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FREIGHT TERMINALS AND FREIGHT HANDLING AT TERMINALS.

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(Continued from last issue, page 680.)

There are a number of different systems of telpher carriers in use to-day which are giving satisfaction, and this seems to be a method capable of development to give very efficient service. It has been proved that distance of travel is a comparatively small factor in the cost of handling by this is very hard to accomplish with an ordinary telpher, except by a method of "transferage" designed by Mr. W. McL. Harding, of New York, which will be described later.

Telpher carriers are now becoming such a regular feature in connection with freight handling that quite a number

Fig. 11.—General View of M., K. & T. Terminal at St. Louis, Showing Telpher Tracks and Switches; also Tramways Platforms and Hatchways.

telpher carriers, this fact enables a plant to be installed and operated at comparatively low cost, even where there is quite a long haul.

In a freight terminal it is always desirable that every square foot of space should be covered by the carrier and

of manufacturing concerns are prepared to install them in large houses guaranteeing a saving in the cost of handling that will pay the expense of the installation in from one to two years, depending on the amount and kind of freight handled. It has been asserted that certain manufacturers will agree to install overhead electrical appliances which would transfer freight 1,500 feet at a cost of 5 cents per ton

* With the Montreal Tunnel and Terminal Company.

for that portion of the work which is now costing more than 25 cents per ton.

A typical arrangement of an overhead telpher carrier system is that in operation at the Bergen, N.J., freight house of the Erie Railroad. A general plan of the houses is given in Fig. 8. It will be seen that there is one inbound platform and two outbound 1,400 feet long with a carrier running down the centre of each platform and connected with cross tracks and switches at each end. A detail view of the carrier truck and running track is shown in Fig. 9. This type is illustrated as being a general sample of a great number of telphers in use. Ten machines operating at one time on the three tracks keeping to the regular routes indicated by the arrows in Fig. 7, would be able to handle 1,000 tons of freight in a day of 20 hours, allowing each machine 6 minutes to make the round trip of 3,000 feet. The average speed of each telpher would be 500 feet per minute, including all stops for picking up and setting down the loads and the maximum travelling speed 1,500 feet per minute.

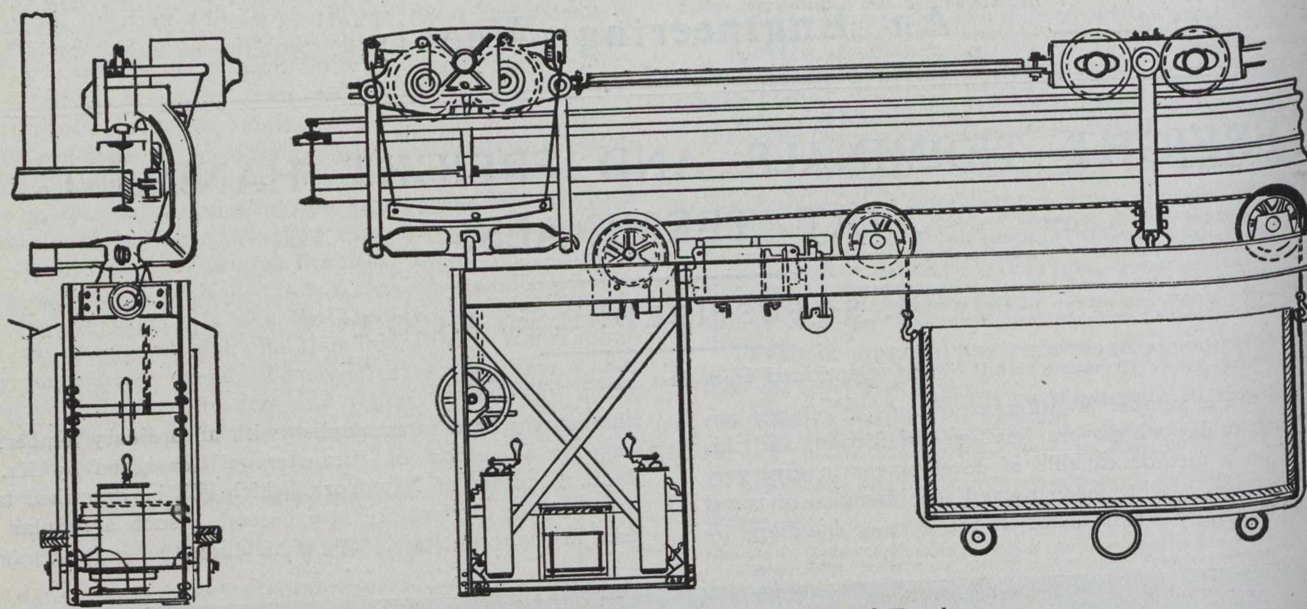


Fig. 9.—Details of Telpher Carrier and Truck.

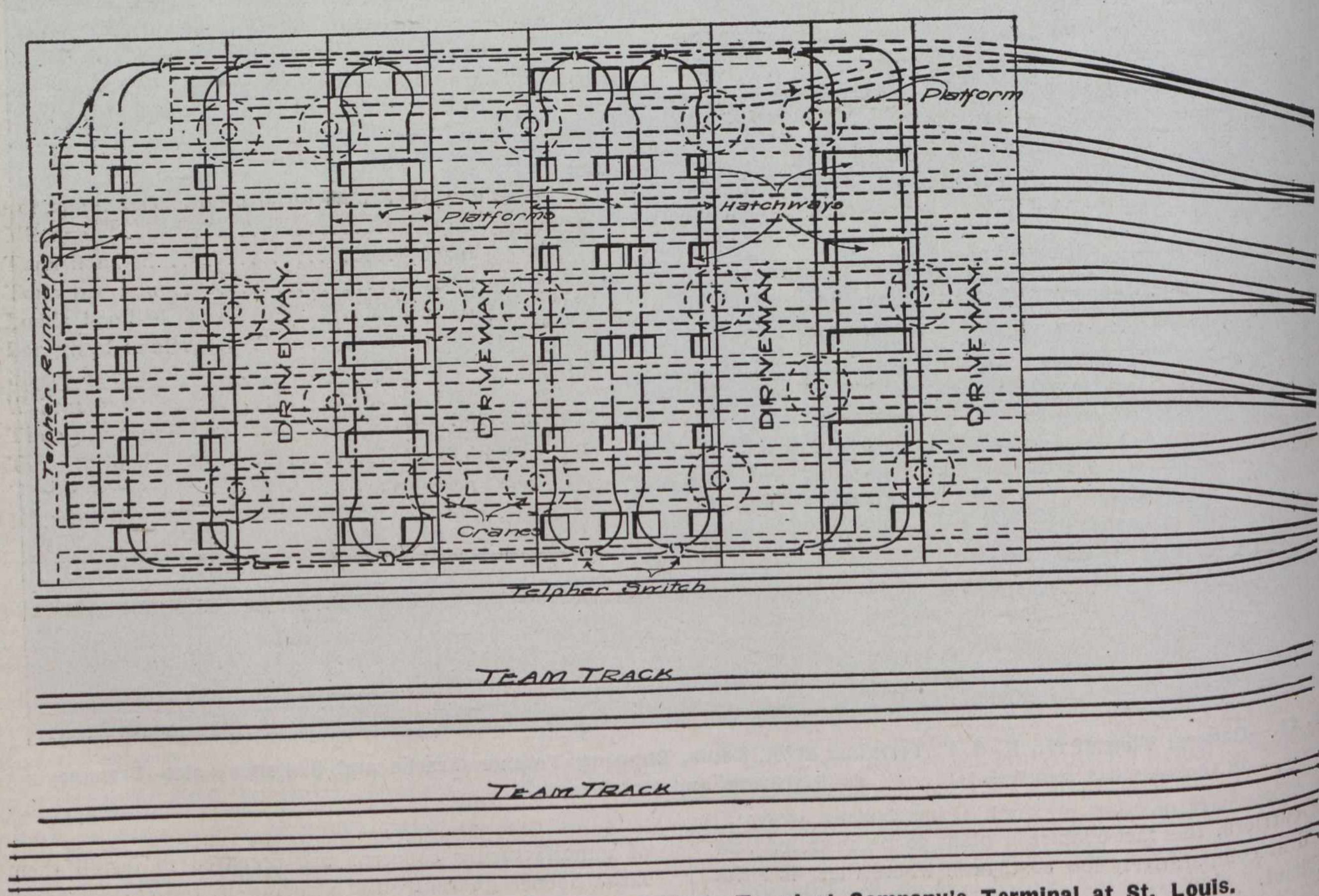


Fig. 10.—General Plan of Missouri, Kansas and Texas Terminal Company's Terminal at St. Louis.

These telphers are designed to carry a maximum load of 1 ton and an average of 1,000 lbs. for each trip. In operation the trucks carried by the telpher are wheeled right into the freight cars, where they are loaded up with merchandise and then wheeled out to the centre of the platform. The telpher carrier comes along overhead, picks up the load and carries it to the outbound cars, where it is lowered down opposite to the car into which the load is to be deposited. It is then wheeled into the car and unloaded from the truck.

The cost of handling in this manner had been figured at 5 cents per ton, exclusive of the labor cost of trucking the load from the car to its position below the telpher.

The Missouri, Kansas and Texas Terminal Company has erected at St. Louis a double deck freight terminal with the object of reducing the terminal costs, congestion and loss of time in handling L.C.L. freight.

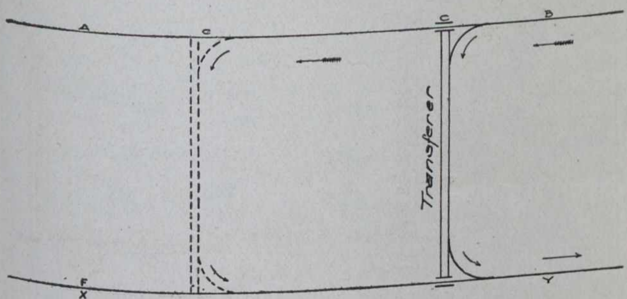


Fig. 12.—Transfer System.

The ground floor of this terminal is occupied by the tracks and cars, and the upper floor is kept entirely for the receipt, delivery and storage of freight. The freight is all transferred from the cars to the upper floor and vice versa by means of an overhead telpherage system, the runways of which are located over the second story. These runways run across the house at right angles to the tracks and in the same direction as the teamways and platforms. At each side of the house is a track connecting all the cross tracks so as to make complete circuits for the telphers. The switches at these end tracks are automatically operated by electricity. A general plan of the building arrangement is shown in Fig. 10, and a view of the team floor, telpher tracks and hatchways in Fig. 11.

The building itself is a structural steel building with brick walls and reinforced concrete floors. In plan its dimensions are 403 ft. by 232½ ft., and accompanying the freight house proper are team, switching and storage tracks and an automobile shed, the whole occupying two and a half city blocks. The shed and mechanical handling plant is designed to handle 100 tons per hour and 75 per cent. of the freight handled is outbound; the capacity of the shed is at present 77 cars, but provision has been made for future expansion. On the ground floor of the building twelve tracks enter from the open north end by ladder tracks with four branches. Each track has a maximum capacity of nine cars. The tracks are spaced in pairs opposite island platforms between the columns supporting the building. With this arrangement trucking through the cars is eliminated and a fixed uniform column spacing is obtained. The platforms are made wide enough to allow two trucks to pass each other.

Immediately east of the building are four team tracks with a capacity of 60 cars, 20 of which are served by a 12-ton gantry crane.

In the upper floor of the building there are four driveways 38 feet wide extending across the width of the building. Alongside the driveways are four platforms, two 82 feet wide and 230 feet long which provide storage space for inbound freight and two narrow platforms 42 feet wide and 217 feet long for receiving outbound freight. All the package freight is loaded up into small platforms or trucks on wheels, which in turn are picked up bodily by the telpher.

The telpher runways are located longitudinally above the wagon platforms, i.e., in a direction at right angles to the tracks on the lower floor. Two runways are provided for each of the 42-foot platforms and for one of the 82-foot platforms, the other 82-foot platform is supplied with four runways. The wheeled platforms and all the loads are transferred from the cars to the teams and vice versa, through a number of hatchways in the floor to the upper level. These hatchways are placed over the low level platforms and below the telpher runways, and so spaced that there is one hatchway for every two cars. Practically no trucking is done on the lower level because all the transferring of freight is handled by the telphers which pick up the load at one hatchway and take it to any other hatchway over the car to which the load is to be taken, here the load is lowered to the cars. At present there are 18 telphers, 16 of which are of 2-ton capacity and the remaining 2 are of 6 tons capacity.

There are 100 wheeled platforms or trucks each 4 feet wide and 6½ feet long, supported on two 10-inch side wheels. Small castor wheels at each end. An arrangement of ratchet lever is fitted to enable one man to move a full loaded truck even up an incline. The telpher machine can hoist these trucks at a speed of 60 feet per minute and travel with them at 500 feet per minute.

In addition to the telpher system there are 17 jib cranes attached to the building columns for loading and unloading the freight from and to the wagons. Fourteen of these are of 1 ton and three of 5 tons capacity.

Transferage.—These two systems of telpherage described have the disadvantage that the carriers must travel over fixed routes and therefore cannot cover areas. A system has been devised by Mr. McL. Harding which will overcome this difficulty by enabling the telphers to cover areas instead of lines. He gives this system the name of "Transferage System."

Fig. 13.—Electric Trucks Ready for Use in Freight Sheds.

A diagrammatic sketch illustrating this system is shown in Fig. 12. It is in effect a combination of overhead travelling cranes and travelling trolley or telpher hoists. The following paragraph is taken from Mr. Harding's brief description:

In Fig. 12 let the line A B correspond to the telpher track. A transfer or electric carrier can run in either direction. The transfer travelling in the direction of the arrow at the points C can pass upon the moving switch S and then upon the transferer, which is movable similar to a travelling crane. The transferer is not supposed to move with the telpher and load but can do so if necessary. The load can, therefore, be deposited anywhere in the space between the two lines A B and X Y. The dotted cross lines show the transferer after it has been moved to the left. There may be two transferers mutually connected upon the same tracks and sets of switches upon each side thus working from cross-overs.

This system seems to be capable of being adapted to suit the varying requirements of a freight terminal. The telphers can be driven at a speed of 500 to 1,000 feet per minute and the transferers, only having short distances to travel, could move at about 100 feet per minute. Trailers might also be used with the telphers and with this system the cost of hoisting, travelling and lowering should not be very high, even for long travel distances.

Motor Trucks.—In the last few years a number of electric storage battery trucks have been put on the market by different concerns and are being quite largely installed in freight terminals. Among the first trucks of this type to be put into use were those of the New York Central at the Grand Central station and the Pennsylvania New York terminal, which were used solely for the handling of baggage. Since then, however, they have been modified and varied into different forms suitable for handling package freight. This type of truck is illustrated in Figs. 13 and 14. Fig. 13 shows trucks ready for use in a freight station, and Fig. 14 shows one loaded.

These trucks have the great advantage of their flexibility, hence their ability to pick up a load at any point in the freight shed and then take it right into the car where the load is to be stowed. This feature, together with their carrying capacity, has in many terminals where they have been installed, enabled the freight handling force to be reduced as much as 50 per cent., with consequent reductions in the terminal costs of handling the freight. The Erie Railroad has at its Jersey City transfer some 20 trucks handling 45 cars of transfer freight and 75 to 85 cars of outbound freight daily, and after an exhaustive test covering the greater part of a year it was found that they were able to reduce the cost per ton from 39 cents to 29 cents, including the cost of running repairs to the trucks.

The following table gives details of the daily average service of motor trucks on a large New York pier:—

Mileage	13.6
Tons handled	225.0
Tons per hour	20.3
Loads handled	230.0
Length of haul	1,585 ft.
Pieces per load	29.8
Weight per piece	88.5 lb.
Time per round trip	2.89 min.
Time to load	58.00 sec.
Time to unload	60.3 sec.
Men in gang	8

A very complete series of tests were made at Providence, R.I., in connection with the performance of these motor trucks, and the accompanying table gives the figures obtained. In the first row the figures refer to the results obtained at the Providence transfer platform, the second is the outbound freight house, third is the inbound freight house, and the fourth is the Providence line pier, Fox Point.

A few general dimensions of the trucks generally in use will not be out of place. Their over-all lengths are usually between 9½ and 10½ feet, with a corresponding length of platform of 6½ to 8 feet. The widths of standard trucks

Fig. 14.—Electric Truck Hauling a Heavy Load of Freight.

varies from 3 to 3½ feet, while the height of the platform above the ground is about 20 inches. The wheel base is made 52 inches and the gauge varies around 3 feet as an average. They are made with varying capacities but the standard trucks as manufactured now do not exceed 3 tons in capacity with the weight of the truck about 1 ton. They are usually designed to give a maximum speed of 10 m. per hour, with a range of intermediate speeds.

The use of these trucks is naturally only in its infancy, but where they have been installed they certainly have shown marked decreases in the cost of handling freight.

Conclusions.—In summing up and studying the relative merits of the different systems of handling freight by mechanical means, each system will be found to have its disadvantages; for instance, in the case of an overhead telpherage system, the telphers are practically confined to fixed lines of travel, and the loads which they have to handle have to be

	* Hours in Service	* Distance (Feet)	* Weight (Pounds)	Average Tons P. Hour	* No. of Loads	Average Length of Haul (Feet)	Average Number of Pieces per Load	Average Weight per Piece (Lbs)	Average Weight per Load (Lbs)	* Total Number of Pieces	Maximum Load (Lbs)	Average Mins. Running per Load	Average Time to Load (Mins)	* Total Hours Loading & Unloading	* Total Hours Running	No of Men in Gang	* Wages of Men	Cost of Labor P. Ton Including Checking Clerk	* Wages, Not Including Checking Clerk	Cost of Labor per Ton Not Including Checking Clerk
1	87.4	175,930	501,956	2.87	402	438	13.5	92.4	1248	5419	4500	4.40	5.90	60.53	29.50	3 & 4	55.70	22.191	35.77	14.251
2	105.17	67,315	630709	3.00	527	128	15.4	77.7	1197	8086	5100	2.70	4.57	80.88	24.30	3	58.42	18.523	34.78	11.024
3	120.53	143840	742923	3.13	561	256	15.4	86.0	1324	8629	9000	2.75	6.90	94.78	25.77	3 & 4	76.13	20.495	49.22	13.250
4	55.19		717839	6.53	467	177	10.2	150.5	6080	4767		7.10					34.03		34.03	9.482

* Total for 13 days in #1 & #4.
" " 12 " " #2 & #3.

transferred into the cars by hand. This disadvantage can be reduced though by the use of a number of wheeled platforms such as are in use at the St. Louis terminal previously described.

Again, taking the use of electric storage battery trucks, they are able to overcome this difficulty of the telphers, but on the other hand, they have the disadvantage of requiring a great deal of platform space on which to make their necessary movements, which space might be advantageously used for storage purposes in the case of a telpher system. Another disadvantage of motor trucks is that in order to handle a large business it would require more motor trucks than telphers on account of the fact that the truck has to wait for the unloading and loading up, whereas the telpher carrier picks up or deposits its load and continues its journey to take another load, and it is continually doing efficient work. For this reason it does not seem as though the motor truck could be so efficient as a telpher system, as it can hardly be conducive to economy to have an expensive piece of machinery lying idle for some length of time. Possibly this difficulty can be overcome by the use of trailers, or with small platforms or removable bodies to the trucks. This is a development which no doubt will soon be put into practice.

In designing a freight terminal engineers should take great care to consider the question of mechanical handling of freight. Even if there is no intention of making such an installation immediately, provision should be made for the future handling of a growing business by mechanical means, by looking into the subject and ascertaining what method is most suitable to the particular conditions and requirements of the terminal in question and, if necessary, making such alterations to their design that will enable the necessary machinery to be installed when the business at the terminal warrants the additional expense.

The following table gives a few figures which have been gathered from various sources and which are of use in figuring on the design of a freight terminal:—

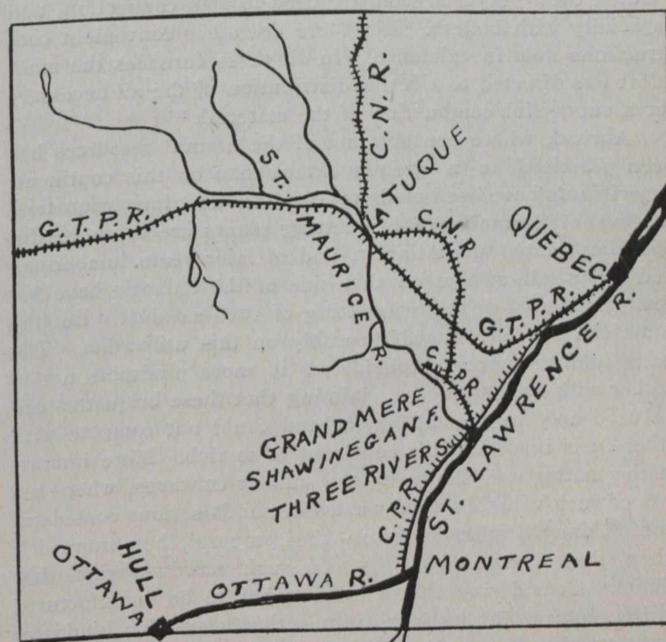
Average load on hand truck	225 lbs.
Average trucker's speed (per minute)	125 ft.
Average tonnage in a car (varying in different localities)	10 to 20
Average cubic feet in a car	1,200
Average width of drays	6 ft. 3 in.
Maximum width of drays	8 ft. 6 in.
Minimum width of drays	5 ft. 0 in.
Average length of drays and teams	20 ft. 0 in.
Maximum length of drays and teams	34 ft. 0 in.
Minimum length of drays and teams	13 ft. 0 in.
Average speed of telphers (per minute)	600 ft.
Maximum speed of telphers (per minute)	1,500 ft.
Average speed of motor trucks (per hour)	6 miles
Maximum speed of motor trucks (per hour)	10 miles

In conclusion the writer wishes to express his indebtedness to Mr. John A. Droege, superintendent of the New York, New Haven and Hartford Railroad for his kind permission to use his book "Freight Terminals and Trains" from which many of the diagrams and data contained in this article were obtained. and to the Sprague Electric Company, of New York, for the illustration of the St. Louis terminal of the Missouri, Kansas and Texas Company.

