scheme was adopted:

The dipper arm was taken off the electrically driven Thew automatic shovel owned by the company and the pile driver leads about 20 feet long were hung from the end of the boom, being held in position by two braces running back to the main frame of the shovel. A hammer weighing 2,600 lbs., with a wedge shaped cutting edge about 8 inches deep running parallel to the track, was specially cast. The cutting edge was placed this way in order to not injure the remaining concrete in the street. This scheme worked excellently and no trouble whatever was found in breaking up the concrete as rapidly as it could be taken away.

The concrete breaker, which could swing through 350 deg., was placed on one track and on the other track the derrick car was placed. This derrick car had a 60-foot boom, which could also swing through 360 deg. and could move itself up and down the track. This car was used to break up the larger pieces of concrete and load them on flat cars placed behind the concrete breaker, also to unload skips in which were placed the smaller pieces of concrete

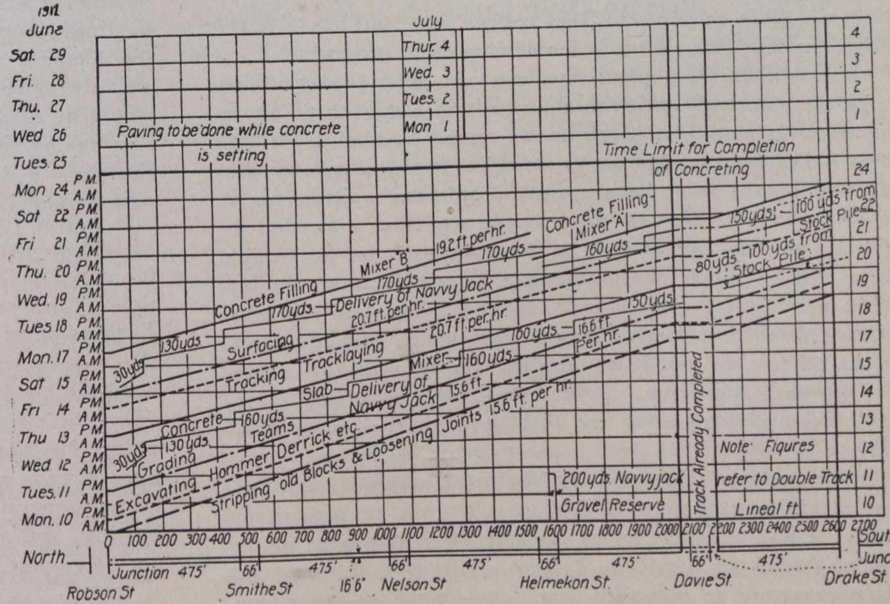


Fig. 2.—Progress Chart of Track Reconstruction Work.

and earth, this material being dumped into wagons standing alongside.

The concrete breaker and derrick car backed up on the old track as soon as the concrete was broken up for a rail length ahead of them.

The price of common labor was $3 per day of 10 hours, and teams received $8 per day shift of 10 hours and $9.50

for night shift. The average haul for teams was ¾ of a mile and for the track cars about 2 miles. The cost of the work was as follows:

Digging up wood blocks, 8 9/10 cts. per sq. yd.

Tearing up old track, 11 cts. per ft. of single track.

Breaking up concrete, 40 cts. per sq. yd., or $1.13 per cu. yd.

Excavation, loading and dumping, 82½ cts. per cu. yd.

Removing material by teams and work train, 65 cts per cu. yd.

Mr. G. R. G Conway, M. Am. Soc. C.E., is chief engineer of the B.C. Electric Railway Co., and the work was carried on under the supervision of Mr. C. B. Vorce, M. Am. Soc. C.E., engineer of construction, assisted by Mr. H. J. Tippet, engineer maintenance of way, and Mr. A. J. Kennedy, roadmaster.

REPORT ON MOOSE JAW MUNICIPAL HEATING PLANT.

A report was presented to the City Council of Moose Jaw, Sask., recently, on the advisability of installing a municipal heating system, by Mr. J. D. Peters, the municipal electrical superintendent. The report in abstract follows:

"Before deciding upon what line of action to adopt regarding the new power plant to replace the one destroyed by fire on May 25th, there are several things to be taken into consideration, at least the suggestions and advice that are forthcoming regarding this matter make it necessary to consider everything carefully. I will endeavor therefore to point out to you clearly and as briefly as I can my own views regarding the matter. I will say I am not prejudiced in any way, but am anxious that we shall get the best and most ecomonical and up-to-date plant possible. I also think that I am in a better position to discuss this matter than any other person, as I know the conditions under which we have been operating. The first thing I would suggest would be the changing from the two phase system to the three phase. The advantage of the three phase system is:

1st.—That 25 per cent. less copper wire and space is required in the lines and interior wiring.

2nd.—The three phase systems are generally conceded to be the standard, and with the result that only three phase apparatus is carried in stock to any extent by manufacturers. Two phase is regarded as "special." It is often very difficult to obtain two phase apparatus without waiting for it to be manufactured, two phase being regarded somewhat as special, and the demand for it decreasing, I do not think there will be much effort among the manufacturers to improve upon it. To consumers having plants in different cities it would be an advantage if our system were the same as the other cities, as it would allow the interchange of motors or other apparatus. Beyond this, and the saving in interior wiring, there would be little gain to the power consumers.

"The cost of changing by the most expensive method, that of exchanging new motors for old ones at present in use, at a loss to be borne by the city of 50 per cent. of the cost of the motor, would be $12,000. However, it would not be necessary to do this with many consumers, as the majority would be served by specially-connected transformers. Taking into consideration the value of copper cut out of lines, I do not think the cost of changing lines from two phase to three phase would exceed $6,000. It would take some time to figure out exactly the cost of changing, but I believe my figure of $6,000 would cover it. Now is the time to change when we have no generators, and I think that it would be worth more than the cost of changing to be right up-to-date.

"Regarding the central steam heating system, if you will refer to my annual report for last year, you will find the following: 'To instal a steam heating plant system and connect with our plant to accommodate sufficient business to warrant placing back pressure on our engines would entail an expenditure of at least $300,000. From such a plant we would derive a revenue of about $1.25 for every kw. produced. Therefore to sell sufficient exhaust steam to make 10 per cent. on capital expenditure, or $30,000, it would be necessary to sell the exhaust produced by manufacturing 2.-400,000 kw.h., or twice total output for the year 1911. Then this amount would have to be sold during the heating season of about eight months. Further, on account of our widely varying load, we could not utilize all our exhaust during the hours of heavy load, and would, no doubt, have to make up with live steam during the hours of lightest load. Our very low load factor is against the proposition. When all these things are considered, I believe our annual output would need to be about six times the output for 1911 before we could go into the heating business to advantage, and the load factor of the plant would need to be improved.'

"I have during the last few days been checking up this statement quoted above, and do not think it necessary at the present time to modify it in the least. I would only emphasize the last few words referring to the load factor. There are so many things to be taken into consideration in figuring out the advantages and disadvantages of the steam heating system that it would require months to get a full reliable report upon the matter, and it looks to me as though it were scarcely worth investigating at the present time, considering our present load conditions. I would not recommend any action towards the installation of a heating plant without having a full report from a heating expert and one whom we are sure has no 'axe to grind.'

"The prospects of going into the heating business at some future time should not, however, have any effect upon our present requirements of generating apparatus, as we would require other units to take care of our heavy loads and summer loads, the exhaust from which could be utilized for heating system. As to the location of the plant, if the heating business was started a more central location would be slightly more desirable. However, the cost of such a site would be so great that it would pay better to run the necessary mains from the present site to the business section of the city. I do not think there is a better location for a power plant in the city than the present one.

"I do not regard the heating business as being suitable for municipal ownership, as only a comparatively small portion of the ratepayers could expect to share directly in the benefits of such a system. Indirect benefits might come in the way of reduced rates for electricity, but on the other hand the heating business might turn out a failure, and drag down the electrical department with it. However, these are points for more of an expert than myself to deal with. I have already pointed out to you that we will require, in any event, generating apparatus that is not adapted for steam heating, and also that the present location of the plant need not be changed.

"I will therefore recommend that immediate steps be taken to restore full electric light and power service at the earliest possible date by the installation of a steam turbine and generator large enough to handle our maximum loads until such time as we can get a smaller unit installed. If the machines are available I would instal a unit of 1,000 kw. capacity at once, and a 500 kw. unit as soon afterwards as possible. These two units will handle our business during the coming winter, but it will be necessary to add to this capacity next year. Then if we have a favorable report upon the matter of steam heating, and decide to go into it, a unit suitable for it can be installed next year. At the present time this department is standing a net daily loss of about $225, so you will see that prompt action is necessary.

