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# The Canadian Engineer

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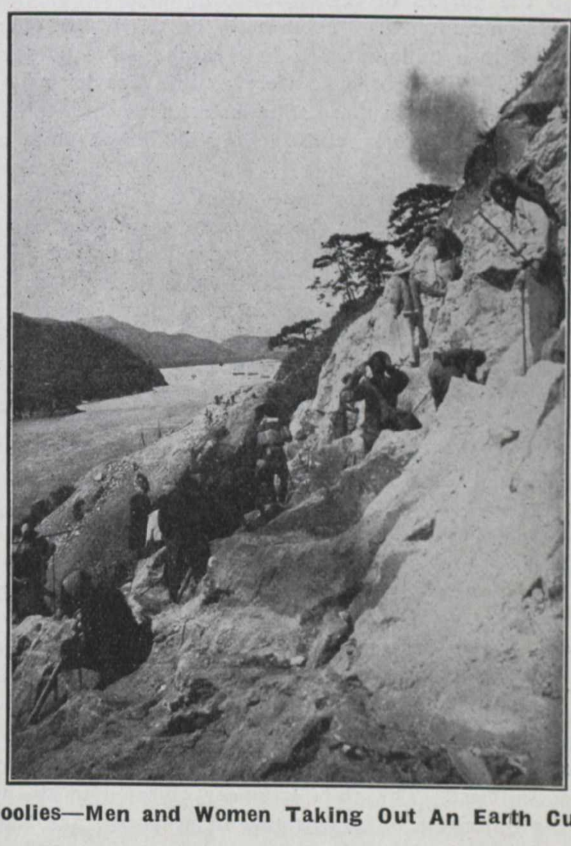
## THE CANTON-HANKOW RAILWAY

H. L. BODWELL

The Canton-Hankow Railway purposes to connect the city of Hankow, on the Yang-Tse, which has already rail connection with Peking and the Trans-Siberian road—with the city of Canton, the greatest port of South China, and the largest city of the Chinese Empire. The length of the main line will be about 720 miles. It will pass through some of the richest agricultural districts in South China, which produce principally, rice, tea and silk, and through a mountainous region in the northern part of Kwong Tung Province, where vast deposits of coal and iron ore lie practically side by side; the iron absolutely untouched, and the coal used only locally for cooking purposes. Very little is known of the mineral wealth of South China, and very little of what is known has been developed. The opportunities for foreign mining companies are nil, and native enterprise in mining development has, up to the present, principally confined itself to taking over mines already developed by foreigners, and, by mismanagement and corrupt dealing, ruining what had been thriving industries.



Coolies—Men and Women Taking Out An Earth Cut.

To the United States belongs the credit of first seriously undertaking the building of this line. About the year 1902 (?) a concession was granted to an American syndicate, backed by J. P. Morgan, for the construction of the 720 miles of main line, and for a network of branches that would probably equal in length the main line itself. From the American standpoint the concession was, theoretically, an excellent one, including as it did exclusive mining rights for ten miles on either side of the main line.

From the Chinese point of view, one of the principal terms of the agreement was that the line should be owned and operated by the American company. The Chinese were opposed to the railway falling into the hands of the Belgian-Russian-French interests, which controlled the Peking-Hankow line already built; but the Americans got over this by selling a majority of the shares to the Belgians though the company remained American. This, combined with serious local opposition to the work of the survey and construction, led to the repurchase in 1905 of the entire concession by the Imperial Government at Peking. The price of repurchase was six million taels; about $4,000,000 gold.

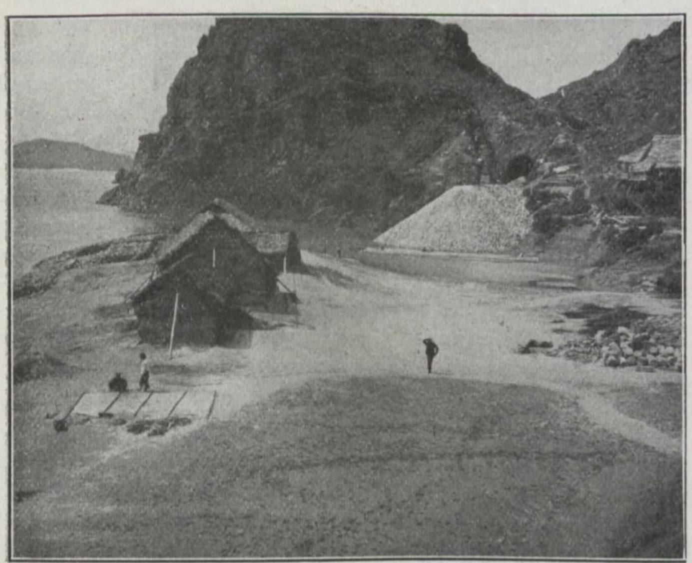
At the date of repurchase by the Chinese, considerable work had been done by the American-China Development Company. A reconnaissance of the entire route was made by Mr. Parsons, of New York, consulting engineer of the company. This reconnaissance was more like a royal progress than a railway survey. Parsons travelled in State with a fleet of house boats, and a full regiment of over 1,000 native soldiers as escort. He was not taking any chances. Later, location surveys had been carried out for about 100 miles of the main line north from Canton. A branch of 30 miles from Canton to Samsui on the West river had been built and had commenced operating passenger trains, and about 10 miles of main line at the Canton end were under construction.

The difficulties of construction work were much increased by the bad climate—malaria and dysentery being the chief scourges. Added to this, the constant delay and obstruction over the purchase of right-of-way; and the difficulties in the removal of the graves that are scattered promiscuously in thousands over the country, and the absolute refusal of some communities to allow construction work to be undertaken at all, made progress very difficult. Native opposition became stronger and more widespread until the selling of a majority of the shares to Belgian capitalists gave the Chinese an argument that could not be gainsaid. They claimed a breach of contract, and insisted on the repurchase or the cancellation of the concession.

Thoroughly convinced of the value of and the need for this railroad, the Chinese proposed to build the line themselves. Separate companies were formed in each of the provinces through which the line was to pass, viz., in Kwong Tung, Hunan and Hupeh, and these companies took over the debt for the repurchase of the concession, together with all assets of the late A.C.D. Company, chief of which was the thirty miles of finished line. The three companies shared the assets and liabilities of the A.C.D. Company in the proportion of 3:3:1 for Kwong Tung, Hunan and Hupeh. Receipts from the branch line were at that time averaging $500 gold per day.

The Kwong Tung Company with a capital of, I think, twelve million dollars, Mex., was organized at Canton amid great enthusiasm. "China for the Chinese" was the slogan, and "No foreigners need apply." Shares were sold to Chinese only, and single shares of $1 face value might be subscribed for. Great excitement prevailed in Canton, and when the shares list was opened for subscription, it was 50 per cent. over-subscribed.

This Kwong Tung Company is the most wealthy and most progressive of the three. They spent about a year only, squabbling over the appointment of officials. Kwong King Yang, a graduate of Columbia University, was made chief engineer. He advocated the employment of foreign engineers under himself, to supervise the actual construction. For several months the company was without a president, and no one would assume the responsibility of ordering the material or certifying the accounts for material already purchased and work already done.



**South Portal of Tunnel at Tai Miu Hop. Top of Concrete Culvert Showing Above Water at Toeod Embankment.**

At last Sir Chen Tung Liang, late Chinese Ambassador at Washington, accepted the presidency. He is one of the most high-minded and capable officials of South China, and from that date progress commenced.

In the spring of 1907 the company commenced engaging resident engineers. A Chinaman was given the first residency, the second and fourth were given to Japanese, the third to a Norwegian, the sixth to a Swiss, the fifth and seventh to Canadians, Mr. J. Hutton, of Goderich, Ont., and myself, and the eighth to an American, Mr. J. C. Hyer. Mr. R. R. Carr Harris, jr., a Canadian, was made divisional engineer, in charge of 50 miles of construction, while Mr. J. T. M. Burnside took charge of a locating party of three Canadians, Messrs. Jordan, McDonald and Baby, the balance of the party being Chinese.

This brings the history of the Canton-Hankow Railway up to the time when the writer arrived in China, in July, 1907. For the succeeding four years construction and surveys were pushed forward as actively as possible. Under K. Y. Kwong, chief engineer, contracts for grading were let during the first two years up to mile 90, and during 1909 and 1910 up to about mile 140.

At first the chief engineer let all grading contracts in small sections of 100 feet to 1,000 feet, or 1 cut or 1 fill, etc. No attempt was made to induce big firms to undertake any considerable portion of the line.

With the advent of the foreign engineers came the letting of larger contracts; from five to ten miles of heavy work being let in one piece. There were no big native contracting firms and the company would not hear of any foreigner securing a contract, although several firms were anxious to take over the construction of a part or the whole of the line. For the first thirty miles north of Canton the line traverses an almost level country, only a few feet above the sea and subject to almost annual inundations by the overflowing of the North river, the Pei Ho. After this, from mile 30 to mile 50 a more broken country is passed through, though the grade does not at any point reach an altitude of one hundred feet above sea level. About mile 50 the valley of the North river is reached, and this is followed for over 200 miles, in fact, right to its source in the Che Ling Pass, in the extreme north of the province. Thence following down the Hsiang river in Hunan through Chang Sha, and on to Hankow.

In the gorges of the North river some of the heaviest work is encountered. From mile 60 to 70 the quantities amounted to a million and a half yards; about 30 per cent. solid rock. Miles 70 to 80 were a little heavier and about 50 per cent. S.R. In these 20 miles are four tunnels in sandstone or granite rock, and ranging in length from 250 to 1,000 feet.

Bridges and culverts were all of a pemanent character and were mostly built by the company, employing day labor. The first bridge worthy of note is the Kotong river bridge, 20 miles north of Canton. This was, I think, eleven spans of 30 feet each—D.P.G.—on concrete piers about 25 feet high. The Kong How river required two spans of 200 feet each; the Woong Ngan at about mile 95, 1,180 feet long and about 70' above bed of stream, 60' D.P.G.'s. with 2-200' river spans. The Shiu Kwan Bridge over the North river, about mile 143, five spans of 200' each; sub-grade being about 90 feet above W.L.

While these are the principal bridges, smaller spans were numerous. Owing to the severe floods on the North river, where the water sometimes rises 50 ft., the grade had to be kept high. This necessitated long culverts and high bridge abutments, 50 and 60' usually.

Most of the bridge foundations were in soft yielding clay, requiring piling. On residency 7, between 3,000 and 4,000 piles were needed; yet there was not a single steam pile driver on the work. The piles were all driven by drivers operated by hand winches, striking about one blow per minute at best. The chief engineer objected to the use of steam pile drivers on the ground of economy, and the difficulty of moving them about in a country of no roads.

Consequently the work of putting in foundations took much longer than necessary. A foundation which had been under way long enough to have been easily finished, had proper methods been employed, would be perhaps half done when a flood would sweep over the entire work, and 30 or 40 feet of water cover the excavations for two or three weeks. By the time everything was under way again a couple of months would have elapsed. This was repeated again and again at the same bridge, with repeated losses of material and equipment at each flood.

Nearly all the classes of work outside of bridge construction were done by contract. Contract work was tried on bridges also, but the results were not satisfactory. As the Chinese had never heard of overhaul we did not enlighten them. In practice it very seldom existed, for though the grading contracts called for every yard of material from cuts being placed in embankments, regardless of haul, the chief engineer did not insist on this being carried out. Contractors were allowed to waste and borrow; the company acquiring extra right-of-way for this borrow in many cases. First contract price for earth work ranged from 14c. Mex. to 20c. per C.Y. ordinarily, although one firm got as high as 43c. on about 600,000 C.Y. of work.

Rockwork was very badly handled in the open cuts. Holes were usually drilled indiscriminately over a large area and then sunk only 2 to 3' deep. No attempt was made to keep a proper face, or series of faces and benches in open cuts, and consequently the consumption of powder was needlessly great. In sandstone cuts the contractors usually shot up the rock very fine so that two men could carry out the largest fragments. Most of the rock cuts were, like the earth cuts, and the side-borrow, carried out in baskets.

Granite rock would not break up so fine, and in some of these cuts native wheelbarrows were used and in other cases Koppel dump cars and light tracks where the haul exceeded about 200'. It was practically impossible to induce the natives to alter their own methods of rock handling. First contract prices for rock excavation varied from $1.50 to $2 Mex., i.e., 75c. to $1.25, gold, per cubic yard.

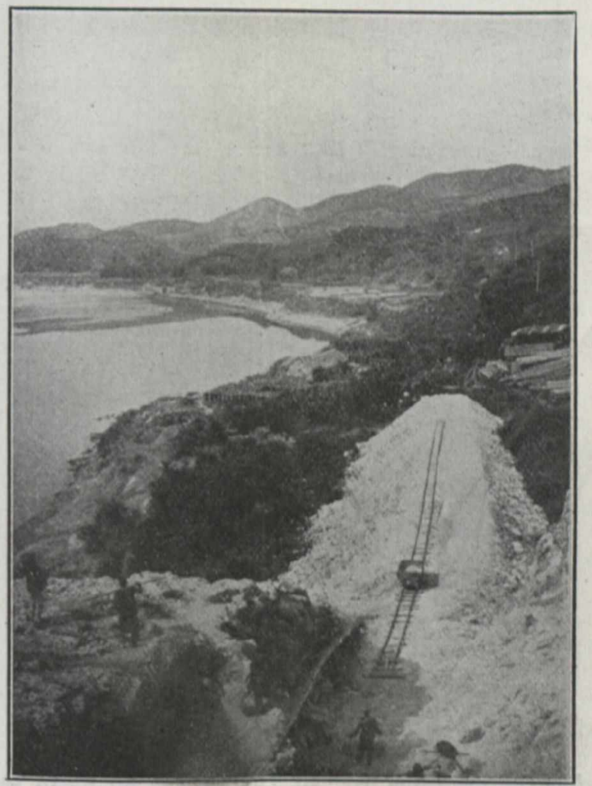
Tunneling contracts were let at so much per lineal foot for excavation and so much per lineal foot for lining. All material for forms and timbering where necessary, was supplied free of charge by the railway company at the work. Prices ranged from $57 to $75 Mex. per lin. ft. for tunnel excavation. The area of the standard tunnel section was 400 sq. ft., giving about 14.8 cu. yds. per foot run. At $75 per lin. ft. this is equivalent to $5.07 Mex. per C.Y., and at $57 is equivalent to $3.85 Mex. Prices for concrete lining ranged from $17 to $42 per lin. ft. of tunnel. Very little temporary bracing was required in any of these tunnels.

The method employed was that of piercing a top drift in advance of the bench; widening this drift out to the full arch section, and afterward removing the bench. Material was loaded by hand into small dump cars and run out by man power. In some cases a wooden chute or trough was used for loading material from the drift and arch section into the dump cars.

The resident engineer arriving in China for the first time finds he has innumerable little things to contend with that have never occurred to him before. Though the country is at peace, he is not allowed to proceed to his residency until a guard of twenty soldiers has been provided, and rifles and revolvers and ammunition are on hand. He asks who are to be his rodmen and chainmen and is told to pick up and train some natives on the work. The engineer is also instrument man, back flag, head and rear chain and rodman, rolled into one. The interpreter provided by the company usually becomes the "stake artist," since he is probably the only one on the party who understands foreign figures or perhaps who has ever seen a white man. The interpreter usually starts out on line wearing silk slippers and carrying an umbrella and a fan, and with a fixed idea that his work consists in repeating in Chinese to the coolies as much or as little of the engineer's instructions as he may think necessary. It becomes the painful duty of the engineer to instil quite other ideas into the mind of this future celestial railroad builder.

A residency party consists of an interpreter and a clerk, both of whom know a little English, a store-keeper and a time-keeper who knows less, a pay-master who knows none at all, and foremen and survey coolies as required, who usually know no English and very little of anything else. The rodmen and chainmen, picketmen and axemen all come under the head of survey coolies, and are usually absolutely green natives and have to be trained on the work—a process requiring infinite patience.

Running a location survey in a rough and wooded country with a green party of natives, not one of whom has ever before seen a transit or chain, is not my idea of heaven. The axemen disappear into the bamboos and when the engineer leaves his transit and walks ahead he finds them sitting calmly in the shade, smoking cigarettes or talking with the interpreter. They one and all seem to imagine that the foreigner is paid to build the railroad so the responsibility rests with him and the labor too. This is another point on which the natives have to be disillusioned.

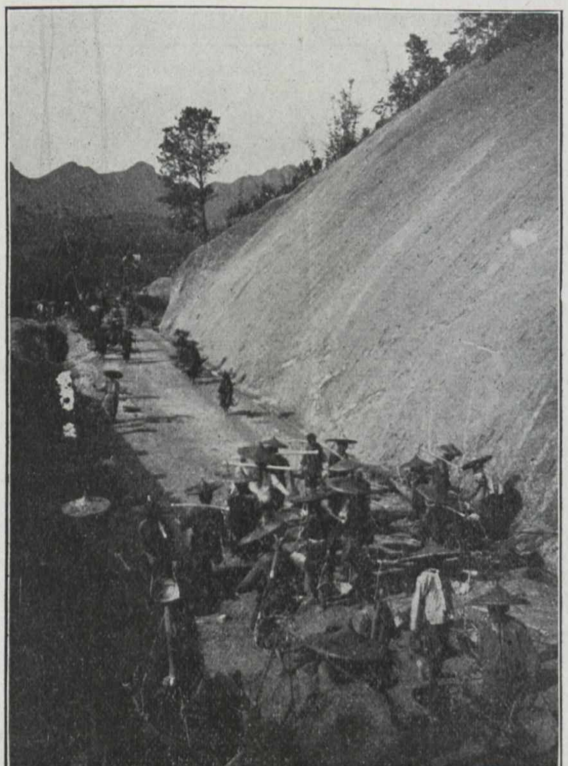


**Looking North From Ridge Above Tai Mui Hop Tunnel; North River on Left.**

The usual order of work on a residency was followed—location and referencing, then cross-sectioning and figuring quantities. After this, right-of-way plans were made up in sections of 1,000 of line, on a scale of 40 ft. 1 in., showing every little rice plot with the area in Chinese Mou. These were traced and prints sent to R. W. Dept. This was very necessary where one acre of land might have 20 to 30 different plots and as many owners. R. W. purchasing agents established offices every 20 or 30 miles and bought enough right-of-way to allow contractors to start. After that they bought as little as possible, or just enough to keep the work going. This caused continual friction with the natives, and frequent riots and delay to the work. The only injunction known in South China is that of the mob, and the wording is generally "Clear out or we will chop off your head." When this is backed up by an entire village, headed by the old women, armed with buckets of sewage and with ladles for distributing same, both contractors and engineers are likely to give way.

Disturbances of this sort occurred in some cases where construction had been commenced without the right-of-way having been purchased. In other cases when the right-of-way was paid for but the natives were opposed to the building of the line. The guards of native soldiers usually proved useless in such emergencies.

The purchase and removal of graves from the right-of-way was another difficulty. As ancestor worship is part of the Chinese religion, graves are kept up for thousands of years. Consequently wherever one goes one finds graves scattered about the hillsides, sometimes in small numbers, sometimes as thickly as they can be placed. Graves of poor coolies did not cause much difficulty. The standard compensation for one of these was $4.00 Mex. But when the line



**Coolies—Men and Women Taking Out An Earth Cut.**

passed over or close to the grave of some member of a wealthy family, it was likely to prove an expensive location. As much as $4,000 Mex. was paid for the removal of a single grave, and this only after a year's delay. In one instance about 500 ft. from a tunnel portal our embankment was just clear of the grave of a noted ancestor of a wealthy land owner. The president of the railway actually recommended swinging the tunnel tangent five or ten feet and building a fifty-foot embankment partly in the Pei Ho river for 1,000 feet, in order, not to avoid this grave entirely, but to keep our slopes just clear of it, so that the spirit of the departed might not have his view of the river entirely cut off by the railway embankment! The clan concerned were content when they found the grave was five feet above subgrade and the slopes of our dump rested only on its lower terraces.

