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Index to Volume 21

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The Canadian Engineer

An Engineering Weekly.

CHRYSOTILE-ASBESTOS.*

By Fritz Cirkel, M. E.

The asbestos industry of Canada has made phenomenal progress in development and expansion since the winter of 1904-5. This is manifest upon comparing the statistical returns of 1904 with those of 1909. In 1904 the output of asbestos amounted to 35,479 tons, valued at $1,186,795; whereas in 1909 it was 63,349 tons, valued at $2,284,857—an increase in tonnage of 27,870 tons, and in value of $1,098,062. This rapid advance has been primarily due to the discovery of additional deposits, and to the new uses to which asbestos has been applied. As a consequence, new quarries have been opened, new mills established, the annual output largely increased, and the asbestos industry placed on a firmer basis than in any time in its history.

Valuable deposits of asbestos have been discovered in the Townships of Broughton and Thetford, and added to the productive quarries already in existence; while a number of the older quarries—which, some twenty years ago, were worked for "crude"—have been re-opened: and several of these gave such promise of remunerative working, that additional mills have been erected thereon.

Under the term "asbestos" is understood, generally, a group of minerals the fibrous, crystalline structure of which, combined with special qualities and characteristic appearance, entirely differentiates them from any other minerals. Some varieties possess such fine, silky, elastic fibre, that they can be carded, spun, and woven similar to wool, flax, or silk; hence, owing to this property, the mineral has been called a "mineralogical vegetable"; also "a physical paradox."

In mineralogy, three minerals are classified under the term "asbestos"; namely, antophyllite, amphibole, and serpentine. Chemically, the two first-mentioned minerals much resemble each other; being silicates of lime and magnesia, and alumina: compounds of silica with an earthy base, generally represented by the formula $RSiO_3$; while the last—serpentine, is a hydrated silicate of magnesia, represented by the formula $3MgO$, $2SiO_2$, $2H_2O$.

In the case of asbestos, no method has yet been discovered whereby it is possible to forecast the depth of any quarry, and this lack of scientific method is largely due to the fact that the material is one of those minerals which has not been studied profoundly. At the time the report was compiled, the latest news from the asbestos district in the Eastern Townships of the Province of Quebec was that asbestos had been found at a depth of 400 feet, whereas previously the greatest depth of the workings was about 200 feet. The usual practice is to start quarrying on a promising spot, and gradually to widen and deepen the quarry as work progresses. In the majority of cases the claims have nothing more to show than surface outcrops, and only occasionally have pits been opened to depths of 15 feet or 20 feet. The very irregular character of asbestos chutes, both laterally and vertically, does not admit of intelligent exploration by deep shafts; for example, if a shaft is started on what is considered to be an excellent surface, it may be expected that, immediately beneath, a lean chute will be encountered. If by chance it is found that the lean chute extends vertically for some distance the conclusion to be drawn is not favorable, whereas it is possible that had the shaft been sunk, say, 25 feet away the results might have been entirely satisfactory. Twelve years ago a certain shaft was carried down to a depth of 137 feet, but the ground penetrated did not pay to work, and it was concluded that the property was of little value. The error of this conclusion has been demonstrated by the excellent deposits since exposed throughout the underground workings at that very part—indeed, the portion of the property originally condemned has proved to be by far the richest asbestos ground yet discovered in the district. From actual operations it has been ascertained that asbestos occurs irregularly as "vein" or "slip" fibre in pay chutes in the serpentine, the high grade material alternating with the lean; that the quality found at 200 feet is the same or nearly the same as that found on the surface; and that exploration work by shafts, unless large drifts are run therewith, is entirely misleading.

The study of geological conditions has fairly well established the fact that the serpentine of the Eastern Townships—the mother-rock of chrysotile-asbestos—is a Secondary rock, and that it is the alteration product of olivine (dunite), a rock-mineral of igneous origin. It can be shown conclusively that in nearly all cases the olivine rock was changed gradually into serpentine, or a hydrous silicate of magnesia, and that subsequently, through the action of certain agencies, fissures were formed and filled with an asbestos-bearing solution, which gave rise to the ultimate crystallization of the fibre. To what depth these rock masses have been affected by all the changes, in order to produce what is known as asbestos rock, must remain a matter of surmise; but the author ventures the opinion that the workable asbestos deposits extend to a considerable depth, probably to several thousand feet.

Quarrying of Asbestos.

The work of extracting the asbestos from the rock in which it occurs, and converting it into a saleable article, can be placed under the following heads:—

(1) The quarrying proper, that is, the blasting, separating the dead from the useful material, hoisting the same from the pits, and transporting it to the cobbing sheds or mills.

(2) The cobbing or dressing of the better qualities, that is, the separation of the fibre by hand from the adhering rock particles; together with the mechanical treatment, in mills, of all rock or fine material containing fibre; grading of products; and subsequent transportation of product over railways, and by shipping to the markets of the world.

It is important that all the different stages through which asbestos has to pass until it is a finished product, be treated separately; since these involve the entire expenditure from the winning of the crude material in the rock, up to final delivery to the consumer. The success of a quarry depends to a very large extent upon not only the peculiar

*Abstracted from report of Department of Mines.

qualities of the mineral, and the mode of its occurrence—which differs so widely from those of any other known mineral—but also upon careful, economic, and intelligent direction of the various operations enumerated.

The first operation in opening a quarry is, the removal of the soil which covers most of the asbestos-bearing areas, which varies in thickness from a few feet up to 25 feet. In Black Lake, the crest and slope of the large serpentine ridge is for the greater part covered with a thin layer of humus, thus rendering prospecting work comparatively easy; the lower ground of this locality, however—the area between Black Lake and Thetford—is covered to considerable depth with soil, while at Thetford, the thickness of the overlying soil is, in some places, 15 to 20 feet. The removal of this soil for open quarry work is performed only in the summer time; the winter, on account of frost and snow, being too severe for this class of work.

The soil is generally cleared off with pick and shovel, and loaded into large dumping cars on trucks which are laid for this special purpose close to the work, and shifted when required.

followed in late years. The principal advantage of the system employed in these mines lies in the fact that, generally, a number of different zones—both lean and asbestos-bearing—are thus laid open, hence the work, also the supply of the ore, can be regulated to better advantage according to requirements.

As a general rule, in all the larger pits the rock is taken down in a series of benches, stopes, and terraces, which vary in dimensions according to the size of each pit. A good illustration of systematic progress in quarry work is the long pit of the King quarry of the "Amalgamated Asbestos Corporation," at Thetford. This pit has a length of 1,350 feet, and an approximate average width of 350 feet. The height of the benches and stopes varies from 5 to 30 and 40 feet in the deepest part; while the length of the terraces varies between 50 and 250 feet.

The great bulk of the dynamite used in the asbestos quarries contains 40 per cent. of nitroglycerine; the cartridges being, as a rule, 8" long, by 1¼" diameter, and are packed in boxes of 50 pounds, containing from 85 to 95 cartridges. The price is from 14 to 15 cents per pound.

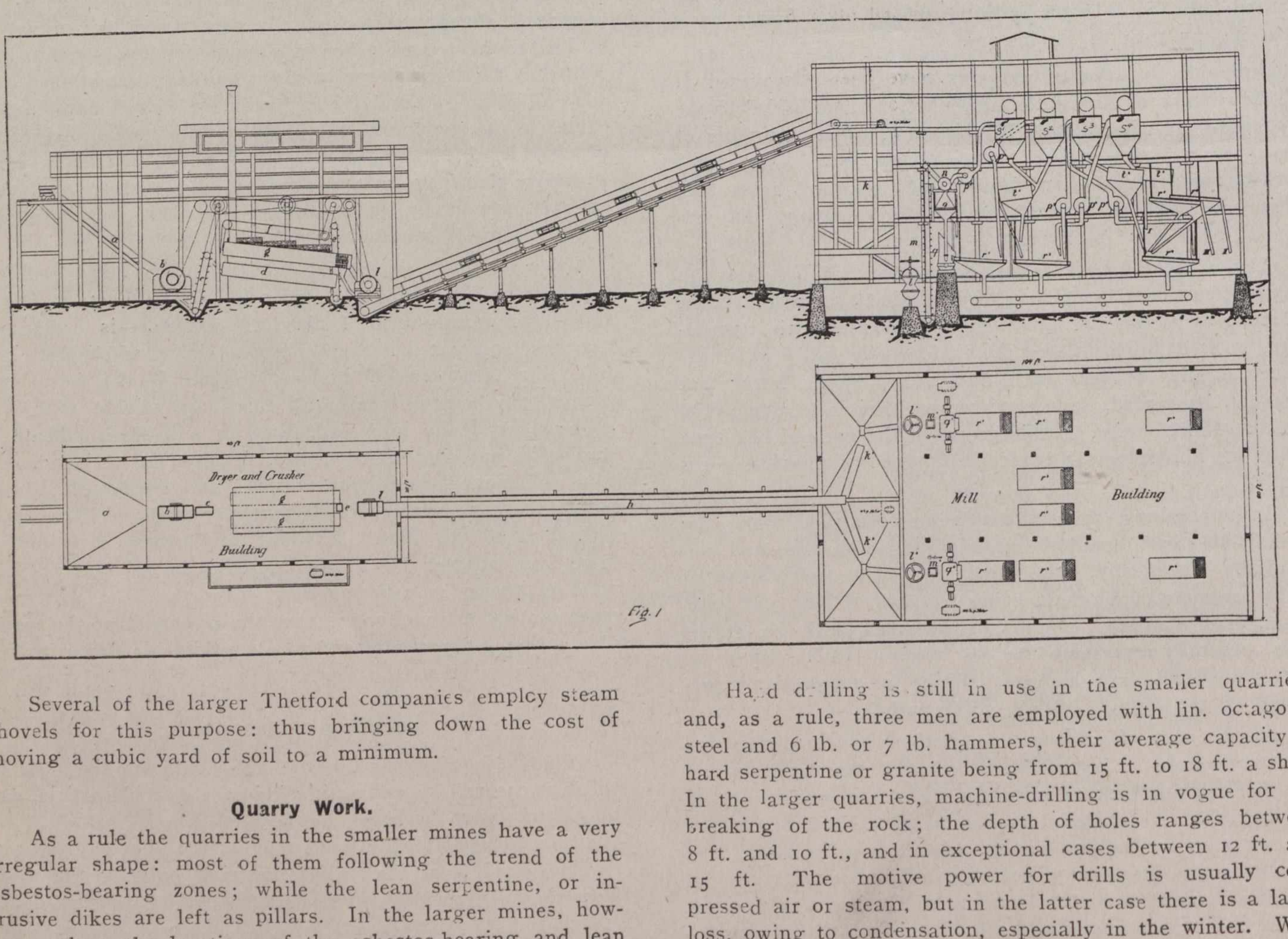


Fig. 1

Several of the larger Thetford companies employ steam shovels for this purpose: thus bringing down the cost of moving a cubic yard of soil to a minimum.

Quarry Work.

As a rule the quarries in the smaller mines have a very irregular shape: most of them following the trend of the asbestos-bearing zones; while the lean serpentine, or intrusive dikes are left as pillars. In the larger mines, however, where the locations of the asbestos-bearing and lean rock, and the location and extent of intrusive dikes have for years been more fully studied, the quarries have, generally, a more regular outline: as at the King, and Bell pits, Thetford; also at the large quarry in Danville.

At these quarries, no discrimination has been made between dikes, lean or rich portions of the serpentine; no pillars of any rock have been left, for the reason that these would only prevent mining with advantage towards depth. The shape of the quarries is rectangular: and while the outlines of the walls are not strictly in conformity with that shape, nevertheless the execution and the progress of the work in the pits indicates that a definite system has been

Hand drilling is still in use in the smaller quarries; and, as a rule, three men are employed with lin. octagonal steel and 6 lb. or 7 lb. hammers, their average capacity in hard serpentine or granite being from 15 ft. to 18 ft. a shift. In the larger quarries, machine-drilling is in vogue for the breaking of the rock; the depth of holes ranges between 8 ft. and 10 ft., and in exceptional cases between 12 ft. and 15 ft. The motive power for drills is usually compressed air or steam, but in the latter case there is a large loss, owing to condensation, especially in the winter. With compressed air the loss in transmission is small, and the amount of drilling done is comparatively high. With steam drills the operating results are from 40 ft. to 45 ft. per shift of ten hours, while the cost per foot, including power, labor, and explosives, but not wear and tear or interest, is from 15 to 18 cents. Lately electric percussion drills have been adopted, but while their use has several advantages over those driven by steam or compressed air, many improvements will have to be made on the present design before they will become general. In most cases the power is conveyed from the electric motor to the drill by a flexible shaft. Compression springs are placed in the rear of the carriage; the drill carriage is released when the springs have been compressed to a certain pressure, and the drill is thrown forward by the force of the expanding springs; springs in front of the carriage serve to force the drill back after the blow has been struck, and there is the usual shifting arrangement by which rotation is effected.

All hoists are of the double-cylinder type, with reversible friction drums. The latest type of cableway hoist has friction drums mounted on one axle, with brakes worked by hand lever and link motion. This hoist is known as the special cable-way engine, and is everywhere replacing the engines with separate drums. As a rule, the distance over which the rock has to be transported in this manner does not exceed 400 ft., while the depth does not exceed 185 ft. With a 40-h.p. hoist 240 to 300 tons can be raised in a ten-hour shift. In order to provide a steady supply of ore one company treating about 300 tons of asbestos rock in the mill, and raising for this purpose an average of 500 tons, has employed eight cable derricks. The dumping cars are hauled by manual labor and by power; in the large quarries ten and 12 ton locomotives are employed, and in some cases they cover from 50 to 60 miles a day.

The Dressing of Asbestos for the Market.

Under the term dressing is generally understood the process by which the miner converts his mineral into a saleable article, or by which he extracts a marketable product from it. This process in the case of asbestos is divided into, (1) hand dressing; and (2) mechanical dressing.

As already mentioned above, the separation of the useful from the useless material is made in the pits after blasting: the larger pieces of rock being broken up, and the fibre gathered into boxes and sent to the dressing sheds; while the so-called fines and stones containing small fibre are sent to the mill for mechanical treatment.

In some of the larger quarries the process of hand-cobbing—as a result of many years' experience—is worked out to great perfection. The following is a description of the hand-cobbing process pursued for over fifteen years in one of the principal quarries.

There are two cobbing-sheds at this mine: one in which men only, and another in which girls only, are employed. The men's cobbing-shed receives all rock containing the longer fibre. Small one-hand sledge hammers weighing from six to seven pounds are used in breaking up the rock, the longer fibre being screened by a sieve with 3-16" holes, and sent to the girls' cobbing-shed; while the screenings, and the rock containing small fibre, are delivered to the mill.

In the girls' finishing-shed—which receives besides the products of the men's cobbing-shed also the loose pieces of fibre from the pits—the girls are seated at long tables, having underneath a series of compartments for the reception of the Nos. I. and II. fibre. The hammers used in breaking up the rock and freeing the fibre from the same, weigh from 3 to 4½ pounds, and the steel plates upon which this work is done are 10" to 12" square, and ¾" thick.

In order to get rid of all adhering rock particles, the No. I. fibre is cleaned by a sieve with 9-16" holes, and the No. II. fibre by a sieve with ⅜" holes. All refuse from the cobbing table and screenings is sent to the mill for mechanical treatment. The crude fibre ready for the market is put up in bags holding 100 pounds.

It is not claimed that the process outlined above effects a complete separation of the fibre from the rock, for the crude still contains some 5 or even 10 per cent. of rock; but it is the outcome of some fifteen years' experience, and has given better results as to extraction and cost than any other known method.

Most of the companies working on ground containing a limited quantity of crude, do very little hand-cobbing, and extract only No. I., the balance being subjected to mechanical treatment, which accomplishes the extraction of the fibre, with a saving of time and labor.

Although the mechanical methods applied in asbestos separation is practically the same in every mill, no two mills are built alike. The serpentine in the different localities varies in hardness and toughness; one quarry extracts Nos. I. and II. grade by hand; another only No. I. grade: while others have abolished hand cobbing entirely, and send the whole output of the quarry through the mill. In some mills two qualities are produced; in others four or sometimes five. These factors combined with other minor considerations, dictate to a certain extent the course of treatment which has to be followed, and the kind of apparatus to be employed.

In order to illustrate the working of the serpentine method generally adopted, a description of a typical mill is given, which, by reason of its simple construction, will, it is hoped, facilitate the study of the principles involved.

A plan showing the arrangement of this mill is given in Fig. 1; No. I. and No. II. crude are hand-cobbed, and the balance of the asbestos material is sent to the mill for treatment. The serpentine used is massive, and of the usual hardness as found in the Black Lake and Thetford districts. Two qualities are made in the mill with an additional grade out of the tailings of the shaking screens.

First Part of Separation.

All the asbestos rock and fines produced at the mines are dumped into an ore bin (a), then crushed in a jaw breaker (b) raised by means of bucket elevator (c) to a chute which empties into rotary dryer (d). A bucket elevator (e) raises the material to a belt conveyer (f), transporting it back to the other side of the dryer and delivering it to the second dryer (g). The end of the latter is perforated, and effects a division of the rock into "medium" and "rough." The rough is again crushed in a second jaw breaker, while the "medium" or undersize falls directly upon the belt conveyer (h), which also takes up all the crushed material from the breaker. The belt conveyer then delivers all the crushed material to two ore bins (k^1) and (k^2), which discharge through an automatic feeder to the Butterworth and Low crusher (1). A bucket conveyer (m) discharges the rock into a fiberizer (n), and after thorough diminution the material falls on a screen (o), where a fan (p^1) takes up all the liberated fibre and deposits the same into collector (s^1). The residue from screen (o) is delivered to cyclones (q); the discharge of the latter is thrown on screens (r^1); here two separations of sand and fibre are effected, the fibre being taken up by fan (p^2) and deposited into collector (s^2), the sand disappearing under the screens into a hopper, which empties on the sand conveyer (u).

Second Part of Separation.

All fibre extracted from the rock is now placed in collectors (s^1) and (s^2). From here, it passes through a grading screen (t^1), having arms within, moving in opposite directions. In this screen two grades are made: long fibre thrown on screen (r^2), and short fibre (or undersize) thrown on screen (r^3). These screens effect a partial separation of the sand from the fibre; the former falling on the sand conveyer (u) and the latter being sucked up and placed into collectors (s^3) and (s^4). From collector (s^3) the fibre is again screened in revolving screen (t^2), the oversize constituting now fibre No. I., and the undersize being again treat-

[2] The Engineering and Mining Journal, 1909, page 1238.

ed on an oscillating screen (r^4) in order to get rid of the sand. Whatever fibre remains on this screen is taken up by fan (p^5) and is deposited in collector (s^3).

The No. II. fibre which is in collector (s^4) goes through the same process of clearing as the No. I. fibre, described above, and the final results are a Nos. II. and III. grade, in addition to the No. I grade referred to.

Theoretically, the principles introduced would allow a perfect separation of all the asbestos from the rock, and of the different grades; but practically this is very difficult to accomplish, and is rarely attained.

In the extraction of pieces of steel and iron from the ore, powerful magnets are employed. An effective design for this purpose is in use in some of the Montana mines[1], and its adoption in the asbestos mills of Quebec will not meet with any difficulty. The magnet can either be placed over the conveyer belt, or over the shaking screens. The metal to be removed consists of pieces of steel, bolts, track spikes, and castings from the machine drills; in fact any iron that may get into the ore on its way from the stope to the mill.

Fiberized Asbestos Ready for Market.

Uses of Asbestos.

The steam packing appears to be the first application of asbestos to engineering, and the various forms of this manufacture now available are very numerous. About 30,000 tons of asbestos paper are used yearly for the protection of buildings from fire, and it is estimated that the adoption of the material by the various municipal authorities in the United States alone would result in the sale of at least 100,000 tons. After the joists of a modern residence are put in place asbestos plaster may be employed for the ceilings, in conjunction with either wood or metal lathing, and, used in this manner, it is said to offer a positive barrier to the fire passing from one floor to another.

An interesting process is that used in connection with the protection of metal for light buildings. The material is composed of a core of annealed sheet steel which is immersed at a very high temperature in a bath of cement compound, the heat having the effect of opening the grain of the metal and allowing the compound to enter. The sheet is passed through a pair of hot rolls, and pure asbestos felt is applied to both sides under pressure. The resulting material, it is said, will resist fire, water, gas, and sulphur fumes for an indefinite period, and it possesses the strength, rigidity, and lightness of sheet iron, combined with the portability of the most effective ready-made roofing material.

In the future one of the largest uses for asbestos fibre generally will probably be in the manufacture of roofing slates. Hundreds of millions of these have already been made, while the demand for the fibre in this connection in increasing daily, and now amounts to about 10,000 tons yearly. Tests have shown than after three months the material becomes impervious, indestructible, and as hard as iron. The non-conducting qualities of heat should render them advantageous for both hot and cold climates. A factory for the employment of this process has been equipped at Lachine, Quebec.