A concrete bowstring roof truss is a feature of the recently constructed Belleville Theatre in Paris, France. The truss has a clear span of 69 ft. and an overall height of about 15 ft. The top chord approximates a parabola and is connected with the bottom member by six vertical suspenders, spaced about 10 in. on centres.

ST. MAURICE VALLEY FOREST PROTECTIVE ASSOCIATION.

One of the most significant gatherings held in Montreal was the annual meeting of the St. Maurice Forest Protective Association held recently at the Place Viger Hotel. This organization, which is just one year old, marks the beginning of a new era in forest protection. Hitherto the matter of protecting the forests has been one between the individual limit holder and the government. In this field the advantages of co-operation are very great, but until the formation of the St. Maurice Association every lumberman battled with the fires on his own limits as best he could. A year ago the limit holders in this valley, seeing the waste and inefficiency of individual effort, got together and formed an association. They appointed a general manager who took charge of all the fire rangers and directed them as one army, posting every man where he could be of the greatest advantage. The association, which controls an area one hundred and sixty miles



Map Showing Location of St. Maurice Valley, Quebec.

long with an average width of one hundred miles, embracing in all seven million acres, taxed itself one-quarter of a cent per acre, and to the $17,500 thus raised the government of Quebec added $3,000. With this money there were opened or re-opened 525 miles of pack trails, there were purchased canoes, axes, shovels, tents, and gasoline motors for railway patrol, and a beginning made in erecting telephone lines and in connecting these with existing telephone systems. The result was that 97 incipient fires were promptly extinguished and the association came through the year with practically no loss. This year it is proposed to extend the trails, to connect up the telephone lines and to erect lookout stations from which watchmen may send out warnings to headquarters so that a sufficient force of men may be sent promptly to put out the fire. The officers for the first year were: President, Mr. Alexander MacLaurin, of Montreal; vice-president, Mr. W. R. Brown, of Berlin, N.H., and La Tuque, Que.; manager, Mr. H. Sorgius, of Three Rivers. Owing to the illness of Mr. MacLaurin which has necessitated a trip to the south, and the occupation of Mr. Brown with other features, these gentlemen (though both are enthusiastic over the work) retired and the new officers elected were: President, Joseph Dalton, Three Rivers; vice-president, S. L. de

Carteret, La Tuque; manager and secretary, H. Sorgius, Three Rivers.

One of the successful features of the gathering was the banquet at the Place Viger Hotel when about twenty-five gentlemen, members of the association or interested in the work, discussed an excellent menu and afterwards listened to a few pithy speeches.

UTILIZING SAWDUST.

By C. W. R. Eichoff, M.E.

The inconvenient process of burning this valuable waste, taking into consideration the fact that this sawdust, when moderately dry, has the same heat value as the wood from which it originates, has led to the design and construction of many different styles of furnace, which in some cases have brought a betterment and in others failure. Furnaces of the "Dutch oven" style are mostly used in this connection, and especially with boilers. But there are other convenient constructions now in existence. In all these furnaces the main effort was directed to a better distribution of the air necessary for a successful combustion of the material.

Abroad, where conservation of the natural resources has been practised to a greater extent than on this continent, experiments have been made to form this dust into briquettes. At present a number of briquetting plants are in successful operation across the Atlantic, and of later years lumbermen and other mill-owners on this side of the Atlantic have become interested in the briquetting of such sawdust. But the American has not looked favorably on this utilization. The large lumber concerns considered it more profitable not to bother with such a process, claiming that these briquettes can be used only to a small extent and could not compete with other fuels in which this continent is so rich. More interest in the matter was shown by the smaller concerns, where the loss of such valuable wood wastes demands serious consideration. Many owners took up the proposal, but dropped it when they learned the cost of such sawdust briquetting plants. Considering that a product has to be manufactured which requires for its fabrication either a suitable binder or great pressure not using a binder, it is essential that every part of such a plant be designed and constructed with the utmost care and skill in all its details.

Suitable binders are water-gas, pitch, tar, rosin, flour, water-glass and others of the same nature as used in the briquetting of coal. As these binders materially increase the cost of manufacture, their use was found prohibitive, and machines are now used that deliver the goods without the application of a binding material.

The sawdust in this process has to be perfectly dry before being put into the press. From the press the briquettes are transported automatically into a cooling room, and when cool they are hard and ready for transportation. Such briquettes are an excellent fuel for residence use in fireplaces and stoves, do not corrode, and leave very little ashes and soot. The cleanliness, rapid ignition, intense heat and odorless combustion make them a fuel preferable to the best wood. They are also the most convenient fuel for power house use in saw-mills and in logging locomotives, replacing coal or sawdust, which latter would take considerable space. They are also very convenient as a kindling material. The briquettes are of oval form, to facilitate ventilation when piled up.

Presses are built with a capacity of 24 briquettes a minute, giving 14,400 briquettes in ten hours, each briquette weighing about half a pound, which would be equivalent to a daily output of 3.6 tons. The power required for the driers and this press amounts to about sixteen horse-power. Another press has a capacity of nine tons a day, requiring 45 horse-power for the machine.

Use for Dry Distillation.—A very attractive process is the charring of sawdust and subjecting it to a process of dry distillation. The remaining charred material (charcoal) is then briquetted and yields a briquette of very high heat value, equivalent to the best anthracite coal. The process is practically the same as that used in the distillation of wood. The resulting by-products are an illuminating gas, which can be used to light up the mill, wood vinegar or pyroligneous acid, wood spirits or methyl alcohol and wood tar. The wood tar can be subjected to further treatment and yields creosote, benzol, naphthalin, paraffin, etc.

Sawdust has been used for the operation of gas producers for power purposes, in which cases it can be handled either in the loose form or in the form of briquettes.

Related to the briquetting of sawdust is the manufacture of artificial wood. This material is of great tenacity and strength, does not decay and is less susceptible to the action of the atmosphere than is natural wood. All this artificial wood can be sawed, planed and cut, but not split. The manufacture of it has become quite an industry abroad. Decorations for walls, ceilings and furniture are manufactured from mixtures the essential part of which is sawdust. These ornaments rival carved work and are a great deal cheaper, replacing those made of zinc, papiermache and artificial stone or cement.

Sawdust is the essential part of a stone-like material used for building purposes and also for paving blocks. These paving blocks are said to outlast the regular creosoted wood blocks.

Sawdust is pulverized and used instead of sand. In this state it can be colored, perfumed and used for many purposes, such as for sachet bags and the like.

Miscellaneous Uses.—The writer remembers the time when this fine sawdust was used in offices instead of sand and blotters. Its polishing qualities in the pulverized state for gold and silverware are well known. Further, from fine dust of colored wood, such as mahogany, etc., stains can be made to be used in imitating other woods. With linseed oils one can make a filler. The material for this filler is best obtained from the kind of wood on which it is to be used.

Sawdust and shavings are used for packing glassware, porcelain and other ceramic articles. In this state it must be dry, so as not to have a detrimental effect, especially on ceramic goods.

The use of sawdust for cleaning floors is too well known to need mention; not so generally known is its property of preserving eggs.

Any person handling oily and painty tinware should know that it is an excellent means for cleaning fresh paint from such tinware, rendering the vessels perfectly dry and clean.

Sawdust is used in the manufacture of insulating material for steam boilers and steam piping, and as insulating filler in fireless cookers, ice boxes, walls, etc.

It can be laid in cement floors instead of sand, rendering these floors warmer and more porous. It is used for roofing material instead of sand, making roofing paper lighter for transportation and so reducing cost.

Charred sawdust is an excellent means for filtration of liquids and has disinfecting qualities, making it more suitable for this purpose than ordinary charcoal. Added to brick it makes a more porous brick. Mixed with clay it can be used for the manufacture of filtering articles; this has proved to be an attractive process.

Sawdust is used to absorb moisture in building walls that are exposed to water. In the manufacture of cheap wallpaper and artificial flowers it is used in the form of a fine dust. Other uses are for cementation in steel mills, for cleaning purposes in the production of gas, in the manufacture of calcium carbide and carbonundum, and, in foundries, for pickling.

Everybody knows of its application in the manufacture of powder and explosives. Further uses are for floors in gymnasiums and riding schools, for the manufacture of paper, for slippery streets in winter, and for bedding in stables. Sawdust improves soil mechanically, and, when saturated with stable manure, it also works chemically on the soil and so improves it. Sawdust is also used in sawdust mortar (for moist places) and in horticulture to protect hot-beds, etc. With proper manipulation a good wood soil, so valuable in gardening, can be obtained. In the manufacture of soap for washing and cleaning purposes sawdust is also employed.

Very promising is the manufacture of sugar and alcohol out of waste woods; but these processes are not yet far enough advanced to be of commercial value and to justify large expenditures at the same time. Finally, sawdust is the only material now used for a cheap production of oxalic acid.

DISADVANTAGES OF CHEMICALLY PURE WATER AS A BEVERAGE.

Word comes of investigations carried on by a number of French naval surgeons into the use of chemically pure water as a drink, which may be of interest to some of our readers.

To make water chemically pure it has to be distilled, and the continued use of distilled water as a beverage reduces the strength of the physical organism, because, while it is free from all germs, it contains nothing but oxygen and hydrogen. The mineral salts are left behind during the process of distillation, and the mineral salts are really indispensable.

"As long as life persists in the body," these surgeons declare, "the elimination of mineral salts goes on, and this means the rapid demineralization of the organism."

Demineralization, it is explained, leaves one's system in such a state that the natural tendency is to become tubercular. It was found that there were numerous cases of tuberculosis among the young sailors of the French navy, and this was, after long investigation by the surgeons of the navy, attributed to the demineralization of the water.

The distilled water was used in the belief that it was best for the sailors, and the naval authorities were anxious to make every condition as healthy as possible. Just now the surgeons are studying the best means of treating the distilled water used aboard the ships with mineral matter. Of course, pure water is wanted, but as conditions are now it is held that ordinary drinking water would be even better than the chemically pure, if the latter was responsible for the increase of tuberculosis in the navy.

Few people continually drink chemically pure water, and for this reason the dangers could not well be learned until this discovery was made. There are a number of ways in which the germs in water may be eliminated and at the same time the mineral salts left in the fluid. Distilled water is scarcely palatable at the best, as it is these very necessary mineral salts that make it really palatable.

An effort is being made to provide further proof of the dangers of chemically pure water as maintained by the surgeons of the French navy by means of experiments on animals.

USES AND ABUSES OF WATER FILTRATION.

At the meeting of the New England Waterworks Association, Mr. G. H. Pratt, chemist of the Rhode Island State Board of Health, read an article on the above subject, an abstract of which we give below.

In connection with the uses of filtration of water, the author would first mention a few of the conditions which call for such treatment. For many years a town or city may have been using some water of comparatively good appearance as a supply, when suddenly there appears an unusual amount of typhoid fever among the people. Investigation demonstrates that it is the water supply which is common to these cases, and bacteriological tests prove that the water of the stream is polluted. Further investigation shows that there have been some cases of typhoid in a small village upstream, which has no sewage purification, and the excreta from these cases has found its way into the water supply of the down-stream neighbor. This experience—such a common one in the case of cities and towns taking their supplies from streams which have an increasing population on the watershed—leads to a full appreciation of the need of purification, and the resulting improvement in the supply with attendant betterment of the health of the community serve as evidence of one use to which filtration is put.

Another city may be enjoying an exceptionally good health record, especially as to typhoid fever, but the presence of a large amount of organic matter, giving the water a high color and a vegetable taste, causes criticism of the supply, and, regardless of analyses as to its sanitary purity, a large number of citizens persist in the contention that the supply is not what an up-to date city should be furnishing, until finally it is decided to filter the water by mechanical filtration in order to get a water of better appearance. The criticism above referred to immediately ceases, and the people receive a practically colorless water with comparatively no taste in place of the old familiar "organic brew." Thus æsthetic reasons may in many cases be sufficient cause for filtration, and the resulting output certainly justifies its use in these cases.

Similar to the above instance, the presence of different algæ may be the cause of disagreeable odors and tastes which demand filtration by methods which, in such cases, usually require aeration in conjunction with either double slow sand filtration or mechanical filters.

Some cities or towns and numerous small private supplies have been troubled, in cases where the supply is from driven wells, by the presence of iron in the water. This iron often exists in the lower state of oxidation or ferrous condition and upon contact with the air separates from the water as a "brick dust" sediment. Such supplies as this can be purified by methods involving aeration and oxidation of the iron before filtration or in the case of smaller supplies this has been successfully done by the use of a patented double filter which utilizes sand and animal charcoal.

Many industrial processes, especially bleaching and dyeing, require water of good color, low in iron, and free from turbidity. This requirement has resulted in the installation of a large number of filter plants, and the use of filtration for these purposes has been invaluable to numerous mills of this and other countries.

A great many times filtration is resorted to largely, if not entirely, to remove turbidity from the water. This is true of many western waters.

Having thus brought out different conditions which call for the use of filtration, the author will now cite certain concrete instances of illustrations which have been made for the different reasons above mentioned, and will present results which will show the efficiency of such plants when properly operated in improving the objectionable features which they were primarily installed to remove.

As instances of purification of supplies which have at times, prior to the use of filtration, been the cause of typhoid fever,—or, in other words, as instances to illustrate filtration for removal of bacterial pollution—we may cite Lawrence, Mass., and Providence, R.I. The Merrimac River receives sewage pollution at Lowell and at many other points above Lawrence, and its average bacteriological condition during 1910, to cite one typical year, as received on to the filters, was a total count of 9,100 bacteria per c.c., and the colon bacillus, which is taken as evidence of the presence of sewage contamination, was present in all the samples examined in 1 c.c. tests. The output from the plant (old filter) showed only 57 bacteria per c.c. and the test for B. coli communis was positive in only 8.3 per cent. of the samples examined in 1 c.c. tests. This shows a removal of 99.4 per cent. of the bacteria and a very marked improvement of the conditions as to the presence of B. coli communis.

The water supply of Providence is obtained from the Pawtuxet River, and prior to the year 1906 was used without filtration. During these years there were at least two typhoid fever epidemics which were traceable directly to contamination of the drinking supply of the city. The first was in 1882 and the second in 1888, the latter epidemic being caused by the fact that the attendants upon a case of typhoid fever had considered the river a means of quick disposal of the fecal matter of the patient.

TABLE 1.
PROVIDENCE WATER SUPPLY.
(1902—1905)

Source.	No. of Samples.	Average Turbidity.	Average Sediment.	Average Color.	Average Bacteria per c.c.	Remarks.
Intake	96	Slight to decided	Considerable .	46	4,000	
Tap in city. .	96	Very slight to slight	Slight	41	730	After reservoir system and distribution
Per cent removal	—	Appreciable ..	Appreciable ..	10.9	81.8	

(1906—1911)

Source.	No. of Samples.	Average Turbidity.	Average Sediment.	Average Color.	Average Bacteria per c.c.	B. Coli in 10 c.c. tested. Per Cent. of Samples.	Remarks.
Intake	144	Slight	Slight to considerable ...	48	2,525	92	
Tap in city...	144	None	None to very sight	28	60	1.7	After filtration, reservoir system and distribution
Per cent removal	—	Complete	Almost complete	41.7	97.5	—	

Agitation for purification immediately followed this last epidemic, but it was a number of years before the type of filter could be settled; but finally, in 1902, the contract was let for slow sand filters, and beginning with 1906 the city was furnished with filtered water. The results were noted at once, not so much from the standpoint of color—for as in the case with this type of filtration only a comparatively small per cent. of color is removed,—but by the freedom of the water from turbidity and sediment and by a reduction in the organic matter which had caused a marked vegetable odor and taste. Besides the visible improvement in the supply, the analytical study of the conditions before and after filtration showed the changes which were effected, and the excellent sanitary condition of the supply.

As an indication of the work which these filters have performed, I would present (Table I.) the following figures, showing the average condition of the river as to appearance, color, and bacteria for four years from 1902 to 1905 inclusive as shown by bi-monthly tests made by the Rhode Island State Board of Health, and for comparison similar figures on samples taken from a tap in the city covering the same period. These figures show that during this period the distribution system and reservoir storage effected some purification as shown by the slight improvement in the appearance, a removal of 10.9 per cent. of color and 81.8 per cent. of bacteria. Tests for B. coli communis were not made by the board at this time.

Similar figures are also presented (Table I.) showing the average condition of the river for six years subsequent to the use of filtration covering the years 1906 through 1911, and similar figures from a tap in the city for comparison. These figures show a marked improvement in the appearance of the water, a 41.7 per cent. of removal of color, as compared with only 10.9 per cent. due to the reservoir system prior to filtration, which would indicate 30.8 per cent. due to the filters themselves, and show a removal of 97.5 per cent. of the total number of bacteria present. B. coli communis was found to be present in 92.0 per cent. of the number of samples tested on the river, and in only 1.7 per cent. of those taken in the city during the filtration period, these tests being on 10 c.c. samples.

In the preceding tables one sample has been omitted in striking the bacterial averages for the tap in the city during the six years of filtration because of the fact that certain conditions which will be brought out later required the use of river water which affected that sample. The figures presented, therefore, are a true measure of the water of the city during filtration, and show the good work which has been accomplished in removing the bacterial pollution from the water.

The water supply in East Providence is taken from the Ten Mile River, which is a polluted stream receiving sewage from Attleboro, Mass. The condition of this river became such that in 1899, upon the recommendation of the State Board of Health, a mechanical filter plant was installed. The results have been highly satisfactory, showing a reduction from 8,160 bacteria per c.c. in the river to 33 per c.c. in the effluent, or a removal of 99.6 per cent., and complete removal of B. coli communis at all times. These analyses were of monthly samples taken the first eleven months of this year. In addition to this efficiency for bacterial removal, the plant at the same time reduced the color from 61 in the case of the raw water to 6 in the filtered water, or a removal of 90.1 per cent.

From the above, it has been plainly shown what can be accomplished by either slow sand filtration or mechanical filtration in removing dangers from bacterial pollution of water supplies, and it would seem to indicate very little choice between the two systems from the standpoint of removals effected, but with the advantage in favor of mechanical filtration from the standpoint of removal of color from water high in organic material. I will not attempt to go into a discussion of the relative merits of these two systems of purification, as that is not the subject of this paper, but I will simply say that each system is efficient under certain conditions, and local conditions should, in all instances, assist in the selection of one or the other method.

As an instance to illustrate the use of filters for removal of color, I would cite the case of the plant at East Warren, R.I., where during 1911 the color in the raw water averaged 74, and was reduced by the mechanical filters to 11, or a removal of 85.1 per cent. This plant is an illustration of a case where slow sand filters, while they would have delivered a sanitary output, in a short time would have experienced trouble from algæ present, and the output would not have given satisfaction to the consumers because the water would still have been highly colored instead of being practically colorless as is the present condition.

At Newport, R.I., there is a mechanical filter plant which has been installed to serve a double purpose of removing bacterial pollution and also to remove odors due to algæ. This is an up to-date plant in every way, using a system involving aëration, coagulation, and sedimentation, followed by filtration and then disinfection of the supply with hypochlorite of lime. The color of this water is comparatively low, and the resulting output is of good appearance, when the plant is being operated up to its possibilities, and the effluent is largely free from algæ and odor troubles. Likewise, the water is reduced as to bacterial count to a point where it is practically sterile.

Next passing to the question of concrete instances of installations for the removal of iron, I would mention the the plant at Marblehead, Mass., where by the use of aëration and filtration through sand the color of the water is improved from a rusty appearance to a practically colorless water, and the iron is reduced from 4.70 parts per million to .06 parts, or a removal of 98.7 per cent. One installation has come under my personal observation where the particular apparatus above referred to, which employs a double-cylinder filter using sand and animal charcoal, showed a removal of iron 8.00 parts to .10 parts, or 98.75 per cent. removal, with accompanying improvement in the appearance of the water.

In connection with the use of filters in the purification of water for industrial purposes, I would say that I have been touch with a number of installations where mechanical filters have been installed of different types which, when properly operated under proper supervision, turn out a product which gives entire satisfaction and shows purification in every way comparable with the results above given.

In treating the second part of my subject, namely, the abuses of water filtration, I would call attention to a number of ways of abuse which might lead to criticism of the whole idea of filtration, but in citing these cases where such abuses have occurred, for obvious reasons I will refrain from naming the installations in most cases.

In the case of slow sand filtration, one would consider it an abuse to attempt to purify a water high in algæ content which would result in clogging of the beds and a general upsetting of operating conditions at the plant. Of course, double slow sand filtration, especially if in connection with aëration, would qualify this previous statement, as aëration and a pre-filter would put the water in condition where it could be handled by the secondary filters, but where aëration followed by coagulation and sedimentation and filtration by mechanical filters would obviate all of the trouble due to clogging of the beds, it would seem as if it was abusing the at times satisfactory method of slow sand filtration to attempt to handle such a water by simple slow sand filtration.

It would also seem an abuse of this method to use it in connection with filtration of highly colored water, which would subject the method to criticism on account of the unsatisfactory appearance of the output.

Another abuse of this method in connection with operation of the filters is too quick changing of rates of operation, which tends to disturb the bacterial action going on at the surface with attendant poor results from an analytical standpoint. Also attempting to overcrowd the filters by running at too high rates is a practice which is sometimes met with, which results in diminution of the efficiency of the plants.

A slow sand filtration plant which would handle a given water satisfactorily might, as was the case in Providence, be installed without covering the beds. Such an installation as this in this section of the country is certainly an abuse of the method, for the result invariably would be what was found in Providence, that as soon as a hard winter struck the plant the beds would become covered with ice and it would be impossible to get at the surface to clean without removal of the cakes of ice. This condition occurred in Providence for a short time during February, 1907, finally necessitating opening the river gate, and the use of raw water for about two weeks or so before the weather moderated and before the ice could be removed. This experience resulted in steps immediately being taken to cover the beds, and this experience should serve as a lesson against such open installations in this section of the country.