"We have been already offered several generating units for quick delivery, both new and second-hand. Among these we have an offer from the Canadian General Electric Company to substitute a three phase outfit for the two phase outfit already ordered from them, and to ship same immediately. This is an exact duplicate of the one already ordered, with the exception of the winding of the generator, and the same guarantees and other terms of the contract will apply. All that is necessary to obtain the outfit at once is to give the company an order to change the winding of the generator from two phase to three phase. The price will be the same, except for some slight adjustments to cover switchboard not now required in the contract, and the exciter set to be given in part payment, but which is now destroyed by fire. There will also be a charge of $350 for work already done on the two phase machine. Condensor equipment can be shipped in six weeks, and until this arrives the turbine could be operated non-condensing. If this proposition was accepted we could have full service restored in about five weeks' time, and would also have a thoroughly up-to-date machine in our plant. In our present plight I believe it is the very best action to take."

CHLORINATION AT CLEVELAND, OHIO.*

By Dr. D. D. Jackson, Sanitary Expert, New York City.

When the chlorinating plant for treating the water supply of Cleveland was placed in operation in September, 1911, disagreeable tastes and odors were noticed from time to time and investigations were undertaken to regulate the application of the chemical and determine its effectiveness as a sterilizing agent. It was found that the unsatisfactory results were due to the use of unnecessarily large amounts of chlorine. The quantities of chlorine have been reduced while the sterilizing effect upon the water has been sufficiently active. The efficiency of the process was demonstrated during the present year, both by analytical results and by the fact that while ice movements in April caused specific infection in the water supply at the intake during three days, yet there was no accompanying rise of typhoid in the city. Since the installation of the new four-mile intake the water supply of Cleveland has been in a satisfactory sanitary condition at all periods of the year, with the exception of the short intervals during which the annual breaking up of the ice has occurred. The sewage-laden ice from the river and harbor has, on several occasions, infected the supply at that time, especially in 1910 when the ice movements were oscillating and protracted.

Under present conditions infection occurs only during and directly after the ice movement and it is at these times only that it is imperative to treat the water with hypochlorite. In order to insure the use of standard amounts of chlorine when sudden increase or decrease in pumping takes place, it is recommended that an automatic device be installed which will regulate the flow of hypochlorite solution directly in proportion to the flow of water, and that experiments be made with a view of substituting the chemical solution by compressed chlorine gas made directly from the electrolysis of common salt. This gas is more effective at low temperatures, is readily eliminated from the water by its more rapid reaction, can be easily regulated and is in all respects like treatment with ozone, but more practical of application and much less expensive. The estimated cost of an installation for Cleveland is $2,000 and the cost of treatment from 40 cents per million gallons downward to about 25 cents as liquid chlorine comes into general use and is made on a large scale.

With the present funds available for waterworks purposes at Cleveland it is proposed to extend the old intake line to a point 16,000 ft. northwesterly from the old west-side crib, thereby having two long lines ready for use so that in case leaks should develop in one the other would be available for use while repairs were in progress on the damaged line. The extension of this intake together with the installation of permanent apparatus to treat the lake water is believed to be a satisfactory method of insuring a pure supply of water and is much less expensive than building filters.

The present chlorinating plant consists of a small mixing tank 4 ft. in diameter and 3 ft. 4 in. deep, equipped with a mechanical stirrer. There are two 11 ft. 8 in. diameter solution tanks, 7 ft. 5 in. deep; a 1 per cent. mixture is used, the feed being controlled by two orifice tanks with float valves. The daily pumpage is about 70,000,000 gal., so that from 11 to 18 lb. of hypochlorite per million gallons is used, corresponding to an amount of chlorine of from 0.5 to 0.7 parts per million. Sudden changes in pumpage, together with the sometimes great variation in the strength of the individual drums of chloride of lime, has at times been a source of difficulty in the application of the treatment. This difficulty was greatest at the time when it was thought that 0.8 parts per million of chlorine was necessary. It is now found that from 0.5 to 0.7 parts is sufficient. Any amount in excess of 0.8 parts produces during cold weather objectionable tastes and odors.

In Jersey City, where the first practical tests of the treatment were made, it was found that 0.35 parts of chlorine per million was sufficient; this amount was used also at Cincinnati. In the Croton supply of New York 0.5 parts was required and in the Bronx supply 0.6 parts.

Compressed chlorine, liquefied under pressure, is now on the market sold in 100 lb. cylinders and can be had at about 8 cents per pound, about double the price of hypochlorite of lime as far as available chlorine is concerned. It has, however, many decided advantages over hypochlorite in that it is a pure and definite product which is absorbed by the water as a gas. It is easier to apply with regularity and its added cost is nullified by the fact that almost no labor is required in its application. No solution tanks are necessary and no lime sludge has to be disposed of. The only installation required for this treatment is a gas pressure-regulator with pressure gauges on either side of the regulator. The gas then passes through a series of hard rubber orifices and is absorbed in the flowing water. The only labor required is about 5 min. work to connect up a new 100-lb. tank once in 6 hours in the case of the Cleveland supply.

In regard to typhoid fever since the new 4-mile intake was installed in 1904 the death rates have been low. The year immediately following the installation of the new intake the typhoid death rate dropped from 48 to 15 per 100,000 and has averaged 16 for the 7 years that this intake has been in use. In spite of the low death rate there have been occasional times when for short periods the water appeared to be the source of slight infection and this infection occurred always in the early part of the year. It was to stamp out this source of risk that the sterilization of the supply was adopted.

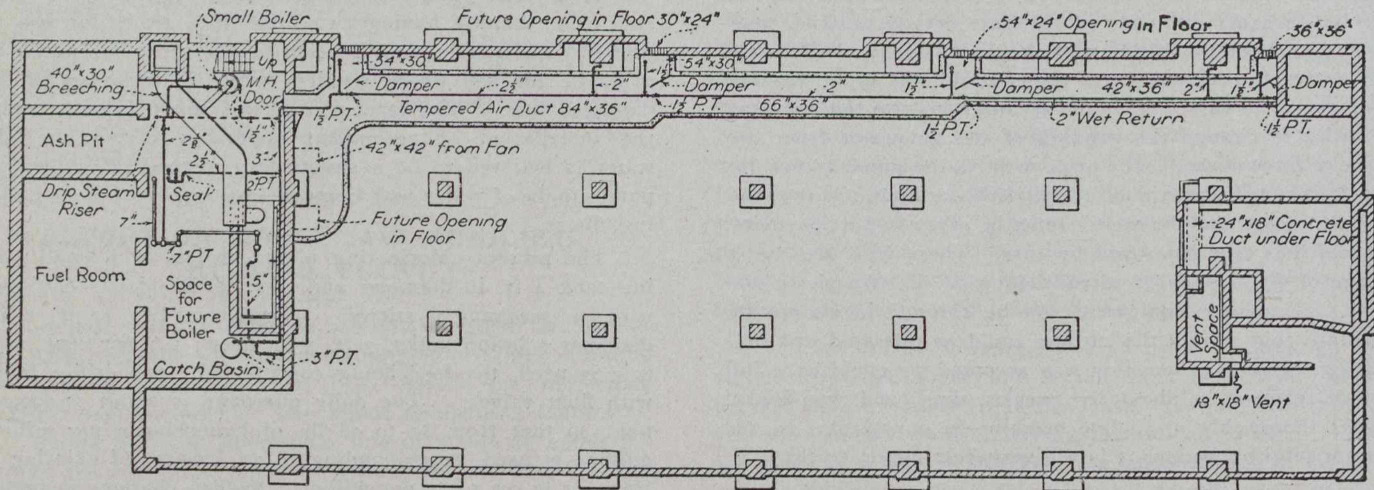
* Paper read before American Waterworks Association.

HEATING AND VENTILATION OF A FACTORY.*

By Samuel R. Lewis.