At times the construction work was seriously delayed by sickness amongst the coolies; sometimes as many as 20 per cent. of the entire force would be ill, with fever and dysentery. Of individual camps I have seen 60 per cent. incapacitated at one time. There were very few cases of plague on the work and only one or two of cholera.

Another serious source of trouble was the brigands in the hills, and the pirates on the North river. During the winter of 1908-09 the entire work was suspended for a period of one month, on account of a series of armed robberies on the work. The offering of rewards of $100.00 per head for every robber captured did more to stop the trouble than all the extra soldiers provided by the government.

Now the last European engineer has resigned and the work is entirely in native hands. Once more the dragon flag floats supreme over the whole length of this great road. The foreigners have come and gone, and now that the worst difficulties of construction have been overcome, the natives will no doubt be able to complete the work and assume the credit. And if errors of judgment were made in the building of the road, and if the cost was double what it should have been, and the time occupied treble the necessary time, who shall bear the blame? Who but the foreign devil! But that, of course, is part of the bargain; that is the "White man's burden."

## LARGE REINFORCED CONCRETE PIER.

A pier of reinforced concrete, 800 feet long by 250 feet wide, with two-story reinforced concrete sheds, is to be built at Halifax, N.S., for the Intercolonial Railway. These structures are a part of the extensions to the railway's terminal wharf, bulkhead, and sheds. The pier is the first of four to be built at a cost, it is estimated, of about $3,000,000. The general contractor is the Nova Scotia Construction Company.

## THE BODIO POWER STATION.

The hydro-electric installation, situated between Lavorgo and Bodio, deriving its power from the River Ticino and its tributaries on the left bank, has recently been opened. The total fall utilized varies from 255 to 260 metres, and the available power during mean summer flow amounts to 38,000 h.p., but by the creation of reservoirs on the mountains it will be possible to regulate the flow during slack seasons. The works comprise the dam at the intake with strainers; a delivery channel 8,800 metres in length, with a sectional area of 6 square metres, which, in order to convey the requisite maximum volume of 15,000 litres per second, entails a velocity of flow of 2.5 metres; a head reservoir with a capacity of 6,600 cub. metres to equalize the supply, and a pressure-main, 2.8 metres in diameter, which takes the form of a circular channel inclined at an angle of 86 per cent. This tube is 2.8 metres in diameter. This main is terminated by double steel pipes, with diameters of 1.7 metres, each of which supplies two turbines of 10,000 h.p. The power house is thus laid out for 40,000 h.p., but only 30,000 h.p. will be installed at present. The turbines are direct-coupled to triphase generators working at 8,000 volts of 50 periods. Power is already being supplied to two factories—to the Diamantic works, where artificial emery is produced, and to the Gotthard works for the manufacture of ferro-silicon in large electric furnaces, and of ferro-chromium in a small one. It is intended shortly to employ the power for the manufacture of nitrogen from the air.

The Bodio power station also supplies current for the Biasca-Acquarossa Railway.

## PRELIMINARY PROBLEMS IN THE DESIGN OF MANUFACTURING BUILDINGS.*

By E. H. Darling.

The actual design of a manufacturing building, as a structure which is to be built of certain materials, to carry given loads, does not, as a rule, present any engineering difficulties which cannot be satisfactorily solved by the usual methods given in books that treat on this subject. It resolves itself simply into the problem of ascertaining, as nearly as possible, the stresses which the loads produce, and of proportioning the materials to take care of these stresses. The preliminary problems, however, which fix the nature of the building, its size, shape, arrangement, the materials to be used, and the loads to be provided for, all form an immensely broader subject, extending beyond the bounds usually set for the engineer, and touching the very heart of the world of business and manufacturing.

These preliminary problems bear the same relation to the detail design that the work of the locating engineer, on a new railroad, bears to the work of the man who stakes out the line, only in the case of manufacturing buildings they are more complexed. In the following discussion, the writer will endeavor to show how exceedingly complex the designing of a manufacturers' building may be, and the relation of the engineer to this only partially developed field of work. Older members of the Engineering Society will probably find little in it of interest or profit, for it is written for the purpose of stimulating the minds of the younger members by suggesting lines of thought which will tend to broaden their ideas of the profession they have chosen.

Before one can appreciate the complexity of the problems which the design of manufacturing buildings presents it is necessary that he have a thorough knowledge of building materials and the special use for which they are adapted.

With all this data at his finger tips, he is in a position to consider the preliminary problems relating to the design of any particular plant. These problems may be discussed under their heads.

1. The problems of utility.
2. The problems of location.
3. The problems of finance,

but while the discussion may be thus separated, in an actual case, the problems are so interdependent that they must be weighed, one against the other, in order to attain the highest possible efficiency. Efficiency in this case means the greatest ultimate value for every dollar expended.

Some of these problems can be handled by means of mathematics, with precision. Some can be settled by the obtaiiing of definite data. The facts once known, the question is settled beyond discussion. Some conclusions are reached instinctively, or through natural habit without conscious thought. But by far the larger part are a matter of judgment and the more highly this faculty is developed in the designer, the greater his knowledge, the wider his experience, the more accurate will be the solution.

The use to which the building is to be put, will, of course, largely determine the general type of design. In many lines of manufacture the building is virtually a tool or machine, and as such it should have the same careful attention of an expert as is given to any part of the equipment. Many a plant with the latest and most expensive machinery is handicapped for all time by the poor design of the building that contains it.

*Abstract of paper delivered to Engineering Society of the University of Toronto, Nov. 1st, 1911.

Plants for the manufacture of similar products will probably resemble each other, but need not necessarily be alike, for different methods, different ideas or special conditions may mean an entirely different lay-out. Fortunately the designer is not usually called upon to design the process of manufacture, but it is essential that we have a thorough understanding of the routine through which the materials have to pass.

The amount of floor space, head room, light, ventilation, etc., that each process will require must be decided upon. The question of light receives a great deal more attention these days than formerly, and the effect on the design is quite marked. The different rooms or buildings must be so arranged that the materials may pass from one to the next with the minimum amount of handling or transportation. Provision must be made for the receiving of raw materials and for the shipping of the finished product. Necessary store rooms must be provided at convenient locations. The power plant should be so located as to make the distribution of power convenient and economical. The same rule applies to the heating and lighting plants and waterworks system, and all this must be done with an eye to the health, convenience and safety of the employes.

The method and order of erection must always be kept in mind. The cost of putting certain materials in place may be greatly increased unless the work can be done in a certain order, or at a particular time.

### Problems of Location.

The actual location of a manufacturing building is usually determined by the owner from business consideration with which the designer has nothing to do, but the site once fixed, the effect on the design of the building or plant is far-reaching.

For every line of manufacturing there is an ideal lay-out, but to realize it one would have to have an ideal site, ideal facilities for obtaining power, labor, materials and transportation, an ideal climate, and an ideal balance in the bank. Since such conditions are seldom, if ever, obtainable, it becomes the designer's aim to adapt his design to the special conditions and circumstances, and make the best use of what he has.

The nature of the climate where the building is to be erected must be taken into consideration. The extremes of heat and cold, the violence of storms, the possibility of cyclones and earthquakes, the maximum snow fall the roof will have to sustain, the depth of the frost line for foundations, etc., are some of the questions that depend on the climate. If the plant is to be operated throughout the winter in a northern locality, the problem of heating becomes an important item. As a rule it is poor economy to put up a cold building and then install an expensive heating system to keep it warm. Apart from the mistakes made in this particular, nearly all the other questions will be taken care of by following local customs which have been found to give the most satisfactory results after long years of trial.

The locality in which the building site is situated also has a very important bearing on the design. The very nature of the building will depend upon the facilities for obtaining building materials and their cost. The conveniences for transportation and handling heavy girdles, etc., must often be considered. The designer must not only have a knowledge of the cost of brick, lumber, cement, stone, steel, terra-cotta, etc., at the place where they are produced, but must know the nearest source of his supply, the transportation charges, duty, etc., and the cost of labor required for placing the materials in the building. These latter considerations often prohibit the use of what would otherwise be economical and desirable construction.

Government restrictions and regulations for the health and safety of the employees and the protection of the public must be carefully observed. If the site is in a large city, the building laws will probably place further restriction upon the designer and give him something to puzzle over in his spare moments. In addition to this, there are usually many special by-laws relating to smoke, noise, or other nuisances. In order to obtain reasonable insurance rates the rules of the Fire Underwriters must be carefully followed. Labor conditions must be studied, not only in their relation to the cost of the work, but there are places where the unions can dictate what the nature of the building is to be.

The size, shape and position of the lot will practically determine the proportions and arrangement of building or buildings. In some cases the position of railway switches, and the like, control the general lay-out. The proximity of high buildings may make impossible the natural method of lighting and change the orientation.

The probability of future extension must be taken into consideration from the start and a general scheme sketched up for as far ahead as possible. A good plan is to build the plant in units so that the addition of a unit to each department will maintain the proper proportions of the whole plant. The installation of one machine in one department may require the addition of a whole wing to the building, to take care of the corresponding increase in another department. In this case, provision should be made for as many wings in proportion to the space provided for such machines. However, it is not always possible to apply this system. For example, in a plant where there are to be many electric motors (and the number is likely to increase) it would show great lack of foresight if the transmission system were so designed that it were necessary to re-wire the plant and put in larger distribution mains every time another motor was added to the equipment. Here is an instance where it would be true economy to anticipate the greatest capacity that would ever likely be required, and provide for it at the start. Now the building itself is usually a construction to which this rule applies. Not only should a reasonable amount of room be provided for future needs, but it is even more important that the probability of any increase in floor loads or the capacity of crams, etc., be taken into account at the start. It is usually very unsatisfactory, and always expensive to try and strengthen a building for loads greater than originally planned for, even though the type of construction will permit it. No one who has not had to face such a problem and be responsible for the results, can appreciate what it means, besides, it is exceedingly aggravating to the owner to find a scheme of extension blocked or crippled just through the lack of a little foresight in making the original lay-out.

### Problems of Finance.

The questions of finance which the designer has to consider usually have nothing to do with the securing of the money necessary to carry out the work. But the problem which he does have to keep in mind always is how to get the utmost efficiency from every dollar invested. This means more than merely saving money in the construction. "Savings never pay dividends." It means even more than getting good value for the money spent, for every dollar invested is just one more on which must be paid interest, taxes, etc., if the enterprise is to be a success. If, instead of putting the dollar into unnecessary expensive construction or some inappropriate ornamentation, it is so used that it will save something in the cost of maintaining or operating the plant, this means increase in profits. The dollar so invested is helping to earn dividends and is not dead capital.

Thus all the financial problems to be considered here center around the principle of the ultimate value. Will it pay in the long run? But until an infallible rule can be discovered to answer this question it will be necessary, after using every device of mathematics and human wits, to still trust to Providence for the results.

The success or failure of an investment depends on the rate of interest received from it and time it has to run. In the case of a building these terms mean the amount of service got out of it, its life or period of usefulness, and its final or "scrap" value. Just what constitutes economical construction for a particular building will depend upon the values given to these conditions.

As an illustration of extreme conditions, take the temporary grandstand for a football match, and a ten-story office building. For the former, which is to be used for a few hours only, the very cheapest type of construction is economical, while for the latter, whose period of usefulness will be fifty years or more, only the most permanent construction, in spite of the greater cost, will pay.

Where the answer to this question with reference to some particular building is not so obvious, it is necessary to assume a certain number of years for the period of usefulness and fix on a sum which will fairly represent its value at the end of that period. From these figures it is possible to determine the per cent. which the value of the building decreases annually. For example, if the original cost of the building is $10,000 and it is estimated that at the end of twenty years its value will be about $3,585, it can be shown that the annual decrease in the value is nearly 5%. This decrease is called "depreciation," and if the books of the owner are kept correctly it will be taken care of in one of three different ways:

1. The value of the building as an asset will be decreased 5% every year. This is an approximate method and is only correct for the twentieth year.

2. A sufficient sum of money will be put aside each year and invested as a sinking fund so that at the end of twenty years it will amount to the total depreciation—in the above case, $6 415. The amount of the sinking fund at any time gives the depreciation of the building to date.

3. A certain sum will be spent annually in repairs so that at the end of the period the building will still be worth its original cost, $10,000.

Assuming that it is possible to get 5% per annum interest on money, the amount necessary to deposit in the sinking fund every year would be $194 (all problems of this nature are solved by the regular rules for annuities—a very interesting and profitable study for anyone having to do with long time investments).

This same amount, $194, represents the average sum which will have to be spent in repair to keep the building at a constant value by the third method. If to this we add the interest on the investment, 5% on $10,000=$500 we have $694, which is the actual amount the owner is paying each year for the building apart from such charges as taxes, insurance, etc.

Suppose a cheaper construction were used, so as to save $2,000 in the cost of the building, but that as a consequence the depreciation amounted to 10% per annum, instead of 5%, then the value of the building at the end of 20 years would be $973. The sinking fund would be $212.44, and the annual cost of the building, 5% on $8,000=$400, $400+212 =$612. This means an annual saving of $82 by using the cheaper construction which in 20 years would amount to $2,712—the ultimate saving to the owner.

In the above example the building has been considered simply as an investment but a far more important consideration in a manufacturing building is its relation to the process of manufacture. Methods are constantly changing, requiring corresponding changes in the building long before it is worn out. In this sense again a manufacturers' building is like a machine—its period of usefulness is not always measured by its durability. Some little invention or change in process sends it to the scrap-heap. It may be just as good as new but it is worthless.

This relationship is so important in some lines of manufacturing that the method of considering the building as an investment as above is not worth bothering about except for purposes of book-keeping. The only question asked is—will it reduce the cost of manufacturing sufficiently to pay for itself in a reasonable time?

Now the financial problems of manufacturing usually involve amounts of much greater magnitude than have to be considered in the building or plant. It is quite possible that $100,000 worth of goods could be turned out annually in a $10,000 building. Hence the great importance of the relation of the building to process of manufacture. In this case if 1% could be saved in the cost of the goods produced by increasing the cost of the building 10%, it would pav for itself in one year.

If in a plant employing 100 men it were possible, by cutting a door in a wall, by changing the location of a machine, by taking out an obstructing column or some other device, to save 6/10 of a second of each man's time per minute, or 6 minutes a day, it would mean that 99 men could then do the work which formerly required 100. If the average rate of wages were 20 cents per hour, it would save $600 a year. It can be shown that if the owner were to borrow $2,600 at 5% to make this alteration it would pay for itself in 5 years.

But it may be that through faulty design in the first place, it is not possible to make this change, and as a result of this, the owner is losing $600 a year which in 20 years would amount to $19,846.

Many a manufacturer is losing this $19,846 and much more through carelessness in the design of his plant.

It may be noted here that saving in time in manufacturing is a double saving. Not only is there a saving in workmen wages but the capacity of the plant is increased, as more work can be turned out in a given period. The profit on this extra work must be credited to the change which makes it possible. In addition to this, time in delivery is often a very important factor in securing a contract, and in such cases higher prices may be obtained.

The above discussion is an illustration of what is called Efficiency Engineering or Scientfic Management as applied to buildings, a subject that is attracting a great deal of attention just at present. So fine are some engineers' figuring that it has been suggested that even the time which the manager of a concern spends in looking after and ordering repairs to a building be capitalized and added to the ultimate cost.

Usually, however, more weighty reasons make it unnecessary to go to such refinement. In any new venture, which has a struggle before it with a possibility of failure, the first cost must be kept down to the lowest possible figure even at the sacrifice of efficiency, and questions of future growth, may, within reason, be left to take care of themselves. While it is true many a manager to-day bewails his lack of foresight in not preparing for the rapid growth of his business, still it is better that conditions are as they are than that his business had been wrecked at the start by an overload of debt.

This brief statement of the preliminary problems in the design of Manufacturers' Buildings should make clear at least one fact and that is, that the final plan must be a compromise—a compromise between the "possible" and the "expedient," between the "ideal" and the "practicable." In the completed building there may be many things that at first glance looks like blunders but a deeper investigation will show a carefully thought out purpose.

A good definition of an ideal building is given by Mr. Charles Day in his book "Industrial Plants." He says: It must so conform with all the industrial requirements that "the work of manufacturing may go forward with practically as much freedom as though the building did not exist at all. That is, the workers, whether employed at individual machines or engaged in moving material from point to point, should, to all intents and purposes, be unconscious of the existence of the housing structure." The building that will answer all requirements thus efficiently for the least cost—the period of use being considered—will be the best solution of the problem.

This discussion should also bring out the fact that the design of manufacturing buildings is more of an engineering than an architectural work. It will have been noticed that throughout this paper the name "designer" has been used and not "architect" or "engineer." The reason is that neither of these names, used in their usual sense, give a correct idea of this branch of the profession. A new term has come into use and we now have the "Industrial Engineer."

The average architect is not only entirely incompetent to handle these problems but all his training quite unfits him for this class of work. The ordinary rules of architecture are too narrow to be applied to what is virtually a machine. Besides, in a large number of cases the questions of architecture never enter at all. There are many examples of handsome but inefficient manufacturing buildings. On the other hand there is a great deal of justice in the charge that works designed by the engineer are unnecessarily hideous, and the industrial engineer cannot consider himself properly qualified if he has not a knowledge of the ordinary rules of architecture and aesthetics as applied to buildings.

But, as shown above, the work of the industrial engineer requires more than a knowledge of Architecture and Structural Engineering. He must have at least a general knowledge of applied science in all its branches in order to be able to grasp the salient features of any part of the manufacturers' installation, or his process of manufacture. It is not to be expected that he should be able to advise his client in his own business of manufacturing, but he will often find that his clients' ideas of what he wants are limited by his lack of knowledge as to what is practicable. Here the engineer can be of assistance. It must be admitted, however, that more often the engineer will have reason to feel extremely flattered by his clients' faith in his ability to accomplish the impossible.

In addition to his professional training, the industrial engineer must have a broad mind, free from narrow prejudices, to be able to appreciate the good points in special materials and constructions. He must have sound judgment and a fair talent for prophecy to build for the future. He must be a wide-awake, up-to-date business man with more than enough ability to handle the details of his own work, for the financial problems referred to above require a business acumen not usually expected of an engineer.

After all the preliminary problems in connection with some particular building have been threshed out, the actual work on the design and construction can begin, if the engineer has complete charge of the work.

Then follows in natural order the making of the general plans and specifications, the calling for tenders, selecting reliable contractors and awarding the contracts, the laying out the lines of the work, the fixing of levels, the checking and approving detail drawings, the inspection of materials and work, the ordering and installing of and putting in operation the equipment, and the thousand and one details which have to be attended to in order that the work may be done in an orderly, expeditious and systematic way and be brought to a satisfactory and successful conclusion.

But these problems have to do with the actual design and construction and are beyond the scope of this paper.

## CONCRETE, LATTICED AND TUBULAR POLES.*

Your committee in presenting the following paper on "Concrete, Latticed and Tubular Poles" recognizes that the concrete pole is now becoming better understood both as to construction and placing.

Like storage batteries, superheat and exhaust steam turbines, its introduction was handicappeed by a recommendation for general adoption. We believe that its merits will ultimately be recognized for use in special cases.

The latticed pole or tower for symmetry of construction and beauty of appearance and stability is in a field by itself and where extraordinary heights are called for to withstand very great strains, the properly designed latticed pole or tower undoubtedly will hold its own and possibly will never be replaced by any other form of construction.

The tubular pole has its own place and can be used on city lines where other poles would not be acceptable.

Concrete has been used in cases of emergency for reinforcing wooden poles, and tubular poles may also be protected by concrete or cement foundations that will give them great stability.

We are indebted to Gillette's Hand Book for the cost and construction data, permission to use which has been granted by the author of the book, and for which we desire to record our thanks.

We present the following data for your consideration:

**Reinforced Concrete Poles.**—The possibilities of reinforced concrete poles have recently been very carefully investigated by the Richmond (Ind.) Home Telephone Company, which has constructed a line across the Whitewater river, using poles ranging from 4 to 55 ft. in height, of the construction shown by Fig. 2.