A new material, of German origin, for the manufacture of tiles for floors is now being made in the United States, and is prepared in the form of cement with short fibre asbestos. It is claimed to be impermeable to water, to possess the elasticity of wood, and to be as hard as cement, while it is more durable than asphalt, and is a non-conductor of sound. Asbestos paint has been made for many years, but recently it has assumed considerable importance. It is suitable for rough wood-work—rafters, beams, warehouses, etc.—and numerous experiments have proved that it possesses remarkable fire-resisting qualities.

Asbestos "wood" and boards are employed to a large extent for protection against fire, and when these products are saturated with asphalt compounds they are usually for electric cut-outs and switchboards. A comparatively new application of asbestos is an agglutinated mixture which is moulded into all shapes required by the electrical industry. It possesses the qualities of incombustibility, non-conductivity, and non-absorption of moisture, and is being used in connection with electric lighting and the heating of buildings, and on tramway cars. A method of insulating metallic surfaces for electrical purposes consists of applying a paste in which asbestos is a constituent.

Other applications of asbestos are connected with the manufacture of socks, gloves, "leather," and mechanical brakes. The leather is made by dividing asbestos into very fine fibres, coating them with a solution of rubber, and evaporating the solvent. Long asbestos fibre interwoven with wire is used for brake linings for automobiles and other vehicles.

CONCRETE MIXERS AS QUARRYING MACHINES.

If we consider a concrete mixer as practically a quarrying machine turning out stone ready for instant laying in the walls of a building, it is rather a striking result of this kind of quarrying that a half-yard mixer should be able to turn out in eighteen days all of the concrete required for a building 76 ft. wide, 400 ft long, and four storeys high. This, however, is the high efficiency story of a Ransome concrete mixer which was used to prepare the material for building a new public bath house lately erected by the city of New York at Coney Island. All of this material was handled by a single half-yard Ransome mixer, electrically-driven, and equipped with a fixed charging hopper filled from a 20 cu. ft. Ransome hoist bucket operated by a hoisting engine. Several times during the construction of this building the contractor got from his one Ransome mixer as high as 65 batches per hour. The average output during the whole construction period for this mixer has been about 50 batches, or 25 cu. yds. per hour.

SEWAGE PURIFICATION IN CITY OF PHILADELPHIA, U. S. A.

As part of the work treating the sewage of the City of Philadelphia a disposal plant is now being constructed in the north-western part of the city, and in close proximity to the intake of the Torresdale filter plant on the Delaware River, where approximately 240,000,000 gallons of water are filtered daily. There is a tidal range in the Delaware River at this point of about five feet, which is sufficient to carry the sewage, after it has emptied from the creek into the river, up-stream as far as the intake of the filter plant. It is, therefore, important that the sewage which enters the Delaware River from the creek should be treated.

A force main causes the sewage to enter two sedimentation tanks; these tanks are of the Imhoff type; they are also designated as Emscher tanks, because they originated in the Emscher district of south-western Germany. These names are used somewhat indiscriminately, but refer to the same type of tank. At the Pennypack Creek sewage disposal works each Emscher tank will be 30 feet inside diameter and 32½ feet deep from the outlet weir to the lowest point of the sludge chamber and will project about 12 feet above the ground. The earth embankments will be carried to the top of the tanks and planted with trees and shrubs, so that the works will not be visible from State Road.

From the Emscher tanks the sewage passes to a dosing or equalizing tank, and thence to the percolating filters or bacteria beds. The media in the beds will be six feet deep and be composed of hard stone from 1 inch to 3 inches in size. The effluent of these filters will be settled in a shallow basin, where provision is made for disinfection with calcium hypocholorite either at the inlet end or as the effluent finally passes into the creek.

A pipe extends eastward from the Emscher tanks to a sludge bed composed of sand underdrained with tile, so that every opportunity will be given for the moisture to drain from the sludge. Two methods of construction are to be used for separating the flowing sewage from the sludge chamber. The former being radial and vertical flow type; in this case the force main sewage enters by a weir at the top, flows out and under a circular baffle, then rises and passes over the circumferential weir. The solids settle down into the lower or sludge chamber, where, after digestion, the sludge is removed by the hydro-static head in the tank through a pipe to the sludge bed.

The experiments made at the Spring Garden testing station showed that judicious baffling added very largely to the efficiency of sedimentation. In this case the roof of the sludge chamber is of galvanized iron, forming a series of concentric ridges and valleys; the sewage enters the basin at the centre and is compelled to flow up and down by means of the four concentric baffles so placed that the velocity of the sewage as it rises is much less than when it descends. In the valleys of the roof are openings through which the settled solids fall into the sludge chamber; the tanks are so designed that the bubbles of gas rising from the sludge are deflected toward the ventilators and prevented from passing through the fresh sewage in the settling chambers.

In the experimental tank operated at the testing station it was found that the sludge which collected in the lower part of the tank was thoroughly digested, and when withdrawn was inodorous and unobjectionable; best results were obtained by drawing it off in small quantities from the bottom of the tank at least once a week, so that only the oldest and most thoroughly digested sludge was removed. The withdrawal of sludge produces additional agitation in the sludge chamber and thereby causes fresh masses of sludge to be subjected to bacterial action.

The sludge withdrawn from this experimental tank contained on an average 82 per cent. moisture, but it is believed that from the Emscher tanks sludge will be obtained containing as low as 75 per cent. moisture. The importance of obtaining sludge low in moisture will be evident when it is considered that from the same amount of dry solids sludge 90 per cent. moisture is twice the bulk of that containing 80 per cent. moisture, and sludge 95 per cent. moisture occupies four times the volume of sludge 80 per cent. moisture.

The sludge withdrawn from an Emscher tank contains a large quantity of methane, which, when relieved from the hydrostatic pressure in the tank, expands, lightening the mass, allowing it to dry much more rapidly than ordinary sedimentation sludge. It may conveniently be removed from a sludge bed in from five to six days and possesses a tarry odor. When this odor was first observed, it was thought to be due to the fact that some of the sewage at the testing station had come from a gas works, but from reports from the Emscher district, where tanks of this kind are in use, it appears that this tarry odor is peculiar to digested sludge drawn from such tanks.

ALLOYS FOR AERONAUTICAL PURPOSES.

Activity in aviation has stimulated experiments aimed at producing lighter and stronger alloys, the chief work during the past year being presented in the annual report of Arthur D. Little, Inc., of Boston, as official chemists to the American Brass Founders' Association. The report says:—

The great commercial importance of alloys for aeronautical purposes combining low specific weight with high strength has brought many experimentors into the field. One of the alloys produced is called Electron, its main ingredient being the light metal magnesium, to which are added zinc, copper and aluminum in varying quantities. This alloy is claimed to be of fine grain and homogeneous, of low specific gravity, and possessing considerable strength. One of the Zeppelin air ships whose mechanical parts were made of this metal is stated to weigh 3½ or 4 pounds less than were it constructed of the materials previously used.

Another metal for aeroplanes patented in England has the following composition:—

Aluminum	70 to 90%.
Magnesium	5 to 18%.
Cadmium	2 to 12%.

Another aluminum alloy made in Germany for aeronautical purposes is called "Duralumin." It is officially claimed to have a strength of 85,000 pounds to the square inch, and to be very resistant to sea water. It is stated that this material is to be used in some of the Zeppelin air ships and also by the English Admiralty.

NEW PUBLICATION.

"The Pulsometer" is the title of an attractive hand book recently issued by the Pulsometer Steam Pump Company, of 17 Battery Place, New York City. The book is fully illustrated with numerous recent photographs showing the Pulsometer employed for different kinds of work. It explains fully the operation and construction of the Pulsometer, and the chapter on steam economy shows that inasmuch as the Pulsometer is really a condensing engine, it uses less steam per gallon of water lifted than the ordinary reciprocating pump. Different paragraphs are given explaining the special adaptability of the Pulsometer for a variety of uses, and the tables on pipe sizes, loss of head due to friction in pipes and other data on the flow and pumping of water should interest all engineers. Copies of this book may be had by writing to the above company.

CHARACTERISTICS OF WOOD STAVE PIPE—SOME EXAMPLES OF ITS USE AND COST FOR WATER SUPPLY.*

There are two distinct forms of wood stave pipe in common use. One is termed "continuous" and the other "machine made." Both are built of the same character of wood, and the staves are of equal thickness for like pressures. Those built into "continuous" pipe are made of uniform thickness throughout their lengths, with a bead on one longitudinal edge and with a saw kerf at each transverse edge into which a metal plate is inserted to make a water tight joint. The bead on the longitudinal edge serves to make a water tight joint by being squeezed into the face of its neighboring stave when the iron bands surrounding the pipe are cinched up. The staves are made in unequal lengths to enable joints to be broken in constructing the pipe. The staves are held together by round iron or steel bands of such diameters and spacing as will retain the pressures required, each end of the bands passing through a malleable iron shoe and having a thread to which a nut is fitted. Thus the staves can be brought together so close that no leakage can occur unless it oozes through the grain of the wood.

This form of wood pipe is built in the trench, and from 16 ins. to any diameter required, but is more commonly used for pipes over 24 ins. in diameter. It has one special feature well worth noting, if the pipe leaks at any point in the longitudinal joints, these leaks can be easily stopped by cinching up the bands near the leaks or if some defect shows up in the pipe line a few years after building, sections can be easily removed and replaced, by substituting new staves, or new bands.

The staves built into "machine made" wood pipe have two beads upon one longitudinal edge and two corresponding grooves in the other longitudinal edge. The beads are a little larger than the grooves, thus insuring their being totally filled and made water tight. At one end there is a tenon, cut 4 ins. long, where the staves are one-half the thickness of the balance of the walls of the pipe. On the other end there is a chamber cut 4 ins. deep. The tenon is smaller in diameter at the end than at the shoulder, and when driven into the chamber makes a water tight joint even though the two shoulders are not in perfect contact.

The staves are cut radially to correspond with the diameter of the pipe, and are held together by a steel band, steel wire or copper clad wire. This band or wire is wound spirally upon the pipe by a machine. The high tension produced by the machine squeezes the beads into the grooves making a longitudinal joint that cannot leak so long as the elastic limit of the band is not overcome.

Where steel is used for banding the pipe it is run through a bath of warm asphalt, which adheres to its surface, thus protecting it from any water which might ooze through the grains of the wood. After the pipe is wound, and the tenon and chamber cut, it is rolled in a bath of hot asphalt which adheres to the outside of the steel and wood protecting them from outside oxidizing agents. It is then rolled in a bed of sawdust. This sawdust enters into asphalt and forms a protection for it in shipment and handling.

"Machine made" wood pipe are made in lengths from 5 to 12 ft. and shipped to the work ready to be laid. They are laid by driving one piece into another until the two shoulders are in contact, or nearly so. No skilled labor is required; the inspector standing on top of the trench can readily observe whether the pipe has been driven home by observing the two shoulders. This form of pipe is made for diameters from 3 in. to 36 ins. Either form can be laid around curves of from 90 to 200 ft. radius, according to the diameter of the pipe.

One of the usual questions asked is "What pressure can wood stave pipe safely withstand?" The proper reply to this is that the tensile strength of the material composing the bands represents the pressure the pipe will stand. Wood pipes are made to withstand pressures up to 200 lbs. per sq. in., so far as the writer knows. The more the pressure under which the pipes are subjected, the more steel or wire is required to band them together.

As the tensile strength and elastic limit of iron and steel are well known, it becomes a simple matter of computation to determine the gauge and spacing of the bands to make a wood pipe which will withstand any pressure up to 200 lbs. Beyond this pressure it is likely the water would waste through the pores of the wood so that a higher pressure would not be economical or practicable.

The writer has experimented with wood pipe up to a direct pumping pressure of 300 lbs., without fracturing the pipe. This experiment was made to ascertain what a pipe built for pressures up to 100 lbs. would do if it was subjected to a water hammer equal to three times the pressure. At 250 lbs. the water oozed through the walls of the pipe. At 300 lbs. it spurted in small streams at a few of the longitudinal joints, with a few leaks at the transverse joints. The pressure was suddenly removed to nothing and gradually brought up to 100 lbs. with the result that the leaks stopped. This showed that, while the steel bands had been stretched, the elastic limit had not been overcome, and the pipe would, under such conditions as frequently exist in a long pipe line, safely withstand a wide range of pressures suddenly applied.

Pressures from 100 to 150 lbs. are common in machine made wood pipe, while continuous pipe of large diameter is successfully operating under pressures from 80 to 130 lbs.

Assuming that wood stave pipe is laid where it will be constantly subjected to water pressure the life of such is entirely dependent upon the life of the material with which it is banded. While the life is somewhat problematical there are well-known illustrations where steel banded pipe has been in continuous operation for 50 years without apparent deterioration. While the writer has industriously made inquiries wherever such might be expected to give reliable information he has failed to learn of a single case where steel bands have given way on machine made pipe.

The engineer who designs a continuous wood stave pipe provides for at least a factor of safety of 3 in determining the size and spacing of his bands. The manufacture of machine made pipe provides for an equal factor of safety. Now when steel or iron corrodes it does so by pitting, and thus it is reasonable to assume that two-thirds of the cross-section of the steel can oxidize before the band will fail under ordinary conditions. From the writer's observation sheet steel, such as composes the bands of machine made wood pipe, pits in irregular spots, and never on a straight line, thus the band may be two-thirds gone before the pipe will fail.

Where oxidizing agents are known to exist, such as in salt marshes, through salt water or sulphur deposits, the pipe should be banded together with copper clad steel wire. This copper clad wire is cheaper than solid copper wire. It has an elastic limit of about 50,000 lbs. per sq. in., a tensile strength of from 90,000 to 100,000 lbs., and a coefficient of expansion less than two-thirds that of copper. Thus it becomes a product equal in strength with the

*From a paper by T. Chalkley Hatton, Annual Convention American Water-Works Association.

steel and far better than copper. The writer knows of several cases where copper clad steel wire wound wood stave pipe has been successfully used where cast iron and steel pipe were very unsuccessful.

The claim is made by wood pipe manufacturers that wood pipe has a greater carrying capacity than cast iron pipe of equal diameter, and from a few well conducted experiments this claim seems reasonable. Marx, Wing and Hoskins conducted careful experiments to determine the coefficient of friction in wood pipes.* They found that coefficient n amounted to .009. Mr. Campbell on the El Paso and South-Western Ry. pipe line, heretofore referred to, found the value of n in 13,200 ft. of 10-in. wood pipe to be .00866, and in 47,500 ft. of 16-in. wood pipe to be .0092.† Mr. Campbell had exceptional facilities for determining the true values of n which are rarely found in actual practice.

The value of n in new cast iron pipe has been determined repeatedly and found to be .012. From the results of these experiments it appears quite true that a wood pipe has greater capacity than cast iron of like diameter. For instance a 12-in wood pipe with a loss of head of 8.85 ft. per 1,000 will carry approximately 2,025 gals. per minute, whereas a new 12-in. cast iron pipe under the same loss of head will carry about 1,810 gals. per minute. A 30-in. wood pipe under a loss of head of 2.05 ft. per 1,000 will carry about 11,600 gals. per minute, whereas a 30-in. cast iron pipe under the same head will carry about 8,810 gals. per minute. The longer the cast iron pipe is used the less its carrying capacity, under frequent conditions. The capacity of wood pipe does not diminish with age, the inside perimeter becoming smoother from use.

So far as the writer's knowledge goes there have been very few well conducted observations made of the leakage from wood pipe lines. From general observations made by the writer of lines in operation, no leaks of any significance have been apparent. Mr. Campbell, however, conducted careful observations on his lines, and states that, after two years, there was no material leakage in the 10 miles of 10-in. and 16-in. wood pipe line between the source of supply and the reservoir, which pipe was working under a maximum pressure of 130 lbs. That in the 12.6 miles of 11-in. and 12-in. pipe lines below the reservoir, and subjected to a less pressure, the 11-in. line leaked 17.046 gals. per mile and the 12-in. about 3.702 gals. per mile. Along the railway, when the maximum pressure was 130 lbs. the 11-in. pipe leaked 120 gals. per mile, and 8½-in. and 7½-in. pipe leaked 268 gals. per mile. It occurs to the writer's mind that if there were 103.4 miles of wood pipe in this installation wherein the maximum leakage was 268 gals. per mile, and 8.6 miles wherein the leakage amounted to 17,046 gals. per mile, there must have been some defective joints or pipes in the latter section which needed looking after, that if 90 per cent. of the whole line was practically water tight, the other 10 per cent. could easily be made so. However, from the result of the careful observations made by Mr. Campbell, it seems reasonable to assume that wood pipe, properly made and laid, can be made water tight under a pressure of at least 130 lbs.

This subject may be concluded by considering the difference in cost in installing wood stave and cast iron pipe. This difference is made up of several items, as, for instance: the cost of the two characters of pipe delivered f.o.b. cars at nearest railway point. Hauling pipe alongside of trench, width and depth of trench. Laying pipe, etc.

The difference in cost of furnishing and delivering the two characters of pipe at railway points is largely dependent upon the difference in diameters of the pipes to be used. The larger the diameter the greater the difference. The difference in weights per foot of pipe also increases in direct ratio to the increase in diameters. Therefore the cost of transporting wood pipe from railway to trench is from one-third for wood pipe 8 ins. in diameter, to one-sixth, for wood pipe 30 ins. in diameter of the cost of transporting cast iron. To overcome frost conditions the wood pipe need not be built as deep as cast iron pipe, as wood is a good non-conductor and can be laid closer to the surface of the ground without being damaged by frost. In laying wood pipe no bell holes are necessary, and this item of cost is eliminated, which, in rock excavations, becomes a very important item. As there is no lead and hemp used in laying wood pipe these items of cost are eliminated, as is the cost of melting lead, transporting and furnishing fuel, and caulking joints.

While it is impossible to compile a table showing the difference of cost between furnishing and laying the two characters of pipe which will fit conditions existing generally, it can easily be determined at a glance that there is a difference in favor of wood pipe; that this difference depends upon the size of the pipe, and that it can easily be determined for each locality when freight and labor charges are known.

A few instances of known costs might be interesting. The 23 miles of 30-in. continuous wood stave pipe laid for supplying Lynchburg, Va., with water, under the direction of Mr. James H. Fuertes, M. Am. Soc. C. E., cost for furnishing and laying pipe, exclusive of trenching and backfilling, from $1.82 to $2.10 per. lin. ft., depending upon spacing of bands. This wood was shipped from the Pacific Coast at a freight rate approximately $300 per car.

The 42-in. continuous wood stave pipe laid as a supply main for the Atlantic City Water Works, under the direction of Mr. Kenneth Allen, M. Am. Soc. C. E., cost, exclusive of trenching and backfilling $2.25 per lin. ft.

The 24-in. machine made pipe line laid under the direction of the writer for Carney's Point, N.J., cost exclusive of trenching and backfilling $1.32 per lin. ft.

Comparing the above costs with the cost of cast iron pipe of equal diameter, delivered f.o.b. cars at railway point, and the cost of lead and hemp for making joints, omitting transportation charges from railway to trench, laying charges, extra excavation for bell holes, fuel for lead melting, caulking and handling cast iron pipes.

The 42-in. cast iron pipe would cost at $22 per ton....	$6.11
The 30-in. cast iron pipe would cost at $22 per ton	3.47
The 24-in. cast iron pipe would cost at $22 per ton	2.43

The difference in cost of laying wood and cast iron pipe including trenching and backfilling, and under exactly the same conditions, is well set forth in Mr. Campbell's paper above referred to.

He states that the 384,300 ft. of wood pipe from 11 to 3½ ins. in diameter were laid at an average cost of $0.0472 per lin. ft., whereas the 101,200 ft. of 12-in. cast iron pipe, including lead and hemp, were laid at an average cost of $0.2343 per lin. ft.

It is not the writer's purpose to recommend to his colleague, who may be interested in laying supply mains for water works, wood stave pipe under all conditions, but to suggest that, after knowing the conditions, he look into the advisability of using wood stave pipe, study its applicability to the existing conditions, including the comparative cost with cast iron or steel pipe, keeping his mind open to recommending the installation which will best suit the conditions, and he will find many circumstances when he can save his client's money and secure for him equal service.

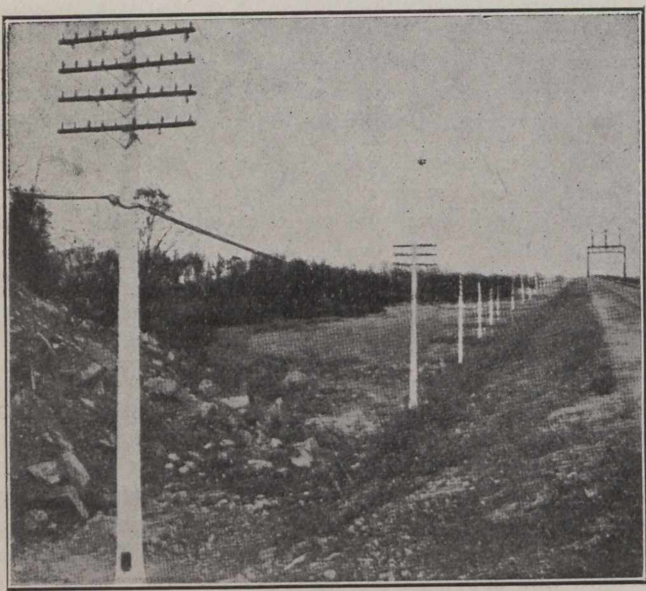
*See Tran. Am. Soc. C. E., Vol. 40.