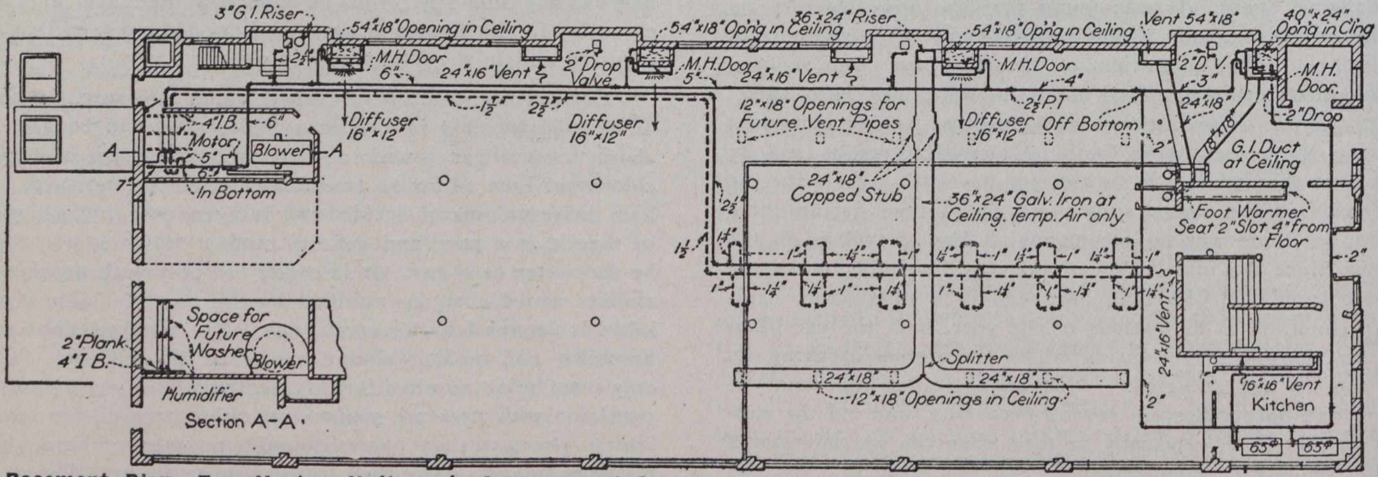
The object of this paper is to describe the heating and ventilating arrangements of the factory of the Defiance Tick Mitten Co., Toledo, O. The first floor is used for storage, packing, etc., while the second floor is occupied by about 250 operatives, nearly all women, who work at power sewing machines, pressing and finishing tables, etc. There are a number of steam-heated forms upon which the finished gloves and mittens are pressed. The desire of the owner was to provide an especially sanitary, light and attractive building, as he had learned by experience that these features had so great an influence on the attendance and efficiency of the labor that it was a good business investment as well as a function of good citizenship to provide them. The operatives are nearly all paid by piecework, and are found to be quite independent as to their attendance. By providing pleasant and healthful surroundings for the girls and women, with such equipment as individual steel lockers, a warm lunch, shower baths, rest rooms, etc., the tendency is to maintain a full force when labor is scarce, at the expense of competitors who have less attractive shops.

The building is of reinforced concrete construction, with brick curtain walls and a saw-tooth roof. The windows are all in steel sash. The roof is of composition, laid on finished plank, and supported on steel trusses. The building is intended as the first of a group of a similar type, surrounding a central administration building and power plant. It is one-half of a future unit, and the division of the apparatus is such that the boiler, fan, coils, etc., for the other half may be added later on. Thus, the cost of the present plant was very little in excess of what it would have been had there been no thought of future additions. The boilers are placed in a sub-basement; one has capacity for all heating, ventilating and manufacturing requirements, and the other is provided for summer use for manufacturing and water heating. The principal manufacturing demand for steam is for heating the metallic forms used in pressing the finished product.



Basement Plan, Showing Tempered Air Duct Supplied by Fan on First Floor and Leading to Flues Containing Heating Surface.

Fresh air is supplied through special steel casement sash, and is drawn through tempering coils and steam jet humidifiers to the supply fan. The steam supply to the tempering coils is controlled by a thermostat so that the tempered air is never cooler than about 60 deg., or warmer than that, unless the outside temperature is higher than 60 deg. The steam jets are controlled by a sensitive element which operates within a range of less than 5 per cent. of the point at which it is set (about 40 per cent. relative humidity). The supply fan delivers this conditioned fresh air through a concrete duct (which also serves as a return pipe trench) to the bases of the various flues. These flues have, near the ceiling of the first floor, individual coils, which have automatically controlled steam supply valves. The thermostats which operate these valves are of the



Basement Plan, Fan Heater Unit and Arrangement for Doubling the Capacity and the Steam and Air Distribution, Particularly for Second Floor.

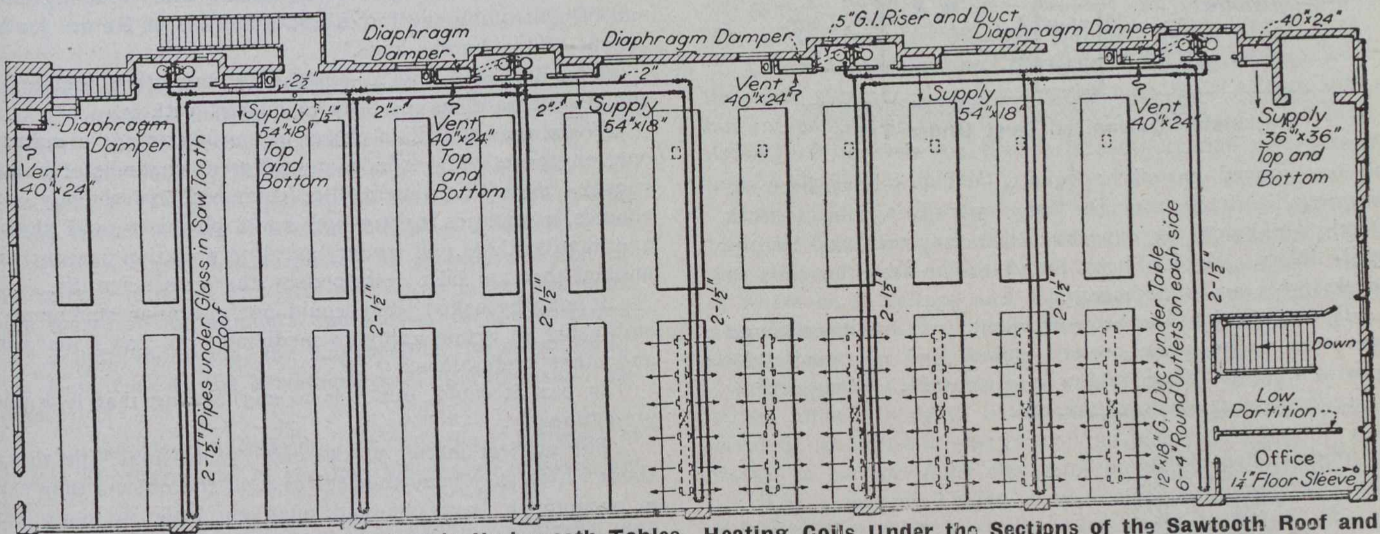
* Paper read at meeting of the American Society of Heating and Ventilating Engineers, Detroit, Mich., July 11, 12 and 13, 1912.

gradual or stage operating type, and reduce or increase the amount of heated radiating surface as the temperature requirements dictate.

The various supply flues discharge some air into the first floor, but their principal function is to serve the second floor, where a minimum of 30 cu. ft. of fresh air per occupant per minute is provided. When the building is being

blast gate for regulating the volume to each person, is provided. To offset possible cold drafts from the exposed roof or skylights, pipe coils under separate hand control are placed under each saw tooth glass area.

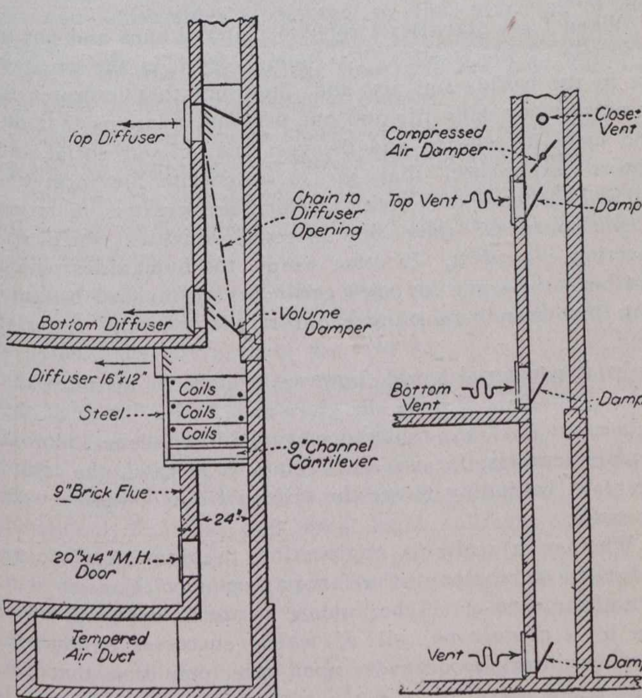
Many of the operatives walk some distance, and are liable to arrive at work with wet skirt bottoms and damp feet and ankles. A floor inlet would be objectionable from