For poles 30 ft. long and under, the moulding is done horizontally on the ground and the pole erected when hard like a wood pole; for poles over 30 ft. long the moulding is done in forms set vertically in the pole hole. The figures in Table A are given as the cost without royalty of concrete poles moulded as described. These costs are for poles erected excluding the material cost of steps but including labor cost of setting steps, and they are based on the following wages and prices:

| | |
|---|---|
| Foreman, per day | $3.00 |
| Laborers, per day | 1.75 |
| Cement, per barrel | 2.00 |
| Stone, gravel or sand, per cu. yd. | 1.00 |

For sake of comparison, the cost of cedar poles has been added to the table; these costs include poles, unloading, dressing, gaining, roofing, boring, hauling and setting.

Regarding the methods of constructing concrete poles, all of the larger concrete poles (that is, poles over 30 ft. in height) are built upright in position ready for use, the former being set perpendicularly over the hole in which the pole is to be placed, the hole having been dug to conform with the size pole prior to the setting of form; thus when the concrete is poured in at the top of form, the hole is entirely filled and the concrete knit firmly to the solid earth that has never been disturbed. No replacing of earth or tamping is required.

All poles under 30 ft. in height, up to the present time, have been built on the ground and set after they have been seasoned. It is possible that with the proper equipment and a little practice it will be found that even the smaller poles can be built more economically upright. As the larger poles are built upright in the position which they are to occupy there is no heavy material to handle and consequently no necessity for any heavy rigging or equipment. After the form has been placed over the hole the reinforcing rods and binding wires are placed, and it is then ready to receive concrete. After the concrete has been poured in, it is left for about three or four days, depending on the weather, before the form is removed. The most economical way of handling concrete is with a small mixer, capable of mixing 2 or 3 cu. yds. per hour and the old fashioned grain elevator. With this equipment, the concrete is placed as rapidly as it is mixed and with the same power. The falling of the concrete from the top of the form tamps it sufficiently.

The estimate of the cost of the finished pole is based on the following prices: Crushed stone $1.25 per cu. yd.; sand $1.10 per cu. yd.; cement $1.75 per bbl., and labor 20 cents per hour.

On lines where the poles are close to the track, the most convenient method of erection is to rig a hinged stiff-leg derrick on a flat car, with a boom of sufficient length to pick up poles on cars at either end of the derrick car. This derrick should be hinged so as to be conveniently lowered to pass under grade crossings and obstructions of any nature. On

*TABLE A—COMPARATIVE COST OF REINFORCED CONCRETE AND CEDAR POLES.*

*Richmond, Ind. Home Telephone Co.*

| Concrete Poles | | | | | | | | | | Cedar Poles — Cost | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Length | Top | Bottom | Size steel | Cubic ft. conc. | Cost of steel | Cost of conc. | Cost of bind. W. | Labor | Total cost | Top | F. O. B. cars | Labor | Total |
| *Ft.* | *In.* | *In.* | *In.* | | | | | | | *In.* | | | |
| 25 | 6 | 10 | 1/4 | 16 | $1 57½ | $2 24 | $1 20 | $1 70 | $6 71½ | 7 | $2 60 | $1 50 | $4 10 |
| 30 | 6 | 11 | 3/8 | 21 | 2 29 | 2 94 | 1 20 | 2 20 | 8 63 | 7 | 6 25 | 2 00 | 8 25 |
| 35 | 6 | 12 | 1/2 | 26 | 3 91½ | 3 64 | 1 20 | 2 70 | 11 45½ | 7 | 8 75 | 2 40 | 11 15 |
| 40 | 7 | 15 | 5/8 | 36 | 6 31 | 5 04 | 1 50 | 4 20 | 17 05 | 8 | 12 00 | 3 50 | 15 50 |
| 45 | 7 | 16 | 7/8 | 43 | 8 56 | 6 02 | 1 50 | 5 70 | 21 78 | 8 | 17 20 | 5 00 | 22 20 |
| 50 | 7 | 17 | 7/8 | 50 | 9 50 | 7 00 | 1 80 | 7 20 | 25 50 | 8 | 20 20 | 6 50 | 26 70 |
| 55 | 7 | 18 | 1 | 56 | 13 34 | 7 84 | 1 80 | 8 95 | 31 93 | 8 | 24 80 | 8 50 | 33 30 |
| 60 | 7 | 19 | 1 | 61 | 14 56 | 8 54 | 1 80 | 11 70 | 36 60 | 8 | 29 75 | 10 00 | 39 75 |

*From Report of Committee of American Street Railway Association at Annual Convention, Oct. 9, 1911.

steam railway construction, where the pole line is often 60 to 70 ft. from the track, a derrick truck with jack-arm is used in the same manner as the car, picking up the delivered poles from the ground instead of from the car.

The prime factors in the construction of concrete poles are the materials forming the grout. This is true of all concrete construction, but particularly so in the construction of concrete poles, where the cross-section is small and the greatest possible tensile strength is desired. Unless the best quality of materials is used, desired results cannot be obtained.

The steel reinforcing rods are placed 1 in. from the surface of the pole in three sets; four rods extend to the top of the pole, four rods two-thirds of the length of the pole and four rods one-third of the length. In testing the finished pole to destruction this distribution of the steel was found to be practical, giving a uniform stress from top to ground line. (A 30-ft. pole with 6-in. top and 9-in. base deflected 3 ft. at the top from a plumb line, and straightened when the load was removed without any apparent damage to the pole. A 30-ft. pole must stand a strain of 2,500 ft. lbs. at the ground line.)

The features to be reckoned with in the building of a line of concrete poles are transportation and erection. A 30-ft. pole, with a 6-in. top, will weigh 2,000 lbs. It is a practical proposition to build this length pole in a yard, in forms on the ground. A pole of any greater length should be built in place, from the ground up, although there have been erected 45-ft. poles that weighed 5,600 lbs.

The reinforced 30-ft. concrete pole with 6-in. top and 9-in. base, and corners chamfered to 1 in. radii contained ½ cu. yd. of concrete and 200 lbs. of steel, the cost being as follows:

| | |
|---|---|
| 200 lbs. of steel at $1.85 per 100 lbs. | $3.70 |
| ½ cu. yd. concrete, at $7.50 per yd. | 3.75 |
| Total | $7.45 |

The Fort Wayne & Wabash Valley Traction Company has made reinforced concrete trolley poles and transmission line poles, the cost of which was as follows in 1906:

The trolley poles are 32 ft. long, 8 ft. of which is below the ground level. The pole is 10 ins. square at the ground level and 6 ins. at the top, and is reinforced with eight twisted steel rods, ⅜ in. It contains 22½ cu. ft. of 1:3:3 gravel concrete, and 122 lbs. of steel, weighs 3,300 lbs., and costs $7.50 at the gravel pit. The transmission pole is 42 ft. long, 8 ft. being underground. It is 12 ins. square at the ground level, and 6 ins. at the top, and is reinforced with eight twisted steel bars (½ in.), four of which are 32 ft. long and four are 42 ft. long. It contains 29 cu. ft. concrete, 242 lbs. reinforcing bars and 21 lbs. of steps, weighs 4,400 lbs. and costs $13.

## *WROUGHT IRON TUBULAR POLES*

*Table Giving Approximate Weights, and Probable Deflections When Held and Loaded As Stated*

| Length of Poles, 35 feet | | | | | | | Moment of Inertia | | | | | | | | | | | | | Greatest Safe Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Weight | Butt 21 ft. long | | Middle 10 ft. long | | End 7 ft. long | | | | | | | | | | | | | | | |
| Lbs. | Std | X | Std | X | Std | X | | | | | | | | | | | | | | |
| | Nominal Dia. in inch | | | | | | I | 100 | 200 | 400 | 600 | 800 | 1000 | 1200 | 1400 | 1600 | 1800 | 2100 | 2400 | Lbs. |
| 652 79 | .... | 5 | ..... | 4 | .... | 3 | 20.676 | 2.23 | 4.46 | 8.92 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 450 |
| 633 82 | . | 5 | .. | 4 | 3 | ..... | 20.676 | 2.23 | 4.46 | 8.92 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 450 |
| 613 58 | 6 | . | 5 | ..... | 4 | ..... | 28.134 | 1.64 | 3.28 | 6.56 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 515 |
| 910 37 | .. | 6 | ... | 5 | .... | 4 | 38.933 | 1.117 | 2.234 | 4.468 | 6.702 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 713 |
| 880 20 | .... | 6 | ... | 5 | 4 | ..... | 38.933 | 1.117 | 2.234 | 4.468 | 6.702 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 713 |
| 777 77 | 7 | . | 6 | ..... | 5 | ..... | 43.078 | 1.069 | 2.138 | 4.276 | 6.414 | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 770 |
| ,080 17 | .... | 7 | 6 | ..... | 5 | ..... | 71.380 | 0.645 | 1.290 | 2.580 | 3.870 | 5.160 | 6.45 | ...... | ...... | ...... | ...... | ...... | ...... | 1,087 |
| 1 965.70 | 8 | . | 7 | ..... | 6 | ..... | 72 610 | 0.634 | 1.268 | 2.530 | 3.800 | 5.060 | 6.34 | ...... | ...... | ...... | ...... | ...... | ...... | 1,019 |
| 1,421.02 | .. | 8 | .... | 7 | 6 | ..... | 105.740 | 0.435 | 0.870 | 1.740 | 2.610 | 3.480 | 4.35 | 5.22 | ...... | ...... | ...... | ...... | ...... | 1,486 |
| 1,277 02 | ..... | 8 | 7 | ..... | 6 | ..... | 105.740 | 0.435 | 0.870 | 1.740 | 2.610 | 3.480 | 4.35 | 5.22 | ...... | ...... | ...... | ...... | ...... | 1,486 |
| 1,375 54 | .... | 9 | 8 | ..... | 7 | ..... | 149.670 | 0.305 | 0.610 | 1.220 | 1.830 | 2.440 | 3.05 | 3.66 | 4.27 | 4.88 | 5.49 | ...... | ...... | 1,885 |
| 1,669 73 | ..... | 10 | 9 | ..... | 8 | ..... | 211.953 | 0.218 | 0.436 | 0.872 | 1.300 | 1.740 | 2.18 | 2.62 | 3.05 | 3.48 | 3.92 | 4.578 | 5.13 | 2,451 |

Top line in table gives load in pounds, applied 18 in. from end.

Formula used in figuring deflections:

$$\text{Deflection per 100 lbs.} = \frac{100 \times 35.937.000}{3 \times 26,000,000 \times I} = \frac{46.073}{I}$$

With end of Poles 6 ft. under ground. Moment of Inertia $= I = 0.0491 \times (D^4 - d^4)$.

$$\text{Deflection} = F = \frac{W L^3}{3 E I} \quad \text{where} \begin{cases} F = \text{Deflection in inches.} \\ W = \text{Load applied in pounds.} \\ L = \text{Length of pole (in inches)}-(6' + 1'6''). \\ E = \text{Modulus of elasticity} = 26,000,000. \end{cases}$$

## WATER METERS IN WASHINGTON.

The superintendent of the water department of Washington, D.C., W. A. McFarland, has compiled and analyzed figures of costs and income of the water works which apparently demonstrate that it is necessary for the commissioners to increase the meter rates. This is due to several causes. In the first place, it is found that the annual income from each consumer diminishes by about $1.50 when the change is made from flat rates to meter basis. In addition, the average annual cost of each meter is: reading, 20 cts.; repairs, 22 cts.; depreciation, 27 cts.; a total of 69 cts. per meter per year. That is, under the existing rates there is a decrease of net income of $2.19 for each meter which is installed. The average cost of installing meters is estimated to be $13 each.

This is not taken by the commission as an argument against the use of meters, but only that the meter rates were made too low. It desires to install meters on 45,000 additional existing services, as well as on all new ones, which are being connected at an average rate of about 3,000 a year. An advance has been decided upon which will add $107,000 a year to the income from meter rates on the basis of the present number of meters.

# SASKATOON WATER FILTRATION PLANT.

T. Aird Murray, C.E., Consulting Engineer to the Saskatchewan Government.

The City of Saskatoon obtains its water supply from the South branch of the Saskatchewan river. The water is pumped direct from the river into a settling basin and then supplied by direct pumping to the distributing system.

The river water for many months is more or less turbid. Maximum turbidity occurs in the months of June and July owing to the melting of the snows and ice in the mountains. The turbidity is due principally to coarse suspended clayey matters and to fine particles of glacial silt. The pathogenic character of the water is good, there being little sewage contamination and great dilution, the minimum flow being 208,000,000 cubic feet per day. Pathogenic conditions are more likely to occur immediately after the ice melts, when sewage matters are brought down the river in cold storage from Medicine Hat, Calgary, etc.

The citizens of Saskatoon have all along been dissatisfied with the character of the water owing to the amount of silt at times delivered at the taps, and some time back requested the Government Bureau of Public Health to advise as to the best means of clarifying the water. The author, along with Mr. George Clarke, the city engineer, made a thorough investigation into the local conditions, and after a careful study of analyses of the water and data collected from experimental work, concluded that the conditions would be best met by installing gravity mechanical filters together with the use of sulphate of alumina as a coagulant.

A similar type of filtration plant had recently been installed at the city of Prince Albert under the direction of the Bureau of Health, dealing with the water of the North Saskatchewan river. The results have proved satisfactory.

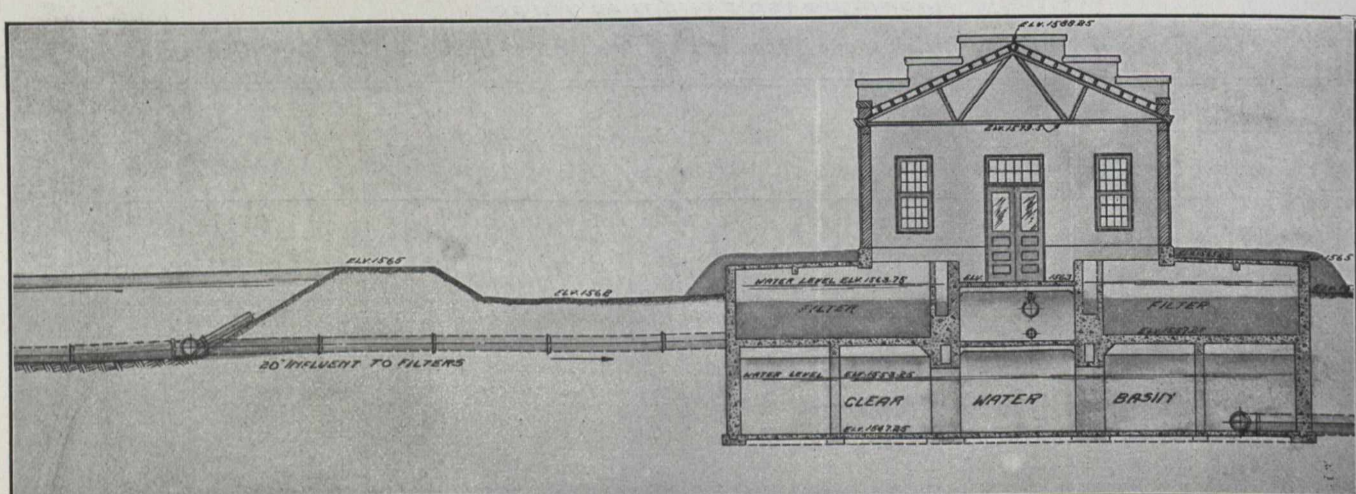
The following description of the plant should be of interest to readers of The Canadian Engineer, as it represents, perhaps, the most up-to-date installation of mechanical water filtration yet installed in Canada. The general principles and complete methods of control are very similar to the installation at Harrisburg, U.S.A., where average yearly efficiencies have been obtained, as follows:—

Removal of color 100 per cent., removal of suspended matter 100 per cent., and bacterial removal 99.6 per cent.

The whole of the plant is being erected by contract with Messrs. Roberts, of Philadelphia, who are the makers of the filter units and controlling apparatus.

The water to be filtered is taken from the Saskatchewan river at a point opposite the existing pumping station. It flows by gravity to two deep wells from whence it is pumped to the existing storage basins, which are being converted into a sedimentation basin.

This basin will be divided into two compartments by a wall extending across its centre. The water is admitted to that section of the sedimentation basin farthest from the filtration plant through three bell shaped delivery pipes; flows toward the central division wall, is there collected into three bell shaped pipes, which extend to within 12 in. of the high water level in the basin affording a weir effect to the naturally subsided water. It is then conveyed through a cast iron pipe around the central division wall to the second half of the sedimentation basin, which acts also as a coagulating basin. Provision is made for feeding sulphate of alumina into the pipe line conveying this naturally subsided water to the second half of the sedimentation basin or coagulating basin. It is then delivered through similar bell shaped pipes, flowing toward the end of the coagulating basin, collected into bell shaped pipes as described in the preceding basin, which convey the water to the pipe leading to the filters; provision being made also for feeding sulphate of alumina to the water in this pipe just after leaving the coagulating basin.




**Section Through Filter Plant.**

The treated and subsided water then flows through the 20-in. influent main down the filter gallery and is distributed through 10-in. pipes to each of the six filters.

During the process of filtration the water flows into and fills the concrete pocket in front of each of the six filter units, rises to a level with the tops of the steel supply and wash trough, spills over onto the sand bed, filters through the sand and gravel and is collected by the bronze strainers into the wrought iron strainer system. It is then conveyed through the central cast iron manifold collecting pipe and across the front of the filter to the effluent rate controller.

The effluent rate controllers are set to deliver a given quantity of water under a head of 10 ft. 6 in., and are capable of adjustment to within 30% above or below the normal rate for which they are designed; they in turn deliver the filtered water to the filtered water storage reservoir, located beneath the six filter units.

The filtered water then flows by gravity from the storage reservoir to the high duty pump suction well, from whence it is pumped to the stand-pipe, from which it flows through the distribution system to the consumers.

Each of the six filter units is equipped with hydraulically operated valves, which permit the filter being controlled from an operating table located on the operating floor immediately in front of each unit.

The equipment includes a centrifugal pump for supplying water for washing the filters, also a blower for supplying air under pressure during the washing process. Each of these units is independently driven by an electric motor mounted on the same bed plate.

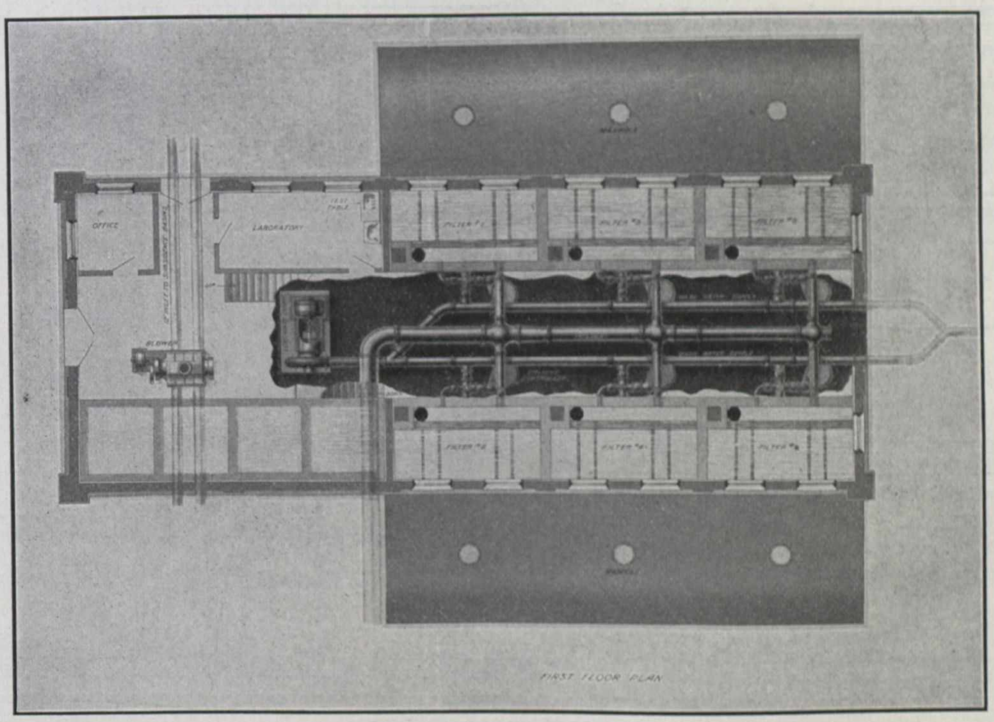
The plant is so arranged that the filters can be washed either by using the centrifugal wash pump for filtered water or by filtered water taken from the force main leading from the high duty pumps to the stand-pipe, affording an auxiliary wash in case of accident to the wash pump.