In connection with slow sand plants, it is necessary to have competent help administering the plant, and one of the easiest ways to abuse a plant is to put it into the hands of inexperienced operators.

The above remark about labor in connection with plants is especially true in the case of mechanical filters where the supervision must be particularly close and where tests for color and alkalinity must be made to regulate the doses of chemicals used.

One of these plants which has come under my observation has operated for a number of years satisfactorily, turning out a water which had given entire satisfaction in connection with work in a bleachery. When I was consulted with regard to difficulties which were occurring, I found that the only trouble was that the parties in charge did not have an understanding of the question of alkalinity control of the plant, and the residual alkalinity of the effluent had dropped to a point where the water was passing the plant at times in an acid condition, or at best with an extremely low alkalinity, resulting in after-coagulation in the vats and throughout the system. This condition had been caused by the fact that a certain mill above them had been discharging a larger amount of acid wastes in the river than at the time their formula for operating was figured for them. Not knowing how to vary the dose from time to time, they had stuck to the old formula with the resulting poor work until corrective measures were taken. The addition of alkalinity to the water put the plant back into its former good condition.

At another installation concerning which I had been consulted, I found another condition which was causing trouble. The responsible man in charge of the plant for some reason or other was assigned to night duty, and he was attempting to make his control tests for color and alkalinity at night by artificial light. This, of course, gave far from accurate results. Another trouble at this plant was that the one man was expected to operate the flow of chemicals from the tanks which were located in the pump house and at the same time attend to washing the filters in a filter house which was located about one-eighth of a mile away. This spreading out of the plant made it impossible for the lone operator to properly attend to the dosing, and the result was that the flow of chemicals varied from time to time, with resulting poor output from the plant. Here, too, I found trouble in connection with the dosing, for the formula they were using to operate by had evidently been recommended without a knowledge of the water to be handled, and they too were operating with a too low residual alkalinity.

At another plant this same trouble as to a low residual alkalinity was found to exist, and the output contained undecomposed sulphate of alumina. Investigation showed that this operator was using an indicator solution many times too strong, and the alkalinity tests which he was obtaining were absolutely inaccurate. They also were not showing intelligence with regard to the necessity of increasing the doses of chemicals to meet varying conditions in the raw water. Corrective measures, recommended by the State Board of Health, and instruction of the operator, has resulted in this plant turning out one of the best outputs in our state at the present time.

At still another plant the biggest difficulty discovered when troubles arose seemed to be with the application of the chemicals, which in this plant required an extremely close control on account of an influence on the color of the filtered water as the residual alkalinity became too high. The engineer who was employed when this plant started was a man who had been for years pumping water out of the reservoir under the old system, and he could not be made to realize that careful supervision was necessary, and grossly neglected controlling the flow of the chemicals. These operating troubles immediately ceased when a new, competent engineer was put in charge of the plant.

The effect of an abnormal amount of organic matter or algæ in comparison with the color of the water sometimes has resulted in an under dosing with coagulant, as this additional amount of organic matter has seemed to prevent proper coagulation with resulting incomplete removal of the constituents which it was intended to remove, and the effluent has contained alumina and abnormal amounts of color and algæ. Proper dosing in view of the above-mentioned conditions has resulted in excellent work from this plant.

Another abuse is oftentimes attempting to operate a plant, with every possibility for good results, by methods which some men of limited experience may have used at some other plant, meeting entirely different conditions. Such cases have occurred under my observation, but have been capable of adjustment when instructions have been given which had in mind the type of plant and the raw water to be handled.

In connection with the operation of plants of the mechanical type, it is essential that the night man should be one who can be depended upon to stay awake, as a nap for an hour or two may result in throwing the whole operation of the plant out of adjustment for several hours. I have had my experience with this trouble.

Having thus brought out the conditions which call for filtration of water supplies and having shown the good results obtained with certain installations, I have also attempted to point out a number of ways in which filtration plants are at times abused. One or more instances of abuse are sometimes the only cases of filter plants coming to the attention of some people who immediately condemn the possibilities of the whole proposition of water purification on this meagre knowledge.

I would take this opportunity to warn you waterworks men against such conclusions from knowledge of some plant or plants which may not be doing all that has been claimed for them. I would also particularly caution that you do not take the cases of abuse which I have mentioned as indicative of any lack of confidence on my part in the ability of plants to purify water satisfactorily when the following essential points have been observed: First, have the choice of the system and the general outline and construction of the plant in the hands of competent consulting engineers who are experts in these matters; next, having obtained the plant properly constructed and designed to handle the water to be filtered, obtain the best possible men to oversee and run the plant after instruction from competent specialists, and if trouble occurs, call in advice to straighten out the difficulty instead of experimenting blindly; and last, throughout the whole operation of the plant bear in mind that you are handling an efficient machine capable of results, and not an automatic affair which can be left to its own resources.

HOT GALVANIZING.

A new hot galvanizing process has recently been patented by Professor Charles F. Burgess differing from other previous processes in that it covers the use of an alloy of zinc and iron for coating iron or steel. The alloy is composed of about 92 per cent. of zinc and 8 per cent. of iron, and is prepared in a powdered or granulated form. The alloy is applied to the iron and steel in a similar manner to the well-known process of sherardizing.

Arthur D. Little, Inc., of Boston, who touch upon this matter in their report as official chemists to the American Institute of Metals, say that it is claimed by the inventor that the finished coat is dense and silver white in color and electro-positive to iron, but less so than pure zinc, with the result that it does not corrode as rapidly as zinc, and yet at the same time protects the iron or steel equally well.

CONDENSER TUBES.

A number of interesting papers have been presented before the British Institute of Metals, among which might be mentioned "The Corrosion of Brass Condenser Tubes" by Mr. Paul T. Bruhl. This paper is the result of a thorough study of this troublesome problem, and brings out certain very interesting conclusions arrived at by the author. "In this connection attention should be called," says Carl F. Woods, of the staff of Arthur D. Little, Inc., chemists and engineers, of Boston, "to the proceedings and the report of the corrosion committee of the Institute, which was opened a year ago with a view to carrying out an exhaustive and authentic research on the corrosion of brass and bronze. The committee have decided to erect in Liverpool a plant in which the conditions of marine condenser service should be as closely imitated as possible. The plant is to consist essentially of four cast-iron tubes, each fitted with tube-plates to carry twelve condenser tubes, these iron tubes representing four small independent condensers. The condensers will be connected direct to the exhaust of a small engine, which in turn will drive a circulating and vacuum pump for circulating sea water through the condensers. Each condenser will be fitted with the same kind of tubes, and the committee has decided for the first set that one condenser shall be equipped with the so-called "Admiralty" mixture with a tube plate of naval brass, the equipment being carried out with the same extreme care insisted upon by the "Admiralty" practice. The second condenser will represent the best class of commercial practice, the tubes being 70-30 mixture and the plates of yellow metal. The exact equipment of the other two condensers had not been decided upon at the time of the committees progress report, but they will be compositions representative of commercial practice. The results obtained from careful experiments carried out in this way should be of the utmost value, as it should be possible to practically duplicate service conditions and at the same time to control the various conflicting conditions in such a way as to arrive at definite, well-founded conclusions

POWER SUPPLY ON THE RAND.

By A. E. Hadley, M.I.E.E.*

[NOTE.—The Victoria Falls and Transvaal Company, Limited, was formed at the end of 1906, with the object of supplying power in South Africa and Rhodesia, and of acquiring the concessional rights to develop the Victoria Falls. Mr. Hadley read a paper on this power development work recently before the Institution of Electrical Engineers, Great Britain, and it is an abstract of this paper which we publish below.—Ed.].

Under the original proposal a supply to the Rand was to be given partly by transmitting power from the Victoria Falls, 700 miles distant, and partly by steam generating stations located on the reef. The author became associated

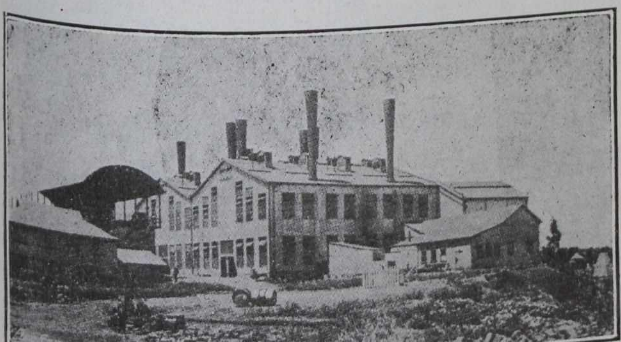


Fig. 1.—Exterior of Generating Station at Simmerpan.

with the company shortly after its formation, and after its original proposal had been modified through giving up the plan to supply part of the requirements of the Rand with power from the Falls.

The great demand for power on the Witwatersrand has arisen through the extraordinarily successful development of the gold mines on the reef, which, although only discovered in 1886, now produce 33 per cent. of the world's output of gold. Further, it is estimated by the leaders of the gold-mining industry that the work of raising gold will still be in progress on the Rand 100 years hence.

Turning for a moment to the history of electric power on the Rand, a few details will be of interest. Siemens and Halske were the first to obtain a concession in 1894, and formed the Rand Central Electric Works, Limited, in 1895, which had a plant aggregating 3,200 kw. capacity in 1906. Another concession was obtained by the Simmer & Jack mine in 1897, from which the General Electric Power Company was estblished in 1906 with plant having a capacity of 2,500 kw. In 1905 Messrs. Lewis & Marks, having in view the possibility of supplying the Rand from their coal-fields at Vereeniging, 35 miles south, commenced obtaining wayleaves for a pole line, while certain European manufacturing companies sent out representatives to report on the prospects.

The Victoria Falls Company ultimately took over the two existing supply companies in 1907, and purchased the Vereeniging wayleaves from Messrs. Lewis & Marks, at the same time entering into an agreement with them for the right to establish a power station at Vereeniging. In 1907, pending the installation of modern plant, a supply totalling 4,000 kw. was given from the existing steam stations which had been purchased.

As soon as it was appreciated that a cheap power supply was available the mining groups entered into contracts with the company, and the demands for power have since increased so quickly that it has throughout been the greatest difficulty for the company to raise capital and install plant rapidly enough to satisfy the demand.

In 1908 the largest group of mines, viz., that controlled by the Rand Mines, Limited, and Messrs. Eckstein & Company, decided to change over their mines to electric driving. In addition to the supply of electricity to this group of mines, the conditions called for the supply of compressed air for working the rock drills.

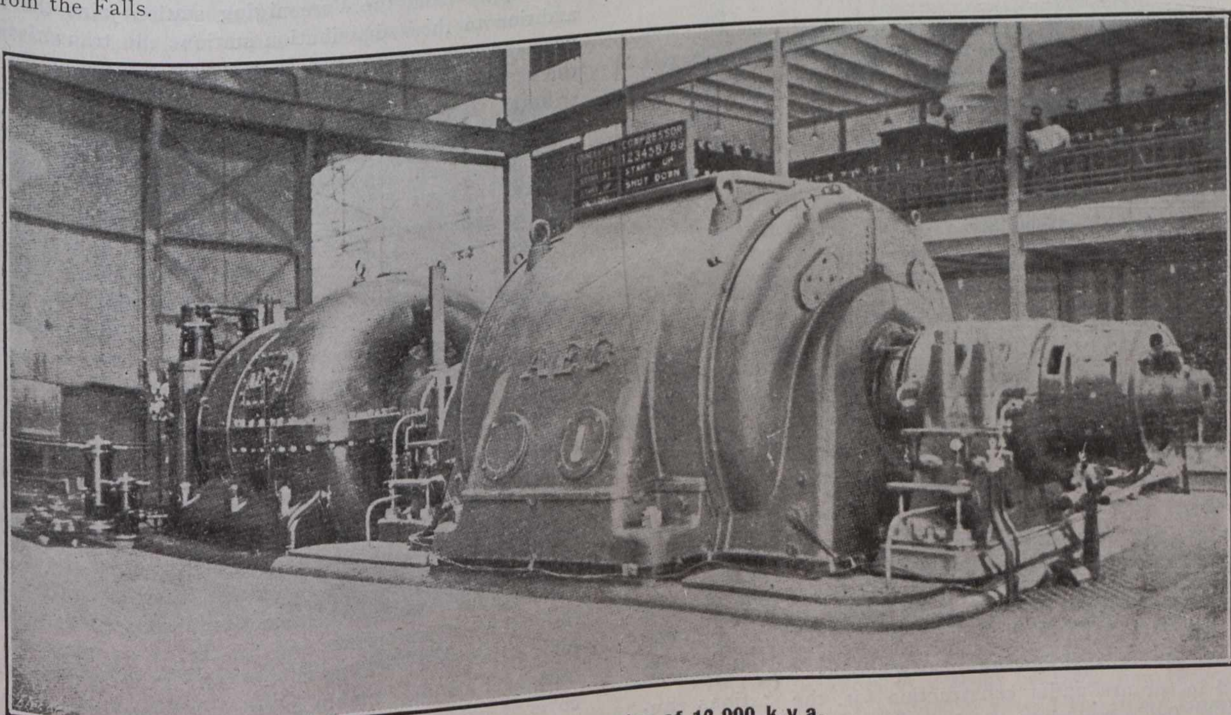


Fig. 2.—Turbo-Generator of 12,000 k.v.a.

The peak load of the combined undertaking has reached 88,000 kw., and the sales average 1,350,000 units per day. These figures include the sales of compressed air to 10 mines. The air units represent practically the same amount of energy as if these 10 mines had converted their compressors to electric drive and purchased electricity. When the further

* Managing Director of the Victoria Falls and Transvaal Power Company.

demands for power which have already been notified are met by the plant now on order, the sales will reach 2,000,000 units daily. The monthly load factor, based on the hour of maximum output, varies from 70 to 74 per cent.

The supply is furnished to all mining consumers at 2,100 volts and 525 volts. The necessary step-down transformers and switchgear are provided by the power company, while the consumer supplies the sub-station building and pays the power company a sum equal to 2 per cent. of the power bill to cover the losses in the step-down transformers.

The standard price in mining contracts covering not less than 12 years is 0.525d. per unit, as long as the monthly load-factor is above 70 per cent., the load-factor being based on the hour of maximum consumption. This price is subject to periodical revision depending upon the cost of production, and further, a participation with the consumers in the profits of the business after a due return has been paid on capital is also provided for. In case of failure of supply the consumers are entitled to a payment from the power company of 7s. per hour for each 100-kw. put out of commission.

The introduction of these prices on the Rand has reduced the cost of power to the mines by 40 per cent., and has reduced the cost of production of gold by an amount varying from 6d. to 1s. per ton of ore milled. It has further resulted in considerable saving of capital expenditure on plant, which in the case of a new mine may amount to £100,000.

The area over which a power supply has to be given lies within a strip about two miles broad and stretching 50 miles from east to west. The total power used by the mines at the present time is estimated at about 400,000 horse-power.

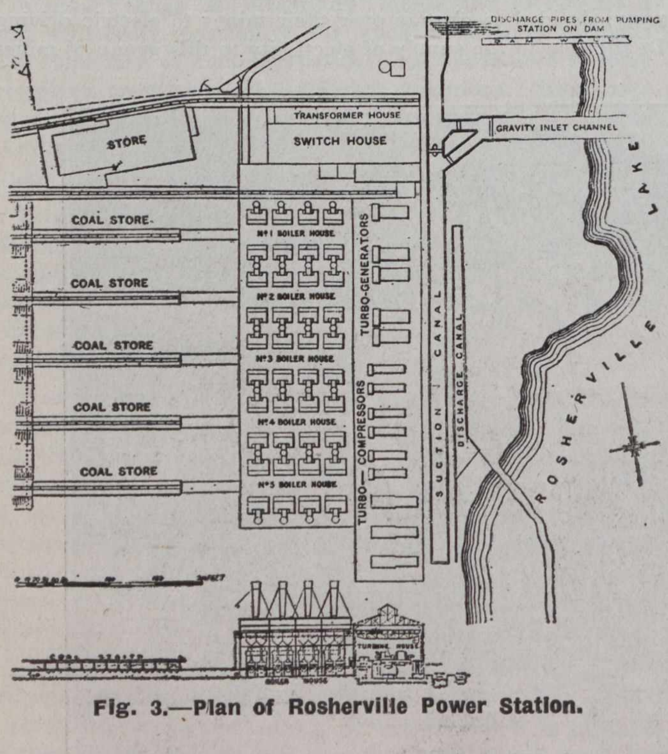


Fig. 3.—Plan of Rosherville Power Station.

Power plants aggregating nearly 180,000 kw. have been installed in, or are under construction for, the stations enumerated in the table given at the end of this article. They are set out in the order in which they were built.

At Robinson Central air station there are also six electrically driven air compressors, each of 3,500-kw. capacity.

At all stations steam turbo-electric generating sets are employed, and produce three-phase energy at 50 cycles. Step-up transformers raise the generator pressure to 40,000, 20,000 or 10,000 volts, and their interposition gives additional security to the machines against pressure rises. This method, in which the generator voltage is optional, gives the further advantage of enabling the stators to be constructed with the bar winding having one bar per slot.

The main system of transmission is effected by means of 40,000-volt overhead lines stretching practically the whole length of the reef. At the present time, however, the western extremity is working as a 20,000-volt distribution line. Where the load is most dense the transmission consists of two rows of towers, each arranged to carry two circuits.

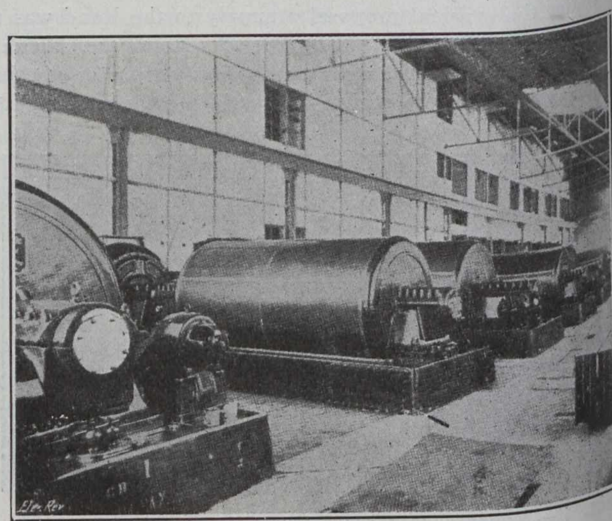


Fig. 4.—Air Compressors at Robinson Central Deep.

The 40,000-volt transmission system is fed at Brakpan, Simmer Pan, Rosherville, and at Robinson Central, where the supply from the Vereeniging station joins the reef. In addition to these distribution stations the transmission lines pass through two further distributing centres at Hurcules to the east and Bantjes to the west. From these six points distribution networks, laid out as ring mains, supply the various sub-stations on the mines. The three eastern distribution stations supply the system through 10,000-volt overhead lines. The central portion of the area is served by an underground 20,000-volt cable system.

The Vereeniging station is connected to the Rand by an 80,000-volt line approximately 35 miles long, terminating at the Robinson Central distribution station, where the pressure is transformed to either 40,000 or 20,000 volts, these pressures being also coupled together through transformers aggregating 16,000 k.v.a.

All transmission and distribution circuits, with the exception of the long-distance 80,000-volt lines, are equipped with the Merz-Price balanced relay system for automatic switch control, without which a reliable supply on the ring-main system could not have been given, and the more expensive radial type of network would have been necessitated. This balanced relay system is also employed for the protection of all transformers and for the large generators. The pilot wires for operating this system on the 40,000-volt transmission lines are combined with telephone circuits in a lead covered cable suspended overhead, while on all distribution networks (both overhead and underground) combined pilot and telephone cables are laid underground.

A special feature of the lay-out of the telephone system is the arrangement whereby the control of all switching and the control and regulation of load, voltage, power factor, and other operating conditions, are in the hands of the control department.

One control engineer or load dispatcher is responsible for all routine switching and linking carried out at any point on the electrical system during his shift, and under the regulations no switching can be carried out without his consent. The load dispatcher, as soon as any switching has been carried out, adjusts a large diagram in the control room so that it shows every connection on the system.

When the contract with the Rand Mines, Limited, was concluded the site for the station was selected at the Rosherville Dam, which is the largest lake on the Rand. This station will shortly have a capacity of nearly 100,000 kw. of plant installed. After the new extensions are completed the turbine room will be 450 feet long and 75 feet wide, and there will be five right-angle boiler bays, each containing eight boilers. The general lay-out is shown in Fig. 3.

The coal-storage arrangements are very complete, the coal being discharged from a height of 14 feet through the floors of 40-ton railway trucks into outside storage bunkers, under which coal conveyers are arranged. The whole structure is open, as roofing is unnecessary, owing to the favorable climatic conditions.

The conveyers, each capable of dealing with 40 tons of coal per hour, run in tunnels under the external coal store, and are fed with coal by gravity through shoots from the coal pile above. These conveyers are kept running practically continuously, allowing the internal coal bunkers in the boiler house to be of small capacity. An automatic tip is fitted over the bunkers, which tips the conveyer buckets when the coal in any particular bunker has fallen below a certain level. Weighing machines are installed in the conveyer tunnels, and the coal is weighed as it passes in the conveyer buckets.

The ashes are discharged from the rear of the stokers into hand trucks in the basement, where natives push the loaded trucks out and attach them to a motor-operated rope haulage leading to the ash dump. The question of removing these ashes by suction is at present under consideration.