†See Tran. Am. Soc. C. E., Vol. 80, p. 182.

PENNSYLVANIA RAILROAD POLE LINES.

A paper by G. Gibbs, read before the American Soc. C.E., gives the following interesting details:—

The meadows section of the Pennsylvania Railroad entrance to the new terminal station in New York City is a 5-mile continuous stretch of semi-tidal meadow swamp land, except for a short section of rock outcropping at Snake Hill. The Hackensack River is crossed midway of this section. The ground surface is covered with a heavy growth of reeds,



Pennsylvania Railroad—Reinforced Concrete Telegraph Pole.

and the top stratum is a peaty bog, from 8 to 15 ft. deep, underlaid with varying strata of clay, fine sand, and mixed sand and clay for very considerable depths. Across this section, and adjoining the track embankment, a pole line was erected for telegraph and telephone purposes, and one for the high-tension power wires.

Ultimately, the telegraph and telephone service will require sixty open wires and two·40-pair cables, and it was desired to make this line entirely secure against probable interruption by severe storms or fires in the swamp reeds. The character of the foundation, as indicated, was bad, and, after much consideration, it was decided to substitute for a wooden pole line, which would be inadequate for the conditions, one of concrete poles, which, while somewhat experimental and perhaps somewhat more costly, would provide a safe and durable construction.

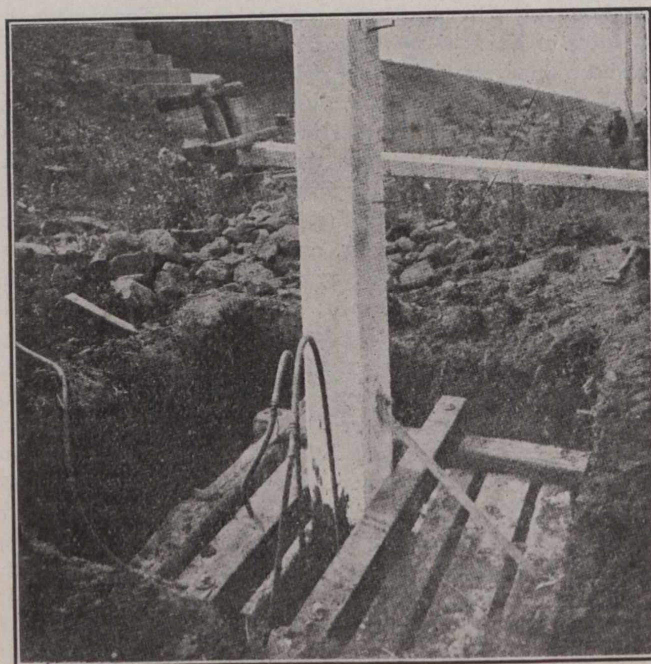
In this section 202 poles were required. They were spaced from 70 to 135 ft. apart, with an average standard span of 120 ft., the variation in span being due to the numerous railway and highway crossings. The heights of the poles above the ground vary from 25 ft. to 50 ft., and they are from 35 ft. to 65 ft. in total length.

The design, made by R. D. Coombs, structural engineer on the staff of the chief engineer of electric traction, called for transverse loading conditions, in case of maximum storms, equivalent to 6,000 lb. at 6.5 ft. below the top of the pole for the 120-ft. span length. The poles are square in cross-section, with chamfered corners and with a taper of ⅜ in. in 5 ft. The 1:2:4 concrete mixture of which they are made was assumed to have an ultimate unit strength, in compression, of 2,200 lb. The reinforcement is composed of mechanical bond bars tied together into a square skeleton frame. In the complete pole this reinforcement is covered by a 1-in. minimum thickness of concrete. The skeleton reinforcement was placed in horizontal frames, and the concrete mixture was poured in and carefully tamped. A special yard was established near the line, in which to make, store and season the poles. The average number of poles made per day was six, and they were left in place sixteen days to season.

After a number of experiments, it was found best to set the poles in pits excavated in the marshy stratum. These pits were generally about 9 ft. square and 5 ft. deep, and a timber grillage was placed around the base of each pole and about 5 ft. below the top of the ground. This grillage consisted of six track cross-ties bolted together and to the pole, and partly planked over by 3-in. rough lumber. The pole, which projected below the grillage and was pointed at the butt, was jetted down by compressed air into the sandy layer, so that the grillage would rest at the bottom of the pit. The pits were then back-filled with rock and clay. Poles on curves are cross-guyed, and the terminal and railway crossing poles are head-guyed with steel cables.

Because of the unusually heavy line and the extra length required for the foundations, the gross weight per pole, exclusive of grillage and cross-arms is more than would be required for ordinary telegraph poles, and varies from 5,300 lb. for a 35-ft. pole to 17,300 lb. for poles 65 ft. in length.

The wires for the transmission of traction energy from the tunnel portal to Harrison sub-station, and the wires of the high-tension signal power circuits in the same section, are carried on a line of steel poles along the southern edge of the right-of-way across the meadows. These poles are set 300 ft. apart, and are designed for not only the present requirements but to carry seven additional three-wire trans-

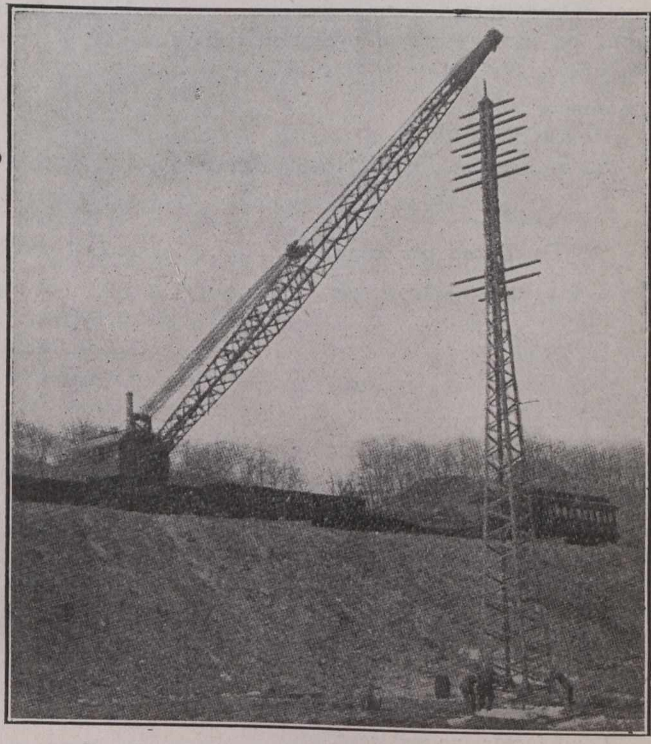


Pennsylvania Railroad—Setting Reinforced Concrete Pole and Grillage With Air Jet.

mission circuits which may be required in the future. The total loading called for a very substantial pole construction, and also for foundations to be carried through the soft upper strata of the marsh to a firm bearing.

The poles are of latticed structural steel, square in cross-section, with one angle at each corner and single-angle bracing. The poles have a parabolic outline, conforming to the load requirements and giving an improved appearance. The parabola is of such flat outline that it was not necessary to bend the main angles before assembling. The poles were completely riveted at the shop, with the exception of the cross-arms. The latter consisted of single ship-channels with flanges turned downward. The pole has a cast-iron cap at the top, and a section of pipe to carry a 250,000-circ. mil copper ground wire, which also forms a part of the negative, or return circuit.

In crossing the Hackensack River it was determined to carry the wires overhead rather than by submarine cables, in order to preserve the integrity of the line against lightning disturbances, and to provide for the use of 33,000-volt transmission in the future. For this purpose it was necessary to carry all wires with the clearance specified by the War Department over navigable streams, and this required the use of two unusually high steel towers. The line approaches the river with 300-ft. spans on 50-ft. poles, rising to an intermediate 70-ft. pole, then sharply to the high towers, 181 ft. 4 in. above high water; the lowest wire in this crossing is 137 ft. 4 in. above high water. The wire span over the river has a length of 765 ft. The towers are of the



Pennsylvania Railroad—Setting Transmission Line Pole With Derrick Car.

same general outline as the poles, but of much heavier section and larger dimensions. They are 15 ft. square at the base and 3 ft. square at the top. The tops of the foundations are 6 ft. above high water, and the total height from the water to the ground wire is 195 ft. The towers are carried on twin-piers, reinforced concrete foundations, each having eleven timber piles under it.

The pole foundations across the meadows are of concrete on from eight to ten piles, depending on the size of the pole; the piles were driven to a depth of from 30 to 80 ft., as occasion required.

The poles, both of steel and of concrete, were erected with a standard 75-ton wrecking derrick, fitted with a special 90-ft. boom capable of lifting either the steel or concrete poles at a point 90 ft. from the centre of the track. The concrete poles were lifted from the cars on which they were loaded, and placed on timber horses adjacent to the excavation, where they were to be set; the cross-arms and grillage were then put in place, and the pole, thus equipped was picked up at the top and lowered into the excavation. The steel poles were picked up from the embankment, where they had been unloaded, and lifted by the derrick vertically over the foundation and set in place.

All high tension insulators are of porcelain, of the petticoat type. Straight-line insulators are made of three pieces, and strain insulators of two pieces. These insulators are mounted on cast-steel pins bolted to the steel channel cross-arms. The transmission line poles supporting the pans crossing the various railroads in the meadows section and the city streets in the Sunnyside yard section were provided with double cross arms, strain insulators, and a dead-end clamping device designed to attach the power wires securely to the structure.

At the Hackensack River the power line rises sharply, in one span, to the top of the high towers, and required special insulating attachments. Each power wire, in passing over the steel cross-arms of the tower, is carried in a saddle supported by a nest of four standard line insulators. The saddle is provided with a special six-bolt clamp, and its wire groove is curved to prevent sharp bending.

The 2,000,000-circ. mil direct-current feeders, in addition to a similar clamping saddle, have an auxiliary butterfly clamp on each side, about 2.5 ft. from the saddle and attached thereto by adjustable rods.

In addition to the present signal circuits through the yard, and feeding the New York division at the Passaic River, the pole line is arranged to carry in the future two three-wire, high-tension power circuits.

RAILWAY EXTENSION IN NOVA SCOTIA.

Announcement was made in the House of Commons, Ottawa, of the government's determination to construct the Halifax and Eastern Railway and to link up other sections of the province with the Intercolonial Railroad, which is a government-owned railway.

The estimates submitted call for an appropriation of $1,000,000 toward the construction of a railway from a point on the Intercolonial Railway at or near New Glasgow, in the County of Pictou, to the Town Guysboro, and from the said line of railway at Crossroads County Harbor to the deep water of said harbor. One million dollars is also asked toward the construction of a railway from a point on the Intercolonial Railway at or near Dartmouth, in the County of Halifax, by way of Musquodobit Harbor and the valley of the Musquodobit, to Dean Settlement, in Halifax County. Toward the construction of a railway from a point on the Intercolonial Railway at or near Alba, in the County of Inverness, to the Town of Baddeck, Victoria County, $200,000 is asked for.

These are reported to be only the preliminary appropriations to provide for the immediate commencement of operations and to cover the cost of construction during the current year. The completion of the three branches projected will involve an expenditure of upward of $4,000,000.

The construction of these railways marks an advance in the transportation development of Nova Scotia; and, as a factor in the industrial upbuilding of the province, it is of the first importance.

The government has also asked or an appropriation of $600,000 for new dry docks and terminal facilities for the Intercolonial Railroad at Halifax, Nova Scotia.

Nova Scotia fares very well in the estimates for expenditures for the coming year, as presented to the House of Commons, Ottawa, for approval. The total amount to be spent in the province for public works, railway construction, river and harbor improvements, etc., aggregate nearly $5,000,000.

A COMPARISON OF COSTS OF POWER SUPPLY FROM LOW HEAD HYDRAULIC PLANTS AND STEAM PLANTS.*

In these days of conservation congresses and commissions we hear much of the duty of developing all possible water powers to their fullest extent, so as to conserve the fuel supply. While the conservation of the fuel supply is desirable it must be kept in mind that in order to bring about this result there is necessary an expenditure of material resources and human effort, both of which should be conserved. Since we measure all values in terms of money the test of the desirability of developing a water power is a comparison of the cost of the power developed and delivered at the point of consumption with the cost of power at the same point of consumption when developed by other means. In many cases the cost may be so great that the final result may not be conservation, but waste; even though the power of the water is utilized and fuel saved.

Before the advent of electrical transmission of energy the utilization of water power required that the factory where the power was to be used should be located near the power, the disadvantages of the location as respects transportation, operatives' dwellings, and so forth, being balanced against the advantage of cheap power. The possibility of the transmission of energy in the electrical form to great distances from the point of generation has removed this restriction, except in those cases where the cost of power is a large element entering into the cost of the finished product.

The writer of this paper will limit his discussion of the general subject to a consideration of the economics of the question for the conditions existing in Iowa.

Energy in the electrical form having been found the most desirable for distribution, and the electric distribution system being independent of the source of power, the limitation is set that the test of economy shall be the cost of delivering the power at the switchboard of the distributing system. Since the life of nearly every part of a power plant is not over 50 years, and that of most parts not over 25 years, it is not safe to consider prices of fuel as differing much from those which prevail at present. The electric plants of Iowa pay at present about $2.25 per ton for coal, of which the less efficient ones use about 12 pounds per kilowatt hour. With coal at $3.25 a ton the cost of supplies per kilowatt hour will be about 2 cts. for small plants and 12 cts. per kilowatt hour for large plants using steam turbines.

The rivers of Iowa not having a very rapid fall, it will be necessary to consider the hydraulic development for low heads of from 8 to 25 ft.

The problem is therefore reduced to a comparison of the economy of power supply from low head hydraulic plants and steam plants, other forms of power plants not being of sufficient importance at the present time to consider. The near future will probably see a development of the producer gas plant to such a point that it will be more economical than the steam plant.

The cost of supplying power is naturally divided into two parts: (1) Fixed expenses—interest, depreciation, taxes, insurance; (2) variable expenses—salaries and wages, maintenance, supplies (coal, water, oil, etc.).

As long as the plant is operating, some of the expenses under the second head are fixed, but as the determination of the proportion between the fixed and variable portions is very difficult, the tendency at present is to include under fixed expenses only those sources of expense which would continue if the plant were idle. The variable expenses being dependent on the output of the station, it is seen that an important consideration in the cost of power service is the relation between the fixed and variable expenses, which is largely determined by the time each year that the power is used. This discussion makes necessary the introduction of a term the meaning of which is often misunderstood—namely: the yearly load factor, which is the ratio of the average power developed during the year to the maximum power developed at any time during the year. This factor varies with the class of customers from 10 per cent. for a purely lighting business in a small town to 80 per cent. for an electro-chemical plant.

Owing to the great range in the cost of hydraulic development and pole line construction per unit of plant capacity each case must be considered individually; so the discussion will now be confined to plants actually constructed or to projects concerning which estimates have been made after a study of the location.

(1) Plant at Iowa City, owned by the State University of Iowa. Constructed during 1906-07. Approximate figures based on three years of operation. Capacity of plant 200 kilowatts. Head 2 to 9 ft.

Investment:	
Hydraulic plant	$39,000
Steam reserve 100 kilowatt (estimate)	11,000
Total cost	$50,000
Total cost per kilowatt	250
Fixed expenses:	
Interest, 6 per cent.	$ 3,000
Depreciation	2,000
Taxes	500
Insurance	150
Total fixed	$ 5,650
Variable expenses:	
Wages	2,000
Maintenance	250
Supplies, coal, etc.	450
Total variable	$ 2,700
Total operating expenses	$ 8,350

Load factor, 20 per cent.
Cost at switchboard, $0.028 per kw. hr.

Steam plant at Iowa City (estimate). Peak load 175 kilowatts. Load factor 20 per cent. Investment: 175 kw. steam plant, $24.500. Investment per kilowatt, $140.

Fixed expenses:	
Interest, 6 per cent.	$ 1,470
Depreciation, 5 per cent.	1,225
Taxes, 1 per cent.	245
Insurance, 1 per cent.	245
Total fixed	$ 3,185
Variable expenses:	
Wages	$ 3,000
Maintenance	800
Supplies	6,000
Total variable	$ 9,000
Total expenses	$12,985

Cost at switchboard, per kilowatt hour, $0.042.

*From a paper by Arthur H. Ford, Iowa City, Ia., before the Iowa Society of Engineers.

(2) Hydro-electric plant at Palisades with steam plant at Cedar Rapids: 800 kw. hydraulic; 15 ft. head; 2,300 kw. steam. Load factor 25 per cent. (estimate):

Investment:

Hydraulic plant	$300,000
Transmission line	25,000
Steam plant	230,000
Total	$555,000

Investment per kilowatt, $179.00.

Fixed expenses:

Interest, 6 per cent	$ 33,300
Depreciation	18,750
Taxes, 1 per cent	5,550
Insurance, 1 per cent	2,550
Total fixed	$ 60,150

Variable expenses:

Wages	$ 13,000
Maintenance	4,500
Supplies	18,000
Total variable	$ 35,000
Total expense	$ 95,650

Cost at switchboard per kilowatt hour, $0.0141.

Load factor on hydraulic plant, 75 per cent.

Steam plant at Cedar Rapids; 3,100 kilowatts; load factor 25 per cent. Investment: Steam plant, $310,000. Investment per kilowatt, $100:

Fixed expenses:

Interest, 6 per cent.	$ 18,600
Depreciation, 5 per cent.	15,500
Taxes, 1 per cent.	3,100
Insurance, 1 per cent.	3,100
Total fixed	$ 40,300

Variable expenses:

Wages	$ 13,000
Maintenance	4,500
Supplies	81,500
Total variable	$ 99,000
Total expenses	$139,300

Cost at switchboard, per kilowatt hour, $0.0204.

(3) Hydro-electric plant at Iowa Falls (estimate); 75 kw.; 25 ft. head. Steam auxiliary 100 kw. Maximum load 150 kw. Load factor 20 per cent. Load factor on hydraulic plant 30 per cent.:

Investment:

Hydraulic plant	$ 36,000
Overflowed land	75,000
Steam plant	14,000
Total	$125,00

Investment per kilowatt, $830.

Fixed expenses:

Interest, 6 per cent.	$ 7,500
Depreciation	625
Taxes, 1 per cent.	1,250
Insurance, 1 per cent.	175
Total fixed	$ 9,550

Variable expenses:

Wages	$ 3,000
Maintenance	500
Supplies	1,320
Total variable	$ 4,820
Total expenses	$ 14,370

Cost at switchboard per kilowatt hour, $0.054.

Steam plant at Iowa Falls. Maximum load 150 kilowatts. Load factor 20 per cent.:

Investment: Steam plant $21,000

Fixed expenses:

Interest, 6 per cent.	$ 1,260
Depreciation, 5 per cent.	1,050
Taxes, 1 per cent.	210
Insurance, 1 per cent.	210
Total fixed	$ 2,730

Variable expenses:

Wages	$ 3,000
Maintenance	500
Supplies	5,260
Total variable	$ 8,760
Total expenses	$ 11,490

Cost at Switchboard, per kilowatt hour, $0.044.

(4) Hydro-electric plant near Webster City (estimate). Capacity of plant 50 kw.; head of water 20 ft.; load factor 40 per cent. Steam plant capacity 225 kilowatts. Peak load 250 kw. Load factor 20 per cent.

Investment:

Hydraulic plant	$25,000
Reservoir*	35,000
Transmission line	3,750
Steam plant	31,250
Total investment	$95,000

Investment per kilowatt, $380.

Fixed expenses:

Interest, 6 per cent	$ 5,700
Depreciation	2,900
Taxes, 1 per cent.	950
Insurance	350
Total fixed	$ 9,900

Variable charges:

Wages	$ 4,300
Maintenance	800
Supplies	5,000
Total variable	$10,100
Total expenses	$20,000

Cost of switchboard, per kilowatt hour, $0.046.

Steam plant at Webster City. Peak load 250 kilowatts. Load factor 20 per cent. Investment: Steam plant, $35,000. Investment per kilowatt $140.

*From report of Iowa State Conservation Commission. 1910.

Fixed expenses:	
Interest, 6 per cent.	$ 2,100
Depreciation, 5 per cent.	1,750
Taxes, 1 per cent.	350
Insurance, 1 per cent.	350
Total fixed	$ 4,550
Variable expenses:	
Wages	$ 3,000
Maintenance	800
Supplies	8,670
Total variable	$12,470
Total expenses	$17,020

Cost at switchboard, per kilowatt hour, $0.039.