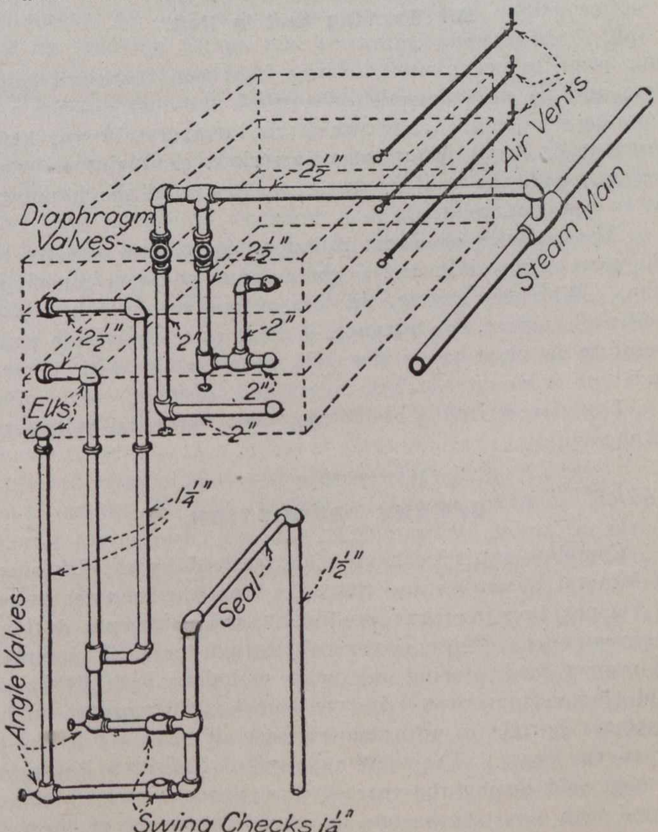
Second Floor Plan, Showing Air Supply Underneath Tables, Heating Coils Under the Sections of the Sawtooth Roof and Location of Fresh Air and Vent Flues.

heated, the fresh warm air is discharged at a point about 10 feet from the floor through adjustable diffusers. It passes across the skylights and is forced against the almost continuous glass surface of the opposite wall. When the building is warm, however, the fresh air is discharged at the floor line through adjustable diffusers, directly at the lines of operatives. When heating, the exhaust air leaves

sanitary reasons, and so the concrete bench for drying purposes is provided and has proved quite effective. The seat is warm, about 100 deg., and through slots in its face a little above the floor, a strong blast of air is about 120 deg. maximum is delivered parallel with the floor. This air also warms the entrance hall and stairway.



Typical Fresh Air and Vent Flues.



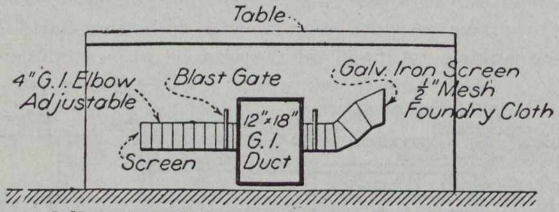
Typical Connections to Heating Coils.

the room at the floor, but when cooling or merely ventilating, the exhaust air leaves the room at the ceiling. To this end, each supply flue and each vent flue has two openings, with adjustable dampers in each.

In order that the operatives at the steam-heated forms may have the maximum of comfort, a 4-in. tempered air inlet at the floor, with an adjustable universal elbow and a

The escape of air from the building when it is unoccupied may be cut off by special dampers in the outlet flues, all being operated by compressed air by one switch valve in the fan room. All toilet fixtures are individually venti lated through local vent openings in the bowls to separate vent flues.

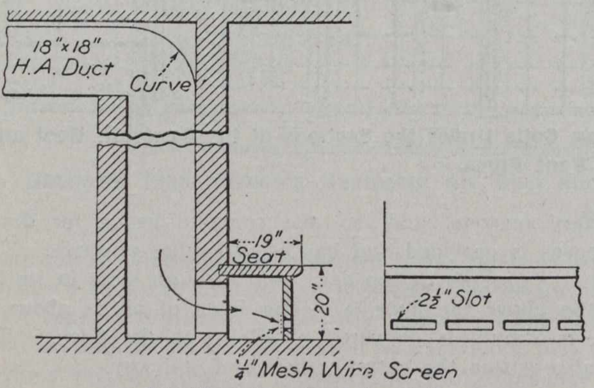
There is no direct radiation. The plant has been in operation through the severe weather of the past winter,



Adjustable Galvanized Duct Under Table.

and has proved entirely adequate. There have been no objectionable drafts, though many operatives sit at work directly alongside the exposed glass surface opposite the supply inlets. It has been found so far that the coils in the skylights are unnecessary.

The ventilation has been excellent. It has been found economical to keep the outlets closed and to rotate the air within the building, taking in no outside air when heat-



Air Warming Seat in Hall.

ing prior to occupancy. There has been increased comfort and no objectionable odor when the humidifying apparatus was in use, and when the temperature was kept down to 65 deg. There was no serious complaint of overheating with the temperature at 70 deg. and the humidity at 40 per cent. relative.

The absence of direct radiators contributes greatly to the ease of cleaning, and to the comfort and fuel consumption. With this system, the loss of heat through the glass and wall surface, for instance, is less, since the inside temperature is close to 70 deg. all over, while with direct radiators it would be close to 212 deg. opposite every unit.

Langdon & Hohly, of Toledo, Ohio, were the architects of the building.

CEMENT PRODUCTION.

Complete statistics have been received by the Division of Mineral Resources and Statistics from the manufacturers of cement covering their production and shipments during the year 1911. These returns show that the total quantity of cement made during the year, including both Portland and slag cement, was 5,677,539 barrels, as compared with 4,396,282 barrels in 1910, an increase of 1,281,257 barrels, or 29 per cent. The total quantity of Canadian Portland cement sold during the year was 5,635,950 barrels, as compared with 4,753,975 barrels in 1910, an increase of 881,975 barrels, or 18.5 per cent. The total consumption of Portland cement in 1911, including Canadian and imported cement and neglecting an export of Canadian cement valued at $4,067, was 6,297,866 barrels, as compared with 1,103,285 barrels in 1910, or an increase of 1,194,581 barrels, or 23.4 per cent.

THE RELATION OF ELECTRICAL ENGINEERING TO OTHER PROFESSIONS.*

By Gano Dunn.

On the wall of a great engineering library is the legend "Engineering is the art of organizing and directing men, and of controlling the forces and materials of Nature for the benefit of the human race."

This is broad and all-embracing, but other professions will find it hard successfully to quarrel with it.

While the immediate object of engineering is a material one, engineers draw from many different channels of human energy, such as generalship, commerce, psychology, mechanics, economics, to say nothing of chemistry and physics and many others, all under an interpretation insight and method that are best described by the term scientific.

It may be asked, Why could not a similar statement of embrasure or scope apply to medicine, the law, the army and other professions?

In part it could, but it is to engineering that it applies pre-eminently.

The subject matter of the older professions, the things about which they busy themselves, and the objects they seek to accomplish have changed relatively little in many centuries. The means have altered but the ends persist. They are approximately the same to-day as they have been throughout history and tradition.

With engineering it is different. There was no such profession a hundred and fifty years ago, and if I may a little anticipate my conclusion, there will be no such profession a hundred and fifty years hence in respect to a large part of what we now call engineering.

Such as it is, engineering is embracing an ever-growing horizon, and is including more and more of the activities of civilization.

When I say activities I refer to material ones and not to the whole of life itself. The human spirit is the greatest fact in the world, and art and literature that interpret it, the acts of our daily life and our personal relations that depend upon it, religion and the vast body of our social and political experience, that go to constitute life form undoubtedly a mass of activities, which are greater, in terms of consciousness, than the material activities which engineering can affect. In other words, the humanities which have been the same for ages can never be invaded by anything that merely rearranges our relations to the material world.

In the material world, however, which is at once the workshop and the throne, the glory and the limitation of the engineer, marvel has followed marvel and shall be followed by more marvels, for we are beginning to catch the tools' true play; beginning to see the vision of our dominion over the earth.

Whether it really is engineering to organize men, to predict the psychology of a fare-paying population, to win the endorsement of a labor union, to treble the yield of a farm by a microscope, all of which successes to-day are called engineering, depends upon the definition that we finally adopt.

It is startling to study the variety and importance of the posts filled by engineers and to note the range of what they do. From the Efficiency Engineer presenting surprises in the output of a factory where the human factor is large, or the Industrial Engineer suddenly after thousands of years

* Presidential address presented at the 29th Annual Convention of the American Institute of Electrical Engineers, Boston, Mass., June 25, 1912.

showing the world how to increase greatly the lay of bricks, or the Agricultural Engineer working miracles with the soil that for ages farmers have struggled with, to the Civil Engineer establishing a kingdom and building the Panama Canal, we have instances in which the engineer is doing more and more of the world's work.

The history of this class of men so rapidly growing in numbers, so rapidly differentiating in function is almost a romance.

The Encyclopedia Brittanica names the middle of the eighteenth century—that is, 1750—as the time before which there were only Military Engineers—who constructed "engines" of war—and it adds that at about that time there began to arise a new class. Little did this new class realize the army it was leading down the industrial paths of time!

The "new class" has surpassed all bounds. From insignificance a hundred and fifty years ago it has increased almost incredibly in numbers and variety of specialization.

As a local indication, the Engineering Societies' Building in New York is the headquarters of fifty thousand engineers.

As another local indication, the American Institute of Electrical Engineers has in the last ten years increased six fold.

The growth in the variety of specialization has been almost as rapid as the increase in numbers.

Where there were only Military Engineers and the "new class" a hundred and fifty years ago, there are twenty-seven recognized varieties to-day.