During the washing process the inlet valve to the filter is closed. The water on the sand bed allowed to filter through the rate controller into the filtered water storage well. The operator then signals by the use of an electric bell controlled from the operating table for the engineer to now closed, and the influent and filtered water to waste valves opened, allowing the treated water to filter through the sand bed as during the process of filtration, the water passing to the drain until the clay particles which were not raised during the washing process to the waste trough are carried off to the drain and until the water is about the color of the treated water being supplied to the filter.

The filtered water to waste valve is then closed and the effluent valve opened, placing the filter in operation and allowing the water to pass through the effluent rate controller to the filtered water storage well beneath the filters.

On each of the operating tables is located a test bibb for drawing samples of the wash water during the washing process, also for taking samples of the filtered water at any time while the filter is in operation.

In the laboratory equipment is included a test basin having properly marked bibbs for taking samples of filtered water from each of the six filters, also provision for taking samples of the raw and treated



**Sectional Plan.**

start the blower. The air supply valve being opened on the filter, the air is admitted to the sand bed, and the latter is scoured for a period of two minutes, after which the air supply is shut off and the wash pump placed in operation and filtered water admitted to the filter through the manifold and strainer system, causing a reverse current for a period of two minutes, which washes the sand, carrying the heavy deposits which have been filtered out of the water during the process of filtration to the supply and wash trough, from whence it is carried to the waste and thence to the drain. This alternate air and water washing is continued for a period of from six to ten minutes, the time depending upon the cleanliness of the sand bed. The duration of the air scouring and washing periods being diminished after the first period of two minutes each.

After the washing process the sand settles back into its normal position in the bed, the heavier particles settling on the bottom with the finer grades toward the surface, or the sand settles in relation to its specific gravity.

The air, the wash water supply and waste valves are water before and after coagulation. The samples of the water are pumped by the use of a hydraulic lift from the sources of their supply to the bibbs. The hydraulic lifts are actuated by the high pressure of the water in the force main from the high duty pumps. By opening the bibbs on the operating tables and test basin, the pressure is released to the hydraulic lifts, which places them in operation.

The chemical feeding plant consists of four concrete solution tanks located in the second story of the machinery end of the filtration plant; two for the preparation and mixing of sulphate of alumina and two for hypochlorite of lime.

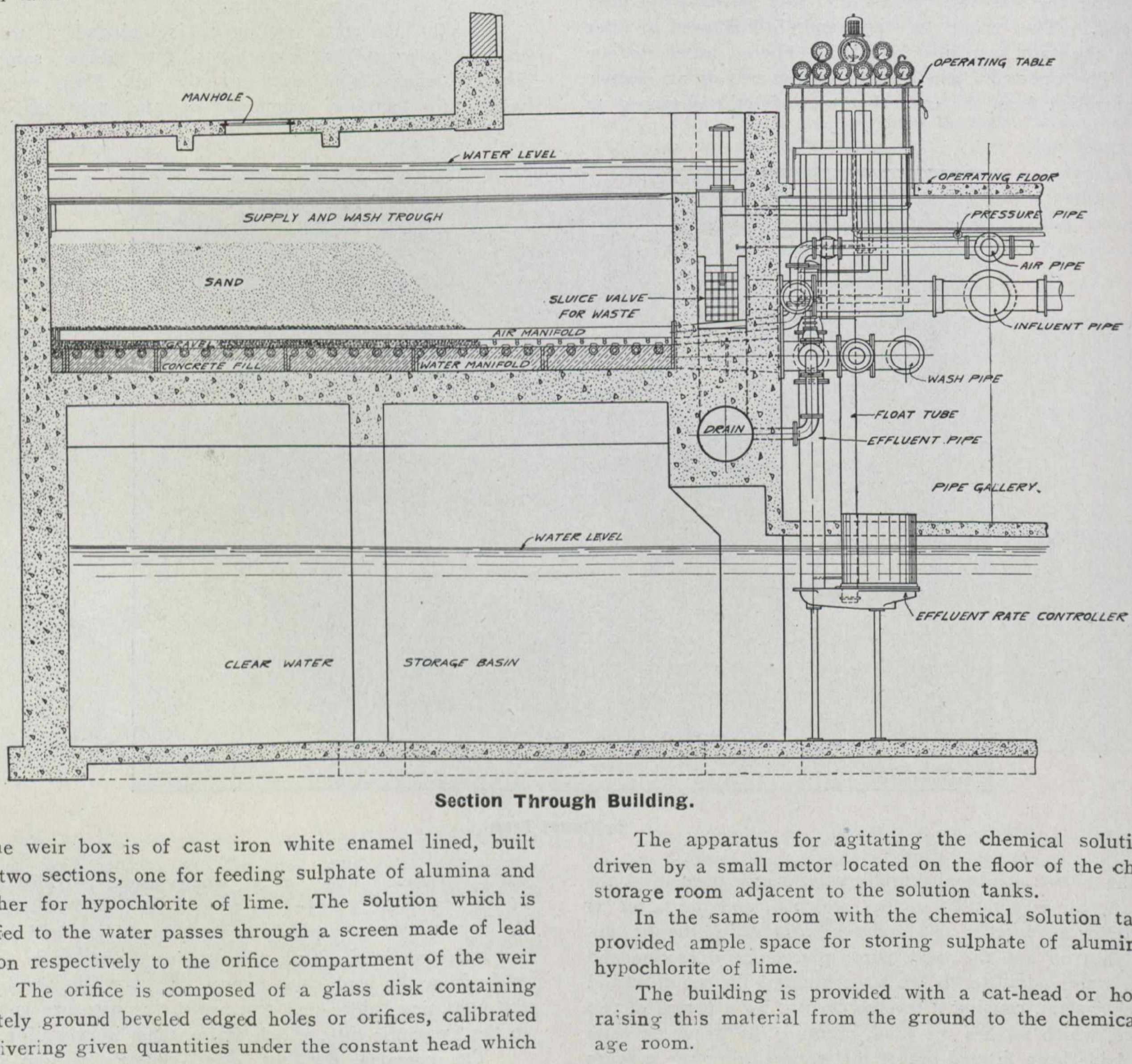
In the sulphate of alumina solution tank the chemical is placed in lump form in wooden dissolving trays and filtered water allowed to spray over the material until it is dissolved and the solution tanks are filled with this liquid. Wooden paddles are driven through the solution by a pair of bevel gears at a slow rate of speed to insure a more finely graded solution.

The hypochlorite of lime is fed into a cast iron cylindrical box, provided with an agitator which thoroughly mixes and dissolves the chemical, after which it is flushed out of the mixing tank by water pressure into the solution tanks, which are equipped with agitators as described for the sulphate of alumina tanks.

Each pair of sulphate of alumina and hypochlorite of lime solution tanks is equipped with a rotary pump which takes its suction from the bottom of the solution tanks and delivers the solution into an overflow or weir box in sufficient quantity to allow approximately the same quantity to flow back into the solution tanks as is fed through the orifice to the points of application to the water to be treated. This pumping and the overflowing of the solution from the weir box provides additional agitation to the chemical solutions, preventing settling in the solution tanks.

is maintained in the weir box. This orifice is capable of ready adjustment by moving the disk on its axis until the orifice of the desired size is located in place opposite the discharge from the weir box.

The solution is then fed by gravity through pipes composed of metals best adapted to withstand the action of the respective chemicals, passing through a sight feed in the laboratory, which permits the operator of the plant to see at a glance whether his feeding apparatus is working or not. From the sight feed the sulphate of alumina solution passes to the points of application above mentioned in the coagulating basin and the hypochlorite of lime solution is fed to the filtered water storage reservoir at a point where the outlet to the high duty pumps takes place.




**Section Through Building.**

The weir box is of cast iron white enamel lined, built up in two sections, one for feeding sulphate of alumina and the other for hypochlorite of lime. The solution which is to be fed to the water passes through a screen made of lead and iron respectively to the orifice compartment of the weir boxes. The orifice is composed of a glass disk containing accurately ground beveled edged holes or orifices, calibrated for delivering given quantities under the constant head which

The apparatus for agitating the chemical solutions is driven by a small motor located on the floor of the chemical storage room adjacent to the solution tanks.

In the same room with the chemical solution tanks is provided ample space for storing sulphate of alumina and hypochlorite of lime.

The building is provided with a cat-head or hoist for raising this material from the ground to the chemical storage room.

## THE NATIONAL BRIDGE COMPANY.

The present capacity of this plant, which has just been erected at Montreal, is 20,000 tons, which will be increased to 40,000 tons by the erection of No. 2 bridge shop during the coming winter. This will bring the new plant to first or second place for size and capacity in the ranks of the bridge and structural companies in Canada. The buildings and plant now complete and in use are the main No. 1 structural shop, 137 ft. by 350 ft., and the power house, machine shop, template shop, erection and paint houses, the stock yard crane runway of 80-ft. span and 400-ft. run and the shipping yard crane runway, 50 ft. by 150 ft. The National Bridge Company is capitalized at £800,000, only a part of which has been issued. The directors include Messrs. J. N. Greenshields, Wm. Lyall, W. G. M. Shepherd, H. W. Beauclerk, and Robert Mackay.

# The Canadian Engineer

ESTABLISHED 1893

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

**NOTICE TO ADVERTISERS.**

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## CONTENTS OF THIS ISSUE.



## THE CITY ENGINEER OF VICTORIA, B.C.

The mayor of Victoria on October 27th suspended City Engineer Smith. This move is an outcome of the agitation in the council carried on by the mayor against the engineer. The mayor is desirous of appointing an engineer of construction for the city who will take over the executive duties of the city engineer, and to this move the city council have objected.

Mr. Angus Smith, the city engineer, graduated in 1894 from the School of Practical Science, Toronto, and from that time until the present has been engaged in municipal work, being city engineer of Stratford for six years until 1906. In 1906 he went west to Regina, and in that town, afterwards a city, superintended the construction of all their public works. In March, 1910, Mr. Smith was appointed city engineer to Victoria. Since he has been there he has secured the hearty support and sympathy of most of the council with the exception of the mayor. The mayor appears to have another nominee for the position, and has worked systematically towards ousting Mr. Smith.

The latter gentleman has earned the good-will of the public, and at the present time this interference with his executive duty does not appeal to a sense of fair play.

Mr. Smith's ability is unquestioned, and it is to be hoped that the other members of the council will not support the mayor in his arbitrary attitude.

## TORONTO WATER.

The filtration plant at Centre Island is nearly completed, and it behooves us to ask at this time, Of what use is it? After this filtration plant is in operation, what would it avail if a serious contamination of the water supply should occur? Filtration will certainly not remove the germs. Passed through sand filters, the lake water, containing little or no organic matter, and but little silt, will remain in its original condition. It will have practically no effect on the organic matter in solution, or the bacteria which are traceable to sewage contamination.

On the 28th of October the writer paid a visit to the chlorination plant at Hanlan's Point, where the water supply of Toronto is treated, and was astonished to find it under the constant control of a technical chemist, bacteriologist, and an assistant chemist under the Health Department. There it was noted that, while it is now the cool season of the year, instead of the chlorine treatment being lessened, it is steadily being increased, there being used at the present time .419 parts chlorine per million. Mr. F. B. Robertson, who is the chemist in charge of the chlorinating plant, finished the work left by Mr. Earl B. Phelps, one of the many consulting experts employed by the city in the past, taking the badly designed scheme of applying the chlorine to the water as it then stood, and revising and adjusting it, so that at the present time it is working well.

As is well known, the action of chlorine on water is not by any means permanent in its bactericidal effects. Akin to the ozone process, its result is due, not to the chlorine so much itself, but to the nascent oxygen liberated for the time being. Unless the water is pure, there still remains food for the cultivation of new generations of bacteria.

The city experts state that they will treat the effluent of the sewage plant with chloride, and what the chloride does not sterilize will be looked after by the lake itself. Of what use, however, is it to treat the effluent with chlorine in order to kill off the microbes when the very food, the presence of which alone accounts for their existence, is still untouched? This is not a question which can be solved by the engineer or bacteriologist, but should be placed in the hands of a competent technical chemist. What the city now requires is thorough chemical advice and control. Eliminate their food and the microbes will soon vanish. Merely killing them off is not sufficient.

The recommendations by the Medical Health Department that the water be subjected to chlorine treatment after filtration obviously shows the scientific work of those who ought to know better. The city employs only two chemists engaged as such, and these are installed in a complete laboratory at the Island filtration plant under the Water Department. They are kept tinkering and experimenting away on water filtration, and this only spells more useless expense.

With proper handling it is probable that the city's water supply would require no treatment at all, or, at the most, would not necessitate the addition and presence of large quantities of such a powerful and obnoxious chemical, which, although destroying the germ, does not eliminate any more than a sand filter the filth from which it springs.

It appears to us that the time has arrived for the city to employ a competent and technical chemist, who is thoroughly experienced on work of this nature, for it is evident there is a conspicuous lack of technical knowledge among the city experts at the present time. If such a man were appointed he could investigate the advantages and disadvantages of the various systems, including chlorine, ozone, ultra violet ray, etc., for the treatment of water, and could also go into the chemical treatment of the sewage effluent. This question of sewage effluent is an exceedingly important one, and we are satisfied that if investigations were carried on along the line of methods of purification of effluent, other than chlorination, it would amply repay the city the expense of such an investigation.

## WORKMEN'S COMPENSATION.

One can scarcely blame Sir William Meredith, who is preparing a report for the Ontario government on the subject of workmen's compensation, for refusing to grant delay in its preparation and presentation. The most important matter is not so much legislation in the individual provinces but the need for a Dominion Act which would apply to the country as a whole. Those employing labor in one part of the country might easily be placed at disadvantage compared to employers in another section where different compensation legislation was in operation. The provinces might well sacrifice their rights in this matter, making a joint request to the Dominion for workmen's compensation law which would apply to the entire country. At the recent Imperial Conference in London, Sir Joseph Ward presented a resolution to the effect that it is in the best interests of the Empire that there should be more uniformity throughout its centres and dependencies in the law of accident compensation. His resolution was adopted. Sir Joseph Ward wanted the British system made universal throughout the Empire. New Zealand and Great Britain are the only countries which have that system. Sir Wilfrid Laurier stated that so far as Canada was concerned, for his part he could approve altogether of the principle. "But," he added, "it is a matter over which the government of Canada would have no power at all. It is within the jurisdiction of the provinces."

## THE LATE PARK COMMISSIONER.

In 1908, Mr. James Wilson, the late Commissioner, took over the administration of the park system of Toronto. At that time that department of the civic service was on a very low plane. Inefficiency characterized every part of it. Under Mr. Wilson's administration, however, this was all changed. After bringing order out of chaos, each year brought new and additional improvements. So much so, that to-day one can hardly believe this work could have become accomplished in the short period of three and a half years.

Mr. Wilson came to Toronto from the superintendentship of the Queen Victoria Niagara Falls Park. Before that time he practised the profession of civil engineering, and it is to this training and experience that a great deal of his after success was due. The City Council must now consider the question of appointing a successor to Mr. Wilson, and it will be no easy task. The appointment, however, should be kept clear of personal or political feeling, and a man of the requisite training and strength of character should be chosen.

## WHAT WE PAY FOR HUSTLE.

In a recent issue of the Monetary Times one of the editorials draws attention to the number of accidents directly due to the spirit of hustle which pervades modern civilized communities. Some of the statements are very much to the point.

Many, if not the majority, of these accidents can be traced to carelessness, thoughtlessness or selfishness. The desire to achieve big results in the shortest possible time at the expense of efficiency is a national trait which the country may well take immediate steps to obliterate. The evil of dollar and dividend hunting, regardless of destruction in its wake, is a menace to Canada's progress and credit. The basis of civilization is the proper respect for life and property. We in this country have by no means sufficient regard for either. The fact is noted by the capitalist and investor abroad and we suffer thereby and will do so to a greater extent, if early improvement is not made.

The national spirit of carelessness is vividly portrayed in the fire waste. In the past 32 months Canadian property has been burned to the value of $57,880,678. This year's losses to date have been at the rate of $44 a minute. In addition, lives lost in fires in four years have numbered 1,072.

Railway accidents account for great loss of life. "Making up lost time" is responsible for many. But the stage apparently has not been reached where we would prefer to arrive at our destination two hours late and alive, rather than on time and dead. Collisions, derailments and parting of trains were responsible in four years for 894 killed and injured. In three years 190 persons were killed and 201 injured at highway crossings. During the past 23 years, 7,263 persons have been killed and 25,668 injured on Canada's steam railways.

Analyzing the statistics of industrial accidents in the latest published report, under the heading of mining, it is found that explosions caused over 35 per cent. of the deaths and over 20 per cent. of the injuries. Falls accounted for nearly all of the deaths and over 66 per cent. of the injuries in the building trades. Among unskilled laborers, 21 men were killed by being run over by vehicles and 17 by falling material, and 53 were injured in a similar way. An alarming increase has occurred in the number of fatalities among workpeople engaged in the handling of explosives. This summer, too, there were 63 drownings in the Lachine Canal. "The chief danger," says a civic official noting the fact, "is in the canal with its deep drop from the banks, making rescue difficult, and it seems advisable to have a railing along those parts of the canal where people most congregate, so that they will not be so liable to tumble into the water." Sixty-three drownings, before a rail was suggested! Such records can be found in any part of the country.

The writer heard an engineer admit that a certain structure, which had been criticized, "might fall in three years' time," with possibly serious loss of life. Railroad contractors were laying new steel recently at a record-breaking pace, while a big crack in the concrete abutment of a bridge was allowed to wait, despite the fact that work trains used the bridge daily. Carelessness with live wires, reckless driving of automobiles—in a thousand ways we violate the first principles of a civilized community.

The reasons for the existence of such conditions are due largely to individual, corporate and legislative carelessness. We need better laws for the protection of life and property and the strict enforcement of such laws. If the Imperial Board of Trade, for instance, had to deal with the question of our railroad fatalities, as they do in Great Britain, their action for reform would be drastic enough to startle us in no slight degree. We can therefore afford to emulate John Bull in his thoroughness of work and his regard for life. Ultimately his results are better, safer and more durable than ours. American hustle takes the vitality out of the nation and in more senses than one.

## EDITORIAL COMMENT.

The Commonwealth Parliament of Australia has now under consideration the bill introduced with respect to the construction of a new transcontinental railway which will connect Adelaide, South Australia, with Perth, West Australia. The length of the line survey is 1,060 miles, and the total estimated cost about twenty million dollars.

* * * *

The first article in this issue of the Engineer is one on the Canton-Hankow Railway in China. This description comes at an opportune time, as the conditions during construction against which the engineers there had to contend have led to the rebellion now going on. The author's remarks give a clear idea of the mental attitude of the Chinese towards foreign enterprise.

* * * *

The design of manufacturing buildings is a subject of some importance, and there has been a good deal written concerning it. However, in a paper given to the Engineering Society of the University of Toronto, and reprinted in this issue, Mr. E. H. Darling deals with the problems connected with the design of such buildings in a different manner, taking up the problems under the headings of Utility, Location, and Finance. This paper, while written for undergraduates, will repay reading by engineers in practice.

The corporation of Bristol, England, have during the past summer tarred upwards of a hundred miles of macadamized road, the greater portion of the work carried out by contract, the tar being distributed hot by means of machines fitted with spraying nozzles working under pressure produced by a force-pump geared to the wheels of the vehicle. A portion of the work is done by hand machine of a similar character, while some is done by hand painting. One or two coats are supplied, according to the character of the road, and the cost works out at about two cents and three cents per yard for one and two coats, respectively, including cleansing and gritting.