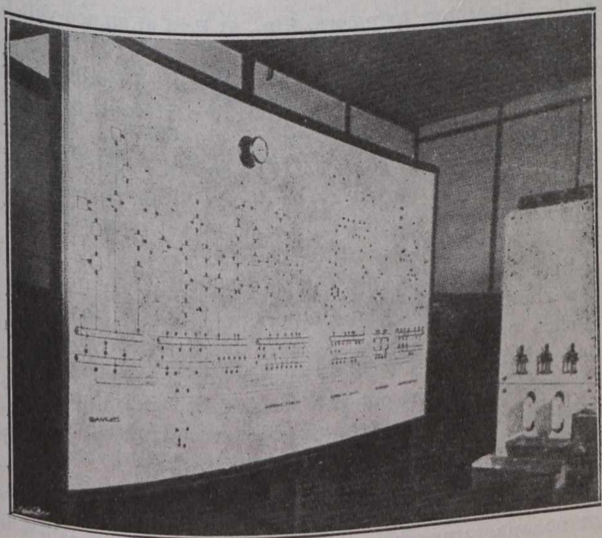


Fig. 5.—Load Dispatcher's Diagram.

The class of coal burnt at this and other Rand stations is mostly the small coal from the collieries in the Middelburg district, 60 miles distant, mixed with a proportion of the duff produced by the coal-cutters. The coal has an average calorific value of about 11,000 B.th.u. per lb.

The large percentage of ash, viz., 18 to 25 per cent. of the coal, and the high load factor at which the plant is operated, necessitated a combination of boiler, superheater and economizer that would give the highest possible efficiency; the high cost of white labor, and the inefficiency of that of the native, also required that the plant should be mechanically operated.

In view of these considerations, and the great cost of constructional work in South Africa, the injector system of induced draught originally devised by Mr. Prat has been adopted in all the power stations. The system has been found to give the utmost satisfaction.

In the lay-out employed, adjacent boiler units are connected to a common ejector chimney, the top of which is 90 feet above the boiler-house floor. An electrically driven rotary fan, capable of developing 75 h.p., blows cold air

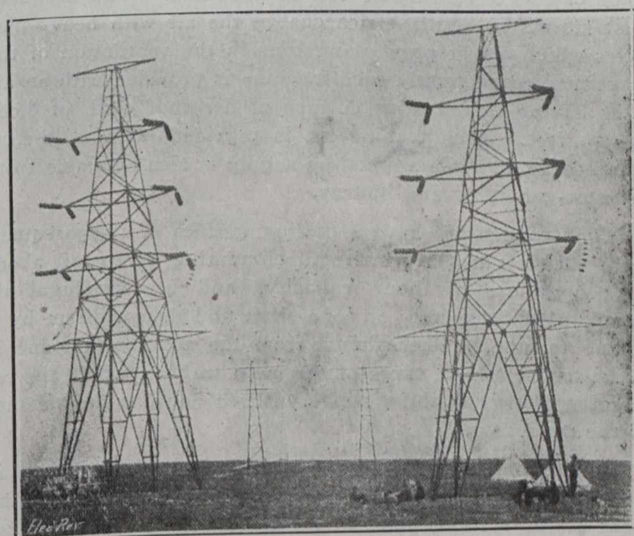


Fig. 6.—Double Tower Line at 80,000 Volts, and Construction Camp.

through the ejector situated in the chimney, thereby producing the necessary suction in the flues, and a draught of about 1 inch is usually employed.

With this arrangement great flexibility in the boiler house is obtained, and by the use of a torpedo-shaped damper in the air pipe regulating the pressure of the air jet, the duty of the boiler unit can be easily regulated to suit fluctuations in the load. The plant is absolutely smokeless, and it is difficult by looking at the ejector chimneys from outside the station to tell which boilers are at work.

The boiler unit selected is the Babcock & Wilcox marine type, fitted with chain-grate stokers, each having an integral superheater and economizer. The boilers are arranged in two rows in each boiler house, with a central and common firing floor. Each boiler has a rated capacity of 32,000 lb. of steam per hour at a pressure of 220 lb. with a temperature of feed water of 100 deg. Fahr., and is capable of producing 38,000 lb. of steam without undue forcing. The heating surface of the boiler is 5,520 square feet, of the superheater 1,720 square feet, and of the economizer 2,200 square feet. A six-hour test on one of the boiler units gave a combined efficiency of boiler, superheater, and economizer of 80 per. cent.

The turbine room at present contains five turbo-generators each of 12,000 k.v.a. (Fig. 2) and six steam compressors each having an input of 3,500 kw.; three more steam compressors each taking 7,030 kw. are also being installed. The turbines are of the A.E.G.-Curtis horizontal type, having one high-pressure wheel with three rims of blades. The admission pressure at the intake nozzles is brought down from 220 lb. at a temperature of 300°—350° C. to about 20 lb. with a superheat of about 20° C. In the low-pressure portion of the turbine, the steam is expanded through 12 stages. Both hand and motor regulation of the speed are arranged for. The total weight of a 12,000-k.v.a. turbine set, including condenser and pumps, is 370 tons.

The stators of each of the six-pole generators are bar wound, having one bar per slot. The machines running at 1,000 r.p.m. produce 50-cycle three-phase energy at 5,000 volts, which is stepped up to either 10,000, 20,000, or 40,000 volts, by transformers directly connected with the stator terminals.

The rotor coils are lined with metal casings before being attached to the rotor by dovetailed grooves and wedges. The rotor carries a ventilating fan at each end. The frequent dust storms in South Africa charge the air with heavy particles which might prove dangerous in the ventilation of the machines, consequently each machine is provided with an air filter having an effective surface of fireproof cloth of 8,000 square feet. Each turbine set is provided with a direct-driven exciter, while a stand-by supply is also available from a motor-generator and battery.

The condensers have a cooling surface of 17,750 square feet; each set has a centrifugal circulating pump of about 663,000 gallons per hour capacity, and a centrifugal air pump, both connected on one shaft and driven direct by a steam turbine. The exhaust from the auxiliary turbine is taken to the middle stage of the main turbine, where the remaining energy in the steam is utilized down to the vacuum of the condenser.

The water for the condensers and compressor jackets is taken from the lake through a channel excavated along the front of the station, and is discharged into a second canal placed alongside the intake; this canal delivers the warm water to the lake at a point as far from the intake as possible. Under normal conditions of water levels the intake water flows by gravity into the service canal, but in order to deal with periods when the water in the lake may be low, a pumping station has been erected half-way along the dam wall at the deepest part of the lake.

The boiler feed pumps are of the turbine-driven centrifugal type, and are installed in the turbine room. With the exception of certain electrically-driven bearing-cooling pumps, all auxiliaries are turbine-driven.

The generator transformers are connected by cables to their corresponding generators, and are each of 12,500-k.v.a. capacity. Where larger transformers have been required, as for the last two sets at Vereeniging, two transformers for each machine have been installed. The transformers at Rosherville are of the shell type and water-cooled, the windings nearest the terminals being specially insulated to withstand between adjacent turns a pressure of 25,000 volts for five minutes. A test pressure of 160,000 volts was applied to the whole of the windings. The weight of each transformer complete without oil, is 50 tons; the oil itself weighs 21 tons.

The steam turbo-compressors at Rosherville are similar to the motor-driven compressors at Robinson Central, and are each designed to deal with 22,000 cubic feet of free air per minute with an outlet pressure of 9 atmospheres (absolute). The power required on the shaft is, roughly, 3,500 kw. In the case of electrically driven sets at Robinson Central each unit is divided into two halves on separate shafts, each motor having a capacity of about 2,000 k.v.a., and being designed to operate at full load at a leading power factor of 85 per cent. The sets run at 3,000 r.p.m. The steam-driven compressors are arranged in two sections on the same shaft with an intercooler between them. The cooling water required for the jackets of the compressor and intercooler amounts to about 40,000 gallons per hour. The air leaves the compressor at a temperature of about 70 deg. C.

Between the compressor and the pipe line an automatic non-return valve is fitted, which allows a compressor to drop out to atmosphere when its pressure falls below that of the air system.

By the use of the rotary compressors the air entering the pipe system is kept entirely free from oil and other impurities liable to be introduced into the air system when piston compressors are employed. The speed regulation of the steam turbo-compressors is automatically controlled by the pressure in the air pipes. The regulation of the electrically driven compressors at Robinson Central is effected by throttling the intake. The weight of a turbine-driven compressor, condenser, and pumps is 180 tons.

The switchgear is laid out in a building at the southern end of the station, and the step-up transformers are in cubicles arranged along the outer side of the switch-house. The last-mentioned is constructed with four floors: the upper floor contains the lightning-arrester gear, the third floor the bus-bars, the second floor the 40,000 and 20,000-volt oil switches, whilst the lower floor is occupied with cableways

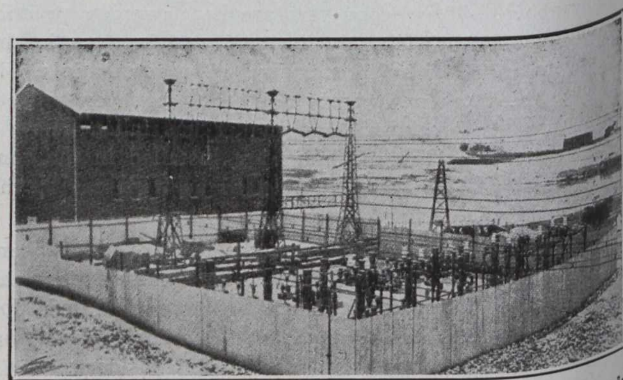


Fig. 7.—Lightning Arresters, Etc., at End of 80,000-volt Line.

and pipe passages. Duplicate bus-bars are installed for both the 40,000 and 20,000-volt systems, the various oil switches being provided with knife selector switches to connect to either bus-bar. The 40,000 and 20,000-volt systems are connected together through coupling transformers. The switches consist of three single-phase coupled switches operated from a remote-control board.

Since the Rosherville station came into commercial service, troubles have been experienced owing to failures of switches on short-circuit. When the Brakpan and Simmerpan stations were started to supply the 40,000-volt transmission and also the 10,000-volt local lines, their total capacity was 24,000 kw., and no trouble was experienced when a short-circuit occurred on the system. When, by the addition of Rosherville, the system grew to 60,000 and 70,000-kw. capacity, switch breakdowns occurred, conclusively proving that no apparatus was available which could be relied upon to interrupt the immense rush of current occurring on short-circuit.

Some serious line interruptions have in the past been caused by the wilful throwing of bare wires over the lines. When this form of short-circuit has occurred near a power station, apparatus has usually been lost.

Dynamos running at a high speed have a low internal reactance. The step-down transformers in the present case were designed with a low reactance to give good regulation, so that probably the total reactance in circuit on a short-circuit was about 7 or 8 per cent. The momentary rush of energy on short-circuit could therefore reach the tremendous proportions of 500,000—700,000 kw. No oil switch, as at present designed, could interrupt this rush of power unassisted. The intensely hot gases formed by the arc, after rising through the oil, come into contact with the air and cause an explosion, which, more often than not, is productive of a switch failure.

About the time that this trouble became apparent on the Rand, exactly the same difficulty was being experienced on stations of similar large output in America, and the problem was vigorously tackled over there. Many methods have been tried at Niagara, Chicago, and other places, and it has become generally recognized that it is necessary to insert additional reactances in order to limit the rush of energy on short-circuit. In certain cases this precaution has proved entirely satisfactory. In others additional methods for assisting the oil switch have been necessary; such as (1) sectionalizing the system on to separate bus-bars and limiting the amount of machinery that would be affected by one short-circuit; (2) the placing of two switches in series timed so that one opens first and inserts a non-inductive resistance, the circuit being actually broken by the second switch; (3) the use of a special type of switch having two moving systems, one of which first introduces reactances, and the other then breaks the circuit.

These methods have been tried on the Rand. The earthing of the neutral through a resistance has proved most valuable, as more than 90 per cent. of the faults start as faults to earth. At Rosherville and Vereeniging reactances having a value of about 6 per cent. have been installed between the dynamos and the step-up transformers. The latest practice is to design both generators and transformers required for power service with large internal reactances.

At Vereeniging and at the Rand end of the 80,000-volt line two systems of switching have been installed. On the first two Vereeniging machines two switches are employed in series, one introducing a non-inductive resistance; while on the last two machines, both of which have not yet been put into service, a two-movement reactance switch is being installed. This switch is constructed on the lines of an oil-break switch, but is provided with a second pair of contacts for the final break. The separation of the first pair of contacts introduces two reactances placed centrally one on each terminal bushing inside the oil tank, and the second pair of contacts finally breaks the circuit.

At some early date the system will also be sectionalized in order to reduce the rush of power on short-circuit, and in doing so reactances of relatively large value can be inserted between sections in those cases where it is not economical to separate adjacent sections permanently.

This problem of switchgear for dealing with enormous rushes of power has proved one of the most difficult that has been encountered so far on the Rand and also in America. It has not yet been finally solved, nor have switches been standardized which are capable of dealing unassisted with these exceptionally severe service conditions. These remarks on switchgear apply not only to the central stations, but also to the distribution stations, and in a less degree to the consumers' sub-stations.

The electrical supply at 2,000 volts and 550 volts to the consumers' premises is effected from step-down transformer stations, which are built by the consumers, but are equipped with switchgear and transformers by the power company. (Fig. 8). There are 60 of these consumers' sub-stations connected to the system, and their individual capacity varies from 10,000 k.v.a. to 2,000 k.v.a., the normal size being 5,000 k.v.a.

The standard sizes of consumers' transformers are 1,000, 500 and 250 k.v.a., designed with the primary windings arranged for either 20,000 or 10,000 volts. A temperature rise of 40 deg. C. is allowed above an air temperature of 40 deg. C. The windings near the outgoing terminals will stand a pressure of 15,000 volts between adjacent turns. The high-tension windings are tested to the secondary windings and core with a pressure of 40,000 volts, and the insulators with 60,000 volts. The transformers have been supplied by Messrs. Siemens, the Allgemeine Elektricitäts Gesellschaft, and the Westinghouse Company.

The transformers are exported filled with oil, thereby reducing the cost of transport and dispensing with the necessity of drying out after erection. In order to allow for the expansion and contraction of the oil each transformer tank is connected with a second smaller tank fixed on the wall of the sub-station. This expansion tank is fitted with a vertical vent-pipe, so that only a small surface of oil is in contact with the air, and by this means sludging is prevented. Each

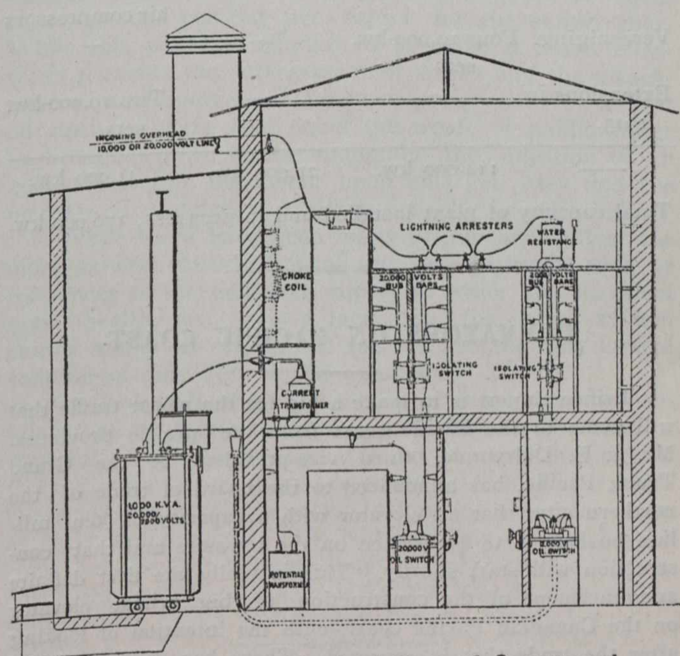


Fig. 8.—Section of Standard Type of Consumers' Sub-station.

sub-station chamber has a short stack, which induces a natural draught and provides effectual ventilation. Double bus-bars are provided for each voltage. The high-tension and low-tension switchgear in each sub-station is arranged in different chambers with a central operating passage between containing no "live" material. The "live" chambers are locked, and stringent regulations as to the possession of the keys ensure that no unauthorized person can obtain access; in no case is one man allowed to enter alone. The total capacity of the transformers in operation, including generator transformers and coupling transformers, is unusually large, amounting at the present time to 450,000 k.v.a.; but this will be increased to 508,600 k.v.a. when the transformers delivered and on order are brought into commission.

The company realize the importance of welfare work and its influence on the conditions of the life of the staff. They give a generous support to recreation and sport, and facilitate in every way the promotion of social intercourse among all classes of the employees.

Some 60 residences and quarters have been built by the company at the various power stations, and at each station a boarding house and recreation rooms are provided. Generally speaking, the conditions of life compare very favorably with those of an engineer on the mines. A fleet of 14 motor-cars is maintained in constant service for the use of those officers and engineers of the company whose duties necessitate visiting the different parts of the system. A special department handles the entire transport of materials, and employs constantly two motor-lorries and 50 mules and horses.

Name of station.	Total capacity of electric generating plant installed.	Steam-driven air compressors installed.	Extensions in progress.
Brakpan	Two 3,000-kw. sets	—	—
Simmerpan	Six 3,000-kw. sets	—	—
Rosherville	Five 10,000-kw. sets	Six 3,500-kw. machines	Three 7,000-kw. steam-driven air compressors
Vereeniging	Four 10,000-kw. sets	—	—
Extensions in 1913.	—	—	Two 10,000-kw. sets
——	114,000 kw.	21,000 kw.	41,000 kw.

Total capacity of plant installed and in progress, 176,000 kw.

ELEVATORS ON PACIFIC COAST

Prince Rupert is to make a bid for the wheat traffic that will come to the Pacific coast from the prairie provinces. Mr. J. E. Dalrymple, third vice-president of the Grand Trunk Pacific, has announced to the board of trade of the northern city, that an elevator with a capacity of ten million bushels is to be erected on the townsite and that construction will start shortly. This is really the first definite announcement of the construction of big wheat elevator on the Canadian Pacific coast, with the intention of looking after the trade that is expected. There has been talk of many in and around Vancouver and New Westminster. Mr. Dalrymple's statement is definite, and shows that the Grand Trunk Pacific will have some of the trade from Western Alberta when its line is completed. The Canadian Pacific Railway at this point will also get busy when the time comes, so it can be taken as granted that elevators will be erected in the neighborhood of Burrard Inlet in due course. Officials of the railway have stated the traffic will be taken care of when it arises, and naturally they will do what they can to increase business.

A number of leading officers of the Great Northern and Northern Pacific Railways have been on the coast during the past week. A stated time is now given when the Northern Pacific will have its own tracks into Vancouver, that is, as far as Cloverdale on the south side of the Fraser River, thence by Great Northern Rails into Vancouver. A joint depot with the Great Northern is spoken of. There has also been a slight hint that the Great Northern would link with the Canadian Northern in a big depot at the head of False Creek. The suggestion is reasonable, for if two depots are erected they will be quite close together, and one large depot would serve the purpose better. But, as one of the officials remarked, it is three years yet before filling in operations will be completed, so there is plenty of time to figure out about the depot.

SOME QUALIFICATIONS REQUIRED OF AN ENGINEER.

By Prof. E. Brydone-Jack, B.A., C.E.*

The following extracts from an article in the Manitoba Engineer for March, 1913, will no doubt be read with interest, especially by the younger men in the profession:

The opportunities opening up to young engineers to-day are more numerous and varied than ever before. We find them taking up the business part of their profession as well as the technical part and holding positions as managers, superintendents, presidents, etc., of large corporations.

If the engineer is to take advantage of these opportunities, how must he be prepared, what are the necessary qualifications in order to attain success?

Evidently knowledge of theory is not the only qualification required, knowledge of practice is not the only qualification required. It is essential that the engineer should possess the knowledge of both theory and practice, but in addition to these he must have character and judgment.

Character and judgment are qualities which determine an engineer's advancement just as much as and perhaps more than his technical knowledge. It is no uncommon sight to see men with an excellent knowledge of both theory and practice occupying subordinate positions, while those with less knowledge but with more executive ability are placed over them.

The engineer is measured and advanced according to his efficiency. True efficiency can only be obtained by a combination of technical knowledge, character and judgment. It is essential that the engineer should learn thoroughly the fundamental principles upon which is based the particular branch of engineering which he is to follow, and that he should have the power to apply them intelligently and correctly. He should be able to observe accurately and reason logically from premises gained by observation or otherwise. His character should be such that his word and honesty can always be relied upon and that he should realize the ethical principles which should govern a man's acts in this world and which should regulate his conduct towards his fellow-men.

His judgment should in all cases be unbiased and depend entirely upon the facts presented. This implies reasoning power and ability to reach logical conclusions.

These qualifications may perhaps be best summed up in the "Specifications for a Good Engineer" in Chief Engineer Starling's report to the Mississippi Levee Commissioners, which are as follows:

"A good engineer must be of inflexible integrity, sober, truthful, accurate, resolute, discreet, of cool and sound judgment, must have command of his temper, must have courage to resist and repel attempts at intimidation, a firmness that is proof against solicitation, flattery or improper bias of any kind, must take an interest in his work, must be energetic, quick to decide, prompt to act, must be fair and impartial as a judge on the bench, must have experience in his work and in dealing with men, which implies some maturity of years, must have business habits and knowledge of accounts. Men who combine these qualities are not to be picked up every day. Still, they can be found. But they are greatly in demand, and when found, they are worth their price; rather they are beyond price, and their value cannot be estimated in dollars."

* Professor Civil Engineering, University of Manitoba.

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CONTENTS OF THIS ISSUE.

THE METER AS A FACTOR IN ELIMINATION OF WATER WASTE.

Within the past few years a phase of municipal engineering that has attracted more than passing interest is that which has to do with the control of public water supply for domestic purposes. In some cases municipalities are supplied by private companies, while in others the system is controlled by the municipality and run as one of its branches of the administration. In either case the problem of supplying the water to each individual on an equitable and fair basis is a very real one, and it would seem that the only satisfactory solution of the problem is the adoption of the meter system.