DISINTEGRATION OF CONCRETE IN SEWAGE DISPOSAL TANKS.*

Attention was first called to the disintegration of cement mortar in concrete, resulting from sewer gases, by Frank H. Olmsted, City Engineer, of Los Angeles, and his deputy, Homer Hamlin, in 1899. The case observed by them occurred in the outfall sewer for Los Angeles, built in 1895. This resulted from the holding back of the sewage in the inverted syphons in this outfall sewer, forming, in principle, a septic tank. Beyond this point the neat cement mortar was badly disintegrated, and it became necessary to consider the reconstruction of the walls and roof of this portion of the sewer. It was observed that this disintegration resulted from the formation of sulphuric acid upon the walls and roofs, which attacked the cement, giving calcium sulphate or gypsum as the final product. It was also observed that the amount of sulphuric acid formed appeared to be too large to be produced by the organic sulphur compounds in normal sewage. Mr. Hamlin suggests that the only possible sources for this excessive amount of sulphur were acids from manufacturing plants, the sulphates in water, sulphuretted water from oil wells, and the sulphur which is always present in small quantities in the normal sewage. The reports do not indicate that the source of these sulphur products was located. The work done in this laboratory would point to the water supply itself as furnishing the necessary sulphates.

The disintegration of concrete in sewage disposal plants was called to our attention about two years ago, when such a condition was observed in the dosing chamber of the septic tank at the State Hospital for Inebriates at Knoxville, Iowa. In addition to this disintegration large quantities of hydrogen sulphide were given off whenever tne dosing chamber discharged, producing extremely disagreeable odors in the surrounding atmosphere and causing complaint from dwellers in that vicinity. The disintegration in this plant, as in other cases observed, occurred above the water line in the dosing chamber. At a later date, the writer observed that the sewage disposal plant at Grinnell, Iowa, showed a condition similar to, if not identical, with that at the Knoxville Institution.

In a recent paper read before a Cement Association in London, by Mr. William Dunn, he reports a similar case, though he does not attempt to show any relation between this condition and the character of the water supply. One or two other cases in this country have come to our notice; but the trouble was less pronounced, and owing to distance, have not been carefully investigated. In the two cases investigated (Grinnell and the State Inebriate Hospital) it was observed that the water supply carried high mineral content, and that the sulphates were high in both, as the following analyses will show:—

Water supply.	Solids on evaporation.	Solids on ignition.	Sulphates, SO_4	
Hospital for Inebriates	2,690	2,670	1,645	Pts. per million.
Grinnell	1,066	1,018	476	

Seven other sewage disposal plants, built along similar lines, have been observed by the writer, and in all there is neither excess or hydrogen sulphide nor any disintegration of concrete, and the highest sulphate content in the water supplies is 51 parts per million. These observations seem to point to a relation between the mineral sulphates of the water supply and the excessive hydrogen sulphide evolved in the process. Analyses of the raw sewage and the effluent were made to determine the sulphates in solution, together with the total sulphur in the raw sewage. These results indicate, first, that the organic matter in normal sewags does not contain enough sulphur to produce the hydrogen sulphide observed in this case; secondly, that where the sulphates in the original water supply are high, there is a reduction in the amount of mineral sulphates found in the effluent, showing that a portion of these mineral sulphates must have been reduced, and assisted in producing, the hydrogen sulphide observed. The moisture upon the walls of the dosing chambers where disintegration occurs contains a considerable amount of sulphur, and all of the lime content of the cement near the surface is converted to calcium sulphate. It is evident, then, that the agent producing the disintegration is sulphuric acid, and that this sulphuric acid comes from the hydrogen sulphide. It is well known that the oxygen of the air will convert hydrogen sulphide to sulphuric acid, but it seemed improbable that the amount of acid here formed could result from this simple chemical action. This belief was emphasized by the fact that the roof and walls of the dosing chambers were coated with what appeared to be yellow sulphur, evidently deposited from the hydrogen sulphide.

At this point Dr. R. E. Buchanan, of the State College, took up the bacteriological study of the problem. He found that normal sewage contains bacteria which have the power of reducing mineral sulphates with the liberation of hydrogen sulphide. He identified these bacteria in the sewage taken from the tanks mentioned and proved by experiment that they would reduce the mineral sulphates occurring in water. This, then, accounts for the formation of the large quantities of hydrogen sulphide found in sewage disposal plants where highly sulphated waters are used. His attention was then turned to the walls where the disintegration occurred, where he found on examining what appeared to be a sulphur deposit under the microscope, that it really consisted of sulphur granules mingled with the mass of living organisms. Many of these were evidently feeding upon this sulphur ,as the sulphur granules were identified within their bodies. Among these bacteria were identified at least one form (and there were probably others) which is known to convert hydrogen sulphide and sulphur to sulphuric acid. This, then, supplies another important factor in the production of the sulphuric acid which is the direct cause of the disintegration. These facts, I believe, establish the relation between the formation of the excessive hydrogen sulphide and consequent disintegration of the concrete and the character of the original water supply.

It then remains to suggest a method for the disposal of sewage where heavily sulphated water is used, without producing a nuisance from the foul odors arising, or injury to the plant from the breaking down of sound concrete.

*Paper read before the Iowa Association of Cement Users.

The Canadian Engineer

ESTABLISHED 1893.

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CONTENTS OF THIS ISSUE.

THE ANTIQUATED WIRING POLE.

Can anything more unsightly be thought of than the wooden pole for carrying street wiring systems? That so many of our otherwise beautiful streets should be totally disfigured by these poles is getting beyond endurance. To those who are accustomed to these sights, the problem may never have appealed, but to the stranger visiting a new vicinity it is one of the most striking features of the neighborhood.

Time was when there was no alternative method for putting up our wiring system, but that has passed. If the above-ground pole must be preserved, there is the aesthetic concrete pole, which, if properly made, is not the eyesore that the wooden pole presents. But the concrete pole has its limitations, evidently.

The proper method, and the one which should be recognized, is that of underground conduits. True, there are many faults to be found with such a system, chief among which is the large amount of cutting through permanent pavements that is necessitated from time to time. But, in spite of any arguments that may be advanced to the contrary, there is no gainsaying that, from the aesthetic standpoint, which is apparently very seldom considered in spite of its importance, the underground method is away in advance of all others. From the standpoint of non-obstruction to fire-fighting appliances, the above-ground pole is a positive danger.

TORONTO BUILDING BY-LAW.

In a recent issue of The Canadian Engineer the revision of the above referred-to by-law was given due prominence. Although the memorial has been presented, and apparently to the satisfaction of those interested from the municipal end it has been given a proper reception, it is well that those concerned keep the matter prominently in mind.

This by-law has been the subject of much controversy from time to time, much of which was useless because non-concerted. Now that the subject has been taken up by prominent members of the engineering profession, the disputed questions must be settled once for all.

There can be no doubt that the architect of the city of Toronto, being a wise man, will see the need of a revision of the present by-law. The source of the representations leaves absolutely no doubt as to the intention, which can be no other than for the good of all concerned. This is not a matter for civic politics, but for competent engineers to settle. It is to be hoped that there will be no sidetracking. Engineers as a class are rather conservative in action, but when there is a pressing need, the decision that characterizes the individual becomes rather prominent in the acting committee.

EXPERT ADVICE.

In view of the fact that most of the so-called "marvellous inventions" turn out to be miserable failures, it is to be wondered at that the general business public does not recognize at least one very good cause of this state of affairs.

If the majority of cases of the referred-to failures are investigated, it will be found that the parties financially interested are men whose profession has absolutely nothing to do with the line of business in which they have sought investment. In other words, they themselves knew nothing about the fundamental principles on which the invention they are interested in should be built. The usual course in such a case is to get a friend, who is an "expert," to look into the new invention, and, if his opinion is favorable, this, coupled to the lurid pictures of the inventor, soon brings forth the required financial backing.

In most cases the "expert" has no practical knowledge upon which to base his opinion. The writer remembers a case where a new gasoline engine had been invented which, it was claimed, would develop about ten times as much power for a given size cylinder as the ordinary type of engine. A "mechanical engineer" had given his opinion that these statements were true. This invention, of course, turned out a failure. The "mechanical engineer" in question was a machinist working in an automobile factory. In another instance a steel expert turned out to be a rather well-to-do blacksmith. So the cases go on.

The truth is that the man who tries to make "easy money" is generally backward in wishing to pay for opinions that are really worth while. The members of the engineering profession have done much to stamp out a certain type of "expert," but there is still room for more work in the field where inventions are concerned.

EDITORIAL COMMENT.

The new McDougall Bulletin 108 on turbine pumps has recently been issued.

* * * *

The Canadian Locomotive Company will enlarge its present plant to double its present capacity.

* * * *

Tenders are being called for the construction of a new C.P.R. depot at Brandon, Man.

DIESEL OIL ENGINES.

Dear Sir,—In your issue of the 22nd inst. you have an article entitled "An Unusual Oil Engine." In comparing this "unusual engine" with the well-known Diesel you give three main causes for the general non-adoption of the Diesel engine, the third of which is that the mechanism in the Diesel is such that the **cost of attendance is abnormal.**

As representatives of Messrs. Mirrlees, Bickerton and Day, the well-known builders of the British Diesel, we feel that we ought to correct such a wrong impression. As a matter of fact the actual log book figures for repairs, maintenance, and attendance in stations where Diesel engines are installed show that these are very much below similar costs for steam plant, and about **one-tenth** the cost of suction gas plant.

So little fear have we of anything going wrong with the Diesel that we prefer to put an ordinary laborer in charge of it rather than a so-called skilled man, and experience shows that if the Diesel is left alone when once erected by the makers, there is no reason to fear any trouble from it for many years.

We have had a 150 h.p. Mirrless Diesel engine running every day since the 4th inst. at Yorkton, Sask. entirely in charge of a local man, who had no previous experience of the Diesel, and in fact, had never even heard of it, and we shall have two 200 h.p. engines running at Moose Jaw, Sask., within the next three or four weeks.

Yours faithfully,

The Canadian Boving Company, Limited.

F. A. Yerbury,

Vice-President and Managing Director.

THE MODULATION SYSTEM OF STEAM HEATING.

The objection most often voiced with regard to ordinary systems of direct steam heating is that they do not allow of close regulation of temperature. If the inlet valve at the radiator is opened on a mild day it is soon necessary to open a window because of the excessive heat. Complete shut-off results in rapid cooling while if it is attempted to partially open the valve, water hammer, poor circulation and kindred troubles ensue. In two-pipe systems—the type most usually met with—there are two valves to be adjusted which adds to the complexity and inefficiency. Aside from the discomfort involved in such experiences, there is always a waste in not being able to operate a heating system at its most economical point. The combination of a radiator with a full head of steam, and an open window certainly does not make towards efficiency. The coal pile is being turned into heat units which are making their direct escape through the window. There is no possibility of modulating the temperature to conform with the variations in the weather.

In hot water systems on the other hand, temperature modulation is the main consideration. By varying the rate of combustion of coal in the heater the water may be given any degree of heat up to 212° with open tank systems. In the case of closed hot water installations it is possible to raise the temperature to about 240°. In very severe weather the radiators can be maintained at nearly the same temperature as with low pressure steam systems, while in the spring and fall a banked fire will provide a mild degree of heat just sufficient to "take the chill off." But a water system is phlegmatic in action. In case of a sudden cold snap it is impossible to heat up the mass of water in a hot water system quickly enough to prevent the building from cooling off to an uncomfortable degree. For similar reasons unexpectedly mild weather is likely to catch a hot-water system napping, so that it is necessary to open doors and windows to dispose of the heat fast enough for comfort. Piping and radiators must be considerably larger than with steam for the same size building with greater first cost and inconvenient bulkiness.

The modulation system of steam heating has now been in practical use for a period sufficiently long to show that it fills these exacting requirements most acceptably. As its name implies, it is a steam heating system with which it is possible to modulate the temperature at each radiator. This is accomplished by means of an adjustable modulation valve on the intake end of the radiator, and an automatic air and water valve on the discharge end. The latter permits the discharge of water back to the boiler, but prevents steam from escaping, while the hand operated modulation valve permits of the radiator being wholly or partially filled with steam, thus allowing the occupant to vary the temperature at will. A most attractive feature of this system is that the steam pressure carried need not be higher than about one and a half pounds, and usually one-half to one pound is ample even in very cold weather. The needless intensity of high pressure steam is thus avoided.

Another feature of excellence is the positive circulation obtained. The fact that the steam cannot escape to the return risers until it has been condensed in the radiator insures a differential pressure between the supply and return sides of the system. The radiator condensation results in a reduction of pressure within the radiator that causes an inrush of steam whenever the modulation valve is opened.

With this system, the general operation is under the immediate control of the janitor or engineer in charge, but the temperature of individual rooms may be varied at the pleasure of the occupant.

BLOWING ENGINE DATA.

The following is abstracted from a paper read by W. Trinks before the Am. Soc. M. E.:

During the past twenty years, American blowing-engine practice has assumed rather set forms; certain types of valves and engines have dominated the market, and their operation furnishes to-day the blast for more than 90 per cent. of the pig-iron industry in this country. A few years ago, however, the contentedness of American builders and users of blowing engines was rudely shattered by a double European invasion: the gas engine and the turbo-blower.

The gas engine, although more economical of fuel than the steam engine, is more expensive in first cost. To reduce the cost per horse-power, high piston speed must be employed; thus the piston speed has been increased from the 300 feet per minute, heretofore considered standard in steam-driven blowers, to 600 feet per minute in modern American gas-driven blowers. In Europe reciprocating blowers run at piston speeds of 750 feet per minute, the gas engines for the generation of power running at speeds very close to 1,000 feet per minute.

An understanding of the reasons why the standard types of American blowing engines are so successful at medium speeds and what their shortcomings are at high speed will be facilitated by a study of the value motion and of the throttling losses through the valves.

As a high velocity through valves is harmful, the tendency is to keep the velocity at a fairly constant low value, and since the piston of an engine has very nearly harmonic motion, it follows that the valve should also have harmonic motion. Fig. 1 shows the valve lift on a displacement basis. The inlet valve is open practically throughout the stroke; the outlet valve should pop open near the middle of the stroke and close at the end.

Fig. 2 shows this same ideal diagram on a time basis. It will be noted that the curves intersect the base line at an angle, indicating that if these ideal-motion curves are realized the valve will strike a blow in seating. The velocity of striking depends upon the lift of the valve and upon the time of one revolution, which means that high-lift valves, while successful for low rotative speeds, become impractical for high rotative speeds.

Engineers have striven to design valves and valve gears for blowing engines so that these valve-motion curves are approximated. There are, however, two circumstances which interfere with attaining the ideal: One is the quantity of air under a lift valve, which lessens the discharge through the valve during its lift and increases the discharge during the closing period; the other is the mass of the valve, which has frequently baffled designing engineers.

Practically all automatic-lift valves close late, depending upon the rotative speed of the engine, lift of the valve and spring loading. The lower the rotative speed and the valve lift and the greater the spring load closing the valve, the nearer the valve is to the seat in the dead-centre position of the crank. Tests and calculations show that in ordinary American blowing-engine practice the valves close so near the dead centre that for all practical purposes they may be considered as closing "on time" and without the injurious effects of late closing, namely, the slipping back of the air and the hammering of the valve.

The behavior of the outlet valves is similar to that of the inlet valve with two exceptions: First, the valve has to open when the piston is moving fastest; second, the pressure difference on both sides of the valve increases rapidly at the dead centre. In Fig. 3 the ideal and the actual valve-lift curves are shown in connection with an indicator diagram on a displacement basis. The slower the rotative speed of the engine, the lighter the valve and the smaller its lift, the more perfect is the approximation to the ideal lift curve. High rotative speeds, heavy valves and small areas uncovered by the valve for a given lift cause the pressure in the cylinder to rise considerably over that existing in the blast space and store up a considerable amount of kinetic energy in the valve which must be taken care of by a cushioning device; otherwise fluttering or hammering results The pressure drops rapidly under the valve immediately after the crank has passed the dead centre, and particular care must be taken to have the valve close promptly in order to avoid hammering.

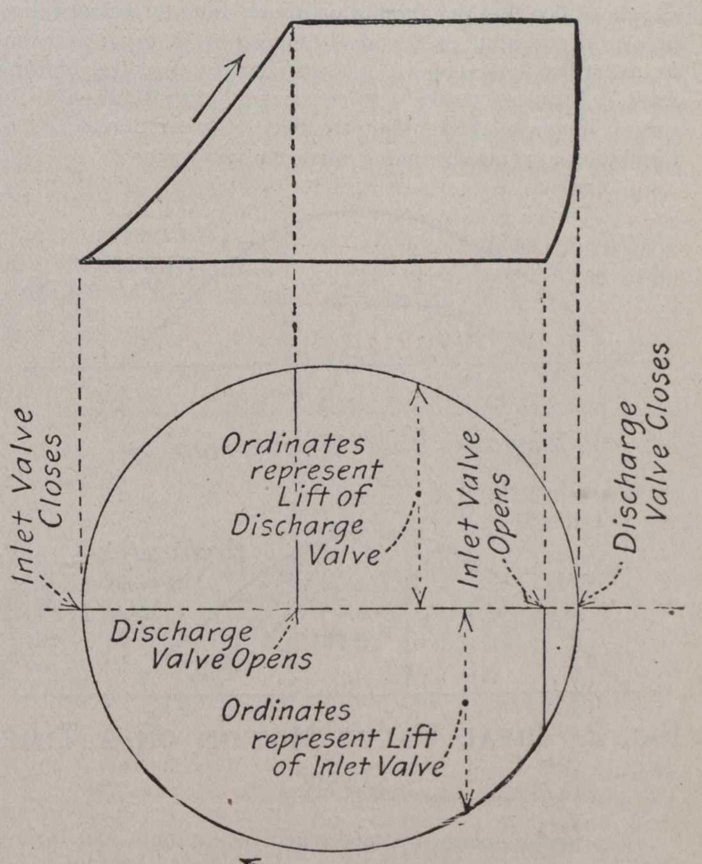

FIG. 1. IDEAL VALVE MOTION ON A DISPLACEMENT BASIS

Throttling loss through valves involves two factors: loss of velocity head and surface friction. The vast majority of valves are so designed that surface friction, such as occurs in long pipes or ducts, is practically absent. For this reason, losses due to velocity head only will be considered. Fig. 4 gives the throttling loss for various piston speeds and for various ratios of valve area to piston area. In this chart the valve area does not mean the so-called free valve area, which is a rather imaginary or conventional quality, but rather the area actually offered to the flow of air at the narrowest part of the valve. It is assumed that the valve has harmonic motion and that the coefficient of discharge is 70 per cent. For a number of valves this latter figure was found to agree closely with the tests.

As long as the clearance volume of the engine is small, mechanical operation of the inlet valve is scientifically correct, because the opening and closing points of the valve remain practically fixed in spite of variations of blast pressure. Conditions are quite different with the outlet valve. Its correct opening point varies with the blast pressure and losses occur if the valve opens at a fixed point and if the blast pressure differs from the one for which the engine was designed.

Naturally, the experiment of running the standard types of valve gears at higher speeds was tried. Comparatively little trouble was experienced with the mechanically operated inlet valves, except that in some of the designs the throttling loss was much greater than might be expected. At 600 revolutions per minute the standard valve gears gave throttling losses ranging from 0.4 to 1 pound per square inch, and engineers were trying to increase inlet-valve areas up to 20 per cent. or more. At the discharge end serious troubles occurred with an increase in speed.

If the American standard valve gears are used for piston speeds of 600 feet per minute or above, inlet-throttling losses of 3 to 6 per cent. of the ideal blowing work occur and outlet-throttling losses of 7 to 12 per cent. of the ideal blowing work. Besides, power for mechanical operation of the valves increases and other troubles of wear, breakage or regulation appear, depending upon the valve gear.

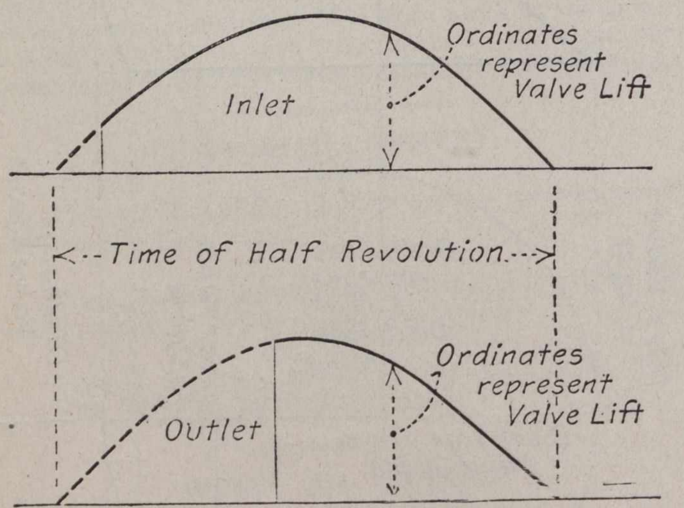

FIG. 2. IDEAL VALVE MOTION ON A TIME BASIS

For piston speeds up to 600 feet per minute and for rotative speeds up to 65 revolutions per minute, the Slick tub employing a movable cylinder, has been very successful. The design has been severely criticized as "wagging the dog and holding the tail still" and the author confesses that he felt the same way when he saw the first Slick compressor more than ten years ago at the Edgar Thompson Steel Works, but the ingenuity of the design is forcibly impressed upon anybody who attempts to produce the same combination of large areas and small clearance space in some other way. If 65 revolutions per minute are exceeded with this type, trouble begins. The inertial forces of the heavy cylinder are hard to take care of and heat the eccentric which moves the cylinder.