* * * *

The art of specification writing is one to which too little attention has been paid in the past, both in theory and practice. As a result, from time to time are developed lawsuits between contractors and owners, leading often into long-drawn-out litigation. There is no reason why it is not possible for the engineer to specify beforehand on all of the important matters, so that no doubt will exist in regard to any feature of the work. For the above reasons, in order to draw attention to this fact, and to give some needed instruction on these points, the Canadian Engineer has made arrangements with a prominent consulting engineeer to write a series of articles bearing on this important subject. This series will start in the course of two or three weeks.

* * * *

Sir Robert Perks, who is now on a visit to Canada, in the course of an interview, said: "The proposition of the Montreal, Ottawa, and Georgian Bay Canal Company will be laid before the new Government as soon as it is ready to receive it. I believe the building of the canal in the near future is now assured. The people of Canada, by their repudiation of Reciprocity in the recent election, have decided in favor of improving the trade east and west in this country. In that connection the Georgian Bay Canal would be one of the important factors, a fact which cannot be overlooked. The United States will complete the Panama Canal in 1913, and will make a desperate effort to divert Canadian trade to Canada's western ports, to the detriment of this country's eastern ports. When the Georgian Bay Canal is built, Ottawa will become a port during the months of the year when the canal is open," said Sir Robert, "in much the same way as Manchester became a port through the building of the Manchester Ship Canal. It would take five years to build a canal from the St. Lawrence to Ottawa."

## CANADIAN SOCIETY OF CIVIL ENGINEERS.

The nominating committee of the Canadian Society of Civil Engineers have forwarded the following list of nominees for officers and members of council for the year 1912. It will be observed that with the exception of the nomination for president, two members are proposed for each office:—

**For President**—W. F. Tye.

**For Vice-President**—H. H. Vaughan, L. A. Vallee.

**For Councillors:**

**District No. 1.**—H. G. Kelley, W. J. Francis, C. N. Monsarrat, G. H. Duggan.

**District No. 2.**—W. B. MacKenzie, H. F. Donkin.

**District No. 3.**—A. E. Doucet, E. A. Hoare.

**District No. 4.**—Duncan MacPherson, S. J. Chapleau.

**District No. 5.**—C. L. Fellowes, H. J. Lamb.

**District No. 6.**—J. A. Hesketh, C. H. Dancer.

**District No. 7.**—C. E. Cartwright, S. H. Reynolds.

# Metallurgical Comment

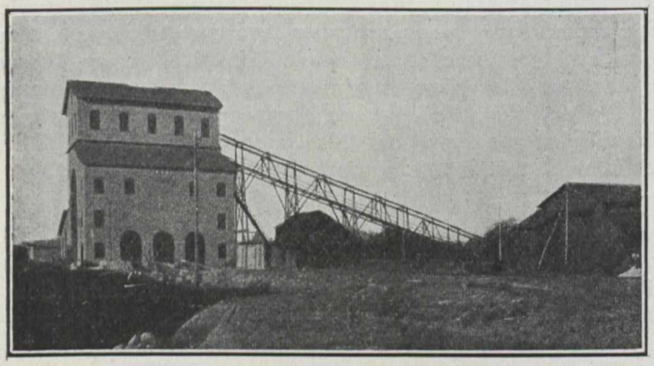
T. R. LOUDON, B.A. Sc.

Correspondence and Discussion Invited

## ELECTRICAL IRON SMELTING IN SWEDEN.

A very interesting paper on electrical iron smelting was given by Mr. T. B. Robertson before the Engineers' Club of Toronto on Thursday, November 2, the following being an abstract:—

Realizing the importance of thoroughly testing the electric furnace on a large scale, Jernkontoret, an association of Swedish ironmasters determined to build at Trollhättan a furnace of 2,500 horse-power capacity.



Although having accumulated large funds they had never previously embarked in a commercial or technical undertaking, but of such moment to the Swedish iron industry was this question that they voted a sum of $90,000 to put up the plant and to further develop the process.

The Swedish Government to assist in the undertaking, decided to furnish power at a nominal figure from their Trollhättan station, the supply being 3-phase current of 25 cycles at 10,000 volts tension.

The construction of the furnace is shown in Fig. 1, two separate portions are to be distinguished, viz., the shaft and the crucible or hearth. The shaft is simply a shell of steel

plate lined with fire-brick. At the top it is riveted to an octagonal channel iron ring, which bears on two built up beams, these being in turn supported by the walls of the building. At the top of the shaft is a Tholander charging bell, a type of bell peculiar to Sweden, which is specially designed to deliver the ore round the sides of the shaft and the charcoal in the center. The crucible rests on a concrete foundation. It also has a steel shell, next to which is a lining of fire-brick, with an inner lining of magnesite brick, while the bowl-shaped hearth is formed by ramming in a mixture of magnesite and tar. The arched roof is built of fire-brick and has four openings to admit the electrodes, which project through the roof at an angle of 65 deg. to the horizontal. At the opening in the roof each electrode is surrounded by a copper water jacket, provided with asbestos packing to prevent the leakage of gas. The electrical contact pieces are wedged between the upper end of the electrode and a holder of cast steel which is supported in a frame, that can be raised or lowered between two guides, one on either side of the electrode.

An important feature of the furnace is the provision made for the circulation of the gases produced by the reduction of the iron ore. The gas is drawn from the cool upper part of the furnace by means of a fan, and blown under the hot roof of the crucible, serving the double purpose of prolong-

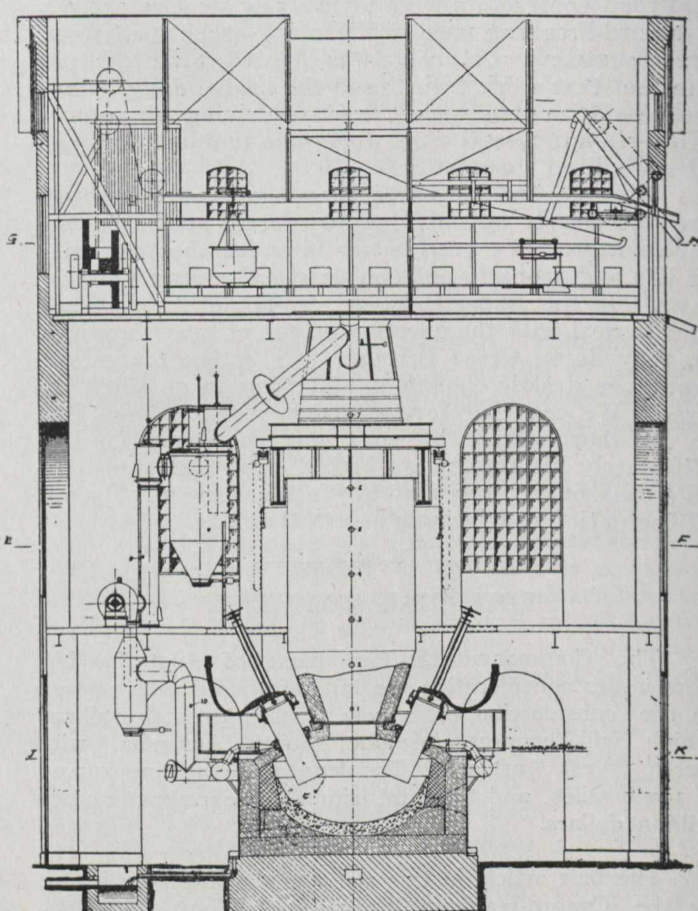


Fig. 1.

ing the life of the roof, and at the same time giving up its heat to, and helping in the reduction of, the charge. The arrangement of gas pipes is seen in Fig. 1, the four tuyeres through which the gas is blown up against the roof being situated midway between the electrodes. The transformers, electrodes, the tap hole arch, and the walls of the hearth are water cooled.

The furnace transformers are two in number each of 1,100 k.v.a. capacity, oil insulated with water cooling. By means of Scott connections they transform the 3-phase, 10,000 volt supply to a 2-phase current, the tension of which by altering the number of primary windings can be regulated between 50 and 90 volts. This alteration is carried out whilst the furnace is working by simply turning a handle, and the arrangements are such that the two phases can work at different tensions.

The low tension busbars from the transformers to the furnace room are 24 in number, each 8 x 200 mm. cross section. From these bars to the electrodes the current is taken by flexible bare copper cables. (Fig. 2.)

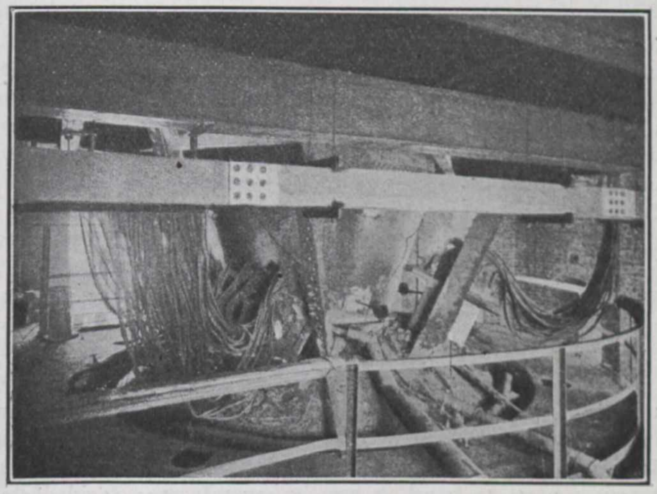


**Fig. 2.**

At the time that the furnace was designed, carbon electrodes in one piece of the necessary dimensions could not be obtained, so that electrodes were built up of 4 pieces, 2 meters long and 330 mm. square. Before being bound together the sides forming the joints were planed true by hand and the joint was made with a thick paste of graphite and molasses. The upper part of the electrode is covered with asbestos millboard and thin sheet iron, to prevent loss of heat.

The furnace was thoroughly dried out with wood and charcoal fires, and heated up electrically by filling the hearth with coke and turning on the current. Charging was commenced on the 15th November, 1910. The furnace began to produce iron regularly and without difficulty, the first few tappings being rather high in sulphur from the large quantity of coke in the hearth. The various ironworks in Sweden sent their ores to be electrically smelted. In order to gain as much information as possible, the burden of the furnace was constantly altered to vary the grade of iron produced. Such treatment involving the frequent alteration of acid and basic slags was not good for the furnace hearth, and it must be admitted that it was something of an achievement for this to stand six months of this treatment without needing any serious repairs.

In Table 1 is given a summary of working results for the period November 15, 1910, to April 9, 1911.

As might be expected the output per kw.-year is proportional to the percentage of iron in the ore, but with ores producing a greater quantity of slag the electrode consumption is smaller.

As the volume of the furnace and the gas piping is constant an excess of gas is being continually produced, proportional to the amount of ore reduced. This gas is allowed to burn into the air at present at Trollhättan, but in the newer plants arrangements are to be made for using it for calcining purposes. About 550 cubic meters of gas are produced per ton of pig iron, and each cubic meter will develop 2,100 to 2,500 Calories.

When calculating the various charges the quantity of charcoal is kept at 6½ hectoliters and the amounts of ore and limestone are varied to produce the destined grade of iron, a typical charge at the time when the author was present at the furnace, being:

| | | |
|---|---|---|
| Magnetite, 266 kg. | } | 410 kg. |
| Concentrates, 133 kg. | | |
| Mill Cinder, 11 kg. | | |
| Limestone | | 32 kg. |
| Charcoal, 6½ hectoliters or | | 100 kg. |

This is dropped into the furnace at one raising of the bell, and tappings are made every 18 charges or about once every six hours.

TABLE I.

| | Period of Operation | | | | | |
|---|---|---|---|---|---|---|
| | 1910 Nov. 15 * | 1910 Nov. 16 to 1911 Feb. 11 | 1911 Feb. 11 to Feb. 19 | 1911 Feb. 19 to Mar. 19 | 1911 Mar. 19 to Apr. 9 | Total |
| Percent of Iron in Ore | 64.92 | 65.57 | 65.06 | 49.50 | 57.92 | 61.54 |
| Percent of Iron in Charge | 59.80 | 62.10 | 62.56 | 42.42 | 53.06 | 57.00 |
| Slag per ton of Iron (kg.) | 390. | 205. | 224. | 780. | 458. | 327. |
| Material charged per hectolitre of Charcoal (kg.) | ..... | 66.49 | 71.13 | 90.31 | 69.88 | 70.77 |
| Charcoal per ton of Iron (hectolitres) | .... | 24.22 | 22.47 | 26.10 | 26.97 | 24.79 |
| Charcoal Contents: | | | | | | |
| Water (kg.) | ..... | 69.1 | 50.8 | 59.8 | 40.2 | 60.9 |
| Gas " | ..... | 41.7 | 36.9 | 49.3 | 43.1 | 42.9 |
| Ash " | .... | 11.8 | 11.0 | 13.2 | 17.2 | 12.8 |
| Coke " | ..... | 293.1 | 277.6 | 323.4 | 325.7 | 301.4 |
| Total kilogrammes | ..... | 415.7 | 376.3 | 445.7 | 426.2 | 418.0 |
| Electric Power | h. m. | h. m. | h. m. | h. m. | h. m. | h. m. |
| Time consumed working | 7 50 | 2,009.56 | 184.32 | 639.18 | 506.34 | 3,348.10 |
| Time consumed in interruptions | .... | 105.39 | 4.58 | 20.57 | 22.11 | 153.45 |
| Total time | 7.50 | 2,115.35 | 189.30 | 660.15 | 528.45 | 3,501.55 |
| Average load (kw.) | 1,121 | 1,319 | 1,694 | 1,017 | 1,733 | 1,344 |
| Total kw. hours used | 8,780 | 2,651,029 | 312,601 | 650,480 | 877,706 | 4,500,596 |
| Kw. hours per ton of Iron | 3,890 | 2,296 | 2,149 | 2,623 | 2,643 | 2,391 |
| Iron per kw year (tons) | 2.31 | 3.82 | 4.08 | 3.34 | 3.31 | 3.66 |
| Electrode consumption: | | | | | | |
| Gross (kg.) | ..... | 13,012 | 1,578 | 2,281 | 2,474 | 19,345 |
| †Net " | ..... | 6,743 | 763 | 1,121 | 1,285 | 9,912 |
| Per ton of Iron: | | | | | | |
| Gross (kgs) | ..... | 11.24 | 10.84 | 9.19 | 7.45 | 10.28 |
| Net " | ..... | 5.83 | 5.24 | 4.52 | 3.87 | 5.27 |

*Filling up of furnace. †Net = 51.24 percent of gross.

The conditions governing the grade of iron produced are similar to those in the ordinary blast furnace, except that the irregular influence of the blast is absent. The furnace gives the maximum output when making white iron, as the making of grey iron requires a rather higher temperature and consequently a greater power consumption. By increasing the amount of ore in the charge when the furnace is making white iron, a low carbon iron with very little silicon is produced, a typical analysis of which is as follows

| | C. | Si. | Mn. | S. | P. |
|---|---|---|---|---|---|
| Percentages | 2.60 | 0.10 | 0.11 | 0.02 | 0.01 |

This iron naturally is full of holes, but instead of these having colored oxidized surfaces, they are silvery white; the absence of oxygen from the furnace atmosphere accounting for the production of this grade of iron free from oxides.

The tension employed varies greatly. This, broadly speaking, increases with the amount of slag produced and with the wear of the electrodes but decreases as the amount of charcoal in the charge becomes greater. The maximum power allowed is 1,900 kw. and to avoid overheating the electrodes the current must not exceed 17,000 amps., so that the voltage has to be regulated accordingly.

The wearing of the electrodes has given rise to some interesting results. When a new electrode is placed in the furnace, the bottom end projects into the actual charge and is gradually abraided and consumed. Between the stock line and the roof is a space filled with furnace gases which contain about 15 per cent. of $CO_2$, so that the portion of the electrode exposed to this gas is very gradually oxidized. The result of this is shown in Fig. 3, where the half consumed electrode was removed for inspection, the line of the surface of the charge being clearly visible. Fig. 4 shows the stump end of an electrode which had been lowered into the furnace as far as possible and kept there until unfit for further use. It will be seen that two of the four carbons which compose it have been burnt through to the centre. About three weeks is taken to burn through an electrode above the stock line, so that in practice each electrode is lowered once every two weeks in order to ensure regular working without risk of fracture, which would result in a lump of electrode being left in the charge.

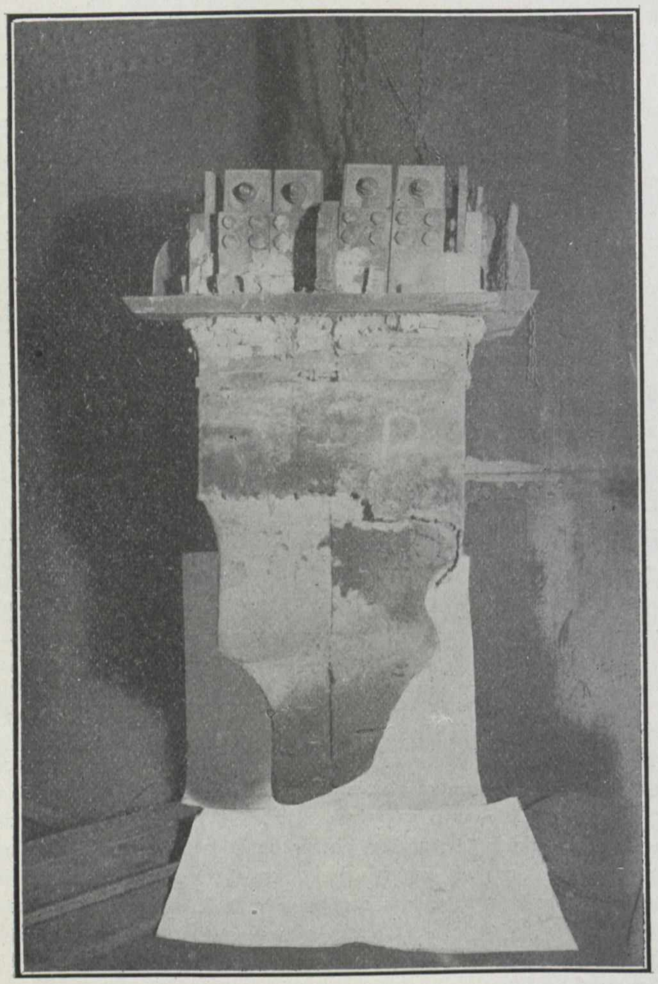


Fig. 3.

A point of interest from a Canadian point of view is the success met with in smelting magnetic concentrates at Trollhättan. The design of shaft in this particular case is not considered suitable for the purpose, being too narrow, but in spite of this, 65 per cent. of finely divided concentrates caused no inconvenience in working. The inventors of the furnace are of the opinion that, with a specially designed shaft, charges of all fine concentrates could be smelted. Canada is rich in deposits of iron sands and lean magnetites, which are easily concentrated, so that where these are within easy reach of water powers, there seems to be a good field open for electric smelting.

In the experiments at Sault Ste. Marie, 1907, no difficulty was experienced in smelting titaniferous ores electrically, and it is interesting that the Swedish experience bears out this point, although no ores were used with more than 0.8 $TiO_2$.

The electric smelting of ores with high sulphur content is another interesting problem. Dr Haanel was successful in producing low sulphur iron from sulphurous ores, but in Sweden there are practically none of these ores mined, so that this point was not confirmed on a large scale at Trollhättan.

The pig iron produced by the furnace was sent to various Swedish iron works for conversion into steel in open-hearth furnaces. The characteristic feature of electric pig iron is its freedom from oxides, and in consequence electric pig of normal silicon content (say 1 per cent. and over) takes a longer time and more ore to convert into steel than ordinary blast furnace grey iron. Low-carbon electric pig iron, however, is found to give surprising results, charges made up of 50 per cent. of this iron and 50 per cent. of scrap producing hot fluid steel with considerable saving in time over ordinary practice. As was to be expected, the open-hearth furnace managers looked somewhat askance at this iron at first, as they knew the disastrous effect of using low-carbon iron full of holes from the blast furnace; however, after giving it a trial the workmen asked for more, as they said that the furnace worked better and more rapidly with the new pig iron.