The waste of water that goes on in many municipalities in many cases is appalling, and in some instances positively criminal. Statistics show that the amount of water wasted during the winter months with the sole object of preventing freezing of pipes is equal to six gallons per day per capita for the entire year. While this waste is allowed to continue it most effectively prevents the enlargement of works and the attachment of new sources of supply at great cost, for almost all statistics show that could the waste of public water be brought down to its minimum, the question of an adequate supply dependent upon enlarged uses and the increase of population would practically be adjusted.

While there have been many arguments against the more general introduction of the meter system, such as references to the unlimited supply of water and its effect upon health, etc., it is a fact that the meter system stands to-day an unqualified success and the only logical solution of this very vexed question.

Looked at from the viewpoint of economics the usefulness of the water meter is unquestioned. Its value in this direction has been demonstrated time and time again. On the other hand, there are some cities in which influences are constantly at work looking to the prevention of their introduction. This will probably always be the case, but the fact remains that the only sensible way to check this enormous waste is by the introduction of the water meter.

THE ENGINEER AND HIS READING.

While, perhaps, the engineer is not more negligent about what he reads regarding what is going on in his profession than many other classes, the fact remains that too many engineers leave our universities with the impression that while at university it was proper he should read, and read much, when he gets out into the field it is work that is called for.

In this day of rapid changes the realm of engineering is no exception, and it behooves the technically trained man to see to it that he does not neglect the opportunities which are afforded him of securing information generally covering the latest practice in all branches of engineering, and particularly the one in which he is most interested. In fact, he is likely to be a better engineer if some of his time is given over to the study of other phases of engineering than the one in which he is specifically interested at the moment.

In order to keep himself posted concerning developments going on in engineering practice, he should most assuredly, in addition to relying on his text-books, spend some time in reading the current technical papers. He should come to realize the importance of knowing what the man is doing who is engaged in the same class of work as himself; in other words, he must modernize his practice; be aware of the progress his profession is making, if he is to be in a position to adopt new ideas and new processes and apply them in his own daily work. He will get such service by a careful reading of the leading technical journals covering the profession of engineering. While a man may succeed, and succeed to a very unusual degree as an engineer without the help which the technical press can afford him, it is fair to assume, other things being equal, that the man who is posted in relation to his work, due to a careful study of technical journals, which show him how the other man is attacking and accomplishing certain results, will make an even greater success.

It is particularly important that the younger engineer just beginning his career make it a practice to read such papers as most adequately cover the particular branch of engineering he is to specialize in, and, where necessary, make a practice of clipping those articles which are of particular interest to him, and which are likely to prove of value in the days which are to come, and which will doubtless have a direct bearing upon his work.

THE WATERWORKS OF CANADA.

Through the courtesy of the Commission of Conservation we have received a copy of a report compiled by Leo. G. Denis, Hydro-Electric engineer of the Commission of Conservation, in which is given a very large amount of valuable data covering the waterworks systems now in existence throughout the Dominion of Canada. The report includes detailed information concerning something like 360 plants, as well as a table showing the number of sewage disposal plants in Canada, which information has been tabulated from data compiled by the committee on sewage disposal of the Canadian Society of Civil Engineers, 1911-1912. The information relating to each waterworks is given under the name of the city, town or village, it being arranged alphabetically under each province, while the provinces are arranged geographically from east to west. The information given has been arranged in a very concise and convenient form, and it is hoped that it will prove valuable to all who are interested in water supply generally. Not only that, but it will also help those directly connected with waterworks systems to become better acquainted with conditions relating to other plants than their own. The report contains a number of valuable charts summarizing the information gathered, and altogether is a very valuable addition to the statistical literature covering this very important phase of the civil engineer's work.

EDITORIAL COMMENT.

A most interesting and valuable symposium on the subject of expert advice comes to this office in the form of a verbatim report of a discussion held at a meeting of the American Institute of Consulting Engineers when that subject was the topic. That the need of better and more intelligent methods of securing expert evidence is called for is evident, and the subject is one that should have great interest for the engineering profession. Those interested may secure a copy of the brochure by addressing a letter to Eugene W. Stern, secretary American Institute of Consulting Engineers, 101 Park Avenue, New York.

With the announcement from Ottawa this week that tenders for the building of the first section of the Welland Canal will probably be called for toward the end of this month, one is struck with the fact that Canada is more and more being confronted with engineering projects that a few years ago would have been considered unlikely. The writer recalls being in the office a very few years ago of one of, if not perhaps the largest, engineering contractor in Great Britain, a man who was at the head of a contracting organization whose activities extend to almost every part of the civilized world. He was asked why it was he gave little or no attention to Canada as a field of operation. He answered to the effect that Canada was yet of insufficient importance to justify his giving it his attention owing to the absence of large projects of an engineering nature. It is interesting to note that that particular firm, as well as two or three others in the same class, now have very aggressive organizations in Canada and are actively bidding for work here. It is pleasant to record a fact such as this. Large work means large responsibility. Our various engineering schools throughout the Dominion will no doubt rise to the occasion and see to it that the type of engineer turned out is equal to the challenge which this day of larger things in engineering in Canada gives him.

* * * *

We beg to acknowledge the receipt of the first issue of the journal of the Regina Engineering Society. This publication, as is stated in the introduction, "symbolizes the spirit and enterprise of the West having for its object the welding of the engineers of the province into a body which shall jealously uphold 'the dignity of the profession.'" To all this *The Canadian Engineer* says "Amen," and hopes that the expectations of the gentlemen responsible for the birth of the Regina Engineering Society and those who are more actively connected with its work will realize their object, which is a laudable one. The journal contains a resumé of the beginnings of this society, the first meeting of which was convened on Tuesday, April 2nd, 1912, and at which fifty engineers were present. During the year there have been about one dozen papers presented, the titles of which indicate the broad scope in engineering which the membership of this society represents. We congratulate the society on its progress, and hope that it will in every sense of the word be successful. It is interesting to note that the following papers have been promised for presentation before the society during the coming months: "Side Hill Grades," by E. W. Murray, B.A.Sc.; "Power and Intensive Cultivation," by A. E. Eisenach; "Compressed Air Water Supply," by F. McArthur, B.Sc.; "Scientific Methods of Designing Streets," by J. R. Ellis; "The Law of Contracts and Specifications," by C. C. Owen, and "Power House Economy," by J. A. Gibson.

On representations made by the Canadian Manufacturers' Association as to the material desired to be submitted, and that more time is required to collect and codify it to the best advantage, the Board of Railway Commissioners has determined that the consideration of reciprocal demurrage and its suggested application in Canada, also what is known as the "Average Demurrage" Plan, should stand until a special hearing to be held at the Central Station Building, Ottawa, Ont., on Monday, June 16th next. Boards of Trade interested may send in their data from time to time as they desire, and present their cases entirely by written arguments.

STOPPING PLANES IN REINFORCED CONCRETE.*

By Edward J. Stead.†

It appears to the writer, from considerable experience of reinforced concrete construction, that insufficient consideration is as a rule given to the determination of positions of stopping planes in this class of work.

Beams and Slabs.—In concreting beam and slab work, it is a common practice to fill up the beam forms to the level of the under side of the slab; then, at a later stage of the work, to follow over with the slab concreting separately. During the interval, the surface of exposed concrete receives more or less injury from dirt, etc., and it has frequently been noticed that the shear reinforcement gets flattened down and knocked out of shape. These circumstances result in a plane of weakness as regards horizontal shearing on the line a—b in Fig. 1. It has further been observed that the stopping planes in the slab concreting are often made vertical over the longitudinal centre lines of beams, as at c—d in Fig. 1.

In this type of design the beams are in general calculated as T-beams; and, notwithstanding the fact that many successful contracts have been carried out in the manner indicated, it is submitted that it is undesirable to make temporary joints in the position shown. No matter how carefully the surfaces are cleaned and roughened, the homogeneity so greatly desired cannot be secured.

To obtain the full value of the area of concrete in compression—i.e., that portion of the beam proper which lies above the neutral axis, together with the width of the slab

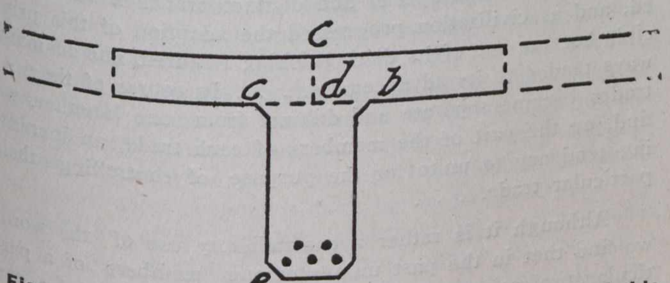

Fig. 1.—Plane Over Beam Centre, Resulting in Probable Weakness in Slab.

acting with it—stopping planes should be excluded, as far as practicable, from that area. Unless the vertical reinforcements in the beams maintain their intended shapes and positions, are rigidly attached to the tensile reinforcement, and well concreted into the compression area, the resulting construction approaches that of a rectangular beam of depth a—e with the slab resting upon it, and the strength will be considerably less than the designer intended.

As a matter of practical construction, stopping planes must occur somewhere in the concrete; and it is suggested that in the case of beams in one direction only—i.e., no secondary beams—the better practice is to cast the beam and slab in one operation, as shown in Fig. 2, in which the dotted lines f—g and h—j represent joint lines parallel with the beams and at the centres of the slabs between them. There can be no serious objection to the joint through the slab, as it is at right angles to the direction of the main reinforcement, the bars of which, being continuous over two or more beams, ensure full tensile strength being available. A temporary face-board would be necessary to keep a vertical face of concrete to join up against on resuming. The upper part of the slab being in compression, the action under loading will be simply pressure on the two concrete faces, and the shearing stress at the joint will be nil.

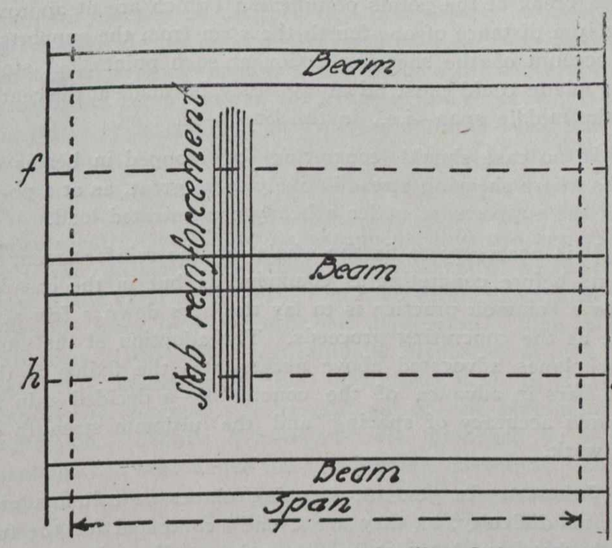

Fig. 2.—Beams Running in One Direction Only—Beams and Slabs Cast as Units—Planes Midway Between Beams.

In constructing larger floors where there are both main and secondary beams, a somewhat similar method is desirable. For the purpose of illustration, a floor has been assumed as in Fig. 3, where the main beams, supported at intervals by columns, run the short way of the building; and between the main beams are the secondary beams, with a slab over all.

Here the main beams and column connections demand special notice, and from theoretical considerations the concreting would be most advantageously carried out in bays across the short way of the building, each bay comprising a main beam and portions of the attached secondary beams and slabs, the joint lines being along the centre lines of slabs and parallel to the main beams, as shown by the broken lines a—a. Complete homogeneity would thus be assured to the main beams and the portions of the slab acting therewith as a T-beam; there would be no break in the work or around

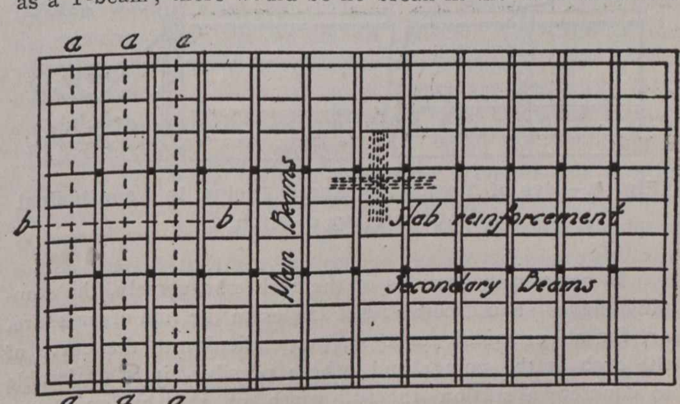

Fig. 3.—Main Beams With Column Supports; Second Beams—Planes on Centre Lines of Slabs, Parallel to Main Beams; also at Centre of Middle Span.

the column heads; and so far as the secondary beams are concerned, the stopping planes would be in the most suitable positions—viz., at the centre of the span and at right angles to the direction of the beam.

* From Concrete and Constructional Engineering.
† Associate Member, British Institution of Civil Engineers.

Assuming, however, that the size of the building is such that the volume of concrete in one bay, as indicated, is too great to be put in without a break, it will be necessary, in order to reduce the amount of work to be done in one operation, to make stopping planes through the main beams. The first point then calling for notice is the necessity for avoiding a break at the points of inflexion (which are at approximately a distance of one-fourth the span from the supports), on account of the shearing action at such points. A stopping plane could most advantageously be made at the centre of the middle span—i.e., in the line b—b.

In no case should concreting be stopped in beams or slabs where shearing stress is likely to be great, as at a point near the supports or under a heavy concentrated load.

It is necessary to fix the whole of the reinforcement in beams before concreting is commenced; but in the case of slabs a common practice is to lay the bars down a few at a time as the concreting proceeds. The adoption of the stopping planes advocated above necessitates the fixing of the slab bars in advance of the concreting—a decided gain as regards accuracy of spacing and the ultimate strength of the work.

Columns.—In general, stopping planes in columns present no difficulty, as they are usually concreted for the full height between floors at one operation. Even if this does not occur, provided the concrete is temporarily left with a horizontal surface, and kept clean and free from foreign matter, no weakness is incurred, as the joint will be at right angles to the pressure upon it.

Arches.—The stopping planes in concreting arches may occur, according to the magnitude of the arch, either longitudinally or transversely. In each case, both the upper and lower reinforcements should be placed and fixed securely in position prior to commencing concreting. Where possible, a strip the full thickness of the arch should be concreted from abutment to abutment in one operation, the temporary joint being made against a profile erected on the laggings, in the case of longitudinal reinforcement only, or, in the case of mesh reinforcement, by short boards set vertically between the meshes, as shown in Fig. 4.

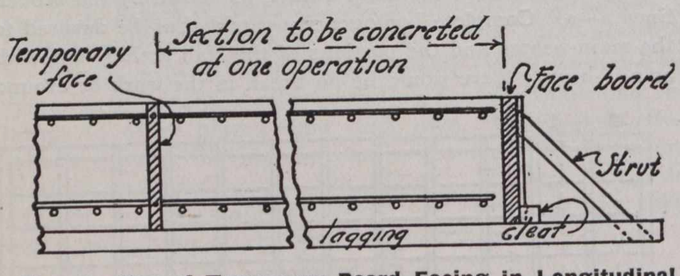

Fig. 4.—Use of Temporary Board Facing in Longitudinal Concreting of Arch.

In concreting sections of the arch transversely, the stopping planes should be at right angles to the line of pressure, or, for all practical purposes, perpendicular to the curve of the arch at the point; and, where possible, it is preferable to concrete a section the full width of the bridge at one operation. The temporary joint in this case will be made against a straight shutter of such depth as to be a very easy fit between the upper and lower reinforcement, such shutter being slipped in from the ends and temporarily secured at the proper angle. On recommencing, the shutter will be drawn out, the face-boards fixed, and concreting proceeded with. The formation of a stopping plane of this description is shown in Fig. 5.

By careful consideration beforehand, the positions of stopping planes ought to be determined and then worked to. Too much emphasis cannot be laid upon the necessity for

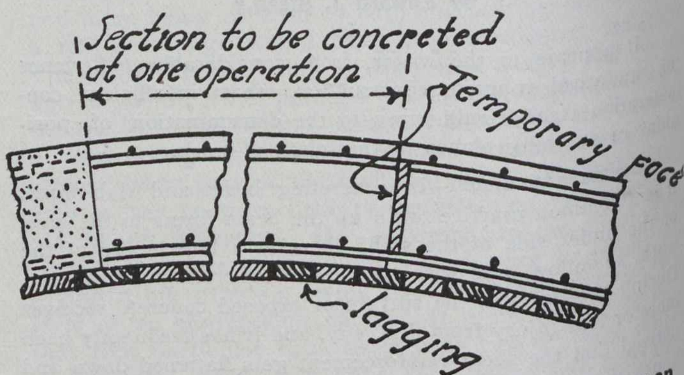

Fig. 5.—Formation of Temporary Joint in Concreting an Arch Transversely.

thoroughly cleaning, roughening, and laying thick grout upon all stopping plane surfaces when concreting is recommenced.

TRADES UNIONISM FOR PROFESSIONS.

By A. B. Howes.

In the study of the history of commerce, trade and manufacture we find that at an early period the advantage of dividing labor into special and distinct branches was realized, and as civilization progressed the adoption of this principle became one of its distinguishing features, and in many ways tended to its advancement. . . . In course of time, as trades became separate and distinct from one another, we find, on the part of the members of each trade, an increasing tendency to unite for the purpose of controlling their particular trade. . . .

Although it is rather a contradictory use of the word, we find that in the past unions among members of a particular profession were, in certain cases, recognized by the Legislature, and were given statutory control over the members of that profession. . . .

That registration is the outcome of modern requirements is abundantly shown by the action of the Colonies in requiring the registration of professions which in the Old Country can be carried on by anyone, although in all probability before many years have elapsed this wise rule will be general in Great Britain as well.

To summarize, the advantages of registration appear to be these:—

The standardization of the qualification of members, at all events as regards a minimum qualification.

Powers of discipline over the members in regard to their professional conduct; powers which are especially effective where such conduct is not within the purview of the law.

Regulation of fees paid to members of the profession.

A closer union in the profession by reason of these three principal advantages.

A general uplifting of the tone and character of the profession by reason of its recognized disciplinary organization.

[Extracts from an interesting paper which Mr. Howes recently read before Quantity Surveyors' Association.]

MAINTENANCE OF SHEET ASPHALT PAVEMENTS.*

By Francis P. Smith, C.E.†

The proper maintenance of an asphalt pavement involves the making of such repairs to it from time to time as are necessary in order that it may continue to render efficient service as a safe and smooth roadway or street.

The deterioration which eventually renders these repairs necessary commences as soon as the pavement is laid and may be broadly classified under the following heads:—

1. Defects due to the wear and tear of traffic.
2. Defects caused by the deterioration, through age and exposure of the bituminous cementing material used.
3. Defects in construction.

Traffic Deterioration.—Under traffic the surface of the pavement is abraded and gradually wears off and the mineral particles exposed on the top are more or less crushed and broken. Where these particles are large, this crushing action is plainly noticeable, but with the smaller particles of sand it is hard to detect it. Under heavy traffic and unfavorable weather conditions, these crushed grains become active centres of disintegration. The crushed particles are not bound together by the asphalt cement and are soon swept away. The holes thus made in the pavement serve to retain the moisture and the edges of the holes are eventually more or less broken down, thus enlarging the hole. This condition reproduced all over the surface tends to make it wear away much more rapidly than would otherwise be the case. The effect of this action, which at first glance appears trival, has been so well established by years of investigation and experience that it has become axiomatic in the paving industry that the heavier the traffic the finer must be the particles composing the mineral aggregate. In hot weather, when the pavement is plastic, the abrasion of the surface is much less than in cold weather, when the pavement is hard and possesses practically no plasticity. In hot weather the caulks on horses' shoes sometimes mark up the pavement to a very considerable extent, but the subsequent action of vehicular traffic wears these marks out almost completely. Nevertheless, in a community unaccustomed to sheet asphalt pavements, the appearance of these caulk marks in a new pavement is always regarded as an ominous sign presaging its speedy destruction and failure. As a matter of fact, if the pavement, especially when newly laid, were not soft enough to show these marks it would be an almost infallible sign that the asphalt cement used in it was too hard and that the total life of the pavement would be less than if a softer asphalt cement had been used. Traffic on a pavement always compresses it and increases its density, and for this reason a two-year-old pavement will always mark up less than a new one. The pressure per square inch exerted by the comparatively narrow tire of a heavily loaded vehicle is much greater than that exerted by the heaviest steam roller used in the laying of sheet asphalt pavements. Even if this were not the case, the kneading action produced by narrow tires passing many times over the surface would always give greater compression than could be obtained by the action of the broad tires of a steam roller.

When the traffic is confined to a comparatively narrow space and is always in the same direction, a distinct pushing force is exerted on the pavement. Whenever the pavement lacks inherent stability, due to an improper mineral aggregate or bitumen which is lacking in cementing value from natural causes or the rotting action of gas or water, or a combination of these defects, very distinct waves or bumps will be produced by the action of heavy traffic. These waves sometimes occur in recently laid pavements in which the asphalt cement used was of the highest quality, but in such cases will usually be confined to a few places. Investigation will almost always show defective binder in these spots, or too soft an asphalt cement, or too great a thickness of pavement owing to an error in the grade of the concrete. A paving mixture, designed to have proper stability when laid two inches thick, will often fail in this respect when laid four inches thick, which is the explanation in the case last cited Too soft an asphalt cement will also reduce the stability of a pavement. Once these waves appear, they are aggravated by traffic passing over them. The wheel of each vehicle rises to the crest of the wave and then drops down with considerable force into the adjacent depression. The plastic pavement in this way is continually displaced at the low spots and shoved up at the high spots until in many instances the concrete will be exposed at the bottom of the depression. Similar depressions are produced by setting manholes too high above the surrounding pavement. Vehicles drop off these high manhole covers onto the pavement and soon pound it out of place. It is better to set all manholes slightly below the grade established for the finished pavement.