Without mentioning all, they range from Civil through Mechanical, Electrical, Mining, Illuminating and Chemical, to Refrigerating, Industrial, Agricultural and Aeronautical. There is even a magazine with the title Human Engineering.

A large and increasing part of the capacity of our colleges and universities is devoted to the education of engineers.

Parts of the engineering curricula are borrowed for what used to be purely classical courses.

The metaphors of the speech of the day often have an engineering basis and—we have a McAndrews hymn.

The man in the street knows something about spark plugs, and many women understand the general principles of the telephone.

The social status of the engineer has emerged from that of a mechanic to one nearly as high as that of the clergyman, the physician or the lawyer.

Relatively recently there has been going on simultaneously with all this, however, hardly noticed, something else —a vast increase in so-called engineering work by men who are not engineers, and at the same time a large drawing off into executive, administrative, industrial, commercial, civic, educational, financial and even legal callings, of men of engineering training.

A history of segregation and disintegration seems to have begun to accompany a history of integration and building up.

For one to say to-day he is an engineer gives very little idea of what he actually does. It does not locate him in one of the twenty-seven recognized classes. It leaves is possible for the hearer to think of him as a "social engineer" or an "efficiency engineer" should he not look like a "civil engineer," but even if he did define himself and say he was an electrical engineer, the hearer would still not know whether he represented the last word on the loading of telephone circuits or his responsibility was to determine whether the great railroad terminals of Chicago should use a third rail or an overhead catenary.

If he should say "I am a teacher," "a physician," "a clergyman," "a lawyer," there would be a much more definite conception attaching to his answer.

There must be, therefore, in the title "engineer" something broader, something not included, or included to a lesser degree in the titles of the other professions or occupations.

A light is shed if we examine the popular definition that engineering is "educated common sense."

Can it be that unlike "physician," "lawyer," "teacher," the term "engineer" does not describe what a man does, but rather how he does it! A method rather than an occupation! It is even so; that is, essentially and with limitations I shall refer to later.

What then is this "method" that has given the engineer his ever broadening domain and brought all kinds of men and callings to his school? He can tell you at once. Here is where he is defined and where his fellows recognize him and each other though they come from the ends of the industrial earth as to diversity of actual occupation.

The method had its birth in Greece, though it was stifled almost to death by the tremendous philosophic, humanistic and artistic energies of the Hellenes. Later it was buried in Europe under the irruption of the barbarians.

The names of Thales, dear to our profession, with his "elektron," and of Aristotle and Archimedes, stand out as having done much for it—especially Archimedes—in spite of the humanistically polarized intellectual atmosphere in which they lived and which they contributed so gloriously to create.

But the Greeks made only a start. To quote an authority, their material thinking was largely based on what has proved to be a wrong method of procedure, the introspective and conjectural rather than the inductive and experimental. They investigated Nature by studying their own minds, by considering the meanings of words, rather than by studying things and recording phenomena. But they saw much of the light with all this.

Though absolutely dead for a thousand years in Europe, "the method" was kept alive during the middle ages in Arabia, although confused with magic, alchemy and algebra.

Then came Roger Bacon, Leonardo da Vinci and Copernicus, and science as we know it began to take shape.

Aristotle had sat down in his chamber and he wrote in a book, "A body twice as heavy as another of course falls twice as fast." Galileo released simultaneously from the top of the Leaning Tower a one pound and a one hundred-pound shot and they reached the earth together, before the eyes of the assembled University of Pisa.

But "the method" was repugnant to the University, and almost to a man they believed their Aristotle, sophistically explained away what they saw, and persecuted Galileo.

Descartes, Newton, Lagrange, Laplace, Francis Bacon connote to engineers the transcendent story, unless for electrical engineers there should be added Ampere, Faraday, Henry, Helmholtz, Kelvin.

The method of doing things that makes an engineer is, therefore, the applying to practical and utilitarian ends the principles and reasoning of science. Engineering is not science, for in science there is no place for the conception of utility. Truth is her sole criterion. In the exalted language of Professor Keyser, "Not in the ground of need, not in bent and painful toil but in the deep-centered play-instinct of the world Science has her origin and root; and her spirit, which is the spirit of genius in moments of elevation, is but a sublimated form of play, the austere and lofty analogue of the kitten playing with the entangled skein or of the eaglet sporting with the mountain winds."

Engineering is Science's handmaid following after her in honor and affection, but doing the practical chores of life, concerned with the useful and the material; with costs and with expediency, and concerned with the humanities only in so far as they are an incident in some particular scheme of reality, and then objectively, if that may be said.

Her methods merely apply straight thinking to material problems for useful purposes.

Does this constitute a profession? No. Some day it will be the way almost everybody thinks instead of a body of specialists and then the difference between a doctor, for instance, and an engineer will be only in the things they busy themselves about; as is to-day the only difference between kinds of engineers.

The centre of education has been shifting rapidly recently—almost as rapidly as material well being has been increasing.

The application of science to living has marked an age as distinct as the age of the climax of Art in Greece.

The "new class" has been but a pioneer in sowing the seeds of scientific rationalization in a field the value of which was only dreamed of by Archimedes and not actually recognized until, as the Encyclopedia tells us, "about the middle of the eighteenth century," when the "new class" began to arise.

And now, as to the limits within which engineering is a method rather than an occupation.

There will always be engineers, for the methods of Science will constantly advance, and there will be needed continually, to interpret and transmit them to mankind, and to make the first applications of them to useful purposes, a class of men who, by instinct and taste, as well as by the possession of what I later shall call the dynamic component, find easier than other men—and consequently perform better the kind of scientific thinking, observation and action that characterize engineers to-day.

What these men will be busy about it is hardly safe to say, although it is probable the present great divisions of engineering will be more or less preserved. It seems certain that a large mass of knowledge that now is called engineering and forms the basis of many of the engineering specializations, will become general knowledge, and will be absorbed by the community, partly as a result of the shifting of the centre of education and partly through everyday familiarity, and the men possessing this knowledge will no longer be called engineers. They will be called farmers, let us say, in the case of the "Agricultural Engineer"—of course, a farmer of a very advanced kind compared to the earlier one.

But the centre of education will not always continue to shift. It is shifting now only because it has so long been eccentric.

It would be a calamity for it to shift too far, resulting in a world whose sole training was applied science and the utilities.

Under such a condition, engineering and the utilities themselves would languish instead of flourishing, for there would be lacking in engineers the dynamic component.

Ample knowledge, insight, information does not make an engineer. He must first be a man. Engineering is not thought like philosophy; it is thought times action, and only when the qualities of action are developed approximately to the same extent as the qualities of thought is an engineer at his best. Only then is his area of effect a maximum.

The qualities of action involve tastes and personality, the feelings, the will. And it is these that constitute the component or factor that makes an engineer's intellectual or rationalizing equipment dynamic—that puts it to use.

It was partly the intense appreciation of the value of the dynamic component that led the Greeks and successive centuries astray in the direction of their education and contributed to an underestimate of the importance of Science and the study of the laws of nature.

We must not go to the equally wrong other extreme.

So far I have said but little of electrical engineering. It must be brought in if for no other purpose than to justify our title. Although the article on "Engineering" in the Brittanica occupies only six inches of one column, it concludes with the following: "The last great new branch is electrical engineering, which touches the older branches at so many points that it has been said that all engineers must be electricians."

If engineering is a method of doing things, and electrical engineering tends to embrace all other branches, there is an implication that electrical engineering is the latest or most highly developed form of the method—the method that is the utilitarian application of the principles of Science to the material facts of life.

Such is unquestionably the case. Born scarcely more than twenty-five years ago, the "youngest branch," Electrical Engineering had the opportunity of striking its roots into the richest of scientific soils, free from prejudices, customs or traditions. It had no entangling alliances, no political laws to retard or encumber it. The field it preempted was the Terra Nova of Engineering, the New World of Applied Science.

Under the influence of those geniuses of Science, Volta, Faraday, Ampere, Ohm, Kelvin, Helmholtz, Maxwell, Oersted, Henry, and with the metric system for its cornerstone, there developed a comprehensive structure of thought and a related scheme of units. The latter are the admiration of the world for their simplicity, their convenience, their precision and their reproducibility. The scientific method as applying to all phenomena acquired its most perfect embodiment in the electric system and its relations.

But there is a philosophical debt that we electrical engineers owe our units. They school our minds. The ability to measure with precision difficult and complicated quantities enables clear thinking on them and renders reasoning about them possible that otherwise could not be attempted. To name a thing is to know it.

The wonderful electrical units are a fluent language that gives the widest opportunity to thought. By their character they educate our faculties of definition and relation.

They typify all quantitative thinking, not merely electrical.

They are the epitome, the last word of the great minds of our age, as to what the scientific method of thought is, in relation to the whole realm of matter and force.

Therefore, although the subject matter of electrical engineering is covering a wider and wider range—so wide as to be almost incongruous, the electrical method of thinking is applicable throughout. It is spreading far beyond.