The quality of the steel produced has been thoroughly tested by making it up into various products and comparing it with steel made from Swedish charcoal blast furnace iron. In no case was the new steel inferior, and from the most recent reports to hand, it was in several cases decidedly superior.

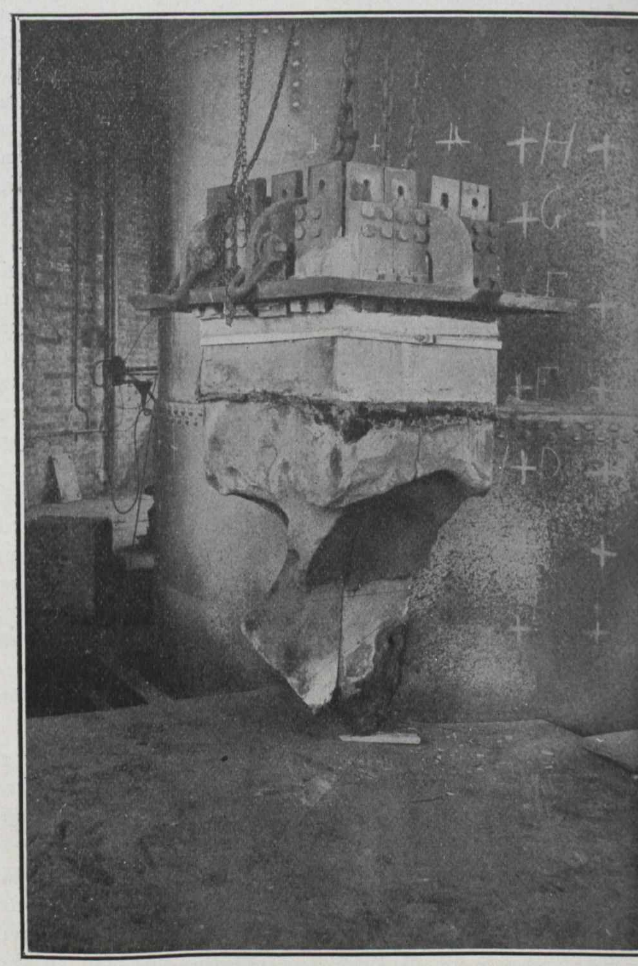


Fig. 4.

The Trollhättan furnace was shut down at the end of May of this year in order to make certain alterations suggested by the results of its six months' campaign. Two of these deserve mention.

1. Since the furnace was designed the manufacture of large carbon electrodes, of high conductivity, has made great progress. It is now possible to obtain cylindrical electrodes of 600 mm. diameter, fitted with screw joints. These have recently been installed at Trollhättan, and result in two considerable improvements, the first one being that the loss due to stump ends is done away with, as when an electrode becomes too short, a new one can be screwed on above it. The second one is that the electrical contact can be made at the point where the electrode enters the roof, in this way saving about 40 kw., which with the old arrangement was lost, due to the resistance of the whole length of the electrode through which the current had to pass. This new arrangement will permit of the furnace taking 3,000 horse-power instead of 2,500 horse-power, the previous capacity.

2. The other important alteration is in the gas circulating arrangement; the old dust-catcher was not very effective as only very fine dust is expelled from the furnace. The result was that the dust collected in the centrifugal fan, and had it not been that this was kept fairly clear by a jet of water, would have choked up the blades in a few hours; as it was, the fan had to be stopped and cleaned once every week. Now a water scrubber takes the place of the dust-catcher, and a fan on the ground floor blows the cleaned gas into the furnace.

At the present time the following "Elektrometall" furnaces are either working or in course of erection:—

| | | Horse-Power |
|---|---|---|
| Sweden— | Trollhättan, one furnace | 3,000 |
| | Domnarfvet, one furnace | 4,000 |
| | Hagfors, two furnaces (3,000 horse-power each) | 6,000 |
| Norway— | Tyssedahl (Hardanger), two furnaces (3,500 horse-power each) | 7,000 |
| | Arendal, two furnaces (2,500 horse-power each) | 5,000 |
| | | 25,000 |

In these newer furnaces, 3-phase current is used, and by means of three single-phase transformers, low tension current is furnished to six carbon electrodes. Owing to the recent improvements in electrode manufacture and furnace design, it is now possible to construct units up to 6,000 horse-power, which it is expected will work for two years without serious repairs to the hearth.

Rather more than three metric tons of pig iron are produced by the electric furnace per electrical horse-power year, using one ton of charcoal for the reduction of the ore.

The furnaces in Norway have a somewhat different form of shaft, as coke is the fuel employed for smelting. The volume of the shaft is smaller, but its diameter is greater than the corresponding shaft of a charcoal furnace. The coke in the charge gives a greater conductivity, so that a lower tension has to be used.

The results obtained from the Trollhättan furnace prove conclusively that electric smelting is now thoroughly established on a commercial scale. The furnace works remarkably smoothly and produces a most excellent product. The comparative costs of electric and blast furnace smelting depend in general on the cost of suitable fuel and electrical energy, as the electric furnace simply substitutes one electrical horse-power year for two metric tons of blast furnace fuel. In Sweden there is no doubt that the electric furnace has come to stay on account of the cheaper production of a better product.

## NEWS ITEMS.

Owing to the fact that the iron ore trade has failed to show improvement that has been hoped for by vessel owners all season, it is expected that navigation will close earlier this fall than for many years.

Conditions are now worse than earlier in the fall, say the managers of independent lines, the only explanation given being that the demand for steel and iron products has fallen behind. Even managers of the fleets carrying ore from their own mines and for their own furnaces have received orders to slow up.

Several independent fleets will be laid up for the winter before the end of November.

## SAFE BEARING LOADS.

A recent official report recommends the following as the safe bearing pressures per square foot on brickwork and concrete:—

| Construction. | Safe Load Per Sq. Ft. |
|---|---|
| Kiln-run bricks laid in lime mortar | 4½ tons |
| Ordinary brick laid in Portland cement mortar | 7½ tons |
| Hard brick laid in lime mortar | 9 tons |
| Hard brick laid in Portland cement and lime mortar | 13½ tons |
| Hard brick laid in Portland cement mortar | 18 tons |
| Pressed brick laid in lime mortar | 12 tons |
| Pressed brick laid in Portland cement mortar | 21 tons |
| Concrete, 1 part cement, 3 parts sand, 6 parts stone | 18 tons |
| Concrete, 1 part cement, 3 parts sand, 5 parts stone | 20 tons |
| Concrete, 1 part cement, 2 parts sand, 4 parts stone | 30 tons |

In case of fine water-washed sand being used exclusively in concrete, the safe loads per square foot shall be 20 per cent. less than those given in the above table. If the concrete contains equal parts of water washed and pit sand, the values given in the table may be used; or, if it is desired to use water-washed sand only, and adhere to the values given in the table, this may be done by substituting a 1:2½:4 mixture for the 1:3:5 mixture, and 1:1½:3 for the 1:2:4 mixture.

## OZONIZED AIR IN LONDON SUBWAYS.

One of the strongest objections made to travelling underground in London is the fact that the air is impure and often stifling. What promises to be a revolution in this particular is a plan which has recently been announced by the authorities of the Central London Railway Company, according to which a system of ventilation will be installed capable of pumping daily 80,000,000 cubic feet of ozonized air into the tube stations and tunnels of that company.

One plant is already in operation and it is hoped that similar ones will soon be completed at every station along the line. It is stated by one of the officials that the plant at each station will pump 400,000 cubic feet of air per hour into the station, or at the rate of 900 cubic feet per person per hour. The ordinary allowance in buildings is about 300 cubic feet of fresh air per person.

The air is drawn from outside through a filter screen, which removes dust and dirt and impure gases. A part of the air is then highly ozonized by being passed over highly electrified plates, the proportion of ozone in the whole being one part in 10,000,000. The air is driven by fans to the level of the bottom of the station, and two-thirds of it is distributed over the platform by ducts, with outlets at a height of 7 feet above the platform. The remainder is driven into the tunnel. The size of the pumping plant is such that it can be installed in a chamber 10 feet by 8 feet by 4 feet, and there are 2 miles of duct work.

# A LARGE CRUDE OIL ENGINE.

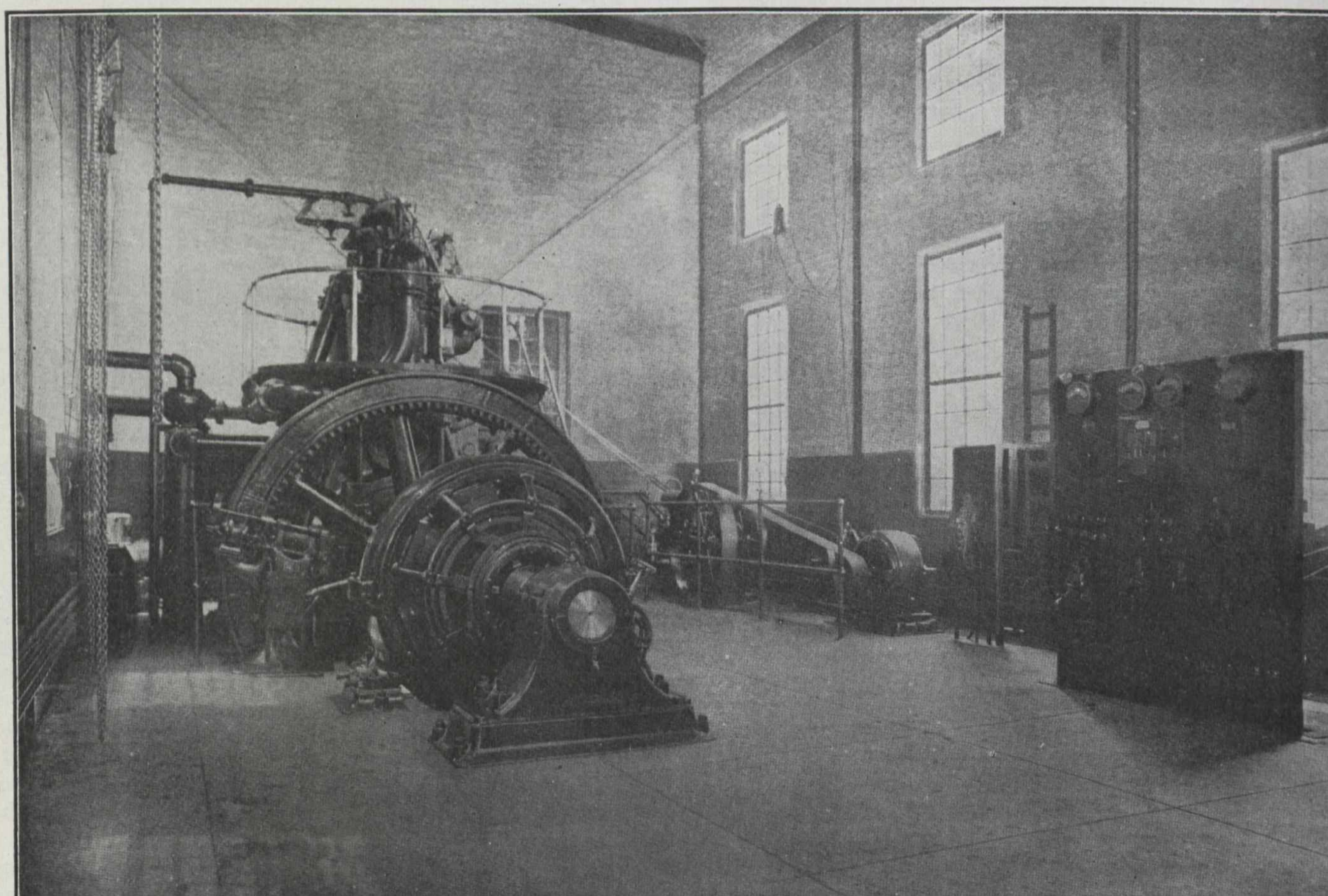
Engineers will be interested in a production of the Atlas Engine Works, Indianapolis, Indiana, U.S.A., viz., a crude oil engine, suitable for power house installation. The engine is of the Diesel type and is designed in such a manner that the hydrocarbon gases are ignited without sudden explosive properties; this is accomplished by first drawing the air into the cylinder, then compressing same by the piston head; the resulting reduction in volume gives a considerable elevation in temperature. When this condition is reached a fine spray of oil is gradually and steadily injected into the cylinder while the compressed air is expanding at constant pressure. Combustion is gradual, no explosion whatever taking place. The pressure and temperature in the cylinder never uses appreciably above that due to the compression of air to about 500 pounds on the first upward stroke. The impulse is taken on and relieved gradually, thus the engine operates without shock.

The oil most commonly used is known as "fuel oil," which is the residue after distillation of the lighter spirits and oil from crude petroleum as obtained from the wells. This oil now costs .02c. per gallon delivered f.o.b. in most United States cities. It averages 7.3 pounds per gallon and each pound represents 19,000 to 19,500 B.T.U. It is not likely that the increasing use of internal combustion engines will materially affect its cost for a long time to come, since the annual production of this grade of oil amounts to more than a billion and a quarter gallons, while approximately only 200 gallons are required for each brake horsepower per 3,000-hour year.

The Atlas Oil Engine works on the four-stroke cycle.

On the first downward stroke of the piston, pure air only (and not an explosive mixture) is drawn into the cylinder.

On the first upward stroke this air is compressed into a small clearance space between the piston and the cylinder



**Installation of 300 B.H.P Atlas Oil Engine Direct Connected to 200 K.W. Electric Generator.**

It is obvious that the energy used to compress each suction charge of pure air to the pressure to which the ignition temperature is normal must be returned to the shaft during the following working stroke, less only the loss due to friction.

Crude petroleum and all its distillates have approximately the same heat value. Whether the oil is light or heavy, high or low priced, it contains practically the same number of heat units per pound. This engine is especially adapted to the use of crude oil and the least expensive products of distillation. It thoroughly consumes the carbon in which the heavier oils are rich, combustion being so thorough as to leave neither sediment, smoke or smell.

head. No combustible mixture exists in the cylinder during this stroke and premature ignition, or back-firing, is impossible.

The compression of the air to 500 lbs. pressure raises its temperature to about 1,000 degrees Fahrenheit, sufficient to ignite the small amount and finely divided spray of oil which thoroughly mixed with a jet of air at about 900 lbs. pressure, is gradually introduced through a small nozzle during about one-tenth of the second downward stroke, at such a rate that the temperature and pressure during the combustion period remain practically constant. Upon entering the hot air in the cylinder this spray of fuel-oil, every globule surrounded by the air which atomizes it, burns steadily as fast as it is injected in o the cylinder. About one-half of a cubic inch of oil (less than a thimbleful) is burned in each 21 in. by 30 in. cylinder during each working stroke, the exact quantity being regulated in proportion to the load by a simple pump, the delivery of which is directly controlled by a powerful and sensitive governor. After the fuel valve closes, the gases work expansively and the terminal pressure is but slightly in excess of that of the atmosphere.

At the end of each working stroke the exhaust valve opens and the products of combustion are expelled on the second upward stroke, thus completing the cycle, which repeats itself in each cylinder during every two revolutions.

The engine stokes itself, the pump delivering exactly the amount of fuel required during each working stroke. It is more independent of attendance than any other prime mover, and automatically adapts itself to all changing conditions.

With each engine, or series of companion engines, are shipped eight heavy steel bottles or storage reservoirs charged with compressed air at about 60 atmospheres or 900 pounds pressure. These air bottles are arranged in two sections, with a cut-off valve for each bottle and another separating each group of four bottles. Explicit directions are provided for their proper location and connection. The manipulation of a starting lever opens a valve which admits sufficient air from one section of the bottles to drive the piston of one cylinder during the first few revolutions, the heat generated by the compression of air in the other cylinder or cylinders

| Date Of Run | 6-21-11 | 6-20-11 | 6-20-11 | 6-19-11 | 6-21-11 | 6-20-11 | 6-21-11 |
|---|---|---|---|---|---|---|---|
| Duration Of Test In Hours | 1 | 1.5 | 3 | 2 | 2.5 | 4 | 1 |
| Load In K.W. Hours By Switch Board Meter | 67 | 85.3 | 132. | 173.5 | 200.4 | 205.75 | 249. |
| K.W. To Compressor By Watt Meter | 24 75 | 22.66 | 23.6 | 25.5 | 29.6 | 29.25 | 31. |
| Transmission Losses To Compressor 23.6% | 5.84 | 5.34 | 5.5 | 6. | 6.98 | 6.91 | 7.31 |
| Net K.W. Used By Compressor | 18.91 | 17.32 | 18.1 | 19.5 | 22.62 | 22.35 | 23.69 |
| B.H.P. Used By Compressor | 25.32 | 23.20 | 24.25 | 26.13 | 30.31 | 29.94 | 31.74 |
| Net K.W. Delivered To Line | 48.09 | 65.98 | 113.9 | 154. | 177.78 | 183.4 | 225.31 |
| Net E.H.P. | 64.44 | 88.41 | 152.62 | 206.36 | 238.22 | 245.75 | 301.91 |
| Generator Eff % Manufacturers Rating. | 87. | 88. | 89. | 90. | 91. | 91.3 | 91. |
| Net B.H.P. | 74. | 100.4 | 171.4 | 229.2 | 261.7 | 269.4 | 331.7 |
| Rev. Of Engine Per Min | 174.7 | 174.1 | 173.13 | 173.1 | 172.8 | 171.9 | 171. |
| Fuel Oil Used Lbs. Per Hr | 50. | 61.3 | 81. | 108. | 120.4 | 128. | 167. |
| Pounds Oil Per K.W. Hour | 1.04 | .93 | .71 | .7 | .68 | .7 | .74 |
| Gal. Oil Per 100 K.W. Hours | 14.22 | 12.73 | 9.73 | 9.6 | 9.27 | 9.55 | 10.15 |
| Pounds Of Oil Per B.H.P. Hour | 67 | 61 | .472 | .47 | 46 | .476 | .503 |
| Gal. Of Oil Per 100 B.H.P. Hours | 9.18 | 8.36 | 6.47 | 6.44 | 6.3 | 6.51 | 6.9 |
| B.T.U. Per B.H.P. Hour | 12829. | 11680. | 9038. | 9000. | 8808. | 9115. | 9632. |
| Thermal Efficiency Of Engine = 2545 / B.T.U. Per B.H.P. | 19.8 | 21 7 | 28.15 | 28.27 | 28.9 | 28. | 26.4 |
| Fuel Cost Of 100 K.W. Hrs In Cts. Oil At 2 Cents Per Gal. | 28.44 | 25.46 | 19 46 | 19.2 | 18.54 | 19.1 | 20.3 |

Summary Of Tests By C.E. Sargent-M.E.
Atlas Oil Engine
300 B.H.P.

meanwhile igniting the oil that has been injected, after which the starting lever is thrown out of commission, closing the air valve, the cams operating the fuel admission valves coming into play simultaneously. The engine is ready for full load in less than a minute after the initia movement of the starting lever.

The air from one section of the bottles is sufficient to start the engine at any time, under any condition, the other section being held in reserve. A three-stage compression pump automatically and continuously charges and recharges the bottles, which in turn supply the jets of air by which fuel oil is regularly injected into the cylinders of the engine.

The governor is driven directly from the main shaft. There are no intermediate gears. The mechanism is not subject to shocks due to the valve gear, as in other oil engines.

The fuel injection pump is of the two-stage type. The first stage is directly controlled by the governor and serves to measure, at the last instant before the beginning of each working stroke, the exact quantity of oil that is to be admitted. This governing stage operates against pressure not in excess of the atmosphere and is sufficiently sensitive in action to perform its important functions with the necessary quickness and accuracy.

The speed can be controlled as closely as any steam engine, and the variation, under constant or changing load conditions, is less than in any other internal combustion or explosion engine. It is guaranteed not to exceed 2% from quarter to full load, or 3% from no load to full load.