Waves are much less liable to appear in those portions of the pavement which are subjected to cross traffic; i.e., in which the traffic does not always move in the same direction. This is usually the case at street intersections, and, if properly constructed, the pavement in these locations almost always lasts longer than in any other part of the street. It has been seriously suggested that in order to increase the effective life of pavements, the direction of the traffic in the afternoon should be the reverse of that in the morning, but the resulting confusion would probably more than offset the gain from such a procedure. Car tracks in a street paved with sheet asphalt may cause the pavement to deteriorate very rapidly. Unless the rails are very heavy and laid on an adequate foundation, they will vibrate excessively when cars pass over them. This is especially the case where tracks designed for light city or town cars are subsequently called upon to carry heavier cars or cars of the interurban type. Not only will the vibration be excessive, but the rails will frequently sink below the level of the pavement and leave depressions where the water will collect. To prevent the vibration from being communicated directly to the sheet asphalt, rows of paving blocks or bricks are frequently placed along the rails, although in many cases the sheet asphalt is brought up directly to the rails. When the vibration is excessive, the sheet asphalt pavement crumbles or cracks in a very short time and leaves an opening for surface water to enter between the wearing surface and the concrete foundation, thus permitting the rotting action elsewhere described to take place.

Effect of Ageing and Exposure.—All bituminous materials used in paving work deteriorate upon exposure to the elements and to the rotting action of escaping gas, water and street liquids. The lighter oils contained in them gradually volatilize, thus hardening the remaining bitumen. As the hardening process goes on, the pavement loses its plasticity and wears away with increased rapidity. Eventually the bitumen loses its elasticity and the pavement cracks. The edges of these cracks crumble away and the cracks become sufficiently wide to be plainly felt by vehicles passing over them. The bumping action previously described in connection with waviness is produced and adds to the

* Abstract of lecture delivered at Columbia University.
† Chemical Engineer, New York City.

rapidity with which crumbling takes place. In order to guard against this and prolong the effective life of the pavement, the asphalt cement used in its construction is made as soft as possible without rendering the pavement too mushy when new. The extent to which this can be carried depends upon the grading and character of the sand employed. With a well-graded sharp sand and plenty of filler, a much softer asphalt cement can be used than with a poorly graded or rounded sand. This is due to the greater inherent stability of the former type of sand. It is obvious that a mineral aggregate which when dry strongly resists displacement will permit the use of a comparatively soft asphalt cement. Modern traffic conditions have in this particular respect come to the aid of the pavement makers. Automobiles in their passage over the pavement are continually dropping a certain amount of oil on its surface which is very evenly distributed by the large number of vehicles passing over it. This oil is gradually absorbed by the pavement and thus softens the bitumen and counteracts to a large extent the hardening action of time upon it. This is very clearly shown in a certain pavement in Chicago, which, prior to the passage of any considerable number of automobiles over it, some five years ago was so hard and badly cracked as to have practically reached its limit of usefulness. The street in question subsequently developed into an automobile centre with the result that the pavement was softened up by the dropping of oil upon it to such an extent that it is still giving satisfactory service. Fifth Avenue, New York City, is a somewhat similar case.

Some asphalts are more easily rotted by water action than are others. With such asphalts it is more than ever necessary to make the pavement as dense as possible to prevent the water from getting into it. Generally speaking, with all asphalts the wetter the climatic or other conditions, the denser and richer in bitumen should the mixture be made.

The action of water upon a pavement may take place from the surface downward or from the bottom upward. The latter action is the more serious and the harder to guard against. The top surface is always compressed to its maximum density by the action of traffic, and if it has sufficient crown and grade to let the water run off and is kept clean so that it will not be covered by a layer of wet mud for long periods, but little deterioration will take place. Where water is allowed to remain in the gutters, the rotting will frequently be very rapid and this will be still more marked if, as in some towns, the dirty wash water from houses is discharged into the gutters. Too frequent washing of a pavement with water at a high pressure is also bad, as the abrasive action of such a jet is very considerable and acts in the same way as the stream from a hydraulic nozzle. In a number of cases water finds its way between the wearing surface of the pavement and the concrete foundation. This may be due to the geological formation of the subsoil strata (and it must be remembered that concrete is not waterproof, especially the type used for foundation work) or the water works its way down between car tracks and the abutting pavement, or through faulty gutter construction, etc. Under such conditions, it has little or no chance to evaporate or drain off and attacks the pavement at its weakest point, i.e., where the compression is the least. It gradually destroys the life of the bitumen and renders it incapable of cementing the grains of sand together. This action progresses upward through the pavement and in some cases is not apparent until only a top shell of good pavement remains. Depending upon the conditions, this action usually manifests itself by a shoving and waviness of the pavement at the point where the rotting has taken place. Owing to the loss of the cementing power of the bitumen, the stability of the pavement has been lowered so that it can no longer withstand the shoving action of traffic previously described. If the pavement is cut through at this point, the white sand grains will be plainly apparent and the whole mass can be readily disintegrated between the fingers. As soon as the rotting action reaches the surface, the pavement is quickly worn away by traffic and a hole is produced.

Gas leaks produce a very similar result and the gas sometimes travels a long distance from the point of leakage before it actually comes in contact with the pavement.

Another cause for the deterioration of sheet asphalt pavement is lack of traffic. Pavements laid on outlying residence streets and culs-de-sac with little or no traffic, crack much more quickly than if they were subjected to a moderate traffic, which appears to be necessary to keep the life in the pavement. This is probably due to the fact that the surface is not in such cases kept at the maximum density by the action of traffic and gradually becomes porous, thus facilitating the evaporation of the lighter oils and also to the fact that the kneading action of traffic, like the continual use of a rubber band, tends to keep the life, so to speak, in the bitumen, and equalizes the stresses set up by contraction and expansion.

Defects in Construction.—These may perhaps be more clearly understood by a general discussion of the principles involved and the correct way of carrying them out and coincidentally calling attention to the particular defects arising from marked departures from standard practice.

Unless the foundation is rigid and of sufficient strength to carry the weight of the traffic passing over the finished pavement, no sheet asphalt wearing surface will give satisfactory service. Being plastic at all normal temperatures, the wearing surface will not bridge over any depressions formed by the sinking or failure of the foundation, but will sink with it. The principles governing good foundation work and design need not be considered here except to say that the sub-grade must be well rolled and compacted in the first place and that good concrete of sufficient strength and thickness should then be put in place and allowed to set before any binder or wearing surface is put upon it. Assuming that the sub-grade has been properly rolled and that the concrete is of the proper thickness and quality, the first point of importance is to see that it is laid to grade. If it is too high in places, the thickness of the binder and wearing surface must be reduced in order that the surface of the finished pavement may conform to the established grade. Any marked diminution in the thickness of the wearing surface will, under heavy traffic, considerably reduce the life of the pavement. On the other hand, if the concrete is laid too low, the thickness of the binder and wearing surface will have to be increased. Within limits, this is not objectionable if the increased thickness is not carried to such an extent as to affect the stability of the pavement, otherwise it will tend to roll and push out of shape under traffic, as previously described. It is usually considered better practice to leave the surface of the finished concrete somewhat rough in order that the binder may key into these depressions and still further resist the shoving action of traffic. After the concrete has been put in place, ample time should be allowed for setting, and this will vary with the weather conditions. Concrete laid in freezing weather will apparently set up when in reality it has frozen. When the hot binder and surface mixture are placed on frozen concrete, the latter is thawed by the action of the heat and becomes mushy and has not sufficient strength to support the weight of the steam roller. Under such circumstances it is impossible to properly compress the hot mixture. In addition to this, the water set free by the thawing of the concrete is forced into the mass of hot material and more or less of it remains entrained in the mass.

In most forms of construction, a binder is laid directly on top of the concrete, although this is sometimes omitted and a paint consisting of asphalt dissolved in naphtha is applied directly to the dry surface of the concrete and the wearing mixture laid directly on this. It goes without saying that the surface of the concrete should be dry and swept clean before the binder is laid upon it. The binder consists of a mixture of broken stone, preferably the run of the crusher with all particles smaller than 1/10 of an inch in diameter excluded and usually not exceeding 1½ inches in its largest dimension, mixed with sufficient asphalt cement to firmly bind the particles together. Sometimes sand or gravel is added to this mixture to increase its density. Where stone chiefly of the larger sizes is used without the addition of any sand or gravel, it is termed an open binder. The denser mixture produced by the use of better graded stone and the addition of sand or gravel is called close binder. The best modern practice calls for the use of the tight binder as it gives a much firmer foundation for the wearing surface and will not be broken up and loosened from the concrete by the passage over it of the teams hauling the hot surface mixture. The stone should be hard and clean; i.e., free from fine adhering particles of dust or dirt, in order that the asphalt cement may firmly adhere to it and the mineral aggregate must be heated to the proper temperature before mixing it with the hot asphalt cement. Stone which is too cold or damp will not coat properly in the mixer and binder which is too cold can not be given sufficient compression upon the street. If the stone is too hot, it will burn the asphalt cement and harden it so that the binder will be brittle and difficult to compress. Sufficient asphalt cement should be added to thoroughly coat each particle of the mineral aggregate and make a mass which, when rolled, will be sufficiently sticky to adhere to the concrete satisfactorily.

A close binder properly made and laid will be superior in many respects to the mixtures which have been laid on a large number of country highways and will carry a fair amount of traffic for a considerable time without suffering any serious damage. Poor binder will break up very easily —sometimes it can be kicked up, and the hauling of the hot surface mixture over it will damage it very seriously. Surface mixture laid on a binder of this kind which has been badly broken up might almost as well be laid on loose broken stone and will not give satisfactory service under heavy traffic. The binder should, of course, be thoroughly compressed with a steam roller before laying the wearing surface on it. Lack of compression will produce an unsatisfactory foundation for the wearing surface, and, as previously mentioned, binder which is too cold or made with too hard an asphalt cement or an insufficient quantity of asphalt cement can not be properly compressed into a dense, tough mass. In hauling the binder to the street over long distances or in very cold weather, it may become chilled below the danger point. During the hauling process a certain amount of surplus asphalt cement usually drains off the stone and accumulates on the bottom of the cart or wagon. If these excessively rich portions be laid on the street, what are called rich or fat spots in the binder course will be produced. As the name implies, these are places carrying an excess of asphalt cement. If these are permitted to remain, the surplus asphalt cement will be absorbed by the hot surface mixture when it is placed over them. This will make a soft spot in the finished pavement which will be displaced by traffic and eventually produce a hole or depression in the pavement. They should, therefore, be cut out and replaced with normal binder.

Before laying the surface mixture on the finished binder course, the latter should be dry and swept clean of dirt; otherwise the layer of wearing surface will not adhere properly to it. The principles governing the manufacture of a suitable surface mixture are similar to those involved in the binder course, except that owing to the heavier duty which it is called upon to perform they are carried further. The particles of the mineral aggregate must be sufficiently hard and fine to carry the traffic without being fractured. They must be of such a character that the asphalt cement will firmly adhere to them and they must be so graded in size as to produce a pavement of sufficient stability and density for the purpose intended. The asphalt cement must be of the proper consistency and the heating and mixing must be so conducted as to produce the best possible mixture. When delivered upon the street, the mixture should be of such a temperature that it can be properly compressed and should be evenly spread by means of hot iron rakes. In many cases the loads of hot surface mixture are dumped directly upon the spot over which they are to be spread. This is bad practice, as the men trample upon it while shovelling and raking it and the rakes do not thoroughly loosen up this trampled material when passing over and through it. Although the mixture is raked to a uniform surface and apparently even thickness before it is rolled, those portions which have been trampled on before and during raking are really covered with a greater quantity of surface mixture than those portions which have not been trampled on and which are covered wholly with what might be termed loose or fluffy mixture. When the roller has completed its work there will, therefore, be a slight unevenness in the finished surface. Under light traffic this would make no appreciable difference, but under very heavy traffic the slight pounding action resulting from this condition would be detrimental and lead to uneven wear of the pavement. Proper and thorough compression of the finished mixture is very essential as this produces a pavement which in its earliest stages is fit to sustain the heaviest traffic. It is always questionable whether portions which are very lacking in compression will be ground out or eventually consolidated. Under unfavorable conditions the chances are strongly in favor of their being ground out. In those portions of the pavement which are inaccessible to the roller, compression is effected by the use of hot smoothers or tampers, or both. If properly handled, the desired results will be obtained, but if used too hot, they will burn the pavement and cause it to scale or grind out. Hot smoothers particularly are dangerous tools to put in the hands of incompetent or careless workmen.

Extreme care should be taken to insure a proper union between the surface laid on successive days. The first loads laid in the morning at the termination of the previous day's work should be a little hotter than normal so that the hot mixture may soften the cold edge of the pavement and bond perfectly to it. The joint should be bevelled and freshly cut away unless the rope joint or a similar method is employed.

The practice of painting the edge of the joint with hot asphalt cement is not to be recommended, as, unless extreme care is exercised, too much asphalt cement will be used and that portion of the pavement will be too rich in bitumen and consequently softer than the rest, which will result in uneven wear and possibly shoving. Great care should be taken not to have any hump or depression when the joint is made. A brief summary of the chief defects and failures met with in practice and the contributing causes is given below.

Cracking.—Cracking of the concrete base—Hardening of the asphalt cement through age—Use of too hard an asphalt cement—Use of an unsuitable asphalt cement—Too little bitumen in the surface mixture—Insufficient compression—Lack of traffic—Improperly constructed joints—Extreme and sudden changes in temperature—Vibration of street car rails.

Disintegration of Surface.—Defective base—Unsuitable mineral aggregate—Insufficient bitumen in mixture—Insufficient compression—Use of too hard an asphalt cement—Use of overheated mixture—Burning due to use of excessively hot smoothers—Action of water—Action of illuminating gas.

Waviness.—Use of an unsuitable sand—Use of too soft an asphalt cement—Unstable binder—Lack of stability in mixture—Too great a thickness of mixture—Projecting manholes—Action of water—Action of illuminating gas—Uneven raking—Too much bitumen in mixture—Excessively heavy traffic in one direction over a limited area.

Scaling.—Too coarse a mineral aggregate—Too hard an asphalt cement—Action of water—Accumulation of mud—Too little bitumen—Excessively heavy traffic.

Repairing.—This should be carried on within a reasonable time after defects first make their appearance. If this is neglected, deterioration proceeds much more rapidly than would otherwise be the case. Holes and depressions are increased in size by the passage of vehicles over them and water accumulates in them, accelerating disintegration.

Two distinct methods of repairing are in general use: 1, The pavement is cut out and removed down to the concrete and replaced with new binder and surface.

2, The upper portion of the surface is first heated by suitable appliances and a thin layer of it removed by rakes and shovels. Immediately thereafter and while the remaining pavement is still warm, a comparatively thin layer of new hot surface mixture is spread over it and raked and compressed in the usual manner followed in the construction of new pavements.

The first method is so simple that but little description of it would appear to be necessary. The defective pavement is cut up into pieces sufficiently small to facilitate its removal and pried up with crowbars if necessary. The adjacent edges of the old pavement are trimmed up with an asphalt cutter and sparingly painted with hot asphalt cement to insure a proper bond between the old and new portions. Under favorable conditions and when the pavement being repaired is not too old and hard, this painting with asphalt cement may well be omitted. All loose debris is removed down to the concrete and a new binder course and wearing surface is then laid in exactly the same manner as when constructing a new pavement. This method should always be employed in filling up holes and depressions or wherever the defective pavement is in such shape as to necessitate its complete removal, as in the case of rotting from the bottom upward and waviness, defective binder or foundation, etc.

The second, or surface heater method of repair, is conducted as follows: The surface heater is placed over the defective pavement and put in operation. Superheated steam, hot air or flame is then brought in contact with the surface and is allowed to remain there until the pavement has been softened to the required depth, usually from ¾ to 1 inch. The heater is then withdrawn and placed on the next spot to be repaired and the burned material completely removed. The space thus left is immediately filled with new hot surface mixture which is spread, raked and finished in the usual manner. Care must be taken to completely remove all burnt material down to such a depth that the new surface after compression will be not less than ¾ inch in thickness except in a very limited number of cases. Skin patching of less depth than this has not proven satisfactory. In order that repairs made by this method will give satisfactory service, it is essential that the remainder of the old pavement which serves as a foundation should be sound and in good condition and free from water rotting. It is not applicable to the class of repairs rendered necessary by defective binder, or foundation, or water, or gas rotting. When it becomes necessary to re-surface, wholly or in part, a pavement which has become too hard through age to give satisfactory service, the surface heater method gives very good results and is much cheaper than a complete removal of the old pavement down to the concrete. By applying the hot new surface mixture to the remaining portion of the old pavement while the latter is still hot from the action of the heater, a satisfactory union between the old and new work can readily be obtained, provided that the hardening of the old pavement has not been allowed to proceed so far that it is impossible to soften it by the application of heat. Cracks may in most cases be more successfully repaired by this method than is possible in any other way. The repairing of cracks satisfactorily is a very difficult matter. If they are cut out and new material put in, this results in the formation of two joints approximately parallel to the original crack. If the pavement being repaired is old and hard, it is difficult to establish a good bond between the old and new portions, and unless this is accomplished, two cracks will shortly appear where only one existed before. This is especially the case where long cracks make their appearance at considerable intervals and in many instances these had better be left until they become sufficiently wide or numerous to render more or less extensive re-surfacing necessary at these places where they occur.

ROAD WORK IN SASKATCHEWAN FOR 1913.

In preparation for the large programme of work in the construction and improvement of public highways in the province for this year, for which $1,200,000 was voted at the last session of the Legislature, the Board of Highway Commissioners is sending out to all the municipalities in the province a copy of the regulations of the Board regarding assistance to municipalities on highway improvement, together with several blank application forms for use of the municipal councils in applying for assistance.

In those places where an improvement can be definitely described in some form or specifications so that a definite standard to work to can be set and a reasonable agreement made between a contractor and the authorities, so that each party will know definitely what is required, the contract system is the best. Most of the work of road improvement will not conform to these conditions, however, and in such cases gangs under a properly qualified and reliable overseer or foreman is the most satisfactory organization.

The worst of all systems is where councillors order out taxpayers to work out their taxes on the road with no proper provision nor systematic selection of roads that should be improved, and with no attempt made to finish the work started if the taxes run out before this is accomplished.

The Board will be much encouraged to grant large amounts of assistance where the organization approaches the best system. Where municipalities are not organized or properly equipped to economically or satisfactorily carry out road improvement the Board would rather undertake the expenditure of what funds they have available in such municipalities through their own organization.

DUCTILITY TESTS OF RAIL STEEL AND SEGREGATION OF STEEL INGOTS.

The following is an abstract of a paper recently read before the annual meeting of the American Institute of Mining Engineers by P. H. Dudley on the "Piping and Segregation of Steel Ingots and Ductility Tests of Rail Steel."

Bessemer steel of 0.10 to 0.15 per cent. of carbon, for splice-bars, spikes and tie-plates, rises in setting and is cast in bottle-mouthed moulds, which must be capped to prevent an overflow from the top. This grade of steel rises in the moulds and makes a longer ingot than the volume of molten steel when first teemed. The ingots, when allowed to cool and then cut open, show, particularly in the upper part, large occluded blowholes, which, when they are not oxidized or do not contain foreign matter, weld more or less completely if the steel is rolled or forged at about 1,100 degs. C.; and it is in this way that the blowholes are closed in the low-carbon steels.

Boiler-plate and fire-box steel often contains more or less minute laminations, which are the remains of small blowholes forming after the setting metal has reached a pasty condition. The blowholes in the low-carbon steels have not been prevented by using deoxidizers, though the ingots are slightly improved so far as the soundness of the steel is concerned. This grade of steel also rises in the moulds in setting.

Ingots of rail steel containing 0.50 to 0.75 per cent. of carbon are of entirely different character when they are sufficiently deoxidized to form comparatively pure steel, as a well-defined shrinkage cavity forms. This important fact should be remembered in discussing rail-steel, for the greater the degree of its deoxidation, the larger will be the difference between the enclosed volume of hot fluid metal in the mould and the cooler or solidified metal, and proportionately still less will be the volume, should the ingot be allowed to become cold before equalizing the heat and rolling. We must deal with three conditions or stages of the steel:—(1) The greater volume of hot molten metal. (2) The less volume of hot set metal. (3) The least volume of cold metal in the dimensions of the rail sections.

The exterior blowholes in the outside walls of the ingots can be prevented from forming by sufficient deoxidizers, as silicon, ferro-titanium, or compounds of these, and aluminum. The last has been extensively used, but all of its oxidation products do not always escape from the metal, and it should not be used when the steel is to be subjected to the present heavy steel wheel-loads. The silicon content for rail steel now ranges from 0.10 to 0.20 per cent., to make it sound and prevent small blowholes from forming in the setting metal. When sufficient deoxidizers are used to efficiently purify the steel, then, as must be expected, a small cavity starts to form in the top under the cap of the ingot in the setting steel, as already described, and its development should be retarded by stripping the ingot and promptly charging it into the reheating furnace.

Rail ingots are no longer allowed to become cold before being charged into the reheating furnaces for blooming. The size and length of the ingots must be taken into consideration, for in those ingots of which the length is from four to five times the width of the base, the steel will set on the interior walls long before their vertical shrinkage of hot to cold metal has occurred, and this increased length will add proportionately to the volume of the interior piping or shrinkage cavity.

Ingot Size in Relation to Rail Sizes.—It was customary a few years ago to teem ingots which were only 18 by 20 or 19 in. square, and roll four lengths of 100-lb. 33-ft. rails. The height compared to the base was so great that before any shrinkage occurred in the vertical hot ingot walls, the interior shrinking cavities developed so large they could not be prevented entirely from forming, even by prompt charging of the ingots, after stripping, into the reheating furnaces to equalize the heat for rolling.

The 33-ft. 100-lb. rails rolled from four-rail-length ingots of the long type developed in the track a great many split heads and some true pipes, the product from two or three mills being quite pronounced in this respect. Of rails which were rolled during August and September, one purchaser removed in less than six years' service more than 10 per cent. for split heads. The trackmen would report these rails as piped, for the segregated metal in the head would crack under the fillet and admit the air, which would soon discolor the interior surface, and these would be considered as piped rails. There was in some instances a true pipe or shrinkage cavity when rolled, which extended into the centre of the web and well up into the head. The trackmen, however, were not able to distinguish between the true piped rails and the split heads, and it was some time before the latter were attributed to segregation and slag enclosures, which, when recognized, were nearly prevented in subsequent manufacture of rails.