Engines employing the Mesta combination inlet and outlet valve have been very successful up to piston speeds of 820 feet per minute. In this type rocking valves, two for each head, control both inlet and outlet; the inlet passes at the side of each valve, the outlet through the centre of the valve. Automatic cup outlet valves are located beyond the rocking valves and are protected against the return closing slam by the mechanical closing of the rocking valves. This latter design has been used on vacuum pumps and compressors for over 20 years. Its adaptation to high-speed blowing-engine practice required doubling the valve equipment for the purpose of obtaining large areas without excessive diameter of rocking valve. The pot outlet valve is cushioned very little and is loaded lightly so as to fly out of the road of the blast without fluttering.

In Europe the high-speed blowing engine is an accomplished fact. There the problem has been attacked along altogether different lines. European engineers long since realized that the harmful kinetic energy stored up in a valve is proportional to its mass and to its travel, and that both should be cut down.

Furthermore, European engineers do not hesitate to use large clearance spaces if by so doing other advantages can be gained, and they meet with success. Matters are different in this country. Clearance in a blowing engine seems to be an eyesore to the American furnace man. The influence of clearance can be summed up in a few words.

(a) Clearance volume increases the necessary size of blowing tub for a given weight of air to be pumped per stroke.

(b) The larger size of blowing tub results in a small increase of friction work and, therefore, in a larger size of power cylinder.

(c) The influence of the increased heat-exchanging surface on the true volumetric efficiency is small.

On the other hand, clearance allows the use of very large valve areas, which decrease throttling work and cause better filling of the air cylinder and also allow higher piston speeds, or in other words, a smaller and cheaper engine. The higher piston speed makes possible the use of a more efficient prime mover, namely, the gas engine. When the truth of this is realized, recognition of the merits of the modern European high-speed blower should present no difficulties. The plate valves are so light in weight and the spring load can be made so small that for the greater part of their working time the valves rest against the guard or stop; this, of course, greatly reduces fluttering. Furthermore, there are no wearing parts and no sliding surfaces or sticking or binding from gummed and dusty oil. The low lift does not allow the valve to acquire destructive velocity in closing. If a sufficient number of valves are used the pressure loss through the valves is small and the filling of the cylinder is almost perfect. The life of the valves is long, provided that they are made of the proper high-grade steel and that the spring loading is properly proportioned. If a valve should break, it can easily be replaced because the valves are light; besides, the inlet and outlet valves are alike so that only a few need be carried in stock.

Particular emphasis is placed upon the almost silent operation of these valves, both by users and builders. No separate cushioning means are employed except that in the Hoerbiger-Rogler valve an elastic plate softens the impact of the opening stroke before the valve strikes the guard. This cushioning alone does not suffice, but another circumstance comes in helpfully. Thin films of oil coat the valve plate, cushion plate and guard. The squeezing of the air and oil between these plates provides a sufficient cushion to prevent injury to the valve.

From a study of the various types of valves and valve gears, it appears that at the present time the low lift, alloy-steel plate valve promises to become the standard valve for high speed blowing engines, because there is neither wear, binding nor sticking; no lubrication is required; there are very small throttling losses; it can be used for the highest speeds; it is inexpensive; and it does away with mechanical gearing, oiling and adjustment.

No matter with what valves a reciprocating blower is equipped, its delivery remains discontinuous; that is, it delivers air impulses comparable to a constant delivery, over which is superimposed a wave motion or vibration. If the blower discharges directly into the blast main, then vibrations are transmitted with undiminished strength and shake the whole line. In steam-engine practice this evil was cured long ago by placing a large steam or water separator near the engine to damp the vibrations of the pipe line. If a similar request is made of a furnace man for the air line, a great deal of resistance is encountered. The author knows of only one furnace plant in this country where a large tank or equalizer was installed for each blowing engine. The pipe lines thus connected are practically free from vibration.

In conclusion it may be said that the reciprocating blower has made wonderful strides in the past decade toward becoming a successful high-speed machine. While the increase of piston speed was started by the gas engine as a matter of necessity, it has also benefited the steam-driven blowing engine, and isolated furnace plants can now work with two air cylinders instead of three, because one will successfully blow a furnace in case of emergency, or else three smaller units may be used.

The combination of the high-speed reciprocating blower with the blast-furnace gas engine makes the use of the latter profitable even in the Pittsburg district where coal is cheap. The latest group of furnaces in this region has been equipped with slow-speed reciprocating steam-driven blowers. If a high-speed gas-driven blower had been on the market, the result would probably have been different.

A gas-driven blowing engine with a piston speed of 800 to 900 feet per minute and a high rotative speed will be the most formidable competitor of the turbo-blower, if European experience may be taken as a guide. There are engineers in this country who have already carried into practice higher piston speeds for gas engines for electric power, and interesting developments in this line of work may be expected in the next five years.

The following brings out the main points of the discussion by Messrs. Johnson de Laval, Baker, Cardullo, and Freyn:—

It is generally accepted that the turbo-blower is much more efficient at low pressures than at high pressures, whereas the reciprocating blowing engine is more efficient at high pressures. A condition in the design of the latter is that the air cylinder must be large enough for the greatest volume to be handled, and strong enough for the highest pressures attained. This results in the large and massive construction which makes such machinery so expensive.

The turbo-blower, on the other hand, suffers because it must have stages enough to furnish the highest pressure likely to be required, although, in ordinary operation, this pressure may be needed only a very small part of the time.

Therefore, the best and cheapest blowing engine is a combination of these two types: a turbine-driven blower delivering air, partly compressed, to a reciprocating blowing engine, which will compress it to the desired pressure. The steam from the reciprocating engine could be used to drive the turbine.

In general, the valves of a blowing engine are a source of difficulty, it being almost impossible to get an inlet valve of sufficient area to allow the cylinder to fill without heavy loss by suction, and at the same time be quick enough to give the desired results at the speeds required in modern engines.

The advantage of maintenance is undoubtedly with the turbo-blower, as compared with the reciprocating engine. However, the magnitude of the alternations of stress in the reciprocating blower is greatly reduced by delivering partly compressed air, and the difficulties of the inlet-valve gear are practically eliminated by delivering denser air under pressure.

The governing of such a combined unit is extremely simple. The ordinary governor on the engine does all that is necessary and no governor other than one to prevent racing is needed on the turbine. The steam from the engine passes directly to the turbine, and as long as conditions remain constant, the speed of the turbine will remain unchanged. If, however, the pressure required by the furnace increases, more steam is admitted to the engine by the governor and this increased quantity of steam causes the turbine speed to increase slightly and, in turn, deliver air at a higher pressure. This automatically compensates for any slight lag due to the greater load on the engine and for the lower volumetric efficiency of the reciprocating blowing engine at higher pressures.

It is well to consider the distinction between a blower and a compressor, in which connection it would appear that the machine described by Mr. Rice is not a compressor but a turbo-blower. It is of the multi-stage type and has no rubbing surfaces, the rotating parts revolving freely with the ample clearances.

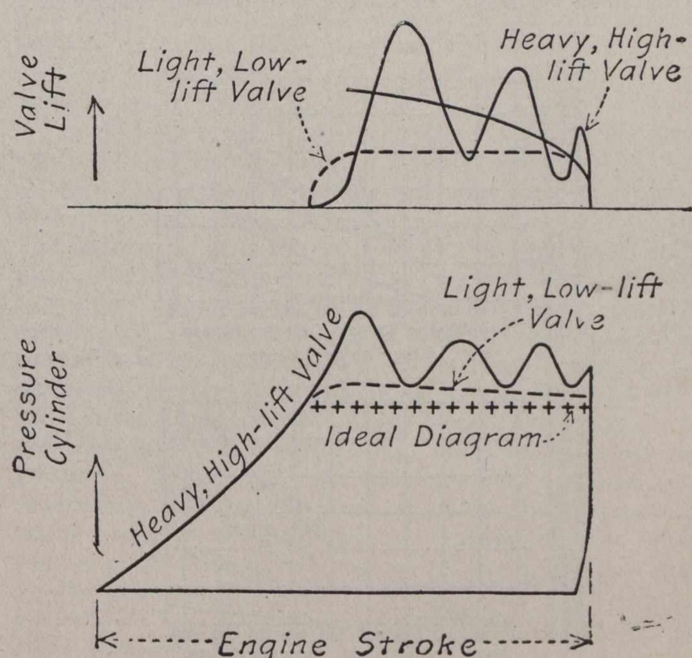

FIG. 3. ACTUAL MOTION OF OUTLET VALVES ON DISPLACEMENT BASIS

The turbo-compressors manufactured by a number of German firms are made up of multiple cylinders according to volume and pressure. The general principle includes high-speed impellers incased in cylindrical chambers, properly cooled both radially and axially. These impellers draw in the air and discharge it, converting the velocity into potential energy in the form of air pressure, the action being similar to that of a centrifugal-pump impeller.

It does not appear necessary to use six stages, arranged in series, for pressures as low as 10 or 20 pounds per square inch. A turbo-blower built on the Rateau principle for 6,000 to 12,300 cubic feet of free air per minute at pressures of 8 to 13 pounds and speeds of 3,400 to 3,900 revolutions per minute, requires only three stages as against the six stages in the one described by Mr. Rice. For pressures of 80 to 150 pounds it is not necessary to employ more than ten to fifteen stages.

European practice has shown that turbo-compressors with capacities of 6,000 cubic feet of free air per minute and above, will give from 70 to 80 per cent. efficiency; for capacities of 3,000 to 6,000 cubic feet, the efficiencies are from 65 to 75 per cent., and these efficiencies decrease to less than 50 per cent. at one-half and quarter loads.

The use of a turbo-blower in connection with reciprocating compressors has been tried recently in England. The existing compressor was coupled to a turbo-blower, the exhaust from the low-pressure steam cylinder passing to the steam turbine; the turbo-blower takes air at atmospheric pressure, compresses it and discharges to the reciprocating compressor where the pressure is stepped up to 60 pounds. This combination has doubled the capacity and has shown a net gain of 17 per cent. over that which would have been secured had an additional reciprocating compressor been installed. Furthermore, it saved the expense of an addition to the building, which would have been necessary on account of the large space occupied by an additional compressor.

Mr. Baker:—Taking all factors into consideration, under certain conditions of fuel cost, the turbo-blower is a close second to the gas-blowing engine. The fuel consumption of the latter is affected by a number of different efficiencies;

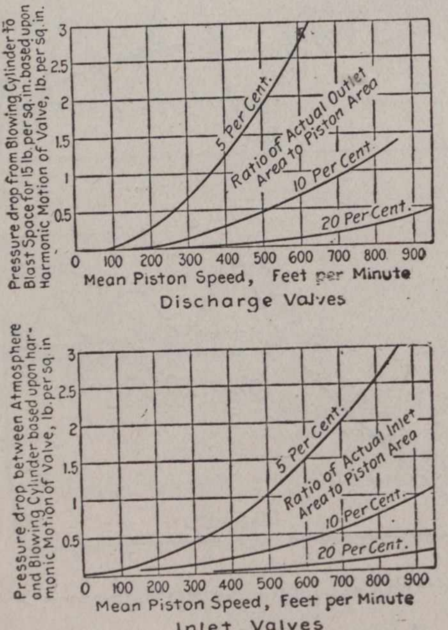

Fig. 4. Pressure Loss through Valves Due to Velocity Head

namely, the efficiency of the blowing tub, which may be called the compression efficiency, the volumetric efficiency and the mechanical friction of the blowing tub. The sum of these efficiencies is the shaft efficiency, which may be compared with the so-called shaft efficiency of the turbo-blower.

The compression efficiency is the ratio of the work required to compress adiabatically to that actually required in the blowing tub; this amounts to about 94 per cent. The losses are due principally to the inertia and friction of the discharge valves, the friction of air passing through the suction and discharge passages, and to late opening of the suction valve.

The volumetric efficiency has been actually determined by a long series of tests on various engines, and has been found to be about 89 per cent. The losses are due to defective clearance, friction of air through the suction valves, leakage of air past the valves and piston, and to the effect of preheating the incoming air.

The mechanical efficiency of the blowing tub is not easily determined, but was estimated at 90.4 per cent. These make a total shaft efficiency of 75.8 per cent., which may be compared with 68 to 70 per cent. efficiency for the turbo-blower.

Builders of blowing engines could take lessons from the pumping-engine manufacturers, and build engines with smaller discharge valves. The valves illustrated by Mr. Trinks are 18 or 20 inches in diameter and of a type which is unsatisfactory in water-pumping work. Although they will be more satisfactory in air work than in water pumping, the objections are of the same character and at high speeds are of the same validity as the objection to similar valves in water pumps. The difficulties could be overcome by substituting a large number of small valves of suitable material, about three inches in diameter.

As far as thermodynamics is concerned, the turbo-blower indirectly uses two and one-half times as much gas as the gas-blowing engine. Regarding the relative cost of the two types of installation, based upon actual figures, consider four or five 100-ton blast-furnace plants, with eight gas-blowing engines installed, six operating the furnaces and two spares, and six turbo-blowers, four operating the furnaces and two spares. Under such conditions it will be found that, taking the thermal efficiency, the constant operation and the fixed charges into consideration, the gas-blowing engine is in the lead, even with coal at $1.80 per long ton.

In isolated blast-furnace plants, however, where the gas has no value, the turbo-blower is the proper installation, especially in plants having one or two furnaces where a constant supply cannot always be depended upon. But for any large plant, particularly blast-furnace plants connected with steel works, it is out of the question to put in turbo-blowers.

There is no doubt that in large steel works it is possible to have electric installations which furnish power at a very cheap cost to the municipalities and industries in the neighborhood. In this connection the gas-blowing engines lead the turbo-blowers.

I cannot see any opportunity for turbo-blowers, with the exception of the one case which Mr. Johnson pointed out, but I have, however, a better suggestion to offer. This is to utilize the waste heat from the gas engine for generating low-pressure steam by which turbine blowers may be run to compress the blast for the furnace.

LARGE IRRIGATION PROJECT.

Work has just been begun on the irrigation of the Mesopotamian desert, a long projected scheme, and the first 3,000 laborers are at work with the preliminary preparations. The British contracting engineer, Sir John Jackson, famous for dock works, has control of the contract, with Arthur Noet Whitley, another Britisher, who has been second in command on the railway construction work across the Andes, as a commander on the spot.

The work is a huge one, for it entails opening a gap through the mountains, building watercourses, dams and reservoirs. Three great barges will be built, the first at Hindia on the Euphrates, whence the first section, irrigating 600,000 acres at a cost of $7,500,000 will be worked. It will then match the work the British government has done in the lower Nile in consequence of the building of the great Assouan dam. It is expected when a regular supply of water once more reaches the arid zone it will be worth at least $200,000,000.

THE STATUS OF GAS AND OIL POWER.*

By J. B. Klumpp.

The economy of operation of gas-power plants was shown in last year's report to be considerably better than that of steam-power plants, except possibly in those stations where steam-turbine units of larger sizes and most approved design were installed. It is believed that for plants of, say 2,000 horse-power and under, the fixed charges due to investment for gas-power plants, including producers, should not exceed the fixed charges of steam-power plants, including boilers, and it is also believed that the depreciation charges for gas-power plants should not be greater.

What may be considered one of the greatest incentives for the introduction of the gas producer and gas engine is the utilization of low-grade fuels which are unsuitable for use in steam-power development, such as the lignites of Texas, Colorado and Washington State, and the low-grade refuse fuels, as the "culm" of the anthracite-coal mines and the "bone" of bituminous-coal mines. From tests made by the United States Government, and also from the operation of plants installed in the above named districts, it is acknowledged that lignite coal with a high percentage of ash can be handled with efficiency, and from reports of plants in operation, both in this country and abroad, the tailings of coal mines having percentages of as high as 50 per cent. have been used with more or less satisfaction. In view of this fact, it is obvious that many gas-producer power plants will continue to be installed throughout certain sections of the United States where such low-grade fuels are in abundance and that central power stations will be erected to distribute electric power at high tension from these points.

The use of anthracite fuel has been successful in a great many types of gas producer and it is a matter of very little moment which type is adopted for the purpose of handling this kind of fuel—either the updraft, downdraft, suction or pressure type—but the use of bituminous fuels is more complicated and has necessitated the adoption of methods that will produce a gas free of tar and lampblack. For this purpose various manufacturers have so designed producers that the tar will either be consumed in the fuel bed, or if appearing in the resultant gas, will be removed by means of special tar extractors. Producers of this type are being made updraft, downdraft and double zone forms and it is fair to say that for a perfect utilization of the fuel at hand, certain modifications must be made in the design and operation of each type of producer to suit the local fuel conditions. In Europe, where the use of gas-producer plants has become more of a general proposition on account of the relatively high cost of fuels and low cost of labor, the adoption of the by-product installation is more prevalent where bituminous fuels are used than it is in this country. From such by-product installations a relatively high return can be made from the residuals in the shape of tar and ammonia, but this factor has not been seriously considered in this country, owing to the relative cheapness of fuels and expensiveness of labor; also on account of high cost of the plant necessary to work up these residuals.

During the last few years the design of the gas engine has been simplified in many ways and, while there have been no radical changes in the general type, the construction has been improved by added refinements in the details of the mechanism, and more particularly in the adoption of high-grade materials and the appreciation of the resultant strains and stresses that take place in these materials. This general tendency to improvement has enabled the manufacturers to lighten the engine, reduce the number of working parts, simplifying the machine as a whole and at the same time this general improvement in design and construction has increased the reliability and reduced the repairs of gas engines.

Changes in valve gear have been made by some German manufacturers in returning to the throttling governor. In the same country they also show a tendency to adopt the Lodge system of ignition, which system has no moving parts to the spark plugs, the current being supplied from storage batteries and intensified by Leyden jars, producing a system similar to the ordinary automobile system of ignition.

One of the objections to installing gas-engine units, introduced more particularly by the industrial people, has been the want of auxiliary steam for heating and other purposes, which auxiliary steam is so convenient when a steam-power plant is installed. The opportunity to increase the economy of a gas-engine plant by utilizing the waste heat of the engine jacket water and engine exhaust is apparent and the attempts to do this so far have met with more or less success, but further developments must be made before it can be successfully accomplished.

In discussing the internal-combustion engine, we must not omit those engines utilizing a liquid fuel directly in the cylinder. Such types of engine will always be in demand where the liquid fuels are obtainable at a reasonable cost. The gasoline engine may be included in this classification (this engine having its own special functions, when the high cost of fuel does not prohibit its operation), but in this discussion the heavy-fuel-oil engine only is considered. The method now generally adopted of obtaining power by the combustion of this liquid fuel creates excessive internal pressures in the engine cylinder, which necessitates a high-grade expensive and heavy engine being built to withstand the pressures. Their use in the past, however, has been very satisfactory, and improvements in design, now constantly taking place, are reducing both their weight and cost. Many engines of this type have been installed during the past year by the American Diesel Engine Company, recently reorganized and now of St. Louis, and the De La Vergne Machine Company, of New York City.

It is desired to bring before the association the fact that development on this line of construction is progressing, and that there are many instances where the gas engine and producer may be installed for our own central-station practice that will prove beneficial to the operator by the economies that will be obtained. The introduction of gas engines for central power purposes will be continued where gaseous fuel is obtainable, either as a byproduct, in the case of coke-oven operation, or where natural gas is available, as the installation of such engines will give economies far exceeding the utilization of the same fuel when consumed under steam boilers. But when such cheap gaseous fuels are not obtainable, the installation of a power plant in each individual case should be carefully studied and the installation, whether gas or steam, should be made on its own merits.

*Part of the report of the Prime Motive Powers Committee, presented at the recent convention of the National Electric Light Association.

A large crack in the walls of the new Victoria Museum, Ottawa, has been replastered but appears to be opening again. A determined effort was made to hide all traces of the big crevice. It was filled in from ceiling to floor, while the opening which has appeared right across the floor inside the entrance door was also closed. It has started to reopen, however, particularly near the ceiling, where it is already quite wide.

THE STREET OF TO-DAY AND TO-MORROW.*

By Guy Wilfrid Hayler, M.Inst.Mun.E., M.R.San.I.

In considering the street of to-day and to-morrow it might not be amiss to first consider the street of yesterday. Roads there have always been since pre-historic times, for man as a nomadic animal always desired to reach from one point to another as readily as possible. First, the beating of a track through the primæval forest, or over the moor, was possibly the first suggestion of what is now the modern street. Continuous traffic, the carrying of heavy loads, etc., incited the idea of a permanent highway, first composed of rough logs or stone, and then developing into a thought-out formation. The old civilizations of India, Egypt, Greece and Italy had their fine main roads over vast stretches of country, and the Romans have left a legacy behind them as the greatest of road makers of the ancient world. To carry their roads the most direct route, they not only overcame great engineering difficulties by piercing mountains and throwing bold arches over rivers, but on a scientific basis they laid the foundation of the art of road making. Roads came before cities, and not until the few congregated houses had developed into the city by long stages and through many eras, did the street as we know it arise. In the cities of ancient and mediæval times the street plan was rarely treated with artistic regard, large outlook or firm grasp, except perhaps in the instance of Piræus, which, as the seaport of Athens, was laid out by Athenian engineers. Blind, tortuous and narrow streets were the rule in them, relieved now and then by splendid temple or palace and noble squares. It has remained for modern times with great traffic and building considerations to grapple with, to insist on street reforms. A sense of civic responsibility has been aroused by the unseemly conditions prevailing, and out of this the passing of the Town Planning Act of 1909 may be considered as the forerunner of further legislation to secure to the municipality and the State the right of control in matters which have previously either been left to chance or else allowed to fall into the hands of those whose sole interest is land and property exploitation.