During the tests conducted by Mr. Sargent, June 19-21, 1911, the following variations were noted:

10% overload to 90% load, .9 revolution, or .53%
10% overload to 87% load, 1.9 revolution, or 1.11%
10% overload to 76% load, 2.1 revolution, or 1.23%
10% overload to 58% load, 2.13 revolution, or 1.25%
10% overload to 33% load, 3. revolution, or 1.75%
10% overload to 25% load, 3.7 revolution, or 2.11%

With oil at 2c. per gallon, assuming the correctness of the electrical manufacturers' generator efficiency ratings, the cost of fuel for an Atlas Oil Engine in direct connected service will not exceed the following rates:

At full load—

1.4 mills per B.H.P. hour, or 14c. per 100 B.H.P. hours.
2.1 mills per K. W. hour, or 21c. per 100 K. W. hours.

At half load—

1.7 mills per B.H.P. hour, or 17c. per 100 B.H.P. hours.
2.55 mills per K. W. hour, or 25½c. per 100 K. W. hours.

Using the latter and an annual power output equal to one-half of the full rated capacity of the engine as a basis, figuring in the cost of attendance and supplies, allowing 10% for maintenance and depreciation, 6% for interest and 3% for taxes and insurance, the last three items applying against the cost of the electrical equipment and suitable building, as well as the engine and its equipment, the total cost of electric current produced by an Atlas Oil Engine is slightly under one cent per K.W. hour, and the annual saving over the cost of electric power from a central station is not less than as tabulated below:

Conversely, these figures represent the possible gross profit from the sale of current produced by an Atlas Oil Engine.

Based upon annual power output equal to one-half full rated capacity of engine.

| Capacity of plant. | 200 K.W. | 300 K.W. | 400 K.W. |
|---|---|---|---|
| Assumed annual power output, (Kilo-watt hours) | 876,000 | 1,314,000 | 1,752,000 |
| Total cost of current produced at 1c. per K.W.H. | $ 8,760.00 | $13,140.00 | $17,520.00 |
| Annual saving over current at 2c. per K.W.H. | 8,760.00 | 13,140.00 | 17,520.00 |
| Annual saving over current at 2½c. per K.W.H. | 13,140.00 | 19,710.00 | 26,280.00 |
| Annual saving over current at 3c. per K.W.H. | 17,520.00 | 26,280.00 | 35 040.00 |
| Annual saving over current at 3½c. per K.W.H. | 21,900.00 | 32,850.00 | 43,800.00 |
| Annual saving over current at 4c. per K.W.H. | 26,280.00 | 39,420.00 | 52,560.00 |
| Annual saving over current at 4½c. per K.W.H. | 30,660.00 | 45,990.00 | 61,320.00 |
| Annual saving over current at 5c. per K.W.H. | 35,040.00 | 52,560.00 | 70,080.00 |

The cost of fuel oil at 2c. per gallon does not exceed 2.1 mills per K.W.H. at full load. The maximum consumption of oil is positively guaranteed, and if the price were 4c. instead of 2c. per gallon, the cost of producing current would be increased only 1/5 of a cent per K.W.H.

Any increase in the power output of the engine would reduce the cost of current, since the fixed charges would be lower per unit of production. If the engine were run at full load continuously during the whole year, one K.W.H. would cost only 7.4 mills, or, in even figures, ¾ of a cent.

Fig. 1 illustrates a power installation employing this engine, which illustrates the space saving this engine affords.

## THE PILE HAMMER IN CONSTRUCTION.

Of the average contractor it can be said that no one is more ready to adopt labor or time-saving appliances than he. This statement applies quite as much to those engaged in excavating operations as it does to the one who undertakes to erect a modern sky scraper or to build a suspension bridge.

This article, however, has to do entirely with the former, for within the past few years the methods of excavation in important operations have presented conditions hitherto simple of execution. Foundations of greater magnitude than ever before demanded are now being made, requiring means not only to prevent the movement or caving of soil into the excavation, but frequently to support the foundations of buildings below which it is necessary to excavate.

The situation had to be coped with and its solution came with the introduction of steel sheet-piling.

Every innovation brings about the development of other appliances kindred to it, so with steel sheet-piling came the power driven pile hammer.

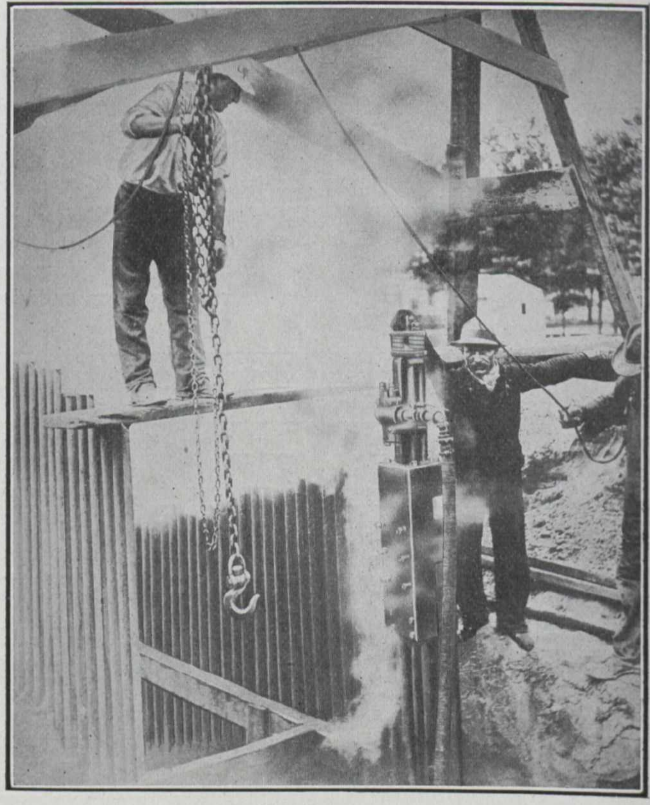
In trench work where pipe was to be laid at some depth below the surface it was the common practice, prior to the introduction of steel sheet-piling, to protect the side walls by planks or wood sheeting driven in place by men with mauls.

Between the old and the new method of trenching no better illustration can be offered to prove the advantage of machine operation than that set forth in the following:

The work was the laying of a terra cotta sewer pipe in the city of Watertown, N.Y. The course of the sewer was in a sandy soil which obtained uniformly throughout its length to a depth of about ten feet, underneath which was a wet sand mixed with gravel. The average depth of the sewer pipe below the surface was 15 feet. The nature of the soil, of course, necessitated the use of sheeting to prevent caving-in of earth and thus permit of a narrow excavation with the minimum of material to be removed. Accordingly, 400 sheets of ⅛-in. corrugated steel sheet-piling in 10-foot lengths were procured, and for driving them a steam driven pile hammer, weighing approximately 650 pounds, was used. The trench was first excavated for its width to a depth of about 5 feet which was left unsheeted. The sheet-piling was then carried by hand and set in position on each side of the trench and driven its entire length before any further excavating was done.

An A-frame built of timber straddled the excavation and from it was suspended a 2-ton triplex differential chain block. It was intended to use the chain block for raising and lowering the pile hammer during the driving and subsequently to withdraw the sheet-piling. Throughout the entire operation the work of placing the sheeting, drying it with the pile hammer, and pulling and resetting, was done by 3 men for each separate operation. As before stated, the sheeting was all handled by manual labor, and it required 1 hour and 30 minutes to set up 32 sheets in position for driving, including the time required to carry these sheets an average distance of about 175 feet. The time required to drive each sheet five feet into the sand was from 33 to 37 seconds; in fact the driving was done so fast that the triplex block could not be worked quickly enough to follow the pile hammer, and so it was steadied by hand, as shown in the accompanying photograph. No difficulty was experienced in doing the work in this way and the chain block was needed only to hoist the hammer from one pile to another. That this method of handling the hammer proved to be a success is, of course, largely due to the fact that it stood only about 4 feet high on top of the sheet-piling. Including the time required for moving both the hammer and A-frame, an average of 7 feet of trench was sheeted on both sides per hour.

Power to operate the pile hammer was supplied by a road-roller. Steam from it was carried through a 1-inch pipe a distance of about 125 ft. The pressure varied from 100 to



125 lbs. The weight of the driving piston in the pile hammer was 70 lbs. and struck 350 blows per minute. The tops of the sheet-piling were protected by means of a special driving hood of soft iron loosely attached to the base of the hammer between its jaws, so that it would not fall off when the hammer was raised. The hammer and driving cap proved entirely satisfactory for, although the thin sheets were used continuously during one entire season, not one piece was damaged seriously and the same sheet-piling is being re-used on another sewer job. The sheet-piling was braced by means of spruce waling pieces, 4 in. by 6 in. by 16 ft. long. The struts were spaced 7 feet apart.

The sheet-piling was all driven ahead of excavation, and as rapidly as the sewer pipe was laid and the trench backfilled, it was pulled, reset and driven, and thus the entire trench excavation was carried to completion.

The contractor for this work was Mr. Wm. J. Semper, of Watertown, N.Y. Wemlinger Type A Sheet-Piling in 10-foot sections was used, and it was driven with a McKiernan-Terry 3¼-in. pile hammer, manufactured and sold by the McKiernan-Terry Drill Co., 115 Broadway, New York.

## TOWN PLANNING.*

**By Mr. Noulan Cauchon, C.E.**

My reason for choosing "Town Planning" as the subject of the paper before you to-night is because of the particular fitness of the engineer for such work and the new field it opens to him.

Town planning we now hear so much about is the revival of an old and long neglected science and art. It was once highly developed and probably reached its finest expression among the Greeks. It should be of great interest and profit to us, a new and growing country, and in particular to Ottawa, where there are such opportunities and where there should be the patriotic ambition to attain the highest artistic expression of our national life.

The men who have been most prominent in this recent revival of civic art have been the architects and landscape artists and to them is due the credit of awakening the public to the hideousness of modern mushroom growth. The sudden increased productiveness given to labor by the last century of inventions has created the abnormal conditions of growth we now strive to cope with. In the nature of things, a city is an exchange, transportation is the flux of exchange.

To bring about ideal existence for those concerned one must necessarily seek first principles. The elemental law governing action in masses as expressed in physics is derived from gravitation and in political economy is formulated, if I may quote Henry George from "the fact that men seek to gratify their desires with the least exertion" which seems but a moral manifestation of gravitation.

Since the time when man was condemned to earn his living by the sweat of his brow his life has been work. His work is the exertion of force against resistance.

So, coming back to our starting point, human activity is fostered and conserved by easing the paths of least resistance for all endeavor, in communication and transportation by finding the minimum rise and fall, by grade reduction in its broadest application mental, moral and physical.

As transportation is, in the exchange of the products of labor, such a large and controlling part of the labor production, it is evident that first consideration must be given to this feature in the planning of cities, the great markets, i.e., exchanges of the world.

Railways deserve the first attention, being the thoroughfares which take care of the greatest tonnage and the largest concentration of people, moving all at the greatest speed and at least cost per person or per ton per mile. By them the cost of gravitation has been weighed and counted. To others it is both less apparent and more costly.

It is the economics of the ordinary street or thoroughfare which have been most neglected, by lack of realizing the scientific means of determining the requirements. A street is acknowledged to have two main functions. First as a channel of communication, surely engineering, and secondly as a frontage for buildings, the architects' opportunity. In the past, responsibility has been shelved mainly by adopting a uniform and fixed standard of width for variable and indetermined conditions, with the result that a development of traffic finds some streets inadequate and widens them at great expense, whilst in others the streets are initially too wide and often lessening in importance, likewise an over capitalization plus its maintenance.

Reforms have tended towards finding the trend of traffic under existing conditions, also the probable future trend of it and adequately laying out continuations of corrected widths. The complimentary result has been to have smaller streets to meet secondary requirements, at lesser capital cost and maintenance, anticipating permanency of requirements. Lowering cost of streets lowers cost of rent, but not the values.

What we want is a definite scientific basis for determining these conditions of traffic beyond doubt and insure permancy to all our work and I think we have this basis in the application of the same laws as apply to grade reductions on a railway and for the same reasons. This would avoid uncertainty, loss, deterioration and conversion of purpose, give better transportation and mean less capitalization of land and improvements, require less houses to the acre to support charges and avoid overcrowding and slums. As a local instance Sandy hill has remained and grown more residential, while the Richmond road is fast becoming commercial.

Artificial conditions which impound the inherent rights of man, life, liberty and the pursuit of happiness, are a costly dam which eventually overflows and often causes a wash-out. Hill tops have never been markets under normal conditions, i.e., security—primitive dwellings sought the hollows, the stream and the lake border for the ease of life, and of work, later on men sought the hills for protection.

During the insecurity of the middle ages castles and dwellings went up hill, but with the advent of security and personal liberty the workers only came down. Under civilization and security, advanced methods and subdivision of labor, man works the rich plains and lives on the hills, relations simple enough in a primitive state but often obscured by the complexity of modern life.

The greatest city planners to whom I find record are Baron Hausmann, who rebuilt Paris, and l'Enfant who planned Washington, both engineers. Sir Christopher Wren, the architect, made a splendid plan for London after the great fire, but, unfortunately, it was not adopted owing to real estate squabbles. These men, in their plans, all recognized transportation as fundamental. The magnificent embankments which embelish the Thames in London are the work of an engineer.

The application of this reasoning to Ottawa calls for determining:—

Economic conditions, industrial, commercial and social.

Zones or areas of adaptation and their development as sub-centres of varied activity.

Transportation, steam and electric, and its expansion.

Art in expressing that which justifies its existence in meeting our wants "with the least exertion" (i.e.:—to find the easiest way of doing things).

For our present analysis let me submit that art is the simple and refined outward expression of inherent truth. Be that truth abstract, organic or inorganic the function of art is to beautify the manifestation of it. There have been glorious manifestations of civic life since the days in ancient Greece when Pericles, the ruler of Athens, who found it of brick, left it of marble.

Let us hope that the like may come to Ottawa. I am inclined to think our hope lies in arousing the whole Dominion to a sense of its responsibilities to Ottawa as its capital and sweeping away the narrow conception of its beautification as being merely a municipal side issue of "parks and playgrounds."

The modern exponents of civic art, from whom we have derived most, are Raymond Unwin, of English garden city fame, and Thos. Mawson, professor of town planning in Liverpool University, who has done so much monumental work, including the beautification of the Peace Palace at The Hague.

Ottawa has had the privilege of personal, critical analysis and enthusiastic appreciation by both. Their advice should not be neglected.

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*Paper before Ottawa Branch Can. Soc. Civil Engineers.

The German school of town planning has mostly turned to the Romantic in Medievalism for its inspiration, a difficult language in which to express or serve modern wants. In France they stick to Hausmann's engineering mentality, where in Paris they are backing it with millions in new undertakings.

At the recent International Town Planning Conference at Philadelphia, many interesting views and their application were discussed. Mr. Adams, town planning expert of the local government board of England, laid stress on the remedy for the ills of the city, being the development of cheap lands outside the city and railway transportation thereto. The relative merits of all kinds of houses were gone into, from the cottage to the skyscraper; from the house with a garden to the house covering a whole lot. The ideal seems to be that which may prove best adapted for each particular purpose, but one must not forget that the standard unit of a community is the family. The man who argued that congestion was not harmful, because he lived healthily in a large, comfortable hotel, was evading the real issue.

The general problem is one of improving, replanning and reconstructing. The opportunity seldom comes to plan and build a new city. The guidance of growth offers neither problem nor interest till development begins to express individuality.

The only organic change in architecture since the groin vaulting of the thirteenth century has been the steel frame and it has not yet found itself in expression so to speak. It is essentially of the lintel, the earliest type of spanning, and as such, I am inclined to argue, should not attempt arch expression. In a being of iron fibre facial lines bespeak activity and strength, likewise the soul or truth of modern life should not masquerade beneath the brow and restful lines of Greek thought, nor the soaring groins of medieval religious enthusiasm.

The business economics of the modern skyscraper are satisfactory, structurally appealing to me as I have read it, "A railway bridge on end with the trains running up and down," the artistic expression of which to date has been a worry to say the least. We should always endeavor expression of structural truth to attain real art.

The field of investigation and the data required are too broad to detail at this meeting. They cover every human activity and function of life. Some instances are:—

Railway stations which are the gates of a city; that they be appropriate and efficient; that they be so arranged that pedestrians may enter and leave with least crossing of the vehicular traffic.

Railways themselves within boundaries.

On surface, level crossings or subways, sidings, smoke and noise.

On viaducts, grade separation, unsightliness, high smoke and greater noise.

In cuts, grade separation but low smoke, less noise (aided by tree screening.)

In tunnels, electrified, giving every advantage with absence of crossings, smoke or noise, (ballast eliminating vibration).

General lines of city traffic converging to greatest convenience, yet if possible by separate routes and at separate intersections for trams, motors, vehicles or pedestrians.

Radical roads, straightness vs. directness, focal points, vistas, broken lines and fronts, the formal vs. the picturesque.

Bridges and their possibilities. A plaza here or a Pont Alexandre III. in Paris, fountains and statues.

Agora, forum, places and squares, sub-centres of: government, civic administration, education, commerce, industry and recreation fostering efficiency, permitting art and architectural scope to express collectively the various activities and functions.

Buildings, their purpose and setting—fitness, accommodation inside and out, be they monumental or the simple home. The stranger within our gates takes his impression of our character as revealed in our buildings.

Water areas and their natural advantages, freedom of access and enjoyment of shores, possibilities of expansion. With us the Ottawa river is fairly secured, but the Rideau awaits action for the prevention of flood, availability as a lake and beautification as a resort.

History and historic associations, buildings, etc., influences, growth, traditions, materials and all that goes to stamp individuality and should be preserved.

The following list may give an idea of some of the data required for thorough investigation:

Contour, survey and plans.

Charts, physical state of site and topography.

Chart of soils and subsoils and their nature.

Charts of climate, rainfall, prevailing winds and details affecting vegetation and animal life.

Plans and information affecting source of water supply and drainage system.

Plans of transportation, steam and electric, etc., main lines of motor, vehicular and other traffic and charts of their densities.

Surveys, plans and charts of all government and municipal areas, details of tenure and ownership.

Charts of industrial, commercial and residential areas shown in different colors. Showing all open spaces, playgrounds and parks and use made of them.

Charts of relative density of population and of relative land values.

Lists and charts of all building materials, showing quantity, accessibility and transportation.

A review of the social and economic condition of the population, of the standard of health and well being, occupation and opportunities for education and culture.

Let us further a campaign of education to get the people of Canada interested and to realize the advantages and enjoyment of things beautiful—a responsibility to their capital.

Let us hope the government will see its way to advance the good work begun by appointing an advisory plan committee as recommended by the Ontario Association of Architects here recently and since endorsed and reiterated by the Royal Institute of Architects in convention in Montreal.

## TRANSMITTING CAPACITIES OF PULLEYS.*

**By Prof. W. M. Sawdon.**

In order to transmit power from one pulley to another there must be a difference in the tensions on the tight and slack sides of the belt. This difference depends upon the nature of the two surfaces, the measure of their friction and the arc of contact. The latter, however, is generally fixed by conditions in the particular installation, such as diameters of pulleys, distance between centers, etc.

The tests were all made with a single-ply oak-tanned leather belt, 5 inches wide by 0.224 inch thick, 1.12 square inches in cross-section and 33 feet long. The pulleys were

*Abstract from paper delivered at the semi-annual meeting of the National Association of Cotton Manufacturers at Manchester, Vt., September 27-30, 1911. The tests were conducted by the author in the laboratories of Sibley College, Cornell University.

all nominally 24 inches in diameter by 8-inch face. A constant belt speed of 2,200 feet per minute or 348 revolutions per minute of the driving pulley was maintained throughout. Observations were made on belt slips for a series of different initial tensions, each covering brake loads from a minimum of 20 pounds to the maximum that the belt would carry or that could be safely put on the driving motor. In each set of tests six different initial belt tensions were used, as follows: 37.5, 75, 112.5, 150, 187.5 and 225 pounds per square inch of cross-section.

The accompanying curves show the results of the tests with reference to relative values of the coefficient of friction and belt slip for all the pulleys tested. These curves were plotted by taking values corresponding to initial belt tensions of 150 and 175.5 pounds per square inch and averaging them. This range of tensions was chosen because it approximates average practice more nearly than does any of the single tensions.