As an electrical engineer, I even find myself thinking of the crowds passing in the streets in terms of amperes and volts, and of the fluctuations of the stock market in terms of current, inductance, capacity, resistance and resonance.

That which can impose form upon our thought enables us successfully to think of any kind of thing.

The forms of thought established for electrical engineering are at once comprehensive, so rigid, so rich in detail, and so illuminating that engineering does not bound them.

They may be called the manifestation of Science in civilization, the best representation of the scientific method at work for utilitarian ends.

They prove that the profession of Electrical Engineering not only deals with single-phase motors, storage batteries, high-tension transmissions, turbo generators, coronas, carbon transmitters and commutation as an occupation, but that it also is a way of thinking, and as such is not an occupation, but the latest and most highly developed scientific method of solving all kinds of practical problems of matter and force, for the benefit of the human race.

LARGE ROLLING LIFT BRIDGE.

One of the principal bridge building contracts of the year has just been placed by the Great Central Railway Company of England with Sir William Arrol and Company, Limited, of Glasgow, Scotland, for the construction of a large new railway and highway Scherzer Rolling Lift Bridge and approaches across the River Trent at Keadby, in Lincoln, England. The requirements of navigation at this point on the River Trent, just above where it enters into the River Humber, are quite severe and necessitated the most careful consideration in selection of the type of draw span, and the engineers of the railway company visited all of the important modern movable bridges in Great Britain and America before deciding upon the Scherzer type as best fulfilling the requirements of navigation and the very heavy traffic over the bridge.

The structure will be composed of two fixed approach spans in addition to the bascule span and the track girder span upon which the moving leaf rolls in its operation, on the well known simple Scherzer principle. The total length of steel work will be nearly 500 feet. Each span will have three trusses, the centre truss dividing the railway and roadway portions of the bridge deck. The railway section will have a width of 29 feet and the roadway 24 feet centre to centre of trusses.

The movable span of this bridge is of the Scherzer single leaf through type and as it will have a movable length of 160 feet and an extreme width of nearly 60 feet it will be one of the largest bascule bridges in the world. The machinery and power equipment designed for opening and closing the bridge in one minute is very simple and effective for so large and heavy a structure. The power will be electrically generated in a machinery house alongside the bridge and this current will actuate the motors which are placed on the rear end of the movable leaf. These motors are geared to the main operating shafts which drive pinions engaging with racks on independent fixed supports outside of the plane of the movable bridge trusses. This method of operation is one of the special features of the latest designs of Scherzer Rolling Lift Bridges, and reduces the machinery and power required to a minimum even in the largest and heaviest structures.

The substructure will consist of steel caissons carried to about 50 feet below the low water of ordinary spring tides and the masonry piers carrying the superstructure will be founded upon these caissons.

The entire bridge is designed in accordance with the latest practice in both foundations and steel structures to carry the heaviest main line traffic of the Great Central Railway between Doncaster, Grimsby and the large modern Immingham Docks on the Humber River.

Sir William Arrol and Company, Limited, will execute the work under the supervision of Mr. J. B. Ball, engineer-in-chief of the Great Central Railway Company, by whom the foundations and approach spans were designed. The Scherzer Rolling Lift Bridge Company, Chicago, Mr. Albert H. Scherzer, president and chief engineer, designed the superstructure, operating machinery and power equipment of the bascule span, and will maintain a general consulting engineering supervision over the manufacture and erection of that portion of the work in co-operation with Mr. Ball's staff.

LARGEST CLOCK IN CANADA.

The clock that claims the above title has recently been installed in the tower of the Vancouver Block on Granville Street, Vancouver, B.C. The four faces of this clock are each twenty-two feet in diameter. The glass contained in the dial weighs four tons, and is seven-eighths of an inch in thickness. The minute hands are eleven feet long and the hour hands about eight feet.

The clock is controlled by a master clock, which is situated on the ninth story of the building. This master clock is a 60-beat instrument, and transmits its time to the large clock in the tower. It is fitted with a pilot dial, which shows at all times the exact position of the hands in the tower piece. The master clock in turn receives its time through a synchronizing attachment, which delivers McGill observatory time once every minute, thereby assuring accuracy.

Machinery for operating this huge timepiece is all set in the clock tower. It consists in the main of a motor, which propels the hands. This motor is controlled by a magnet attachment, which only permits it to run for a period of fifteen seconds, this being the time required for the large hand to travel one-sixtieth part of the circumference of the dial. Thus the hands are still for forty-five out of every sixty seconds.

The current for running the clock is generated by a small dynamo, which is driven from the electric light mains. The energy from the dynamo is stored in accumulators.

These batteries are of sufficient capacity to run the clock for one week if the ordinary sources of current derived from the lighting mains were to fail. In case the storage batteries were to be put out of commission the generator would drive the clock direct.

Every point of friction in the clock—from the motor to the crown gear and hands—is fitted with ball bearings. The clock can be set either from the office of the superintendent or in the tower.

The hour marks are a single bar ten inches wide and about four feet long. They will be left blank, no numerals being painted on them. The dial is constructed of structural steel, and not, as in most of the older clocks of the country, of cast-iron. The minute divisions of the clock are five and one-half inches wide and about one foot long. The hands are made of aluminum.

The clock was erected by the Standard Electric Time Company, of San Francisco, at a cost of more than $10,000.

TRACK SINKAGE NEAR VANCOUVER, B.C.

The tracks of the Great Northern Railway a few miles south of Vancouver have been the cause of considerable trouble to the trainmen for several days. We recently announced the fact that these tracks were sinking in a bog-hole. Since then we have obtained additional information.

Ardley Station, the scene of the trouble, lies right in the heart of the Still Creek district. Still Creek is really a flat sump for the drainage of the district lying between Hastings Townsite and Burnaby Lake. The land it drains has very little fall, and the creek spreads out into wide areas of muskeg. At Ardley both the Great Northern and the British Columbia Electric Railway Burnaby line tracks run close together.

Every day for two weeks trainloads of dirt, brush and rocks have been piled into the hole in the hope that bottom and a firm foundation would finally be reached. Fifty cars of material per day have been put into the sink without any apparent beneficial effect.

TESTS OF BRICK.

The Canadian Department of Mines recently ordered an investigation of the clay and shale deposits of the Western Provinces, and while this was in preparation sixteen lots of bricks were shipped to Prof. A. Macphail, of the School of Mining, Kingston, Ont.

Each lot of bricks contained about twelve specimens; the lots, on receipt, were designated by letters (A to P), and each brick in this division again designated by a number (1 to 12). The following list gives the series letter, the locality from which the bricks were obtained, and the kind of brick:—

List of Bricks Collected for Testing.

Series. Manitoba.

E. Alsip Brick and Tile Co., Winnipeg...... Soft-mud.
B. The Stephens Brick Co., Portage la Prairie .... Soft-mud.
C. A. Snyder & Co., Gilbert Plains....... ... Soft-mud.
D. Leary's Pressed Brick Works, Leary Siding .... Dry-press.

British Columbia.

O. Enderby Brick and Tile Co., Enderby.... Soft-mud.
P. John Coughlan & Sons, New Westminster Soft-mud.

Tests.

Eight separate tests were conducted on the bricks of each series, and these tests are indicated by the letters (a to h). Here follow the specifications under which the tests were made:—

a. Place six thoroughly dried bricks in water to the depth of one inch, and leave them covered over for forty-eight hours. Weigh before and after this partial immersion, to calculate the percentage of absorption in terms of the original dry weight.

b. Test six **dry** bricks flatwise on supports seven inches apart, to determine their transverse strength.

c. Take the six bricks from the absorption test, soaking them some more if they have dried out, and determine the transverse strength of these wet ones.

d. Take one-half of each brick from Series b and determine its crushing strength set flatwise.

e. Take the other half of each of the bricks from b, and determine their crushing strength when set on edge.

Table I.

Series No.	Test a. Per cent absorption.	Test b. Transverse (dry)		Test c. Transverse (wet)		Test d. Crushing flat (dry)	Test e. Crushing on edge (dry)	Test f. Crushing on edge (wet)	Test h. Crushing on edge (dry) after freezing.
		Breaking load.	Modulus of rupture.	Breaking load.	Modulus of rupture.	lbs. per sq. in.	lbs. per sq. in.	lbs. per sq. in.	lbs. per sq. in.
A	13·5	1533	805	1490	773	6975	5960	5132	4700
B	23·2	887	472	843	472	2208	2358	1547	2196
C	22·1	1150	647	1073	594	2435	2567	1983	3260
D	10·5	1295	622	1273	610	2807	2652	2833	3378
E	23·1	983	473	1432	716	1830	2468	2310	2846
F	25·8	1286	746	977	568	2932	2050	2065	1730
G	25·5	704	337	720	345	2612	1744	1562	1250
H	19·2	825	384	920	428	1692	1868	1628	2027
I	22·2	702	365	617	320	1298	1512	1282	1400
J	24·1	774	337	797	343	1220	1492	1502	1989
K	15·8	640	298	506	237	1320	1494	1310	1732
L	14·4	672	313	598	278	2242	1660	1948	1950
M	15·3	657	267	612	249	2343	1364	1513	1503
N	15·8	808	329	662	270	2420	1640	1296	1190
O	20·8	972	467	983	471	1869	1950	2658	1990
P	14·4	2008	972	1618	776	5242	5735	4028	5115

Saskatchewan.