The streets of our already built towns and cities exist, and any quarrel with their widths, beginnings, terminations or general lay-out can at present only be remedied by expensive and cumbersome methods. In the suburbs and parts yet unbuilt it is to be hoped that the scientific principles of modern town planning will prevail. In both cases the street must be viewed, first, from the point of traffic considerations; secondly, building considerations; and, thirdly, æsthetic considerations.

Æsthetic Considerations.

The consideration of the street from an æsthetic standpoint is one which deserves more attention than it usually obtains. We are proud to consider ourselves a practical people, and, unfortunately, ideas of beauty are not bound up with this. Anglo-Saxons are too prone to consider Art as luxury, but it can be shown that "to clothe in an artistic form that which civilization has made useful in the public life" is in the end financially profitable.

But, apart from that, as the ideal street requires to be well planned and well constructed, it is the last human touch, that of harmony and beauty, which will give it character—as essential in the material make-up as in the individual. The example of the beautiful Continental cities is continually alluded to, and while their main principles may be possible of adaptation, it must not be overlooked that we can only evolve on our own lines. Other countries with other customs mean other ideas. The Latin peoples view the street as their larger home. Climate makes this possible with them, but for only a small fraction of the year would it be possible with us. A writer has said of the Parisian: "He comes downstairs to the street; he descends to his thoroughfare as the millionaire expects to descend to his breakfast-room or his study. Whatever the gloom of the house, his street catering to his need of color, variety, beauty and movement, helps him to feel good." If we view the city as Aristotle viewed it—a place "where men live a common life for a noble end"—we cannot but agree that the city can well afford to yield to so innocent and joyous a need.

In any consideration of the æsthetic needs of the street the natural beauty of trees, flowers, and grass must come first. The place of the tree in the street is only slowly being conceded in England. At present it is carried out in a most haphazard fashion, seemingly on the principle that any vacant space calls for a tree. This is surely a wrong way to proceed, as the fine air of spaciousness is constantly marred by uncalled-for clusters of trees, and while wide open space may be spoiled in this way, the planting of trees in thoroughfares of a less width than 80 ft. is, again, likely to be unsuccessful. But much depends on a regular system in street tree-planting, and due consideration being given to the main points which arise, consideration of individual merits of the case. Paris has over 100,000 street trees, and spends over £12,000 annually on their care and cultivation. But Paris has wide streets and boulevards, whereas our English towns have generally narrow streets, where, if the light was obscured by trees it would be extremely prejudicial. But we have very many thoroughfares which would well admit of tree planting, even business thoroughfares, and in London we may well look forward to realizing in the not distant future the "green girdle," at least round the Metropolis, so eloquently advocated by Mr. D. B. Niven. The trees planted in Paris are principally plane trees, sycamores, and chestnuts, while acacia has been introduced and thrived splendidly. The choice of trees is a matter of serious consideration, as so many of the existing specimens in our streets, struggling bravely on amidst countless disadvantages, lead the man in the street to regard the subject as a costly fad. Plane and poplar trees planted in the North of England have been failures, while successful in London, but it needs the advice of an expert in these matters.

The tree-lined street leads one to realize the position which parks, gardens and squares must occupy in the street planning of a well-ordered city. The first merit is, of course, the fact that parks are more and more essential as the lungs of a city, offering physical exercise, recreation and amusement to the thousands who perforce are compelled by the exigencies of modern civilization to spend the major portion of their lives in its midst. But beyond the physical merits, color in the street softens architectural outlines, and so adds to city beauty, and the clumps of park foliage, color and brightness of flowers, refreshing lakes, bring æsthetic charm into town life. Happily there is no need of argument for parks, but it would be well if the various parks of a city were made into a system by means of tree-lined streets or boulevards, connecting them with the city proper. At the same time, as parks are so often on the outskirts, it would be well if they were connected as far as possible in a circle of boulevards round the city. This would achieve to some extent the same result as Continental cities have already achieved by the great boulevards encircling their cities, on the lines of the old fortifications. Continental cities in the matter of their parks and gardens view them as public property in a way quite foreign to England, and they are rare-

*Abstracted from a paper read before the Institution of Municipal Engineers.

ly walled in or railed, but free access is allowed at all times. This privilege is rarely, if ever, abused, and one thinks if only the public in England were allowed a similar concession it would add much more to the enjoyment of city life, and the vandalism of which complaints are now made would gradually disappear. There should be no reason why the exclusiveness of the Britisher should come in when public property is concerned, and an unrailed park or garden would bring the spirit of Nature more into the street and the city than anything else could possibly do. How much more delightful the square of London would be if they were, at the most, guarded only by low rails, and likely enough a move in this direction in the case of parks owned by local authorities would lead to the opening out of the privately owned squares

Next to the part which natural surroundings play in the ideal street is the matter of advertisements. No more vexed question affects city life, and while there is a general consensus of opinion that the regulation of advertisements is urgently required very little is really done. The architect and artist have every reason to grumble because the advertiser who disregards the dignity and propriety of the streets degrades the best elements of their arts. Paris, Brussels, and Rome have restricted the advertiser in many ways, but the restrictions in England have not so far been strong enough to effect more than slight reforms. It is possible that the Housing and Town Planning Act may be used to regulate, restrain and prevent public hoardings, and in London the County Council seems disposed to put some check on the advertising displays on house-fronts. All this, together with the gradual adoption of the permissive by-laws of the Advertisements Regulation Act of 1907, may, it is hoped, lead in time to a better view being taken of the street in an æsthetic sense.

When offensive public advertising is abolished, it will naturally follow that the street embellishments will be better cared for and cultivated. The function and placing of statuary in the streets, which is almost non-existent in England—that is, in comparison with the Continent—will be better understood. Public statuary has an educative and cultural mission. As the Column of July in Paris, the Column of Victory in Berlin, the Statue of Liberty at New York have all served to keep alive national traditions in these various places, let us hope that the beauty of the new Victorian Memorial in the Mall and the proposed King Edward Memorial will awaken a new consciousness in our midst. One of the greatest signs of progress is the fact that the new Victorian Memorial has been erected in a wide public thoroughfare, and not in a park. English cities unfortunately have few open spaces capable of accommodating such a memorial, but with the better development of the street in the future the function of sculpture and the fountain is bound to be recognized. The Fountain of St. Michel in Paris is a striking example of how a city might grace the junction of two great boulevards.

The two last æsthetic considerations of the street are smoke and noise. The former is solving itself mainly by the aid of improved scientific combustion, but the latter is, unfortunately, increasing owing largely to scientific progress in locomotion. A writer in the press recently analyzed the traffic chorus in the Strand, and showed how the very nature of the street, the presence of innumerable side streets, narrowing of the thoroughfare, etc., was largely responsible for an increase in the noise of warning of vehicles. Indeed, all the various traffic considerations which govern the street help to create the nuisance of noise. The presence of two kinds of traffic—fast and slow—in our streets, and the condition of the road surface cause as much noise as the vehicles do by being imperfectly built. By the better development of the street as a traffic artery, the improvement of the road surface, and regulation and restriction of speed, alone will come an abatement of noise. Until then traffic must be tolerated on grounds of public safety.

The Street of To-morrow.

Progress towards the better street, in which the whole profession of the municipal engineer is so intimately bound up, must be on lines both logical and harmonious, and the demands for comfort and well-being must appeal to all as reasonable. The wish for a better street will always be visionary until the want of it is felt. The Civic Renaissance which broke over Italy in the fifteenth and sixteenth centuries was preceded by just such a rational movement. In the middle of the thirteenth century stone bridges began to span the rivers, and city streets and squares were paved with flags. In the fourteenth century the cities were a "spectacle of solid and substantial comfort," and the way, so prepared, heralded the Renaissance. The requirements of progress remain the same to-day, and with municipalities taking the first steps, perhaps unconsciously, in the making of the better street of to-morrow, they are helping in laying the surest foundations of the ideal city, and to give effect to the words of Ruskin, who, speaking of the blocks of London houses, intersected by railways, said: "It is not possible to have any right morality, happiness or art in any country where the cities are thus built, or thus, let me rather say, clotted and coagulated into form; limited in size, and not casting out the scum and scurf of them into an encircling eruption of shame, but girdled each with its sacred pomoerium and with garlands of gardens, full of blossoming trees and softly guided streams."

SHAKE AND SAVE.

The following interesting item, taken from the "Cement World," is certainly worth looking into:—

How much cement is lost by sticking to bags when they are empty? A large construction company, of Boston, Mass., recently conducted an interesting investigation on this subject, and found that they could make an average of 17½ cents per one hundred bags of cement used, by having them thoroughly shaken before bundling for return shipment, and recovering the cement. It was found that it decreased the number of bags a man would bundle about one-third to have him stop long enough to pull the bags over two sticks mouth down and give it a good beating. There were reported on this investigation 7,598 bags. The cost of shaking, bundling, and tagging was $22.44. As shown above, but one-third of this, or $7.48, should be charged as the expense of the cement saved, which amounted to 4,130 pounds.

As these shakings contained a considerable amount of dirt and dust, the tensile strength of the cement was of course reduced. A number of careful tests were made comparing the strength of the shakings with that of fresh cement, the result showing a loss of about 35 per cent. after a seven-day set. Consequently the 4,130 pounds of shakings would be equivalent to 2,664 pounds of fresh cement. This would equal seven barrels, figuring 380 pounds to the barrel. On the jobs on which the investigation was conducted, the cost of cement laid down was $1.41 per barrel, so that the recovered cement was worth $9.87.

The average freight paid for returning the bags on these jobs was 24 cents per hundred pounds; therefore the saving of freight on the 4,130 pounds of cement would amount to $10.91. Therefore an expenditure of $7.48 effected a saving of $20.78, a net saving of $13.30.

METHODS OF MAINTENANCE OF THE STATE HIGHWAYS OF MASSACHUSETTS.*

Before the advent of the motor vehicle, maintenance of state highways was of minor importance as compared with the construction thereof, but with the rapid annual increase in the number of such vehicles, maintenance has become a far greater problem.

Very few of the roads of the ordinary water-bound or of the gravel type will stand up many days under the traffic to which they are now subjected. Some of the roads built of local stone or other material that will in itself furnish a satisfactory binder, are still maintained by keeping their surfaces covered with sand; but these roads are constantly deteriorating, even where the motor vehicle traffic is comparatively light.

Some macadam roads built several years ago before the advent of the motor vehicle are still maintained with sand and remain in a fair condition, while roads that are recently built rapidly deteriorate. This difference in the action of these roads under traffic is not due to poorer methods or materials of construction, but can rather be attributed to the fact that, having been constructed several years before [illegible] destructive influence of motor traffic, the material in the road surface has become cemented together making it somewhat monolithic. Clearly, the most effective method of maintaining macadam roads under present conditions is to use some form of bituminous binder. That which has been used to the greatest extent with economical and satisfactory results during 1910 has been the heavy asphaltic oil. Surface application has been made during the year, consisting of ¼ to ½ gal. of asphaltic oil on 202.4 miles of road, and of tar on 16.9 miles. Of the above, 67.5 had previously been treated in a similar manner one or more times. In addition to the above there are 89.2 miles that have been treated previous to this year with asphaltic oil or tar, but have received no additional treatment this year, so that at the present time a total of 308.5 miles of state highway have received one or more surface applications of asphaltic oil or tar.

In the treatment of these roads practically every bituminous material now on the market has been used, the prices paid during 1910 for the material, delivered on the cars at destination, varying from 5½ to 13 cts. per gal.

Several conclusions have been reached, the principal of which is that, if the preservation of the wearing surface is considered paramount to the prevention of dust, a heavy bituminous material requiring heating before application is desirable.

Second, no bituminous material containing a large percentage of asphalt will adhere to a macadam road unless all dust and dirt is thoroughly removed from the same before applying the oil; and, furthermore, it is preferable that the stone surface be not extremely dry, but rather moist.

Third, better and more permanent results are obtained by the application of two coatings of ¼ gal. to the square yard than by one coating of ½ gal. to the square yard, allowing a few days to elapse after the first application before the application of the second coat.

Fourth, the distribution of the bituminous material under pressure on the surface of the road is preferable to allowing it to flow by gravity, as the application under pressure accomplishes a far more uniform distribution. It does not, however, increase the penetration to an appreciable extent.

*From the report of Arthur W. Dean, Chief Engineer of the Massachusetts Highway Commission, included in the annual report of the Commission for the fiscal year ending November 30th, 1910.

The process of applying bituminous material as a surface treatment on a macadam road is as follows. The road is first thoroughly swept, so that there are no particles or patches of dust or dirt covering the upper course of stone. All depressions are then filled by applying ¾-in. stone, bound with the bituminous binder that is to be used for the surface coating. The bituminous binder is then applied, heated to a temperature of approximately 180%, and distributed under pressure of approximately 75 lbs. to the square inch, using ¼ to ½ gal. per square yard. This is immediately covered with coarse sand, fine gravel or pea stone, and, if convenient is rolled with a steam roller. In the application of the oil it is the universal custom to apply the oil on one side of the road at a time, leaving the other side clear for traffic until the first side treated has been covered with sand. Following are the specifications under which a large portion of the oil used in 1910 has been furnished:

The oil shall be of uniform color, appearance, general character and viscosity, and must fulfil the following requirements:

(a) It shall not froth when heated in 100° C.

(b) It shall have a specific gravity of at least 0.97.

(c) It shall not contain more than 0.5 per cent. of dirt or adventitious mineral matter.

(d) It shall contain not more than 1 per cent. of matter insoluble in carbon bisulphide.

(e) It shall be at such viscosity that 60 cc. measured at room temperature (78°F. or 25°C.) shall when at 100°C. be not less than 250 seconds nor more than 500 seconds in passing the Lawrence viscosimeter, or 200 cc. measured and tested at the same temperatures shall be not less than 900 seconds nor more than 1,800 seconds in passing the Engler viscosimeter.

(f) When 20 grams are heated in a flat bottom dish 3 ins. in diameter for 21 hours in a well-ventilated oven kept at a temperature of 250 C., the loss in weight shall not be greater than 15 per cent.

(g) When subjected to a number of heatings at 250 C. in a well-ventilated oven, with intermediate separations of asphaltene, and matter insoluble in carbon bisulphide, until the final petroleum ether extract is not more than 10 per cent. by weight of the original sample, it shall show the following results, assuming also that this final 10 per cent. has the same composition as the 90 per cent. of the material examined; the total loss shall be not more than 35 per cent. by weight, and the amount of asphaltene in the original sample shall not be greater than 6 per cent. by weight, and the amount of asphaltene formed by this treatment plus that in the original samples shall be at least 58 per cent by weight of the original sample: the amount of matter insoluble in carbon bisulphide as a result of this treatment shall not be greater than 5 per cent.

The detailed cost of oiling one road, selected because the conditions were what are found on an average road, was as follows. This road was treated with about ½ gal. of oil to the square yard, in two applications of ¼ gal. each:

	Per sq. yd.
Cleaning and sweeping	$0.0056
Patching old surface	.0016
Cost of oil	.0319
Heating oil	.0031
Delivering oil	.0038
Distributing oil	.0029
Furnishing sand beside road	.0165
Spreading sand	.0073
Watering	.0012
Rolling	.0002
Supervision	.0025
Total	$0.0766

The average haul for oil on the above road was 2 miles. The sand for covering was furnished and hauled under contract, an average haul of about 2½ miles.

Extraordinary surfacing has been done on 37.6 miles of road. The most noteworthy section of this class of work was the resurfacing of the so-called Revere-Saugus State highway, or Lynn Turnpike. A contract was let late in 1909 for resurfacing this road, but only a short section was done during that year; and early in 1910 the contract was cancelled, and resurfacing was carried on by foreman and laborers in the employ of the commission. This road probably receives more varied and extensive traffic than any other state road. It was constructed of ordinary water-bound macadam in the year 1899. In the resurfacing of this road in 1910 a course of approximately 2-in. in thickness of crushed stone, mixed by ma- [illegible] asphalt, fluxed to the proper consistency, was spread on the road and thoroughly rolled with steam roller. Over this course was thinly sprayed a light coating of asphalt, which was immediately covered with pea stone. The preparation of the old macadam cost $0.809 per sq. yd., and the bituminous surface cost $0.904 per sq. yd., making the total cost of resurfacing $0.993. The cost of this work was increased very largely by the necessity of keeping one side of the road open for traffic while the other side was being resurfaced. This road is now in first-class condition, and should remain so for several years with but very little expenditure for maintenance.

In connection with bituminous work, attention is called to the cost and condition of sand and oil roads built during 1910 and previous years, also, to the cost of maintenance of sand and oil roads that have been built for several years. Sand and oil roads built by the "building-up" method, so called, are the least expensive in construction, but do not until after a lapse of some time develop a uniformly hard wearing surface, probably due principally to inequality of the distribution and penetration of the oil, and partially to the variation in quality of the sand used. Roads built by the mixing method are more uniform in character, but invariably have a surface which, while appearing to the eye to be smooth, is somewhat rough for teams and automobiles passing over them at the ordinary speed at which such vehicles are driven. Either kind of road, however, will in the course of time, with proper treatment, become smooth and even, as has been demonstrated by the condition of the sand and oil roads built in Eastham.

The earliest sand and oil road built by the State Highway Commission in Eastham cost in 1905 for construction $0.1692 per sq. yd. The subsequent expenditure up to the present time aggregates $0.1948 per sq. yd., so that the road up to the present time has cost $0.3640 per sq. yd., or about $3,400 per mile (16-ft. wide); and its condition has improved each year since construction, and is now excellent. The fact that this matter is brought particularly to the attention of the Commission should not be construed as advising that sand and oil roads are preferable to roads built of macadam or good gravel, but rather to show that in localities where neither stone or gravel can be found, suitable for reasonable traffic at reasonable cost, an excellent road can be secured, as has been demonstrated in the above-cited case.

HIGHEST BUILDING IN THE WORLD.

Plans have been filed for the construction at Broadway and Park Place, New York City, of the highest building in the world. From the curb to the apex of the tower it will stand 750 feet and contain 55 stories. The Metropolitan tower is 700 feet 3 inches, and the Singer tower 612 feet.

NOTES ON PERMANENT WAY AND HIGHWAYS AT CROYDON.*

By E. F. Morgan.

Croydon may be described as a large, scattered and hilly suburban town, with very attractive surroundings. It has thirteen railway stations within its area, and consequently contains several centres.

The subsoil in the southern portion of the borough is partly gravel and partly chalk, and that in the northern portion mostly clay.

The length of roads maintained by the corporation is 145 miles, and of bridleways and footpaths 15¾ miles, while there are also 35 miles of private roads not yet declared public highways. The carriageways formation includes the following: Flint macadam, 80 miles; ordinary granite macadam, 44 miles; wood paving, 13 miles; tar-macadam, 5 miles; and special sett paving, 3 miles. The footway paving used in recent years consists of mastic asphalte, York paving, concrete in situ, and "Nonslip" stone, while there is a large area of blue Staffordshire brick paving and ordinary tar paving laid in former years.

The present cost per superficial yard for resurfacing carriageways and construction of footways with the materials described are as follows:—

Carriageways.	s.	d.
1½-in. gauge Guernsey granite average thickness 3 in.	1	8
Kentish flints	1	0
Tar-macadam 3s. to	4	0
5-in. by 4-in. sett paving on 6-in. concrete foundation	14	0
Creosoted wood blocks on 6-in. concrete foundation, average	9	9
Tar painting and coating with coarse granite chippings and rolling with 7½-ton petrol roller	0	1.3

Footways.	s.	d.
Mastic asphalte of best quality 1 in. thick on 3-in. concrete	6	0
Nonslip stone	6	9
Concrete in situ	4	0
Tar paving	2	3
Relaying tar paving	1	9
Redressing old tar paving with boiling tar and coating with granite dust	0	1

The old tar-paved footways referred to are gradually being replaced by a more durable paving material, while miles of originally cheaply formed roads that possibly were able to withstand the light and infrequent traffic of former years are by degrees being reconstructed in a manner suitable for present-day traffic. For this purpose public loans for kerbing, channelling, and footway paving have been raised from time to time. The annual sinking fund and interest charged on repairs of this description amounts to £8,959.

The total net expenditure out of revenue for roads and footpaths for the present financial year ended March 31, 1911, is as follows: Scavenging, £11,908; watering, £1,998; repairs, £19,000; other general highway charges, £8,911, a total of £41,817. The loan charges amount to: Footway paving, £8,959; carriageway paving, £5,123; depots, £592; widening bridges, £1,018; a total of £15,692; making a total expenditure of £57,509.

*Paper read before the Institution of Municipal and County Engineers at a Home District meeting, held at Croydon, on April 22nd.