These curves show that for slips of from 1 to 2 per cent. as commonly used in practice, the plain cast-iron pulley has the lowest coefficient of friction and the plain paper pulley the highest. The values of the plain wood pulley lie between these limits. An interesting feature of the curve of the wood pulleys lies in the fact that up to one-half of 1 per cent. slip it follows very closely that of the paper pulleys, after which the slip increases rapidly and at 1 per cent. the coefficient of friction is only approximately a mean between those of the cast-iron and paper pulleys. As the slip further increases, the curve becomes even flatter and beyond 3 per cent. the coefficient of friction is less than that for cast iron. This condition explains in part a commonly accepted objection to the use of wooden pulleys; that is, a decidedly small capacity for carrying an overload.

The introduction of cork inserts into the faces of the pulleys resulted in each case in a general change in the character of their coefficient of friction. The wooden and cast-iron pulleys tested with the cork inserts were the same as used in the plain-pulley tests. The cork area was from 37 to 39 per cent. of the total pulley face and two complete sets

TABLE 1

| No. | Kind of Pulley | Horsepower Capacities per Inch Width of Belt | | | Comparative Transmitting Capacity at 2 per cent. Slip |
|---|---|---|---|---|---|
| | | 1 per cent. Slip | 1½ per cent. Slip | 2 per cent. Slip | |
| 1 | Cast iron | 1.48 | 1.66 | 2.16 | 100.0 |
| 2 | Cast iron with corks projecting 0.04 inch | 2.32 | 2.57 | 2.69 | 124.5 |
| 3 | Cast iron with corks projecting 0.015 inch | 2.50 | 2.72 | 2.89 | 133.8 |
| 4 | Wooden | 2.29 | 2.43 | 2.47 | 114.3 |
| 5 | Wooden with corks projecting 0.075 inch | 2.24 | 2.46 | 2.60 | 120.4 |
| 6 | Wooden with corks projecting 0.03 inch | 2.25 | 2.43 | 2.55 | 118.1 |
| 7 | Paper | 3.56 | 4.77 | 5.46 | 252.8 |
| 8 | Paper with corks projecting 0.0087 inch | 2.85 | 3.26 | 3.57 | 165.3 |
| 9 | Paper with corks projecting (about) 0.015 inch | 3.12 | 4.00 | 4.72 | 218.5 |

TABLE 2

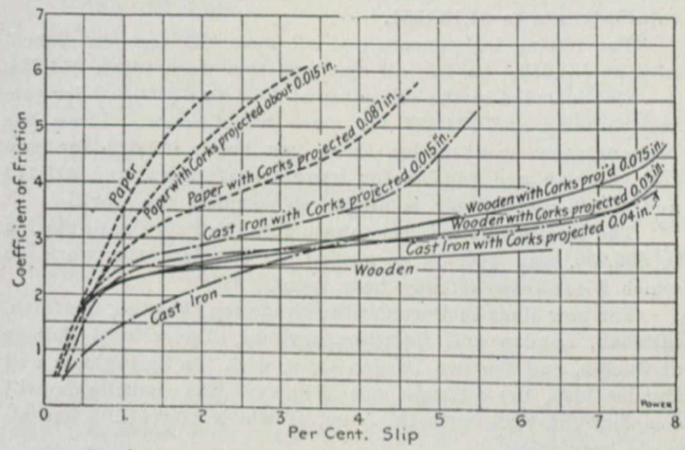
| No. | Kind of Pulley | Horsepower Capacities per Inch Width of Belt | | | Comparative Transmitting Capacity at 2 per cent. Slip |
|---|---|---|---|---|---|
| | | 1 per cent. Slip | 1½ per cent. Slip | 2 per cent. Slip | |
| 1 | Cast iron | 1.72 | 2.03 | 2.33 | 100 |
| 2 | Cast iron with corks projecting 0.04 inch | 2.31 | 2.43 | 2.49 | 107.0 |
| 3 | Cast iron with corks projecting 0.015 inch | 2.41 | 2.52 | 2.61 | 112.1 |
| 4 | Wooden | 2.36 | 2.41 | 2.46 | 105.6 |
| 5 | Wooden with corks projecting 0.075 inch | 2.26 | 2.37 | 2.44 | 104.8 |
| 6 | Wooden with corks projecting 0.03 inch | 2.26 | 2.40 | 2.44 | 104.8 |
| 7 | Paper | 2.78 | 3.08 | 3.20 | 137.5 |
| 8 | Paper with corks projecting 0.087 inch | 2.58 | 2.75 | 2.84 | 122.0 |
| 9 | Paper with corks projecting (about) 0.015 inch | 2.60 | 2.95 | 3.10 | 133.2 |

of tests were made, one for a 1/32-inch projection of the corks and the other for 1/64-inch projection.

In the case of the cast-iron pulleys, each of the cork-insert curves shows a material increase in the values of the coefficient of friction at lower slips and running up to 3 per cent. For the longer corks the values of the coefficient of friction between 1 and 6 per cent. slip are close to those of the plain wood pulleys. Below 1 per cent. slip the wooden pulleys have the higher values. With the shorter corks, considerable advantage is shown over plain cast-iron pulleys as well as plain wooden pulleys up to about 4 per cent. slip, after which the coefficients are but little higher than for the plain cast-iron pulleys. Either of the cork-insert cast-iron pulleys, however, shows a large overload capacity at high slips.

In the wooden pulleys, the cork inserts slightly increase the transmitting capacity for very low slips and up to about one-half of 1 per cent. Between ½ and 1¾ per cent. slip, the plain wooden pulleys have the higher values, while beyond 2½ per cent. the cork inserts again show an advantage.

With the paper pulleys, however, the cork inserts proved detrimental to the transmitting capacity for practically the




**Variation of Coefficient of Friction Work Slip.**

entire range of slip, this being more marked in the longer cork projections.

A simple method of comparison is that afforded by Table 1, which shows the relative transmitting capacity of different pulleys at various practical slips.

These values hold for a belt speed of 2,200 feet per minute and an initial tension of approximately 170 pounds per square inch of belt cross-section. The transmitting capacity of the cast-iron pulley was taken as representing 100 per cent.

While these values represent exactly the power transmitted by the different pulleys in the tests, a comparison on this basis is not fair in that it does not take into consideration the variations in the arc of contact of the belt on the different pulleys, nor the greater stress occasioned in the tight side of the belt by the pulleys carrying the higher loads. One of the observations of the tests was that with increasing loads, the arc of contact on the pulleys also increased. For some pulleys this was more marked than for others. Furthermore, it is an accepted fact that the higher the working stress in the belt, the shorter is its life. A fair comparison then should be based on both these factors remaining constant. This is a difficult comparison to make directly from the tests. It can, however, be made with a large degree of fairness by using one of the formulas commonly used for belt drives. Table 2 was therefore prepared giving relative transmitting capacities of the various pulleys at different slips, when based on constant arcs of contact and constant belt tensions.

These values do not represent actual observations from the tests but were calculated by means of Nagle's formula, using an arc of contact of 180 degrees and a maximum belt tension of 250 pounds per square inch of cross-section and the values of the coefficient of friction from the results of the tests as given in the set of curves.

## COST OF ONTARIO HYDRO-ELECTRIC SYSTEM.

The total estimate of cost of construction of the Ontario Hydro-Electric system, made in 1908, was $4,006,927, according to a statement issued by Hon. Adam Beck, chairman of the commission. Of this $3,515,751 has been spent. Before the line is completed it will cost $405,416 more. The estimate for the right-of-way was $227,375, while the sum expended totalled $456,067, with an additional $40,495 necessary to complete this, which makes the total to complete the right-of-way $496,562.

The amount asked for transmission lines was $1,842,964. The amount already spent is $1,623,172, and to complete their construction a further expenditure of $75,926 will be required. This brings up the total estimate to $1,699,098.

The sum of $1,377,176 was asked for the erection of transfer stations, $1,023,258 has been spent and their completion will involve the further expenditure of $137,099, which brings the total estimate to $1,160,351.

For testing instruments and all tools the cost was scheduled at $31,970. So far, all spent on this work totals $14,954.

Not included in the estimates of 1908 was $106,800 for protective relay and $51,485 for spare transformers. There has been actually spent under these two heads $91,628 for protective relay and $46,336 for spare transformers, and $15,171 and $5,148 respectively is needed to complete the work.

The total estimated cost to complete the Port Credit station is $96,986, and $42,033 is needed to complete the work on which $54,953 has already been spent.

For new lines to Port Credit, Brampton, Weston, Seaforth, Mitchell, London and Hamilton asylums, Agricultural College at Guelph, and the two London lines, with the Springbank and Dundas loop, the estimate was $240,000. The commission will complete the work with this sum, of which $199,477.95 has already been spent.

Step-down equipment for the Watertown and Port Stanley lines will cost $37,914.

Receipts from municipalities to September 30 last totalled $134,422. Estimated receipts to October 1 total $33,807. Payments to the Ontario Power Company for September and October for power and for charges to maintenance and operation will total by the end of this month, $142,991. For September the payment for power to the Ontario Power Company was $74,642. The estimated excess receipts over and above expenditures to October 31 are $25,438.

The estimated expenditures and revenue for the fiscal year of 1911-12, which begins on November 1, are given by Hon. Mr. Beck with the sinking fund out. The total capital cost of the Niagara system to July 31, including all new stations and transmission lines constructed or under construction at that date is $3,921,167.

An income of $473,828 from municipalities based on estimated load of January, 1912, gives a revenue which ends the next fiscal year with a surplus of $828.

This estimated surplus is reached after an allowance of $18,539 has been made for power lost in transmission. The experience of the month of September, however, leaves the commission to believe that such an allowance was unnecessary. In that month, while 11,850 horse-power was purchased from the Ontario Power Company, yet by overlapping it was possible to supply the municipalities with the equivalent of 13,370 horse-power. If this can be continued during the coming year, instead of a loss of $18,000 there should be a profit of about $20,000 to the credit of the municipalities, making the surplus on the year's operations about $40,000.

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The statement of the Nipissing Mines Company shows the operating company, the Nipissing Mining Company, to have had on hand in cash on October 2, $999,894; ore in transit and at smelters, $131,782; ore sacked at mine, ready for shipment, $197,653, or a total of ready assets of $1,329,330. The dividend of 5 per cent. and bonus of 2½ per cent. requires $450,000.

## HUDSON RIVER TUNNELS.*

**By J. Vipond Davies, Chief Engineer Hudson & Manhattan Railroad.**

The Hudson & Manhattan Railroad, which comprises only 19 miles of single track, probably represents some of the most difficult conditions and also the most expensive construction of any similar railroad, and the total cost per mile of road was probably as high, or even higher, than any other rapid transit railroad in existence.

The difficulties in the construction of any such rapid transit railroad as this, practically the whole of which exists below the level of the sea, involved obviously an extremely large cost. But while the total cost of the undertaking is great and involves for the complete railroad and necessary real estate, power stations and equipment, a sum equivalent to approximately two and one-half millions of dollars per mile of railroad, the railroad is peculiar in the concentration of its business, and the short haul over which it operates its traffic permits a low operating cost per passenger to offset the high original capital cost of construction.

The system as a whole, including its connection with the Pennsylvania Railroad, has been in operation only since the first of October of this year. Nevertheless, the growth of traffic month by month for the current year has shown an increase of practically 20 per cent. over the traffic of the same months last year, and as the suburban district of New Jersey develops and the education of the travelling public increases, it appears certain that a growth such as this may reasonably be expected to continue.

### Determining Factors.

The determining factors in arriving at the capacity of a railroad such as this were: (1) The carrying capacity of the train, determined by the dimensions of the cars and the cars per train. Physical conditions of construction at terminals limited the possible train length to approximately 400 ft., suitably divided into eight-car trains The cars are about 50 ft. long by 9 ft. wide. (2) The headway which it would be feasible to obtain with the best possible equipment of brakes on the cars and by a satisfactory signal system, operating an automatic block system equipped with automatic stops, permitted operation of trains on an actual headway of 90 seconds.

### Track Construction.

For the most part the track in these tunnels is designed with ballast foundation, but at certain points, such as on curves and at junctions, the track is on a concrete foundation, but as a general proposition we have found the ballasted track more satisfactory through the ability of the maintenance department to more easily maintain the surface and to renew ties and rails. For the most part the running rail is open hearth steel with carbon between .75 and .90. The steel is entirely satisfactory in these tunnels where the changes in temperature are extremely slight. The principal trouble which has arisen in the maintenance of track is the rapid corrugation of rail at points where power is usually applied or where brakes are applied. In such locations it has been found desirable to renew the rail without any regard whatever to the fact that the wear of the rail may not be sufficient to justify renewal, but the renewal is made solely to obviate the unpleasant "chatter" due to the corrugations in the rail.

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*Abstract of paper read before the American Electric Railway Association, Atlantic City, N.J., Oct. 9-13, 1911.

#### Signal System.

A portion of the system is equipped with a signal system of all-electric design, while the other portion is equipped with the electro-pneumatic system, all being arranged with single overlap and with automatic stops throughout the lines, which are under cover. The well-nigh perfect results obtained from the signal system may be interesting, as from the signal failure reports for the year ending Aug. 31, 1911, the failure of signals was in the ratio of 1 to 1,050,784; automatic stops at the ratio of 1 to 2,793,591.

#### Ventilation.

In the construction of these tunnels, a point which may be of general interest is that of ventilation and temperature in the tunnels. The maintenance of continuity in the single tube system is carried out as far as possible, and only at stations with island platforms or at junctions is there any break in this continuity. The result is that the trains themselves force the column of air through the tunnels to points where exhaust fans are installed, which remove this air column as it is pushed forward to the fans. At the same time at other points intake fans for supplying fresh air from the outside are installed, which force fresh air into the tunnels in the rear of trains to supply the displacement. By actual test and experiment as to the movement of the column of air ahead of trains, it has been found that 60 per cent. of the entire tunnel displacement is pushed forward by the moving trains. I stated just above that fresh air is taken in by intake fans. It will be obvious that in the hot summer months when the external temperature is higher than the temperature in the tunnels forcing air into the tunnels or the changing of the tunnel air with the outside atmosphere would not tend to lower the temperature in the tunnels, but, on the contrary, might tend to increase it. Furthermore, there must of necessity be a large heating effect from the operation of motors, journal bearings and from brakes, as well as the great volume of heat generated by the passengers themselves, and it, therefore, becomes of the utmost necessity to actually lower the temperature in the tunnels.

#### Cooling Effect of Construction.

The construction of the Hudson & Manhattan tunnels, as well as the tunnels of the Pennsylvania Railroad, is for the most part with an exterior metal lining of concrete, but in every case the lining itself is in contact with the moist exterior soil, thereby providing the means of properly absorbing and radiating the heat within the subway into the exterior soil. The effect of this construction has been most satisfactory to the management as well as to the travelling public, with the result that the temperature in the tunnels throughout the year, both winter and summer, does not vary more than 10 degress.

#### Repair Facilities.

In the early operation of the railroad, when only the Hoboken line was completed, and it was desirable to commence operation at once, even with an incomplete railroad, we had no car yard in the open and cars had to be inspected and maintained standing on tracks underground. At a later date, when we were able to extend our lines into New Jersey and get our car shops and yards in operation, it was readily seen how absolutely essential it is in the operation of any such tunnel railroad as this to have the inspection and maintenance of cars executed in the open where there is plenty of natural light. The cheapest thing possible in the maintenance and care of car equipment is daylight, and any underground tunnel must be considered only with proper provision for car-shops and yards in the open daylight.

## RAILROAD AND COMPANY EARNINGS.

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

| | 1910. | 1911. | Increase or decrease. |
|---|---|---|---|
| C. P. R. | $2,302,000 | $2,532,000 | + $230,000 |
| G. T. R. | 963,374 | 1,023,892 | + 60,518 |
| C. N. R. | 403,900 | 459,000 | + 55,100 |
| T. & N. O. | 25,486 | 45,660 | + 20,174 |

The Ontario Power Company of Niagara Falls and the Ontario Transmission Company, Limited, report combined earnings for the nine months ended September 30 last as follows:—

| | |
|---|---|
| Gross earnings | $622,443 |
| Operating expenses | 110,192 |
| Net earnings | $512,251 |
| Other income | 64,756 |
| Total net | $577,007 |
| Interest charges | 504,293 |
| Surplus | $72,714 |

The Ontario Transmission Company, Limited, reports transmission line rental for the nine months ended September 30th of $120,735; interest on bonds, $66,409, so that there was a surplus for the period of $54,325.

## PERSONAL.

The main offices of **A. Eugene Michel** and staff, Advertising Engineers, have been moved into the Park Row Building, 21 Park Row, New York, where larger space has been secured, as necessitated by constantly increasing business. Temporarily the photo retouching and illustrating department will remain in the Hudson Terminal Buildings, but all business will be managed from the new offices.

**A. Leo Miéville, A.M. Can. Soc. C.E.,** has just reached Toronto in order to look after the interests of W. H. Allen, Son & Co., Ltd., Bedford, England, in conjunction with Messrs. Chapman and Walker, of Toronto, Canadian agents of W. H. Allen, Son & Co. Mr. Miéville is no stranger to this country, having been until recently on the staff of the Winnipeg Civic Power Commission.

**Mr. James C. Armstrong,** A.I.E.E., has opened an office in the Traders Bank Building in this city. Mr. Armstrong is a graduate of the University of Michigan, class '99, and since graduating has devoted his time to the acquirement of practical knowledge along special lines. His experience includes the design of some important cement plants, and a first-hand knowledge of naval marine construction and design, both on this continent and in Great Britain; also he has studied and investigated the mechanical equipment of railroad shops and has given special attention to equipment for this class of work of a specific nature. Of recent years he has been on the engineering staff of the Ontario Power Co. and the International Railroad of Buffalo, New York, and in the Porcupine mining district. In his new capacity he will specialize in power plant work, industrial plants, street railways and mine equipment.

## ROCHESTER CONVENTION PROGRAMME BEING PREPARED.

The programme of the eighth annual convention of the American Road Builders' Association, to be held in Rochester, N.Y., Nov. 14 to 17, is now being prepared, and several interesting features have already been arranged.

As has been announced previously the entire four days will be devoted to papers and discussions on the topics of organization, construction and maintenance.

State Engineer and Surveyor John A. Bensel, of New York, will address the convention on the topic, "Highway Administration." His paper will be followed by a discussion on the subject by two state highway commissioners.

Nelson P. Lewis, Chief Engineer of the Board of Estimate and Apportionment of New York City, will present a paper on the topic of the "Adaptability of Roads and Pavements to Local Conditions," and James S. Owen, consulting engineer of Newark, N.J., will have as his topic, "The Maintenance of Roads and Pavements." The topic, "Problems of Construction" will be presented by Maj. W. W. Crosby, of Baltimore, Chief Engineer of the Maryland State Roads Commission. All the formal papers will be followed by discussions.

## COMING MEETINGS.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Tuesday, Nov. 21st, 1911, No. 5 Beaver Hall Square, Montreal. J. E. Ganier, Secretary.

THE SOCIETY OF CHEMICAL INDUSTRY.—Nov. 16th. Meeting of the Canadian Section at the Engineers' Club of Toronto, 96 King Street West, Toronto. Address by chairman, Dr. Anthony McGill, of Ottawa, on "The Standardization of Foods and Drugs.". R. B. Wolsey, Secretary.

THE ENGINEERS' CLUB OF TORONTO.—Nov. 23rd, 96 King Street West, Toronto. Paper by Mr. Joseph B. Tyrell, M.A. "Exploration in the Far North," illustrated with lantern slides. R. B. Wolsey, Secretary.

THE CANAD[illegible] ENGINEERS.—Nov. 30th. Meeting of the Toronto Branch at the Engineers' Club of Toronto, 96 King Street West, Toronto. Paper on "The Niagara River Boulevard." R. B. Wolsey, Secretary.

PROVINCE OF QUEBEC ASSOCIATION OF ARCHITECTS.—Tuesday, Dec. 19th, 1911, No. 5 Beaver Hall Square, Montreal. J. E. Ganier, Secretary.

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

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

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

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

## ENGINEERING SOCIETIES.

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

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

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

MANITOBA BRANCH—
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