When the mills began to make 33-ft. rails and teemed them into the same ingot moulds which had been used for the 30-ft. rails, and then rolled them in four 33-ft. lengths for 100-lb. rails, a great many ingots were not stripped, weighed and charged into the reheating furnaces with sufficient promptness to prevent a number of piped rails, as the requisite mill practice to check them was not then comprehended under the changed manufacturing conditions.

The segregation was also large, and in 1908, for the New York Central lines, I confined the rolling of Bessemer and open-hearth rails in the United States mills to three 33-ft. rail-length ingots for those of about 19 in. square upon the base. It was also stated in the specifications for the New York Central lines that short, stubby ingots of a length from 2.5 to 3 times the width of the base were required for rails. Ingots of about 8,200 lbs. weight were teemed in moulds 20 by 24 in., and, in good mill practice, will practically complete elimination of piped rails. The blooms, however, were cut, and only rolled in three rail lengths at a time. Ingots 25 by 30 in., of about 12,000 lbs. weight, have been used for eight 33-ft. basic open-hearth 100-lb. rails where the ordinary rail-mill equipment had not been installed. The ingots were bloomed and then shipped to a rail mill to be reheated and rolled, and but a few piped rails were found during manufacture. The rails in the track fulfil the requirements of safety and severe service.

The large mass of metal in the short ingots does not cool quickly, and from the teeming of from 60 to 80-ton melts the ingots would be charged into the reheating furnaces in 1 hr. 30 min., and before all the interior metal had set, with but a trace of a shrinkage cavity started. The distance run by the ingots on their cars from the open-hearth department to the strippers and then to the reheating furnaces aids in consolidating the hot metal in the centre of the moving ingots.

Ingots have been teemed and stripped in the ordinary manner, then taken to the reheating furnaces and when ready for rolling taken out, allowed to cool, and when cut, as would be expected, have shown a shrinkage cavity. The blooms from the companion ingots, when promptly charged into the reheating furnaces and rolled as in proper mill practice, have shown only a small trace of the cavity compared to that in the cold cut ingot.

The specifications for the New York Central Lines require that as soon as the ingots are stripped, they shall be charged into the reheating furnaces to prevent the setting steel cooling from its molten temperature to that of cold metal and to thus avoid the formation of the full shrinkage cavities in the ingots. It has been shown, by the cutting of a large number of blooms, that the shrinkage cavity in the top of the hot ingot is not more than 1/20 to 1/30 of the size of that formed when the ingot is allowed to become completely cold before it is put into the reheating furnace for rolling.

There are only 25 piped rails known to have been found subsequently in service in the track in 65, 70, 75, 80, 95, and 100 lb. sections out of about 1,100,000 30-ft. rails, of which the length of the ingot was not over but under three times the width of the base. The ingots were all stripped by hand in the teeming-pit and charged into horizontal reheating-furnaces, a mill practice long since abandoned. Many 0.06 per cent. phosphorus and 0.60 to 0.65 per cent. carbon rails are still in freight and branch-line service. Some split heads have developed in these rails, due to segregation and the heavy service to which they have been subjected.

Designating Rails by Position of Metal in Ingot.—I was at the mills co-operating in the manufacture and inspection of rails and commenced in 1893 to indicate their position in the ingots by stamping on the web of the top, middle and lower rails the letters A, B, C, respectively. This was for the purpose of studying their subsequent wear and behavior in the track. The A rails contained a larger percentage of oxides, which rose in the steel before completely setting in the ingots, and were faster than the B or C rails under the same traffic. The breakages, however, have been slight in the A, B, or C rails after their many years of service. The ingots were teemed with sharp corners in the moulds, of about 2.5 in. radius, and in the A rails particularly, oxides and slag were entrapped in the corners by the columnar structure of the setting steel. The gauge-side corner of the A rails would show indications of breaking down and spawling to a greater extent under the heavy traffic than the B or C rails. It was possible, after the rails were in the track 8 or 10 years, to identify by casual inspection the A rails from the B or C rails, by the more frequent spawling on the gauge-side corner of the head.

Use of Deoxidizers.—The views of Mr. Benjamin Talbot and Sir Robert Hadfield are old, as to the desirability of completely eliminating blowholes and causing the steel to set sound at the risk of producing a shrinkage-cavity, which must be checked from full development; they have been held and practised by me for the past thirty years in the production of ingots for steel rails. The deoxidizers, apart from the manganese, should be sufficient to cause the steel to set sound without blowholes nearly to the extreme top of the cold ingot. The suggestions of Mr. Talbot and Sir Robert Hadfield, that a large percentage of aluminum be used in the ingots to reduce more completely the oxides, I do not consider advisable. It would be better to use silicon or a combination of silicon and ferro-titanium to secure the desired results. We do not use as high percentages of silicon in steel as is employed abroad, except for tyres.

It is now found for our heavy wheel loads and severe service in the low temperatures of several of the important trunk lines that the high-silicon tyres break more frequently than those in which the content is lower. The suggestion to use from 0.3 to 0.4 per cent. of silicon in rail steel without modification of the other chemical constituents would involve the risk of many rails breaking from the slipping of the drivers upon the rail heads. We must proceed with proper caution in introducing deoxidizers which remain (or whose oxidation products are liable so to do) in the bath of steel. Ferro-titanium, while more expensive than either aluminum or silicon, also acts as a flux, and can be used without danger of leaving its oxidation products in the well-made bath of steel.

Segregation of Basic Open-Hearth Steel Ingots.—The segregation in basic open-hearth ingots for steel rails and wheels has not received requisite attention. I have studied the segregation in several ingots, but do not find it as great in well-purified steel as might be expected with Bessemer metal, which contains two or more times the impurities of phosphorus and sulphur. Well-melted, purified basic open-hearth steel sets quietly and the segregation becomes less in degree.

The Illinois Steel Company, at Gary, when rolling rails for the New York Central Lines in 1912, at my request charged an ingot weighing 8,100 lbs. into the reheating furnace as in ordinary mill practice. In about 2.5 hours, when in condition to roll, it was set outside the furnace to cool. The ingot was 20 by 24 in. on the base and poured 73 in. long. A shrinkage cavity in the cold cut ingot was fully developed from hot to cold steel, and was more than twenty times larger than in the bloom crop of the rolled companion ingot as charged in the usual mill practice. Charging the ingot 10 or 15 min. earlier would have prevented even as large a shrinkage cavity as found in the bloom crop.

Drop and Exhausted Ductility Tests for Open-Hearth Rails.—The exhausted ductility tests for the purification of the steel were introduced into the specifications for the New York Central Lines in 1910 to secure from the preceding eighteen years' experience with the elongation tests Bessemer rails of sufficient toughness to withstand low temperatures of 20 to 30 degs. below zero. The ductility which is possible for a given composition, size of ingots, section and other points of manufacture, has been practically ascertained, and it is to be seen by the exhausted-ductility tests whether or not it is secured.

It requires but a moment to stamp the crop of the rail with the 6-in. spacing bar of seven points before placing the butt on the supports of the drop-testing machine. The elongation of each of the six marked inches on the test butts after the drop is measured by a flexible rule, and the increase in hundredths of an inch per inch indicates the per cent. of elongation. It takes but a moment to test the butt, and the exhausted ductility is obtained in three or more blows through it is measured after each blow and recorded. The lower carbon content of the specification gives one range and the maximum content a higher range, and the mean carbon content is between the two. One of the three can be used as may be necessary in locations for safety, speed and wheel-loads of service.

The term ductility in the specifications for the New York Central Lines is used in the sense of tenacity and toughness of the steel, the exhausted ductility being its measure. This also becomes a soundless test for seams, segregation, slag inclusions and other foreign matter in the web or head of the rails, and is better than the special nick-test in other specifications. The elongation and exhausted-ductility tests are made concurrently with manufacture at the plant under the drop-testing machine on 4 or 5-ft. lengths of the top crop of the rail bars. The butts are tested within 3 hours or less after the ingots of a melt are teemed and rolled, and the facts as to the full ductility of the steel as made and rolled are available for the manufacture of subsequent melts.

Conclusions as to Present Basic Open-Hearth Rail Manufacture.—(1) The chemical composition should provide for sound steel of ample physical properties of tenacity and toughness rather than hardness combined with brittleness.

(2) The impurities, phosphorus and sulphur, should be in minor amounts, so the bath of metal can be purified to produce the large percentage of toughness and ductility due to the specified chemical composition.

(3) The ingot should have such relations of area of base compared to the height and weight that under good mill practice and with suitable deoxidizers it can be made with controlled segregation and only a trace of a shrinkage cavity in the top; then, when bloomed under its equalized initial heat, it is rendered pipeless by the usual 8 to 10 per cent. discard.

(4) Aluminum can be replaced and silicon partly so, as oxidizers, with advantage by the use of ferro-titanium to purify, solidify and check segregation in rail, tyre and axle steels, and also some of the lower grades of carbon steels where great purity is desired.

(5) The ductility and elongation tests to date furnish the best and only prompt means of determining the degree of purification of the steel per melt as it is made, by indicating the physical properties secured before another melt is tapped from the same furnace, and are of decided advantage to the manufacturer as well as to the consumer. These tests are so advanced that they must be applied with knowledge and understanding for proper results, and not be made mechanically for specified records.

(6) Every process or step of the entire manufacture of the steel and the rolling and finishing of the rails must contribute its part to secure the highest quality of the product incident to the chemical composition.

(7) Specifications should be drawn to indicate some of the major necessities of the consumer, and the tests and inspection should be conducted so as to aid and invite the co-operation of the manufacturers to meet the progressive requirements in rail steel.

OREGON CONSERVATION COMMISSION.

The fourth annual report of the Oregon Conservation Commission shows that unused streams in Oregon are capable of producing 3,300,000 horse-power. These streams are also capable of supplying water to irrigate fully 4,000,000 acres of land, half of which can be irrigated at a cost of $30 to $60 per acre. Of the 686,129 acres of irrigated land in the State, 3.2 per cent. has received water through the United States Reclamation Service, 3.6 per cent. through the Carey Act, 11.3 per cent. through commercial enterprises, and most of the balance through individual or partnership enterprise.

The commission recommends submission to the people of a constitutional amendment providing for a bond issue for co-operation with the United States Geological Survey. It also recommends state construction and control of sufficient power projects to regulate the market and insure cheaper power.

The report contains the complete text of the Water Code of Oregon, with comments on its operation. The law has greatly stimulated investments, and the determination and recording of early rights has progressed rapidly. Twenty-three separate stream systems have already been surveyed, involving about 275,000 acres of irrigated land. Over 2,000 claims to water have been filed with the board, and complete determinations made on fifteen stream systems, affecting 1,018 separate rights and 106,686 acres of irrigated land.

SAFETY FIRST.

A movement which in a short time has attained widespread popularity and been adopted by many prominent railways is that of "Safety First." A paper on this subject was recently read by N. S. Dunlop, claims adjuster, C.P.R., before the Canadian Railway Club, a portion of which we abstract and publish herewith.

The claims adjusters of all the railways in America, who have to follow the investigation of every accident to employees and the public, and finally settle the claims arising therefrom, are credited with originating the "Safety First" plan among railway employees.

They had a strong feeling that if the large number of avoidable accidents and serious injuries to employees were pointed out to them, they would immediately see the necessity for adopting "Safety First" measures for their own personal safety.

According to the report of the United States Interstate Commerce Commission, and the report of the Railway Commission for Canada, for 1911, there were 3,865 employees killed and 130,158 injured—more than 10 employees killed and 3,562 injured every day in the year. A man killed, or injured, about every 24 seconds.

Now, who is paying this appalling toll? Not the public, not the officers, not the clerks. The men who are paying this toll are the men on the firing line in every department of operation, and a close investigation and observation, extending over many years, has shown that from 60 to 90 per cent. of these accidents are preventable, and occur through men taking chances.

The Canadian Pacific Railway adopted the "Safety First" scheme more than a year ago with good results.

Forty-four prominent railways in the United States and Canada have adopted the plan covering 144,329 miles of railway.

On each district committees are formed with a chairman and secretary, and members from every department of operation serve on these committees and hold meetings regularly. The committees are composed of superintendents, agents, engineers, firemen, conductors, trainmen, yardmen, trackmen, freight porters, checkers, roadmasters, sectionmen, etc., etc. Every department has a right to be represented, and every employee of the railway is expected to be a "Safety First" man.

Most of the railways have adopted a "Safety First" button worn by the committee men, and in many cases employees are asking that they be supplied with buttons, to demonstrate their interest in the subject, by wearing it at all times.

If the committee meetings are held during working hours, the committee men are allowed their time and their expenses, if they are away from home.

The investigation of accidents shows that it is the little thing which many people do not bother about that leads up to a serious accident.

Broken boards in freight shed floors, or on passenger platforms, result in broken legs, or ribs. Children are killed, or injured, through allowing them to play on lumber piles and turn tables, and on railway premises. Trackmen are injured by employees throwing ice or empty boxes off moving trains. Brakemen, or yardmen, should never kick over a knuckle, adjust a coupler or angle cock while cars are moving. They may do these things successfully for a long time, but the loss of lives and limbs results too often. These men are chance takers, and the chance taker is the chief supporter of the artificial limb maker and the undertaker.

Employees should always respect the blue flag. The lives and limbs of their fellow employees depend upon it.

Never stand between the rails and attempt to get on an advancing engine or car. If it is necessary to get on either stand outside the rails. Better get on behind.

"Safety First" says emphatically "do not take chances." The time between the prevention of an accident and causing one is only a matter of a few seconds.

Obstruction should not be left near the track for train men to trip over. Drains should be covered at night. Car checkers and others moving about yards should keep from between the rails. They are made for cars and engines to run upon.

The careless, indifferent foreman will have careless men under him, and a greater number of accidents than the man who is always alive to "Safety First."

Look out for loose or missing grab irons, loose brake circles. Do not go under cars without a blue flag to protect you, and see that the car is on its trucks, or so securely blocked up that a change in weather conditions will not tumble it over upon you.

The conductor's highest duty is the protection of his passengers and he should exercise great care in the starting and stopping of his train, and live up to the very spirit and letter of the rule book.

All men engaged in the operation of trains should at all times observe the strictest sobriety, have proper rest, know the rule book by heart, and observe without any quibbling, every rule in the book. They should have no family troubles, and while on duty think of nothing else but duty.

If in doubt, stop. It is better to delay your train than land yourself and your passengers in eternity.

"Safety First" says use torches around your engine and tender, not matches.

Ring your bell before moving your engine off the ash pit.

Do not stand between the apron and the cab when coaling an engine.

Lower your crossing gates in time. Keep clear of passing trains.

Avoid flying stones, or objects falling off a train.

Do not fool with machines—they can be replaced, hands cannot.

Look out for gang planks when loading freight into cars. Do not allow freight handlers to go in their bare feet. They may step on nails and death by lockjaw is sometimes the result.

"Safety First" warns you that it is better to make your slings and scaffolds safe and to use four inch nails instead of 2½ inch nails. It is better to spend five minutes making things safe than to be taken home with a broken back.

Never allow jacks, angle bars or material near the track where they may be struck by a passing train.

When riding hand cars send a man ahead towards a curve, and, if you are likely to be caught and cannot remove the hand car, "Safety First" says: "Let the hand car go and run towards the engine." Hand cars cost $49.40 each. Human lives can never be replaced. Do not carry guns on hand cars and arrange tools so that they will not fall off.

"Safety First" says to men engaged in blasting: "Do not carry a whole box of 100 detonator caps in your pocket. Two or three are sufficient. An explosion means shocking results."

Men should tell their fellow employees of the dangers of their work before an accident happens, and warn them how to avoid it.

Never approve the actions of careless men. Caution them for their own good and for the good of others.

The vast importance of "Safety First" is demonstrated in the words themselves. You may write volumes on these two words, analyze them, describe their objects, explain them any way you like, but you cannot add to the emphasis of that slogan which is bound to reach more railway men, and be of vastly more importance, than any subject they have ever taken up.

On a large number of railways special men have been appointed whose duties are solely to educate the men on "Safety First" habits. This is done by printed literature, lectures, moving pictures showing the right and wrong way of doing work, correcting defective conditions and impressing upon the minds of all classes of employees the danger of taking chances.

In the operation of a railway "Safety First" should be placed above everything else. Unless men are willing to be careful and avoid injury to themselves and their fellow workmen, they should not engage in railway work. A railway does not want careless men in its employ. "Safety First" is always a great convenience, but in an emergency it is an absolute necessity.

The "Safety First" habit must be the creed of every railway man who hopes to succeed in the prevention of preventable accidents.

If whisky or beer interferes with a railway man's work he should give up his work.

Do not ride between crippled cars.

Pile up lumber in yards, drive down grade stakes, fill up holes, turn down boards with nails sticking out of them, and remove anything a train man may fall over.

Do not, under any consideration, go between moving cars.

Do not allow telephone or telegraph wires to hang too low over tracks. Cut them before some poor fellow is knocked off the top of a car and paralyzed for life.

Teach men to be careful. Do not overload engine tanks with coal.

Whenever an employee is killed, or injured, sorrow, suffering, expense, and, if he lives, crippled earning power, is the result.

Do not allow a man with one eye to work where cars are being moved. He cannot see from the blind side.

Do not leave dynamite, torpedoes or fusees where children can play with them, and do not carry them in your pocket.

"Safety First" never sleeps. It says: "Report and have corrected as soon as possible anything which would cause an accident." It calls at all times for suggestions and ideas, from employees, how to save men's lives and limbs.

DISCUSSION ON "SAFETY FIRST."

Prof. Keay: I think the author of this paper is to be congratulated upon having expressed so much logic in so brief a space. The paper is further to be commended for its intimate and human appeal. That it enters a field far wider than that of the railroads alone is evident from a recent request which I have from the assistant manager of one of the largest shipbuilding companies on this continent, for the bibliology of all railway literature available on the "Safety First" movement. This may be regarded as a frank recognition that the railways are the first in the field. It seems to me that the underlying principle of this movement is a practical answer to that old question: "Am I my brother's keeper?"

Mr. A. A. Maver: The subject of this paper is one of great interest to me, and it is also of great and first importance to all employees, not only in railways, but in industrial establishments of all kinds. It is also of interest to employees, and especially since the Employers' Liability Act has come into force, whereby the employer is held responsible, no matter how neglectful or careless the employee may have been in becoming injured. I was at a meeting in connection with "First Aid to the Injured," and one of our officials spoke on the subject of prevention. He said, "You gentlemen here have purposed to care for and give attention to the injured, but the greatest point of all is prevention"—and he brought in the old adage, "An ounce of prevention is worth a pound of cure." Safety first is prevention. I have noticed in connection with our works, and in the casualty reports which come before me, that the higher the intelligence of the employee the less injuries are sustained, but the lower the grade of intelligence the greater the number of injuries. This is particularly true in the case of our foreign labor, which men are generally of a very low order of intelligence. They are handicapped also by not speaking our language, and, in fact, have to be led out of danger by other employees. The great trouble is that their fellow-employees, who have more intelligence, give them credit of having an equal intelligence, and the result is they are often not warned as they should be. Mention is made in this paper of keeping torpedoes out of the hands of children. These torpedoes are used for the protection of trains during fogs or heavy snow storms, when the visual signals cannot be readily seen, the explosion warning the engineer of danger ahead. They are supposed to be removed from the locomotives when they are sent to the shop for repairs, but occasionally one is left on an engine, and it gets into the shop. It is gotten hold of by some inquisitive man, who sees in it an explosive of some kind, and who slyly puts it under a locomotive which may be moving in or out of the shop. As the wheels pass over it an explosion takes place, the metallic casing flies in all directions, and we have had some serious accidents from this cause; but it is always difficult to find out who put the torpedo on the rail. We had a case of one young man who wanted to hear what kind of a report a torpedo would make. He placed one on a piece of metal, got a hammer and struck it. He not only heard the report, but also had a very badly mutilated hand. This is all through ignorance, yet warning notices have been put up. It seems to me a duty on the part of our employees to point out to their fellow-employees where the danger exists. If this is done a great many accidents would be avoided.

CIVIL SERVICE COMMISSION.

Applications will be received by the Civil Service Commission for the following positions: A correspondence clerk in the Forestry Branch of the Department of the Interior, an assistant engineer in ore dressing and metallurgical division of the Mines Branch of the Department of Mines, twelve technical clerks for temporary employment in the Topographical Survey Branch of the Department of the Interior, and a draughtsman in the Forestry Branch with a knowledge of survey work and general drafting.

Application forms, properly filled in, must be filed in the Office of the Civil Service Commission, not later than the 26th May in the case of the first two and the last positions, and not later than the 19th May for the technical clerks in the Topographical Survey. Forms may be obtained from Wm. Foran, the Secretary of the Commission, Ottawa.

COAST TO COAST.

Ottawa, Ont.—Accompanying is a table showing the results of an analysis of the water supply about to be brought from Esquimalt, as determined by City Analyst Birch. At Elk Lake, "A"; Goldstream, "B"; Sooke Lake, "C"; Richardson Street spring, "D"; and Spring Ridge spring, "E":—

	Free Ammonia	Albuminoid Ammonia	Chlorine	Volatile Solid	Fixed Solids	Total Solids	Nitrates	Nitrates	Reaction
A	.001	.012	.6	3.2	4.2	7.4	.00	.00	Neutral
B	.001	.003	.5	1.5	2.5	4.0	.00	.00	Neutral
C	.001	.008	.5	2.0	.4	2.4	.00	.00	Neutral
D	.000	.001	1.3	6.0	8.5	14.5	.5	.00	Neutral
E	.000	.003	4.2	12.5	25.0	37.5	.8	.00	Neutral

The first two columns are parts per 100,000, and the others in grains per gallon. From the standpoint of purity the albuminoid ammonia as determined from Wanklyn's process, gives the best idea of the purity or otherwise of the water from contamination, taking in view, of course, the amount of free ammonia and chlorine which would be found in excess in water fouled by excreta. That at Elk Lake is slightly lower than the British standard of 0.015; however, it is safer in this country with a higher percentage than in Britain on account of the less densely settled communities. Therefore, bad as Elk Lake supply has been in summer from the point of odor, it has practically no injurious effects, although last year at one time it was felt desirable for the board of health to issue a warning on the subject to the citizens about boiling it. The two city springs are, of course, remarkably pure.