The main depots are situated at West Croydon, Norwood Junction and Thornton Heath, with smaller branch depots at Upper Norwood, Norbury, Addiscombe and South Croydon. The chief depot (at West Croydon) is equipped with workshops for wheelwrights, carpenters and smiths; paint shop, steam-roller sheds, and tarred-material mixing sheds. The Norwood depot contains tarred-material mixing sheds and a railway siding for delivery of material. Mess-room accommodation is provided for the highways employees at twenty-four points in the borough. Dust vans, slop wagons, trolleys, trucks, and timber wagons are built and kept in repair by corporation workmen with the best seasoned material, and reliable work and the most lasting results practicable are ensured.

The corporation do not own any horses. All horses and harness are therefore hired. The contract stipulates that the stables are to be in convenient parts of the borough, and are also to include shed accommodation for carts, etc. The average contract prices paid for hire of horses, etc., per day of ten working hours, are as follows: Horse, cart, harness and man, 8s. 9d.; horse, harness and man 8s. 3d.; horse, cart, and harness, 4s. 9d.; horse and harness, 4s. 4d. Regular drivers are employed by the corporation (for which special and regular horses are retained by the contractors) for dust vans, watering, and sweeping machines, and are paid 4s. 8 d. per day. The average number of horses employed daily is 120.

The average number of men employed is 500. All mechanics, platelayers, roller drivers, flagmen, yardmen, stokers, laborers, scavengers, etc., are paid by the hour Park keepers, museum attendant, and gardeners are paid by the week, and carmen and street orderlies by the day. The method of supervision is by leading working gangers, who become responsible to the district foreman for a limited number of men and carts from the time of leaving the various depots. A system of cost accounts is kept of all manual and team labor and materials used, thereby making it an easy matter to obtain a detailed cost of every description of work executed.

The work of substituting 32,000 super. yds. of granite-macadam on the main road, between Thornton Heath and Purley, with soft wood paving is now in hand. A proposal is also under consideration, which has the support of the Road Board, for the construction of a relief road 60 ft. wide and 3¾ miles in length, skirting the western side of the town, from a point on the main road at Thornton Heath Pond, and rejoining the main road at the southern boundary at Purley, at an estimated cost of £50,000.

Collection and Disposal of House Refuse.

Since 1906 the collection of house refuse has been amalgamated with street sweeping for the purpose of economy. The joint working has had satisfactory results, a saving having been effected in both. In 1906 the cost of house refuse collection amounted to £9,284 per annum, or 6s. 3d. per house, and the street cleansing cost £13,230 per annum, or £108 per mile. In 1911, with some additional 3,600 houses in the district, the cost of the collection is £6,872 per annum, or 4s. 2d. per house, while the street cleansing, with an additional 21¼ miles of roads, cost £11,908 per annum, or $83 per mile.

House refuse is collected in all districts once a week, and in the main business thoroughfares the collection is every other day, or, in some cases, daily.

As a check on the collection, and also to obviate complaints as to non-collection, the carmen are provided with printed cards to leave at houses where they are unable to obtain access or to secure an answer, making the fact known to the tenants. A charge of 2s. 6d. per cart load is made for collection of trade and garden refuse. Several shoots are at present available where the refuse is tipped and used in connection with brickmaking, etc., and an average quantity of 97 tons per day is disposed of at the destructor in Factory-lane. The quantity of refuse dealt with at the destructor during the last financial year amounted to 32,000 tons, and fifty-six carcases were cremated. The residuals (clinker, ashes, etc.), amount on an average to 27 per cent. of the weight of refuse burnt.

For the purpose of facilitating the disposal of the large amount of surplus clinker, a clinker grinding mill has been erected for crushing the material, and thereby increasing its marketable value. A ready sale has been found for the crushed clinker at good prices, and the material has also been useful in our own works. The tins and old metal, and other saleable material, are picked out from the refuse before it is burnt, and sold to contractors. The income derived from such sales during the last financial year was as follows: Clinker, ashes, etc., £679; tins and old metal, £162; other saleable commodities, £95. The cost per ton for burning, including loan charges, but deducting receipts, works out at an average of 1s. 4½d. The number of men employed at the destructor during the day is as follows: Four stokers, one engine driver, one hopper filler, two men at clinkers crusher, two men sifting clinker, one man in office, one foreman. Two men are employed to attend to the furnaces during the night. In addition to the above, the contractor who purchases the saleable refuse has generally eight men and a boy at work in sorting refuse before it is burnt. By arrangement these men also assist in filling the hoppers free of cost to the council.

Parks and Recreation Grounds.

The parks and recreation grounds owned and maintained by the corporation are thirteen in number, comprising 363 acres. The cost of these has been £98,240, and the cost of upkeep for the present financial year is £3,471. Several of these grounds consist of many acres of natural sylvan and woodland scenery on elevated positions, from which extensive and charming views are obtained over the surrounding country.

In seven of the grounds bandstands are erected, where music is provided weekly for a period of thirteen weeks commencing in June. In ten grounds, cricket and football pitches, hockey and net-ball grounds are provided, kept in condition and marked out, free of charge. For the use of tennis courts and bowling greens a charge is made. Free dressing-rooms are provided in several grounds. The number of games played for which special pitches were prepared last year was 8,475. Boating is also obtainable in one park upon a scale of charges, the net profit derived from this source during the last financial year being £142. For the purpose of encouraging cricket and other outdoor games for the youth of Croydon, the council, by sanction of the Mitcham Common Conservators, also prepare and maintain 27½ acres on Mitcham Common at the south-western boundary of the borough. One ground (Grangewood) situated at Upper Norwood was originally a private estate. It contains three lodges, which are used by the parkkeeper and gardeners, and the mansion, which is now used as a public museum and restaurant.

Private Streets.

Private streets are made up in accordance with sec. 150 of the Public Health Act, 1875, and also under two private Acts—viz., the Croydon Corporation Acts, 1884 and 1895. Under sec. 39 of the 1884 Act the corporation have powers, before commencing works, to collect and recover the amount of the estimated cost from the owners.

Unfortunately, for very many years, the necessity for durability in the construction of private streets was not fully appreciated, and consequently many roads—more especially those on a clay subsoil—are a constant burden with regard to maintenance and upkeep. In 1903 the author obtained authority to revise the private street works specification, with a view to obtaining substantial and sound construction in this direction, and although some opposition naturally followed on account of the increased cost at that time, the necessity for the altered arrangements is now generally recognized.

The specification provides for 12-in. by 8-in. specially dressed granite kerb; 12-in. by 6-in. granite channel, with one course of setts; mastic asphalte laid 1 in. full in thickness on a 3-in. bed of concrete; or 2½-in. slab paving of approved quality, laid on a bed of ashes consolidated to 3 in. in thickness as a foundation. The carriageway is specified to be not less than 1 ft. 4 in. in thickness, composed of 9 in. of hardcore, upon which is 3 in. of coarse gravel flints, thoroughly rolled in; 3-in. hand-picked field flints, rolled and coated with 1 in. of Kentish ragstone, the latter material forming a suitable surface for tar treatment. Two hundred streets, representing 22 miles, have been made up in this manner. The minimum width of road is 40 ft.—i.e., footways 8 ft. in width, and carriageway 24 ft.

The specification, of course, varies in the construction of the carriageway in accordance with the character of traffic to which the road dealt with is or may be subjected. In some cases tar-macadam, sett paving, or granite-macadam are specified. For footways in residential roads a slight change is now being introduced for the purpose of giving a rural appearance to the footways. The paving—either asphalte or artificial stone—is laid 5 ft. wide, the remaining 2 ft. to the kerb being paved with small granite spalls, collected from waste products of granite dressers. This forms a tessellated pavement with good foothold, and has the advantage of being both durable and economical.

The average cost of private street improvement works is from 11s. to 15s. per foot frontage. The work is carried out by direct labor, unless a request is made by frontage owners that the work should be executed by contract. The comparison between the cost of direct labor and contract work has been very favorable towards the former. In comparing the prime cost of direct labor with the lowest tenders, an average of 9½ per cent. has been shown in favor of direct labor.

Tar Surface Treatment.

The method adopted is as follows: A gang consisting of eight men commences operations by thoroughly sweeping the road surface. The material swept off is carted from the site; ⅜-in. gauge granite chippings are delivered and placed in small heaps on the footway at either side of the road, at the required distance apart, ready for covering purposes. A horse-drawn tar boiler of 320 gallons capacity, loaded with tar thoroughly boiled and ready for use, is then brought on to the centre of the road. The boiler is equipped with a 2-in. diameter outlet pipe at the back, which discharges close to the road level, and is provided with a tap that can be controlled and regulated by the man in charge of the horse attached to the boiler. Three of the men, by means of rubber squeegees 20 in. in length, commence to deal with the flow of tar from the boiler by spreading and rubbing it over the surface, the horse being steadily drawn forward. One man then commences to spread the chippings from the small heaps mentioned, thoroughly coating the tar. The remaining four of the gang go forward to continue the sweeping in advance of the tar boiler, and so the process is repeated. The chippings are then well rolled in by means of a petrol motor roller until the tar shows through. By this time the chippings are firmly fixed on the road surface, and the road is in fit condition for traffic.

It is found that three boilers will keep a gang of eight men constantly occupied. One pound of pitch to every 8 gallons of tar makes a satisfactory composition. The tar supplied by the Croydon Gas Company is of excellent quality, for the reason that it is free from water, and contains but a small percentage of ammoniacal liquors. This treatment has been found to be of value for the protection of the road surface from damage by storm water, while it minimizes the dust nuisance and decreases the cost of watering. The second season's application requires less tar, and when treated with a finer gauge of chippings produces an excellent surface.

During last season 45½ miles of roads of various widths, representing 613,292 super. yds. of carriage-way, was tar-surfaced at a cost of £3,322, or 1.3d. per yard.

Tar surface treatment is, of course, not applied to roads that are in need of repair, but to those that are in a more or less good condition, for the purpose of bringing them up to modern requirements, and although the cost per superficial yard is apparently small, it means a large sum in reality when the area covered is taken into account. An improved condition of road surface is obtained, but extra cost is involved in obtaining it. It is common knowledge that no branch of civil engineering, not revenue producing, is more subject to adverse criticism than the work of road construction and maintenance, and the difficulties to be overcome in carrying out improved methods without throwing extra burdens upon the rates are not at all times fully recognized.

Tar surface treatment means to some extent an extra expenditure on maintenance, but it has been accurately described as being "worth what it costs."

Permanent Way Construction.

The Croydon tramways, originally owned by a private company, were purchased by the corporation in 1900, and, under the direction of Mr. E. W. Monkhouse, of the firm of Burstall and Monkhouse, electrical engineers, Westminster, the lines were reconstructed and electrically equipped, the first section being opened for traffic in 1901. The length of route at that time was about 10½ miles, 5 miles being double track, and 5½ miles single track with the necessary turnouts; in all 17½ miles single track.

The main line is from the borough boundary at Norbury on the north to the southern boundary of the borough at Purley, about 5¾ miles. The branch lines lead to Thornton Heath, South Norwood, Selhurst, and Addiscombe. The rails (supplied by Messrs. Walter Scott, Limited, of Leeds), are of 7-in. girder section, 95½ lb. in weight, in 45-ft. lengths, and fitted with the Dick, Kerr ("Dicker") joint, specified to be manufactured from ingots of Bessemer steel, subject to the usual mechanical test, the chemical analyses of some of the blows being as follows.

Carbon. Per cent.	Phosphorus. Per cent.	Manganese. Per cent.	Sulphur. Per cent.	Silicon. Per cent.
0.40	0.07	0.95	0.047	0.008
0.47	0.06	0.83	0.041	0.009
0.45	0.06	1.01	0.044	0.005
0.45	0.07	0.80	0.048	0.005
0.46	0.07	1.01	0.042	0.006
0.48	0.07	1.06	0.054	0.010
0.48	0.06	1.10	0.058	0.009

The points and crossings were supplied by Messrs. Askham Brothers and Wilson, Limited, of Sheffield. The tie-bars are 2 in. by ⅜-in. with ¾ Whitworth thread. Drain boxes were fixed where considered necessary at that time throughout the system.

The track is paved chiefly with wood and partly with granite, neither form of paving being more than 4 in. in depth, the object being to enable the concrete to be brought over the flange and up the web of the rail as much as possible, for the purpose of keeping the rail foundations water-tight.

The method of track construction was as follows: After the necessary excavation the rails were set up in position on wire-cut bricks, fished, tied, bound and put to gauge, and adjusted firmly to precise level by means of thin wood packing. The foundation was then trimmed up to provide for a longitudinal block of concrete being formed under the rail flange, 6 in. deep and 1 ft. 9 in. wide, the space between being cambered up to allow a similar depth of concrete under the paving between and on either side of the rails.

Six to one concrete was placed and rammed as solid as possible under the rail, and after allowing this material three hours for shrinkage, a finer mixture of concrete, gauged five to one, was forced in from both sides under the rail flange, for the purpose of securing a tight and solid rail bed. Concrete was then laid on and over the rail flange and brought up the web of the rail to the required level to suit the 4-in. depth of paving.

The tie-bars were fixed 8 ft. apart, and care was taken that the slots in the rail web were kept sufficiently low to enable the tie-bars (by laying them flat) to be embedded in the concrete foundation, and by so doing to dispense with their obstruction and the cost of fitting and cutting and delay in the work of paving.

The wood paving consists mainly of 3-in. by 9-in. by 4-in. creosoted Swedish deal of best quality, cut and creosoted from selected deals under inspection. Basalt lava setts were originally used on gradients considered too steep for wood paving. Jarrh wood blocks were also originally used as a toothing on either side of the rails for the purpose of reducing the wear. The work referred to was carried out by direct labor under the supervision of the author, the cost being £3 1s. 3d. per yard of single track.

After completion, a lease of the whole undertaking was granted by the corporation to the British Electric Traction Company, the terms with regard to the track being that all renewals of rails, points, and crossings, etc., should be done by the corporation at the company's cost, and also that the company should pay £100 per mile of route per annum for upkeep of the paving between and for 18 in. outside the tramway rails.

The car-mileage on the main line since the opening in September, 1901, to February 17th last has been 12,002,656. There is a two and a-half minute service of cars. The average number of vehicles on the main road in the centre of the town per day in summer is 7,800 (excluding tramcars). In 1905 an extension was made from South Norwood to the borough boundary at Penge. This work was carried out in a similar manner, with the exception that the British Standard No. 2 rails and fish-plates (supplied by Messrs. Walter Scott, Limited, of Leeds), were used, and anchor-plates of the Cooper-Howard-Scott girder pattern on the railway bridge approaches. The points and crossings on this extension were also of improved design, and were supplied by Messrs. Hadfield's Steel Foundry Company, Limited, of Sheffield. The granite setts were of a special make, 5 in. wide and 4 in. in depth, with square sides, ends and beds, laid with joints as tight as possible, in a similar manner to wood paving, thus dispensing with the process of ramming. The cost of this extension was £2 17s. per yard lineal of single track.

The lease of the tramways granted to the British Electric Traction Company, Limited, was determined in June, 1906, and the undertaking has since been worked by the corporation. In 1906 a further short length of double line (1⅓ miles of single track) was laid at Thornton Heath at a cost of £2 9s. 7d. nett per yard of single track. After one and two-third years the use of this line was discontinued.

The total length of tramway route owned by the corporation at present is 11⅞ miles, made up of 7¾ miles of double track and 4⅛ miles single track, with turnouts, or 19½ miles single track. The maximum gradient is 1 in 16; other steep gradients are 1 in 19.40, 1 in 21, 1 in 26, 1 in 29.

The South Metropolitan Electric Tramways and Lighting Company, by consent of the corporation, in 1906-7 constructed a line from the borough boundary at Mitcham Common to the western boundary at Wallington to a similar specification as used in the then recent extensions of the corporation track, and by agreement the corporation keep the paving in repair, the company paying in the case of wood paving £200 per mile per annum for single track, and £300 per mile per annum for double track, and in the case of sett paving £150 per mile per annum single track and £225 per mile per annum double track. The sett paving on this line is of similar character to that previously described—viz., 5 in. wide by 4 in. deep, laid with tight joints.

Maintenance and Repair.

For three years after completion very small expense was incurred in maintenance. After that period it was found necessary to renew curved rails of 40, 41 and 54-ft. radii. For this purpose the British Standard No. 4 C section of rail was used in 1904. After three years' wear these were renewed in 1907. The hard-wood toothing blocks, through constant expansion and contraction, also gave trouble, and since 1905 are being gradually dispensed with and soft-wood blocks substituted. The basalt lava setts quickly succumbed to the action of vehicular traffic, and in 1903 they were discarded and granite setts substituted.

The rail joint became the cause of the cars "bumping" in 1905, and upon examination it was found that while the joint itself was perfectly tight, that portion of the joint forming part of the rail had not, on account of unequal hardness, worn with the rail end on either side. This has been remedied by filing down the defective joints with special planing files purchased from Thermit, Limited. Some 10,349 joints have been dealt with, at a cost of 8d. each.

In 1903-4 the track in South Croydon and Purley became waterlogged by reason of an underground stream known as the Bourne Water, which rises near the Caterham Valley. The flow of this water occurs about every seven years, and in the years in question the flow was greater than usual. The effect on the track was to loosen the rails in places, and anchoring had to be resorted to. Some 263 anchors were used on this account. In 1906, in some parts of the track, vibration began to set up in the rails. This has also been dealt with by fixing anchors at the affected points.

The method of anchoring the rails under a running road is as follows: The paving is taken up 1 ft. 3 in. on either side of the rail, and the concrete is removed from under the rail flange for a space about 1 ft. 6 in. by 2 ft. 3 in. The underside of the flange is well cleared of any adhering concrete, to enable a perfect attachment to be obtained. After the necessary drilling, the anchor (which consists of an inverted piece of rail, 2 ft. in length for rail joints, and 1 ft. 3 in. in length at intermediate points) is brought up tight to the rail flange. The bolts are adjusted, and the anchor embedded in the concrete. The paving is then replaced temporarily, and after allowing fourteen days to enable the concrete in which the anchor is embedded to thoroughly set, the paving is again lifted, the rail flange bolted down to the solid anchor, and the paving made good. The number of anchors fixed on the system up to the present is 2,255.

In 1904 corrugations began to appear in parts of the track, both on straight and curved rails, but more particularly on the curves. For the purpose of removing this defect, a rail-grinding apparatus was purchased from the National Rail and Tramway Appliances Company, of Liverpool. This consists of a carborundum block, 12 in. in length, fitted in a frame, and by attachment to a tramway motor water car the block is screwed down in position as required. The work of grinding is necessarily done during the night, and the average cost works out at £4 per mile of single track. For grinding manganese steel points and crossings when necessary to reduce irregularities at the joints, a petrol motor grinding machine (supplied by Messrs. Hadfield's Steel Foundry Company, Limited, of Sheffield) has been employed. This machine consists of a carborundum wheel, 12 in. in diameter, and 2 in. in thickness, connected by flexible shafting with the 4½-horse power petrol motor. One man is required to use the grinding wheel, and one man to attend to the motor.

It was not considered necessary ten years ago to pave the whole of the surface of the main road between the rail and the kerb, but where it was done—viz., in the centre of the town—the expense of keeping the 18-in. outside the rail in repair has been inconsiderable in comparison. In 1905 the 18 in. of paving outside the rail, where the paving did not extend from rail to kerb, required renewal to a large extent, the heavy vehicular traffic, combined with the macadum margins, being the cause of defects in the paving. The paving between the rails has generally worn satisfactorily, but frequent repairs have been necessary since 1905 on account of the rutting along the rail head caused by wheel traffic. With the object of minimizing this source of trouble and expense, an experiment is now being made by the use of a small device called "Antirut," which consists of a small metal insert 3-16 in. in thickness and 4¼ in. in length, fitted in between the joint of the blocks adjoining and at right angles to the rails, the blocks being grooved for that purpose.

The length of the new straight rail required for renewals on the system, to replace worn-out sections, has been less than 300 ft. lineal. From the date of opening the track has been kept under constant supervision, and immediate attention has been given to a rail showing signs of vibration. A statement of the cost of repairs and renewals since the construction of the track is appended:—

No large amount of relaying has at present been necessary, but, as the figures show, a large amount has been expended in upkeep. The present year's expenditure includes the completion of the costly work of renewing practically the whole of the points and crossings on the system. The cost per set, including the necessary new rail connection, bonding, reinstatement of paving, etc., works out at an average of £114. The author estimates that during the financial year ending 1912 the cost of upkeep (practically repairs to paving) will be 50 per cent. less than the present year ended March 31, 1911. Beyond the ordinary effects of wear shown by the rail itself, the track may be said to be in good condition, smooth running is obtained, while loose rails or joints are not in evidence.

As a result of experience obtained in watching the effect of car and vehicular traffic on the particular method of construction adopted in Croydon, and with a full knowledge of both its strong and weak points, the author has formed the following conclusions:—

(1) That all rails should be anchored—in some form—at each rail joint, and at average distance of 9 ft. between the joints. Drain boxes should also be liberally used throughout the system.

(2) That a paving not exceeding 4 in. in depth is most suitable for track work. Deeper paving after becoming worn a quarter of an inch below the rail must be renewed with new material. The paving is less costly; gives an equal surface; and allows the extra quantity of concrete over the rail flange to minimize the opportunity of water getting below the rail.