A. Eureka Coal and Brick Co., Estevan..... Dry-press.
F. Eureka Coal and Brick Co., Estevan..... Stiff-mud.

Alberta.

G. P. Anderson & Co., Edmonton........... Dry-press.
H. Edmonton Brick Co., Edmonton.......... Stiff-mud.
I. Edmonton Brick Co., Edmonton.. .... Soft-mud.
J. Red Deer Brick Co., Red Deer.......... Soft-mud.
K. Canadian Brick Co., Medicine Hat.......Soft-mud.
L. Red Cliff Brick Co., Red Cliff............Stiff-mud.
M. Alberta Portland Cement Co., Sandstone. Dry-press.
N. Calgary Pressed Brick and Sandstone Co., Calgary . ... Dry-press.

f. Take one-half of each of the bricks from Series c, and determine their crushing strength when set on edge.

g. Take the other half of each brick from c, soak it for one hour in ice water, and then subject to a temperature of not less than 15° F. for five hours, all faces of the samples being exposed. The bricks are then thawed in water of not less than 150° F. for one hour. This is to be repeated twenty times.

h. Determine the crushing strength on edge of the bricks after they have been through the frost test.

With regard to the crushing test, the sides or edges of the brick in contact with the machine are to be made flat and parallel with plaster of paris. The opposite sides should be exactly parallel. The testing machine should be equipped with spherical bearing blocks.

The results of the various tests are given in Table I., and are the averages of the observations on six bricks in all cases, except those in test "h," where the bricks which were destroyed in the freezing test were, of course, not given.

The modulus of rupture was calculated from the transverse test by the usual formula:—

$$S = \frac{3}{2} \frac{W l}{b d^2}$$

Table II.—Freezing Tests.

No.	Remarks.	No.	Remarks.	No.	Remarks.	No.	Remarks.
	Series A.		**Series B.**		**Series C.**		**Series D.**
1	8 cracked, 15 broken.	1	5 cracked, 14 broken.	1	20 cracked.	1	16 broken.
2	11 " 15 "	2		2		2	16 "
3	8 " 15 "	3	5 slight crack.	3		3	
4		4		4		4	16 slight crack.
5		5		5		5	
		6	5 slight scaling.	6		6	
	Series E.		**Series F.**		**Series G.**		**Series H.**
1	8 scaling, 20 broken.	1	20 scaling.	1	2 cracked, 8 broken.	1	
2		2	16 broken.	2	2 " 8 "	2	
3		3	3 scaling, 16 broken.	3	2 " 16 "	3	Unaffected
4		4		4	2 " 16 "	4	
5	5 crack.	5		5	2 "	5	
6		6	5 scaling, 8 cracked.	6	2 "	6	
	Series I.		**Series J.**		**Series K.**		**Series L.**
1	8 scaling.	1	3 scaling.	1	8 scaling.	1	2 cracked.
2		2		2		2	8 "
3		3		3	2 scaling.	3	8 "
4		4		4	8 scaling.	4	8 "
5		5		5		5	2 "
6		6	5 scaling.	6		6	
	Series M.		**Series N.**		**Series O.**		**Series P.**
1	2 cracked, 8 large cracks.	1	7 crumbled.	1	20 broken.	1	16 broken.
2	2 " 8 crumbled.	2	16 "	2		2	8 corner cracked.
3	2 " 8 "	3	7 "	3		3	8 cracks and blisters.
4	2 " 16 "	4	11 cracks.	4	16 crumbled.	4	16 cracked. 20 broken.
5	8 " 11 large cracks.	5	8 crumbled.	5	20 broken.	5	8 " 15 "
6	8 " 16 " "			6	12 corner crumbling.	6	

Where W is breaking load at centre in pounds, l is the span, b is the breadth of the brick, and d the depth.

In the case of bricks which had a frog, the area of the frog was deducted from the gross area when the bricks were tested for compression strength on edge.

Table II. Bricks were frozen and thawed twenty times as specified. In the column "Remarks," the numerals denote the number of times the brick was frozen before disintegration began to set in.

RAILWAY DEVELOPMENT IN THE KOOTENAY

The announcement of the West Kootenay Power & Light Company, that it will install a third unit in its main plant at Upper Bonnington Falls, below Nelson, to be in a position to furnish electric power to the Canadian Pacific Railway when the latter electrifies its Rossland branch, is one of the numerous ways in which the construction activity of the railway company in the Kootenay is reflected. The plant is hydraulically developed for 32,000 horse-power, and electrically developed for 16,000 horse-power at present. The change to electricity for motive power on the Rossland branch, it is generally believed, is to be the first step in the application of this agent throughout the system in the mountains.

Preceding this change, for the last two years the Canadian Pacific Railway has been steadily improving the whole system tributary to the Crow's Nest branch, and shortly the through route portions will be of a standard equal to the main line.

The construction in the Slocan, which is to extend the Slocan system over the summit and down to Kootenay Lake, is nearing completion. On the Kootenay Lake section, the old Kaslo & Slocan line of the Great Northern has been re-opened temporarily as a narrow gauge line, to take in supplies and bring out ore. Next season the entire system will be standard gauge. The Canadian Pacific Railway, it is just announced, will construct ore docks at Kalso, the port of that region, and the silver-lead ore of the section will be conveyed in barges to Nelson, where it will be transferred to rail for transport to the Trail smelter.

The steel hull for the new Kootenay Lake steamer has arrived from the yards of the Polson Iron Works, Toronto, in five cars, and 150 men are now at work in the Nelson yards on this $200,000 boat, which next year will take its place in the through service.

Overshadowing any of these evidences of the railway company's intentions with regard to this territory is the rate at which the short line is being pushed through toward the Coast. In eight months, at the present rate of construction, the extension of the present Boundary branch, which now is operated to Midway, will be completed to Penticton, on Okanagan Lake. In thirteen months or less there will be connection with Merritt, the present terminus of the Nicola branch from the main line. On the date that that connection is established, the through Crow's Nest route will be diverted at Nelson to the Boundary branch, when a direct train service between Nelson and Vancouver will be inaugurated. This will be the third route between these termini, and will be much shorter than either the Arrow Lakes route or the Great Northern route.

This revolutionary programme requires practically but a year for its completion, and in all essentials the new Crow's Nest through route will be in existence and operation. When the Lethbridge-Weyburn cut-off on the prairie, and the Merritt-Hope cut-off near the Coast range are completed, the Crow's Nest route will originate at Winnipeg, and it will be at least a co-ordinate route with the main line.

REPORT OF CALGARY MUNICIPAL STREET RAILWAY.

The net profits of the Calgary Municipal Street Railway system for the fiscal year ending June 30 last were $107,-253.49. This and other interesting facts are set forth in the annual report of Thomas H. McCauley, superintendent of the street railways, to the Minister of Railways.

The net profits for 1911 were $87,206.09, showing an increase in the net profits for 1912 of $20,047.40.

The total operating expenses for the year ending June 30, 1912, were $282,600.56, and the total gross revenue for the period was $479,240.24, or the ratio of operating expenses to gross revenue was 59.44.

Salaries paid to employes totalled $172,521 for 1912, as against $76,686.85 for 1911. The total length of main track for 1912 was 52 miles as compared with 36½ miles for 1911.

The report in detail is as follows:—

	1912. Cost June 30th.	1911. Cost June 30th.
Engineering	$ 4,055.40	$ 4,055.40
Track construction	901,622.29	627,320.71
Line construction	94,551.77	62,330.46
Buildings	24,317.85	15,592.55
Shop, tools and machinery	2,145.65	
Cars	205,431.15	109,114.88
Electric equipment	59,318.50	14,000.00
Miscellaneous	639.56	1,042.89
	$1,292,082.17	$833,456.89

Income Account.

Gross earnings	$479,240.24	$275,434.51
Operating expenses	282,600.56	139,601.98
Income, less operating expenses	$196,639.68	$135,832.53
Less		
Real property (taxes)	$ 2,264.18	$ 2,264.17
Interest	45,000.00	23,220.00
Sinking fund	18,160.00	9,370.55
Contingent fund (5 per cent. gross revenue)	23,962.01	13,771.72
Net profits	$107,253.49	$87,206.09

Operating Expenses.

Ways and structures	$ 9,946.12	$ 4,528.21
Equipment	44,934.14	18,150.10
Transportation:		
General expense	17,043.31	11,426.41
Purchased power	74,272.72	45,295.00
Operating of cars	136,404.27	60,202.26
Total operating expense	$282,600.56	$139,601.98

Ratio Operating Expenses to Gross Revenue.