Toronto, Ont.—The Toronto delegates attending the fifth National Conference on City Planning at Chicago have returned. The party consisted of Aldermen S. Morley Wickett and H. J. Anderson, Geo. Powell, Assistant City Engineer; Chas. E. Chambers, Parks Commissioner; Jas. C. Forman, Assessment Commissioner; Messrs. Dunington-Grubb, J. P. Hynes, and E. L. Riggs, of the Civic Guild, and Miss E. B. Neufeld, of the Central Neighborhood House. At the conference were 230 delegates, representing 53 American cities outside Chicago, and six Canadian cities. These composed the best authorities on the subject in America. A great development of the park and boulevard system is being carried out in Chicago. The parks in the city have been linked together by magnificent boulevards about 150 feet wide, splendidly paved and most efficiently maintained, and marked with a cleanliness which is most striking. In a huge semicircle these driveways surround the city, and the base is formed by Michigan Boulevard. In all, there must be between 50 and 60 miles of continuous roadway. This was one of the most impressive works they had seen, stated Mr. Riggs, and pointed out that as the geographical situation of Toronto was practically the same as that of Chicago, the plan they are carrying out there could easily be adapted to our own city. This plan has been already outlined for Toronto by Parks Commissioner Chambers, who stated: "The boulevard system made us envious. Alderman Anderson and I are going to prepare reports on both these features to be submitted to Council soon, and in the hope that Toronto may do something along the same line." Mr. Chambers said that while nothing was known as yet to the choice for the 1914 convention, Toronto would likely be the convention city. Twenty-five cities sent invitations, but Toronto will get the convention. "If they come here we will make the association an international one," said the commissioner. "It will be the first town planning congress to be held in Toronto."

Victoria, B.C.—While the effort to obtain national government participation in the highways progress of the United States accumulate force, the various states, one after another, are adopting legislation providing for the establishment of state highway departments. According to information received by the American Automobile Association National Good Roads Board, which keeps in touch with the state automobile bodies and aids materially in their work, there will be, as a result of recent legislative action, road departments in Maine, Montana, Missouri, Colorado, Idaho, Arkansas and Texas. This makes plainly apparent that the move for federal action has not caused any "lying down" on the part of the states, which have their proper part to perform in the general roads development. Of the addresses given at the second federal aid convention in Washington, called by the National Good Roads Board, none contained a more comprehensive summing up of the situation than the remarks of Representative William P. Borland, of Missouri, who, among other things, said: "I believe that the good road question is the biggest question, without exception, now facing the American people. In Congress we are trying earnestly and sincerly to deal with this problem of the extent and character of federal control and federal aid to good roads. There are difficulties confronting us. Some of us believe in a continuous system of roads, roads that go somewhere, roads that give us the benefit of the scientific progress of engineering skill that has been developed in connection with road building. We believe that federal aid, if it comes at all—and it must come—must mean a better type of roads, long roads, roads of higher class, roads of a more permanent character, roads that go somewhere, roads that mean something in the development of the country. But here is the idea that must occur to every thinking man. We do not have to improve the 2,150,000 miles of highways in the United States. That need not stagger any man's imagination. Experience has shown, at the very threshold of this subject, that 90 per cent. of the traffic on roads goes over less than 10 per cent. of the roads. If we had a system of good roads leading fairly into every section of the country, within the reasonable reach of the majority of the citizens and producers and taxpayers of the country, that system would be a vast advantage over the present system of isolated local control of highways. If we can bring that about by a spirit of self-sacrifice and co-operation, and if we can get together on the idea that it is better to have some good roads than it is to have no good roads, then we will all get behind some proposition and accomplish something for good roads, and it is going to take that spirit of co-operation and self-sacrifice to bring about legislation."

Quebec, Que.—That there is little prospect at present of any Government action towards securing the refining in Canada of silver ore which now goes to New York for the final process, but that the Government expects to shortly enlarge the refinery at the Ottawa Mint so that it will be able to take care of the whole gold production of the Dominion, were announcements made in the Commons recently by Hon. W. T. White, Minister of Finance, in the course of a discussion on a bill increasing from $75,000 to $110,000 per annum the vote for operating expenses. Sir Wilfrid Laurier suggested that in view of the fact that practically all the Canadian silver output, amounting last year to $19,000,000, went to New York for refining purposes, the Government should take steps to encourage silver refining in Canada. Mr White, however, said that economic conditions of refining and marketing and considerations of technical processes, made it impracticable at present to change the present refining and marketing and considerations of policy of centring the silver refining industry on the large and costly American plants.

Toronto, Ont.—The supply of iron ore available under present methods of mining in the entire world has been stated by geologists of international reputation at 22,000,000,000 tons, from which it is estimated 10,000,000,000 tons of iron may be produced. At the present rate of consumption, this supply would last the world about sixty years. There are, however, more than 123,000,000,000 tons of ore not now commercially available, which, with improved methods of production, may be made to yield in the future an additional 53,000,000,000 tons of iron, which would run the world along for another 300 years, if no more iron were used annually than at present.

Winnipeg, Man.—The construction of the Canadian Pacific Railway tunnel under the Selkirk Mountains, for which the contract has been let, will be a tremendous undertaking. Owing to the fact that the tunnel work cannot be accelerated because of the impracticability of driving shafts a mile deep through the mountain, work on the tunnel proper will be necessarily confined to two ends. This will make work slower of accomplishment than if, as in the case of the Canadian Northern tunnel under the mountain into Montreal, a shaft could have been sunk near the centre of the tunnel. If this had been practicable, four shifts could have been employed in tunnelling night and day, and work would have been greatly expedited. As it is, only two shifts can be used night and day on the two drilling surfaces. Some difficult engineering feats are being faced in building the approaches, but these pale into insignificance in the presence of the vaster task of piercing the mountains. Besides this, twenty miles of double tracking, which is now being undertaken in connection with tunnelling, the Canadian Pacific is also asking for tenders for forty-nine miles more of double tracking in the mountains. Twenty-five miles of track are to be built east of Kamloops and twenty-four west of Revelstoke.

Montreal, Que.—The Phœnix Bridge and Iron Works Company is making a new issue of bonds and stock this week, through the Quebec Savings and Trust Company. This stock has already been underwritten, and is now being distributed to the public. The offering consists of $750,000 of 6 per cent. first mortgage bonds, and of $800,000 of common stock. The bonds are being offered at 96 per cent of par, and the stock at $50 per share. The offering is being made simultaneously in London and in Canada. Approximately $450,000 of the bonds and $405,000 of the stock have been taken firm. A new company has just been incorporated at Ottawa with a capitalization of $1,500,000. This company in every way takes the place of the company which has heretofore operated under the same title. After the present issue has been accomplished, there will remain in the treasury to provide funds for future expenses and for the general purposes of the company, $700,000 of the common shares of the company. All the bonds will have been issued. The company has a plant situated in the centre of the manufacturing district of Montreal, where shipping facilities are all that could be desired. The concern manufactures and erects structural steel for bridges and buildings. The cost of delivery, owing to the central location of the concern, is smaller than in the case of most other companies. Operations have now been carried on satisfactorily since 1898, and, save for an occasional year, earnings have shown a fairly constant increase, beginning with $51,000 in 1898 and progressing gradually to upwards of $600,000 during the past couple of years. The land owned by the company allows of an expansion to the works. The assets of the company, at the end of last year including $25,000 which is being provided for improvements, amounted to $1,400,00, while total liabilities were but $57,000. This leaves a surplus of $1,243 against the present bond issue of $750,000. Mr. James W. Pyke is president of the company, and Mr. T. Palmer Howard is general manager.

Victoria, B.C.—Plans for harbor improvements progress steadily. This year Victoria will have its large docks under way. These are to be built by Sir John Jackson & Company, and something will be accomplished also in connection with the dredging of False Creek in Vancouver. To give better facilities for shipping, it is announced that the government will establish a drydock at Esquimalt, this being stated as part of the naval scheme on the Pacific. Mayor Baxter, of Vancouver, who was in Vancouver in connection with harbor and other matters, returned on the 1st instant, and reports that it is very probable that a drydock will be built at Vancouver along the lines of some of the schemes proposed heretofore. News of the government grain elevator is also brought back by the mayor. He does not say, however, that this will be erected right in Vancouver, but it will be close enough for this city to reap benefit from the business Along the waterfront of Vancouver there is hardly room for a large grain elevator, since it is a very busy place. Moreover, if an elevator is erected some distance out it will help to give strength to the outlying reaches of Greater Vancouver. With the passage at Ottawa of the bill to incorporate the harbor commissioners of Vancouver, no time should be lost in completing the personnel of this board, so that this legislation may be effectively implemented. It will be found that there will be many matters for a board of this kind to adjust and adjudicate upon, and if trade grows as it has in the past, and as is anticipated, the harbor commissioners will be kept down to steady business.

Montreal, Que.—The Montreal Engineering Company, Limited, of Montreal, has been given a franchise by the Medicine Hat council to build and operate a street railway system. The by-law will be submitted to the burgesses on May 22nd, when it is expected that the agreement will be approved. The franchise is for a twenty-year term, renewable for a further term of five years or more. Construction will commence June 1st and rushed to completion of the first nine miles of track. Power will be supplied by the city as alternating current, or the company will install its own plant, operated by natural gas supplied by the city.

PERSONAL.

C. H. MITCHELL, C.E., has been appointed a member of the Board of Governors of the University of Toronto.

H. GALE LEGG, town engineer of Preston, Ont., has been appointed to a position in the chief architect's office at Ottawa.

WM. C. SAMPLE, consulting engineer of Fort William, Ont., has been called in by the Township of Neebig, to report on a sewage disposal scheme.

MR. E. J. HOLLAND, acting city engineer of Guelph, Ont., has been appointed city engineer. Mr. W. C. Clauson has been appointed assistant city engineer.

MR. A. T. ENLOW has resigned as manager of sales of the Stark Rolling Mill Company, Canton, Ohio, and has become associated with the Pedlar People, Oshawa, Ont.

MR. H. M. KENZIE, at present in the employ of the water power branch of the department of the interior at Ottawa, has been appointed as city commissioner of Prince Albert, Sask.

GEORGE H. BOWEN, B.A.Sc., has opened an office as consulting, mechanical, and electrical engineer at 34 Victoria Street, Toronto. Mr. Bowen graduated from the University of Toronto in 1909, and latterly has been connected with the Niagara Falls Park Commission.

PROF. R. B. MILLER, dean of the U.N.B. Forestry School, has accepted a position with the forestry branch of the Department of Natural Resources of the C.P.R., for the summer to do consulting work similar to that done by Prof. A. H. D. Ross, of Toronto University, in British Columbia.

MR. F. P. GUTELIUS has been appointed general manager of the Government Railways. He is appointed for a two-year term. He will supervise and direct all departments of the Government railways, and will be in charge of the Hudson Bay Railway when completed. The order provides for the abolition of the present Intercolonial Board of Management. Mr. F. P. Gutelius was born in the United States in 1864; he graduated as a civil engineer in 1887, and started to gain experience with the Pennsylvania Co., Pittsburg, Pa. He went to British Columbia in 1895 and was general superintendent of the Columbia and Western Railway (constructing and operating railway between Robson and Rossland) till 1895, when he joined the C.P.R. He successively held positions as division superintendent, in the Engineering Department, as engineer of maintenance of ways, and became assistant chief engineer of eastern lines in 1906, general superintendent of Lake Superior division in 1908, and superintendent of the Eastern division in 1910. Early in 1912 he was appointed by the Government to investigate all expenditures on the National Transcontinental Railway. He will have his headquarters at Moncton, N.B.

PROFESSIONAL DEGREES GRANTED BY UNIVERSITY OF TORONTO.

The following have completed the requirements for professional degrees as laid down by the University of Toronto:—F. A. Dallyn, the degree of civil engineer (C.E.); E. A. James, the degree of civil engineer (C.E.); C. H. Marrs, the degree of civil engineer (C.E.); D. L. H. Forbes, the degree of mining engineer (M.E.); A. G. Christie, the degree of mechanical engineer (M.E.); E. H. Darling, the degree of mechanical engineer (M.E); G. J. Manson, the degree of mechanical engineer (M.E.); R. S. Smart, the degree of mechanical engineer (M.E.); P. H. Mitchell, the degree of electrical engineer (E.E.).

THE AMERICAN INSTITUTE OF CONSULTING ENGINEERS.

A meeting of the Institute for the purpose of discussing "The Incorporation of the Institute," also "The Physical Valuation of the Railroads of the United States as Authorized by Act of Congress, March 1, 1913," will be held at the Engineers' Club, 32 West 40th Street, New York City, Thursday evening, May 22nd, 1913, at 8 p.m.

TECHNOLOGY CLUB OF LOWER CANADA.

The Alumni of the Massachusetts Institute of Technology met last week in Montreal for the purpose of forming an Association to be known as the "Technology Club of Lower Canada."

The club includes among its members this Alumni of the Institute now residing in Eastern Ontario, Province of Quebec and the Ottawa Valley. The following officers were elected:—President, Mr. F. E. Came; vice-president, Mr. H. E. Stearns; secretary-treasurer, Mr. E. B. Evans; board of governors, Mr. D. J. Spence and Mr. R. Heckle.

The club will have two regular meetings each year, as well as a weekly meeting at a local restaurant for the purpose of forming the object of the organization.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The spring meeting will be held this year at Baltimore, Md., May 20th to 23rd, inclusive, at the invitation of the Engineers' Club, of Baltimore, and the local members of the society. The professional sessions have as usual been arranged by the Committee on Meetings, while all other events are in charge of the local committee under the chairmanship of Layton F. Smith, past president of the Engineers' Club, of Baltimore.

Special railroad transportation concessions have been secured for members and guests attending the spring meeting in Baltimore, May 20th to 23rd, 1913.

The special rate of a fare and three-fifths for the round trip, on the certificate plan, is granted when the regular fare is 75 cents and upwards in United States territory.

COMING MEETINGS.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.—Spring Meeting, May 20-23. Secretary's Address 29 West 39th Street, New York.

CANADIAN ELECTRICAL ASSOCIATION.—Annual Convention will be held in Fort William, June 23, 24 and 25. Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

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

THE CANADIAN FORESTRY ASSOCIATION.—National Convention will be held in Winnipeg, Man., July 7-9. James Lawler, Secretary, Canadian Forestry Association, Canadian Building, Ottawa.

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

NATIONAL ASSOCIATION OF CEMENT USERS.—Tenth Annual Convention to be held at Chicago, Ill., Feb. 16-20, 1914. Secretary, E. E. Kraus, Harrison Bld., Philadelphia, Pa.

ENGINEERING SOCIETIES.

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

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

MANITOBA BRANCH.—Chairman, J. A. Hesketh; Secretary, E. E. Brydone-Jack, 83 Canada Life Building, Winnipeg. Regular meetings on first Thursday of every month from November to April.

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

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

TORONTO BRANCH—96 King Street West, Toronto. Chairman, E. A. James; Secretary-Treasurer, A. Garrow. Meets last Thursday of the month at Engineers' Club.

CALGARY BRANCH—Chairman, H. B. Mucklestone; Secretary-Treasurer, P. M. Sauder.

VANCOUVER BRANCH—Chairman, G. E. G. Conway; Secretary-Treasurer, F. Pardo Wilson, Address: 422 Pacific Building, Vancouver, B.C.

VICTORIA BRANCH—Chairman, F. C. Gamble; Secretary, R. W. MacIntyre; Address P.O. Box 1290. Meets 2nd Thursday in each month at Club Rooms, 534 Broughton Street.

MUNICIPAL ASSOCIATIONS

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

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

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

THE UNION OF CANADIAN MUNICIPALTIES.—President, Chase. Hopewell, Mayor of Ottawa; Hon. Secretary-Treasurer, W. D. Lighthall, K.C. Ex-Mayor of Westmount.

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

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

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

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

UNION OF ALBERTA MUNICIPALITIES.—President, F. P. Layton, Mayor of Camrose; Secretary-Treasurer, G. J. Kinnaird, Edmonton, Alta.

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

CANADIAN TECHNICAL SOCIETIES

ALBERTA ASSOCIATION OF ARCHITECTS.—President, R. W. Lines, Edmonton; Hon. Secretary, W. D. Cromarty, Edmonton, Alta.

ALBERTA ASSOCIATION OF LAND SURVEYORS.—President, L. C. Charlesworth, Edmonton; Secretary and Registrar, R. W. Cautley, Edmonton.

ASSOCIATION OF SASKATCHEWAN LAND SURVEYORS.—President, A. C. Garner, Regina; Secretary-Treasurer, H. G. Phillips, Regina.

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

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

BRITISH COLUMBIA SOCIETY OF ARCHITECTS.—President, Hoult Horton; Secretary, John Wilson, Victoria, B.C.

BUILDERS' CANADIAN NATIONAL ASSOCIATION.—President, E. T. Nesbitt; Secretary-Treasurer, J. H. Lauer, Montreal, Que.

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Secretary-Treasurer, Wm. Snaith, The Thor Iron Works, Toronto, Ont.

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

CANADIAN ELECTRICAL ASSOCIATION.—President, A. A. Dion, Ottawa; Secretary, C. E. Bawden, Birkbeck Bld., Toronto.

CANADIAN FORESTRY ASSOCIATION.—President, Hon. W. A. Charlton, M.P., Toronto; Secretary. James Lawler, Canadian Building, Ottawa.

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

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

THE CANADIAN INSTITUTE.—198 College Street, Toronto. President J. B. Tyrrell; Secretary, Mr. J. Patterson.

CANADIAN MINING INSTITUTE.—Windsor Hotel, Montreal. President, Dr. A. E. Barlow, Montreal; Secretary. H. Mortimer Lamb, Windsor Hotel, Montreal.

CANADIAN PEAT SOCIETY.—President, J. McWilliam, M.D., London, Ont.; Secretary-Treasurer, Arthur J. Forward, B.A., 22 Castle Building, Ottawa, Ont.

THE CANADIAN PUBLIC HEALTH ASSOCIATION.—President, Dr. Charles A. Hodgetts, Ottawa; General Secretary, Major Lorne Drum, Ottawa.

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

CANADIAN STREET RAILWAY ASSOCIATION.—President, Patrick Dubee, Montreal; Secretary, Acton Burrows, 70 Bond Street, Toronto.

CANADIAN SOCIETY OF FOREST ENGINEERS.—President, Dr. Fernow, Toronto.; Secretary, F. W. H. Jacombe, Department of the Interior, 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 and August.

DOMINION LAND SURVEYORS.—President, Mr. R. A. Belanger, Ottawa; Secretary-Treasurer, E. M. Dennis, Dept. of the Interior, Ottawa.

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

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, F. C. Mechin; Corresponding Secretary, A. W. Sime.

ENGINEERS' CLUB OF MONTREAL.—Secretary, C. M. Strange, 9 Beaver Hall Square, Montreal.

ENGINEERS' CLUB OF TORONTO.—96 King Street West. President, Edmund Burke; 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.

INTERNATIONAL ASSOCIATION FOR THE PREVENTION OF SMOKE.—Secretary R. C. Harris, City Hall, Toronto.

MANITOBA ASSOCIATION OF ARCHITECTS.—President, W. Fingland, Winnipeg; Secretary, R. G. Hanford.

MANITOBA LAND SURVEYORS.—President, J. L. Doupe; Secretary-Treasurer, W. B. Young, 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, J. K. MacKenzie; Secretary, A. R. McCleave, Assistant Road Commissioner's Office, Halifax, N.S

ONTARIO ASSOCIATION OF ARCHITECTS.—President, C. P. Meredith, Ottawa; Secretary. H. E. Moore, 195 Bloor St. E., Toronto.

ONTARIO PROVINCIAL GOOD ROADS ASSOCIATION.—President, N. Vermilyea, Belleville; Hon. Secretary-Treasurer, J. E. Farewell, Whitby; Secretary-Treasurer, G. S. Henry, Oriole.

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, J. S. Dobie, Thessalon; Secretary, L. V. Rorke, Toronto.

TECHNICAL SOCIETY OF PETERBORO.—Bank of Commerce Building, Peterboro. General Secretary, N. C. Mills, P.O. Box 995, Peterboro, Ont.

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

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

QUEEN'S UNIVERSITY ENGINEERING SOCIETY.—Kingston, Ont. President, W. Dalziel; Secretary, J. C. Cameron.

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

ROYAL ARCHITECTURAL INSTITUTE OF CANADA.—President, H. C. Russell, Winnipeg, Man.; Hon. Secretary, Alcide Chausse, No. 5. Beaver Hall Square, Montreal, Que.

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

SOCIETY OF CHEMICAL INDUSTRY.—Wallace P. Cohoe, Chairman; Alfred Burton, Toronto, Secretary.

TECHNOLOGY CLUB OF LOWER CANADA.—President, F. E. Came; Secretary-Treasurer, E. B. Evans. Meets twice yearly.

UNDERGRADUATE SOCIETY OF APPLIED SCIENCE, McGILL UNIVERSITY.—President, W. G. Mitchell; Secretary, H. F. Cole.

WESTERN CANADA IRRIGATION ASSOCIATION.—President, Duncan Marshall, Edmonton, Alta. Permanent Secretary, Norman S. Rankin, P.O. Box 1317, Calgary, Alta.

WESTERN CANADA RAILWAY CLUB.—President, R. R. Nield; Secretary, W. H. Rosevear, P.O. Box 1707, Winnipeg, Man. Second Monday, except June, July and August at Winnipeg.