County Borough of Croydon.

Road Surveyor's Department.

Comparative Statement of Net Cost of Track Repairs and Renewals.

Year ending March	Mileage operated Single track. M. F. C	Rails. Cost £ s. d.	Rails. Per mile single track. £	Paving. Cost. £ s. d.	Paving. Per mile single track. £	Total Cost. Cost. £ s. d.	Total Cost. Per mile single track. £
1901	17 2 0	8 17 9	0.51	—	—	8 17 9	0.51
1902	17 2 0	2 1 11	0.12	—	—	2 1 11	0.12
1903	17 2 0	42 9 0	2.46	252 7 2	14.62	294 16 2	17.08
1904	17 2 0	795 9 2	46.11	431 4 0	24.99	1,226 13 2	71.10
1905	17 2 0	1,149 9 7	66.63	247 10 11	14.35	1,397 0 6	80.98
1906	17 7 3	1,222 19 1	68.27	1,041 7 0	58.13	2,264 6 1	126.40
1907	19 4 4	1,604 16 11	82.09	1,206 14 6	61.72	2,811 11 5	143.81
1908	19 4 4	3,185 6 0	162.93	1,144 7 9	58.53	4,329 13 9	221.46
1909*	18 1 1	2,251 12 4	124.14	1,309 3 10	72.18	3,560 16 2	196.32
1910*	18 1 1	4,380 5 10	241.50	1,501 16 5	82.80	5,882 2 3	324.30

*Reduction in mileage due to White horse Road section not being operated.

ÆSTHETIC TREATMENT OF CONCRETE.*

Simplicity of intention in constructional design may issue in a native or spontaneous æsthetic quality. An undesigned beauty reached without treatment is often attained by such a structure as the Forth Bridge or a ferro-concrete silo. Mediæval architecture grew up as a constructive method without æsthetic purpose and achieved results of great beauty. Is not the opportunity given by the new process of reinforced concrete building one that could be utilized for the erection of the much desired original and modern style of architecture? Are the new material and method together sufficient motive? Truthfulness of design to constructive purpose and elemental soundness of proportion, are these sufficient to provide that pleasantness to the eye which is desiderated? Four conclusions arrived at:—(1) We have no instructive guidance towards an unbiassed originality for a concrete architecture; (2) abstract principles like those invoked of proportion are of no assistance; (3) superficial

*Abstract of paper read before Professor Beresford Pite, F.R.I.B.A., before the Concrete Institute on Wednesday.

treatments, as by color, are insufficient for architectural expression, though valuable in assistance; (4) the texture of concrete surfaces modifies and imparts special character to any forms employed for architectural purposes. Therefore while modern considerations of utility and of novel constructional methods determine proportions and may ultimately develop æsthetic qualities, the scholarly and critical analysis and employment of traditional architectural forms suitably modified for execution in concrete is the proper method for the æsthetic treatment of concrete. A historical review of the development of some characteristics of Egyptian, Greek and Roman architecture furnishes proofs of the non-relation of æsthetic treatment to direct constructive facts. Idealized representations of ancient types form the basis of both Egyptian and Greek characteristics, while the Romans frankly separated the decoration from the practical purposes of architecture. In Gothic art, however, the constructive craftsman was the artist and the development of decoration is integral with building craft. In the other crafts of wood and plaster work motives are imitated from stonework and illustrate the modifications produced by the texture of the material into the design of details: of this the Elizabethan ornamental plastered ceilings originated from Tudor vaultings are illustrations.

Modern novelty of constructive method does not remove necessity for study of architectural development, but it will aid adaptation and modification, and thus pave the way for development. Modern Continental design is too eager to demonstrate elasticity possible in employment of form in unusual architectural relations. At home we still are safely and timidly putting brick and stone fronts to concrete buildings. There is a great future before concrete buildings, and it deserves that close and patient architectural study which, deriving from the past, will give certainty to the future æsthetic treatment of the material.

COMING MEETINGS.

AMERICAN SOCIETY FOR TESTING MATERIALS.—June 27-July 1. Annual meeting at Atlantic City, N.J. Secretary, Edgar Marburg, University of Pennsylvania, Philadelphia, Pa.

AMERICAN CHEMICAL SOCIETY.—June 28-July 1. Annual convention at Indianapolis, Ind. Secretary, Charles L. Parsons, Durham, N.H.

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; Secretary, A. C. D. Blanchard,, City Hall, Toronto. Meets last Thursday of the month at Engineers' Club.

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

VANCOUVER BRANCH—
Chairman, Geo. H. Webster; Secretary, H. K. Dutcher, 40-41 Flack Block, Vancouver. Meets in Engineering Department, University

OTTAWA BRANCH—
Chairman, A. A. Dion, Ottawa; Secretary, H. Victor Brayley, N. T. Ry., Cory Bldg.

MUNICIPAL ASSOCIATIONS.

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

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

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

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

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

UNION OF SASKATCHEWAN MUNICIPALITIES.—President, Mayor Hopkins, Saskatoon; Secretary, Mr. J. Kelso Hunter, City Clerk, Regina, Sask.

CANADIAN TECHNICAL SOCIETIES.

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

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

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

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

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

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

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

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

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

CANADIAN FORESTRY ASSOCIATION.—President, Thomas Southworth, Toronto; Secretary, James Lawler, 11 Queen's Park, Toronto.

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

CANADIAN GAS EXHIBITORS' ASSOCIATION.—Secretary-Treasurer, A. W. Smith, 52 Adelaide Street East, Toronto.

CANADIAN INDEPENDENT TELEPHONE ASSOCIATION.—President, W. Doan, M.D., Harrietsville, Ont.; Secretary-Treasurer, Francis Dagger, 21 Richmond Street West, Toronto.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. Frank D. Adams, McGill University, Montreal; Secretary, H. Mortimer-Lamb, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., Castle Building, Ottawa, Ont.

CANADIAN RAILWAY CLUB.—President, H. H. Vaughan; Secretary, James Powell, P.O. Box 7, St. Lambert, near Montreal, P.Q.

CANADIAN STREET RAILWAY ASSOCIATION.—President, D. McDonald, Manager, Montreal Street Railway; Secretary, Acton Burrows, 157 Bay Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto; Secretary, F. W. H. Jacombe, Ottawa.

CENTRAL RAILWAY AND ENGINEERING CLUB.—Toronto, President, G. Baldwin; Secretary, C. L. Worth, 409 Union Station. Meets third Tuesday each month except June, July, August.

DOMINION LAND SURVEYORS.—President, Thos. Fawcett, Niagara Falls; Secretary-Treasurer, A. W. Ashton, Ottawa.

EDMONTON ENGINEERING SOCIETY.—President, J. Chalmers; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, W. B. McPherson; Corresponding Secretary, A. McQueen.

ENGINEER'S CLUB OF TORONTO.—96 King Street West. President, Killaly Gamble; Secretary, R. B. Wolsey. Meeting every Thursday evening during the fall and winter months.

INSTITUTION OF ELECTRICAL ENGINEERS.—President, Dr. G. Kapp; Secretary, P. F. Rowell, Victoria Embankment, London, W.C.; Hon. Secretary-Treasurer for Canada, Lawford Grant, Power Building, Montreal, Que.

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

MANITOBA LAND SURVEYORS.—President, George McPhillips; Secretary-Treasurer, C. G. Chataway, Winnipeg, Man.

NOVA SCOTIA MINING SOCIETY.—President, T. J. Brown, Sydney Mines, C.B.; Secretary, A. A. Hayward.

NOVA SCOTIA SOCIETY OF ENGINEERS, HALIFAX.—President, S. Fenn; Secretary, J. Lorne Allan, 15 Victoria Road, Halifax, N.S.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, W. H. Pugsley, Richmond Hill, Ont.; Secretary, J. E. Farewell, Whitby,

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. Whitson; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

ROYAL ASTRONOMICAL SOCIETY.—President, Prof. Alfred T. de Lury, Toronto; Secretary, J. R. Collins, Toronto.

SOCIETY OF CHEMICAL INDUSTRY.—Dr. A. McGill, Ottawa, President; Alfred Burton, Toronto, Secretary.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, H. P. Ray; Secretary, J. P. McRae.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Wm. Pierce, Calgary; Secretary-Treasurer, John T. Hall, Brandon, Man.

WESTERN CANADA RAILWAY CLUB.—President, Grant Hall; Secretary, W. H. Rosevear, 199 Chestnut Street, Winnipeg, Man. Second Monday, except June, July and August, at Winnipeg.

CONSTRUCTION NEWS SECTION

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

TENDERS PENDING.

In Addition to Those in this Issue.

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

Place of Work.	Tenders Close.	Issue of.	Page
Burnaby, B.C., valves	July 24.	June 22.	68
Burnaby, B.C., steel pipes	July 24.	June 15.	66
Brantford, Ont., business block	July 8.	June 29.	908
Brantford, Ont., school	July 10.	June 29.	908
Danvers, Man., school house	July 5.	June 22.	878
Fort William, Ont., Y.M.C.A. building	July 8.	June 29.	908
Lindsay, Ont., steel and concrete bridge	July 5.	June 15.	70
Lebret, Sask., schoolhouse	July 10.	June 29.	908
Marshville, Ont., bridges	July 17.	June 29.	907
Midland, Ont., sewerage works	July 8.	June 29.	68
Montreal, Que., final filters and appurtenances	July 13.	June 15.	68
Moose Jaw, Sask., electrical equipment	July 24.	June 29.	908
Ottawa, Ont., Hudson Bay Railway	Aug. 1.	June 8.	64
Ottawa Ont. breakwater	July 5.	June 8.	64
Ottawa, Ont., pier and sheds, Halifax	July 20.	June 15.	68
Ottawa, Ont., harbor works, Courtney Bay	Aug. 10.	June 22.	68
Ottawa, Ont., terminal stations	July 11.	June 22.	878
Ottawa, Ont., wharf, etc., Melford	July 5.	June 22.	878
Ottawa, Ont., public building, Shawinigan Falls	July 5.	June 22.	878
Saltcoats, Sask., town hall	July 4.	June 22.	878
St. Catharines, Ont., water works	July 13.	June 22.	66
Sault Ste. Marie, railway	July 15.	June 29.	64
Toronto, Ont., macadam road	July 7.	June 29.	64
Toronto, Ont., seawall	July 17.	June 29.	68
Toronto, Ont., road machinery	July 7.	June 29.	64
Victoria, B.C., bridge work, Fraser River	July 10.	June 22.	878
Whitewood, Sask., sidewalks	July 15.	June 29.	908

TENDERS.

Ottawa, Ont.—Tenders will be received until July 17th, 1911, for the construction of a public building at Rock Island, Que. Plans, specifications and form of contract can be seen, and forms of tender obtained on application at the office of Mr. H. N. Lymburner, Supt. of Dominion Buildings, Montreal; at the Post Office, Rock Island, Que., and at the office of R. C. Desrochers, Secretary Dept. of Public Works, Ottawa.

Toronto, Ont.—Tenders will be received until July 6th, 1911, for all the trades, except foundations and structural steel, required in the erection of a Departmental Store for the Hudson Bay Company in Calgary. Plans and specifications and other information may be obtained at the office of Burke, Horwood & White, Architects, Toronto St.

Toronto, Ont.—Tenders will be received until July 12th, 1911, for concrete foundations of the new Government House in Chorley Park, Rosedale, Toronto. Plans and specifications may be seen at the office of H. F. McNaughton, Secretary Public Works Dept., Toronto.

Tavistock, Ont.—Tenders will be received until July 20th, 1911, for pumping equipment for the village of Tavistock. J. G. Field, Clerk of Tavistock, Tavistock.. (Adv. in the Can. Eng.)

Berlin, Ont.—Tenders will be received until July 11th, 1911, for building concrete abutments at Armstrong's Bridge on the Perth-Waterloo County line, three miles south of Millbank. For particulars apply to Engineers, Bowman & Connor, Berlin, Ont.

London, Ont.—Tenders will be received until July 10th, 1911, for the erection and completion of a Masonic Hall at London, Ont., which is to be of steel, reinforced and brick construction. W. G. Murray, Architect, Room 111, Masonic Temple Bldg., London, Ont.

Port Arthur, Ont.—The tenders for street paving were returned unopened to allow for tenders for all classes of pavement. Tenders will probably be called for later.

Grandview, Man.—Tenders will be received until July 10th, 1911, for the construction of about 18,000 feet of granolithic sidewalk in the town of Grandview, Manitoba. Full particulars will be supplied on application to Wm. Dickie, Secretary-Treasurer, Town of Grandview.

Brandon, Man.—Tenders will be received until July 17th, 1911, for pumping machinery. Harry Brown, Clerk of the Council of the City of Brandon, Man. (Adv. in the Can. Eng.)

Newdale, Man.—Tenders will be received until July 10th, 1911, for the erection of a four-room brick school at Newdale, Man. Plans and specifications can be seen at the office of W. A. Elliott, Architect, Brandon, and with C. Johnson, Secretary-treasurer, Harrison School, Newdale, Man.

Yorkton, Sask.—Tenders will be received until July 24th, 1911, for the construction of 3,500 feet of water main and 35,000 feet of sewer main in the town of Yorkton. McArthur & Murphy, Engineers, T. F. Acheson, Secretary-treasurer. (Adv. in the Can. Eng.)

Burnaby, B.C.—Tenders will be received until July 24th, 1911, for the supply of the special castings required for the municipality of Burnaby water supply. W. Griffiths, Clerk Municipal Council, Edmonds, B.C. (Adv. in the Can. Eng.)

Merritt, B.C.—Tenders are being invited for the erection, upon plans of Architect S. B. Bride, of the new Nicola Valley general hospital at Merritt.

Nanaimo, B.C.—Tenders will be received until July 21st, 1911, for approximately 14,450 superficial yards of asphaltic macadam or other approved paving. Allan Waters, City Engineer, Nanaimo. (Adv. in the Can. Eng.)

Vancouver, B.C.—Tenders will be received until August 10th, 1911, for the supply of all materials and labor in connection with the installation for the municipality of Penticton, of two 100 KVA, three-phase, 4,600 volt, 900 r.p.m. alternating current generators, direct connected to impulse wheels operating at 2045′ effective head; pressure pipe line of about one mile of 10-inch and one mile of 12-inch pipe switchboards, transformers, meters, distribution and street lighting system. F. H. Latimer, C.E., Penticton, B.C. (Adv. in the Can. Eng.)

CONTRACTS AWARDED.

Ottawa, Ont.—Woods and Co., of St. John, N.B., have been awarded the contract for the construction of a new station for the Intercolonial Railway at Campbellton, N.B.

Kingston, Ont.—The construction of concrete pavement, curb, and gutter work, has been awarded to Concrete Construction Co., Guelph, Ont., for $18,701.20. The work consists of 6,100 sq. yds., and other offers amounted to $19,799.20, $22,361.20, $26,418.10, $16,718.70.

Copies of the Canadian Engineer of the issue of June 8th are desired. By forwarding such copies to the main office, your subscription will be extended to cover another month.

Toronto, Ont.—Bishop Construction Co., Ltd., Montreal, Que., and Toronto, have been awarded the general contract for the D. M. Ferry building, Windsor, Ont. Henry Mason, Architect, Detroit, Mich. Contract price, Seventy-two thousand five hundred dollars ($72,500,00).

Winnipeg, Man.—The contract for the large round-house for the Grand Trunk Pacific in Regina was let to the Winnipeg firm of Carter, Halls & Aldinger, at a cost of about $75,000.

Moose Jaw, Sask.—The following contracts have been awarded in connection with sewer and water extensions:—Contract A:—Sewer and water extensions, Prairie Construction Co., Saskatoon, at $30,770; contract B:—Trunk sewer, Patrick Kilkenny, Ltd., Moose Jaw, at $37,653. Other bidders and their prices on Contract A were as follows:—Patrick Kilkenny, Ltd., Moose Jaw, $32,349; Navin Bros., Moose Jaw, $32,713; W. Manders, Moose Jaw, $36,500; City Engineer, $37,300. Contract B:—Navin Brothers, Moose Jaw, $37,713; W. Manders, Moose Jaw, $39,950; Prairie Construction Co., Saskatoon, $42,700; City Engineer, $41,869.

Calgary, Alta.—A contract is being entered into by the city with the Canada Cement Company for the supply of the material required by the city. The price given is $3.15 a barrel, but there is a rebate of 40 cents for the return of the bags, which brings the actual figures down to $2.75.

Vancouver, B.C.—The Northern Construction Company has been awarded a contract for building the Canadian Northern Railway between Hope and Kamloops, a distance of 163 miles. The work includes clearing, grading, the boring of three miles of tunnels, and involves an expenditure estimated at about $15,000,000. Several of the tunnels will have a length of about 2,000 feet near Yale and on the north side of Kamloops lake.

RAILWAYS—STEAM AND ELECTRIC.

The C.P.R. purchased 30,000 tons of rails from the Illinois Steel Co. The order did not go to the "Soo" or Dominion Steel Co., both companies being well filled with orders, and it is presumed that the C.P.R. wanted the rails for quick delivery.

Regina, Sask.—The G.T.P. are about to erect an 18-stall round-house. The officials of the road are desirous of having this work completed to accommodate the first traffic into this city.

Winnipeg, Man.—The Winnipeg Electric Railway furnish these figures. For the first four months of the present year the net earnings aggregate $615,402, as compared with $519,155 for the corresponding period of last year. The percentage gain for this period is 18.5 per cent. Monthly earnings as compared with those of 1910 are tabulated as follows:

	1911.	1910.	Inc. %
January	$157,795	$146,346	7.1
February	147,462	129,094	14.2
March	150,128	120,303	24.2
April	160,017	123,412	37.7
	$615,402	$519,155	18.5

Four months' increase, $92,247. In the early part of the year the earnings did not show a very marked increase as compared to that of later months. April showed the very extraordinary gain of 37.7 per cent., as compared with the corresponding month of the previous year.

LIGHT, HEAT AND POWER.

Welland, Ont.—The municipal council are taking the first steps toward purchasing the Welland Electrical Co.'s plant, with the intention of operating as a municipal institution. The committee have been authorized to secure an expert to place a valuation on the plant. When this information is secured the council will be in a position to take action.

Galt, Ont.—The water supply of the Hydro-Electric distributing station is insufficient for the cooling of the transformers. The return of the water into the well raises the temperature of the water to a degree which is not sufficiently cold to do the work required. To overcome this difficulty a four-inch wrought iron main will be laid to a spring 260 feet distant and the water pumped to the cooling chambers.

SEWAGE AND WATER.

Moose Jaw, Sask.—The municipal authorities are considering the employment of Sandy Creek as a future source of water supply. The water has been examined and the committee in charge are very well satisfied with its investigation and most optimistic as to the outlook in connection with this creek as a source of supply.

Calgary, Alta.—Plans are being prepared for an extension to the water supply; they comprise a large gravity line on the Elbow.

PATENTS.

The following patents have been recently secured through the agency of Messrs. Marion & Marion, Patent Attorneys, Montreal:—

Nos. Canada.

133783—Celestin Masse, Quebec, P.Q.; automatic closet flush.
133818—Thomas G. Allen, London, Eng.; acetylene gas generator.
133822—Messrs. Jonassen & Pytterud, Christiania, Norway; refining machine for paper pulp and the like.
133823—Messrs. Laurier & Monette, Montreal, Que.; conductors' waybills and checking systems.
133864—Delbert I. Cheley, Carnduff, Sask.; disk harrow.
133869—Percy D. Courtenay, Weymouth, Eng.; hat pin holders.

CANADIAN TRADE ENQUIRIES.

The following were among the inquiries relating to Canadian trade received at the Office of the High Commissioner for Canada, 17 Victoria Street, London, S.W., during the week ended June 20th, 1911:—

A Scottish firm of flax and cotton manufacturers are open to enter the Canadian market.

An English firm manufacturing a petrol lighting system, for which very great cheapness is claimed, desire to get into touch with firms of high repute in Canada, willing to take up their agency. They wish to appoint representatives in every province and in Newfoundland.

A Lancashire firm manufacturing rubber heels desire to appoint an agent at Montreal.

A North of England firm manufacturing rubber heel pads and tips, desire to appoint an agent for Western Canada.

The London export agents of an English grocery speciality house desire to arrange for the sale of their manufactures in Canada, and would like to hear from first-class agents.

Inquiry is made for the names of reliable parties in Canada open to take up an agency for the sale of brushes and brooms.

A Montreal correspondent makes inquiry for the names of United Kingdom importers of mica.

A Montreal correspondent makes inquiry for the names of United Kingdom manufacturers of aeronautical supplies for models and experiments.

Inquiry is made for the names of manufacturers of athletic clothing, boots, shoes, etc.; bicycles and accessories; boy scout equipment, boy scout books, crests and emblems; fishing tackle, golf clubs and golf balls; woolen jerseys and sweaters; pen, pocket, table and bowie knives; playing cards and games; razors and scissors, razor strops, shaving brushes, shaving materials; toys and games, and general sporting goods, requiring representation in Canada.

A correspondent who is shortly proceeding to British Columbia, would like to get into communication with United Kingdom firms of automobile, cycle and sewing machine manufacturers requiring representation there.