	59.44%	50.68%

Employees.

Salaries paid	$172,521.75	$76,686.85

Mileage, Traffic and Miscellaneous Statistics.

	1912.	1911.
Passenger car miles	1,643,328	801,086
Passenger car hours	195,206	89,776
Passengers carried	11,578,130	6,420,086
Transfers	1,363,400	756,000
Total passengers	12,941,530	7,176,086
Average fare	4.076 cents	4.196 cents
Average fare (including transfers)	3.615 cents	3.615 cents
Car earnings per car mile	28.722 cents	33.632 cents
Miscellaneous earnings per car mile	.440 cents	.750 cents
Gross earnings per car mile	29.162 cents	34.382 cents
Car earnings per car hour	$2.41	$3.00
Miscellaneous car earnings per car hour	.04 cents	.06 cents
Gross earnings per car hour	$2.45	$3.06
Operating expenses per car mile	17.196 cents	17.426 cents
Operating expenses per car hour	$1.44	$1.55

Car, Road, Etc.

Length of road (first main track)	42 miles	26½ miles
Length of second main track	10 miles	10 miles
Total length main track	52 miles	36½ miles
Length of sidings and turnouts	1 mile	
Total computed as single track	53 miles	

Accidents.

Passengers killed	0	0
Passengers injured	1	3
Others killed	3	2
Others injured	0	0

Cars, Etc.

Passenger cars (closed)	48	22
Passenger cars (open)	1	—
Total passenger cars	49	22
Work cars	4	5
Sprinklers	2	1
Total cars of all classes	55	28

MONTREAL COMPANIES

The announcement has been made that the Quebec Railway, Light, Heat and Power Company will show a satisfactory increase in earnings in its annual financial report. It is stated, apparently in a semi-official manner, that the following will be the result:—

	1911.	1912.	Increase or decrease.
Gross earnings	$1,280,126	$1,565,000	+ $284,874
Operating expenses	661,907	733,000	+ 71,093
Net earnings	618,219	842,000	+ 213,781
Fixed charges and div.	656,319	620,000	— 36,319
Organization expenses	10,681	....	......
Extraordinary Income	111,109	....	......
Surplus	62,328	212,000	......

As the capital stock of the company is $10,000,000 it will be seen that the surplus indicated is equal to 2⅛%. The above comparison fails to indicate the real improvement in the Quebec Railway, Light, Heat and Power Company. Included in the extraordinary income mentioned above for last year was $100,000 which was not earned by the company itself but by its subsidiaries, previous to July 1st, 1910, at which date the amalgamated company began business. In reality, therefore, the surplus of $62,328 might have been shown as a deficit of $26,991 on the year's business, being $37,672, less the organization expenses of $10,681.

The situation, therefore, is that instead of going practically $27,000 behind, as was the case last year, the company will be $213,781 ahead.

The dividend payments amounted practically to $100,000 per quarter. As the dividend was passed some few months ago, these payments will no longer be necessary. Two of these payments were made during the past year, so that had the company not made them, the surplus would have been increased by about $200,000. Assuming that above figures are correct, it is manifest that the situation in Quebec Railway, Light, Heat and Power has improved.

POWER POSSIBILITIES AT CARILLON.

Another new power development in the vicinity of Montreal is being discussed. The site of the proposed development is Carillon, about sixty miles up the Ottawa River from Montreal. Carillon is the terminal point of the Ottawa River Navigation Company. Navigation is uninterrupted, save for canals and locks, from Montreal to Carillon. Here, however, passengers westward bound are compelled to leave the boat and take the train, the cause of the interruption being the rapids or falls of Carillon, and the famous old dam. This dam took some five years to build and cost some $3,000,000.

For many years, a great deal of power has been going to waste at this point. Estimates on the amount of power vary very greatly, some placing it as high as 150,000 horsepower. This estimate, however, is not generally credited. In the estimate made for the commission of conservation, the Carillon rapids are credited with being able to supply 26,000 horsepower from the present possible head of 13.5 feet, but it is added that with the river canalized, and with the water control which is included in the Georgian Bay canal scheme, a head of 40 feet with a total of 200,000 horsepower can be developed.

Mr. Henry Myles, formerly president of the Montreal board of trade, is at the head of the company which proposes to develop the falls. It is claimed that there will be no difficulty in getting the capital, and that the power can be readily sold in the city of Montreal.

NEW FORESTRY ENGINEERS.

At the University of Toronto nine men received the degree of Bachelor of Science in Forestry, and three others are eligible for the degree after passing supplmental examinations. The recipients of the degree were Messrs. R. M. Brown, F. G. Edgar, E. J. Finlayson, H. S. Irwin, R. G. Lewis, C. McFayden, E. C. Manning, W. L. Scandrett and W. J. Vandusen. All of these entered the employ of the Dominion Forest Service. Their present disposition is as follows: R. M. Brown, forest assistant Brazeau forest reserve, Edmonton, Alta.; F. G. Edgar, for assistant Bow River reserve, Calgary, Alta.; E. J. Finlayson, Inspector of Fire Ranging; R. G. Lewis, head office, Ottawa; C. McFayden, forest assistant, Crow's Nest forest reserve, Pincher Creek; W. L. Scandrett, in charge of forest survey party near the Porcupine forest reserve No. 2, Saskatchewan; W. J. Vandusen, supervisor, Crow's Nest forest reserve, Pincher Creek, Alta. Mr. Irwin has since joined the British Columbia forest service.

The State of Wisconsin is overhauling its forest laws, and at the last session no fewer than eight bills were passed dealing with different aspects of the forestry question.

PERSONAL.

J. V. DILLABOUGH, B.Sc., D.L.S., has been appointed office engineer of the Hudson Bay Railway, Fort Garry Court Winnipeg.

MR. J. D. GILMOUR, late of the C.P.R, forestry department, has been appointed supervisor of the Brazeau forest reserve, with headquarters at Edmonton.

DR. A. S. ESTEY, medical health officer of Calgary, Alberta, has tendered his resignation to the mayor and council of that city.

MR. M. J. K. ALLEN, who a few weeks ago resigned as city engineer of Regina, has become manager of the Ontario Asphaltic Concrete Paving Company, which company has just secured contracts for 30,000 square yards of pavement in North Toronto.

MR. G. SKIFF GRIMMER, of the U. of N.B. class of 1908, is engineer and forester for the American Canning Company, near St. Andrews, N.B. The company has a considerable tract of timber and will grow timber for box shooks.

MR. JOHN DUDGEON,. of F. S. Dudgeon, Limited, London, England, called at *The Canadian Engineer* office this week on his way home, after seeing to the installation of one of their excavators at the plant of the Tofield Coal Co., Tofield, Alta.

MR. HARRY HARTWELL, who for the past year has been acting as resident engineer on the Sooke Lake waterworks development scheme, has severed his connection with the firm of Messrs. Sanderson & Porter, which is supervising that work, and will hereafter be identified with the F. S. Pearson Engineering Corporation, of New York city.

MR. R. G. LEWIS, B.Sc.F., has been for some time engaged in the compilation of the forest products bulletins for 1911 at the head office of the Forestry Branch at Ottawa. He will leave shortly for the Maritime Provinces, in connection with the compilation of the study of the wood-using industries of the Maritime Provinces, on which the Forestry Branch is entering.

MR. SAMUEL HALE, the new general manager of Algoma Steel, is at present vice-president and general manager of the Wisconsin Steel Company. He will take up his position about October 1st. Mr. Hale is 43 years old, and was born in Chicago. He started in the steel business in 1893 with the Illinois Steel Company, and served with them in various capacities until 1899, when he was appointed assistant general superintendent. He was subsequently associated with the operations of the International Harvester Company, whose steel properties were organized into the Wisconsin Steel Company, of which, as stated, Mr. Hale was made vice-president in charge of the operations. With these he has been associated for the last ten years.

MR. F. H. McGUIGAN, who was awarded the contract for constructing the new filteration plant for the city of Montreal, has notified the Board of Control that he desires to hand over his contracts to his chief engineer, Mr. Norman McLeod. The controllers were notified recently that owing to ill-health it was impossible for Mr. McGuigan to continue the contract, and asking that all of the contracts be transferred. Mayor Lavallee has stated that the controllers have accepted the principle of the transfer.

COMING MEETINGS.

CANADIAN GAS ASSOCIATION.—Fifth annual convention will be held in Toronto, August 24th to Sept 9th, 1912, during the Exhibition. Sec'y-Treasurer. John Keillor, Hamilton, Ont.

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

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

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

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

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

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

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

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

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

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

ENGINEERING SOCIETIES.

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

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

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

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

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

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

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

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

MUNICIPAL ASSOCIATIONS

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

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

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

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

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

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

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

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

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

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

CANADIAN TECHNICAL SOCIETIES

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

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

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

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, Wm. Norris, Chatham, Ont.; Secretary, W. A. Crockett, Mount Hamilton, Ont.

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

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