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THE CANADIAN ENGINEER

An Engineering Weekly.

ELECTRICAL OPERATION OF DRAWBRIDGES.*

By S. F. Nichols.†

The first installation of electric motors for drawbridges were on highway bridges, commencing about 1890. In fact, railways were comparatively slow in adopting electric power for this purpose. There are several explanations for this. It is only comparatively recently that steam railways have organized well-equipped electrical departments and employed staffs of trained electrical engineers. On the other hand, the lake cities, Chicago, Cleveland, Milwaukee, etc., having early faced the problems of generating and distributing electric current for light and power, and having electric car lines operating on their streets, were very naturally easily induced to adopt electric power for operating their new bridges, and, in many cases, the older ones. In most of these cases, current was obtained from the street car circuits at very favorable rates. The cars had to cross the city's bridges and it was not a difficult matter to arrange for using the car company's power. The steam railway bridges were not so fortunately located with reference to securing electric power for operation, and the only points where this power therefore could be applied to these structures were in the larger cities where the bridges happened to be located. The great majority of the draw spans being at points remote from the larger cities, it was out of the question even to consider electrical operation without the installation of an independent power plant.

Strobel Bascule Bridge; Indiana Harbor.

The improvement in electric motors and other electrical apparatus was so rapid, and electric power became so much more available at many points, that motors were put on many existing structures and the machinery for new bridges was laid out with reference to this method of operation.

An added incentive to the adoption of electric power for bridge operation was furnished by the development of the bascule type of drawbridge, the first of which was the Van Buren Street bridge in Chicago, followed shortly by the

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*From a paper presented at the third annual convention of the Railway Electrical Engineers' Association.

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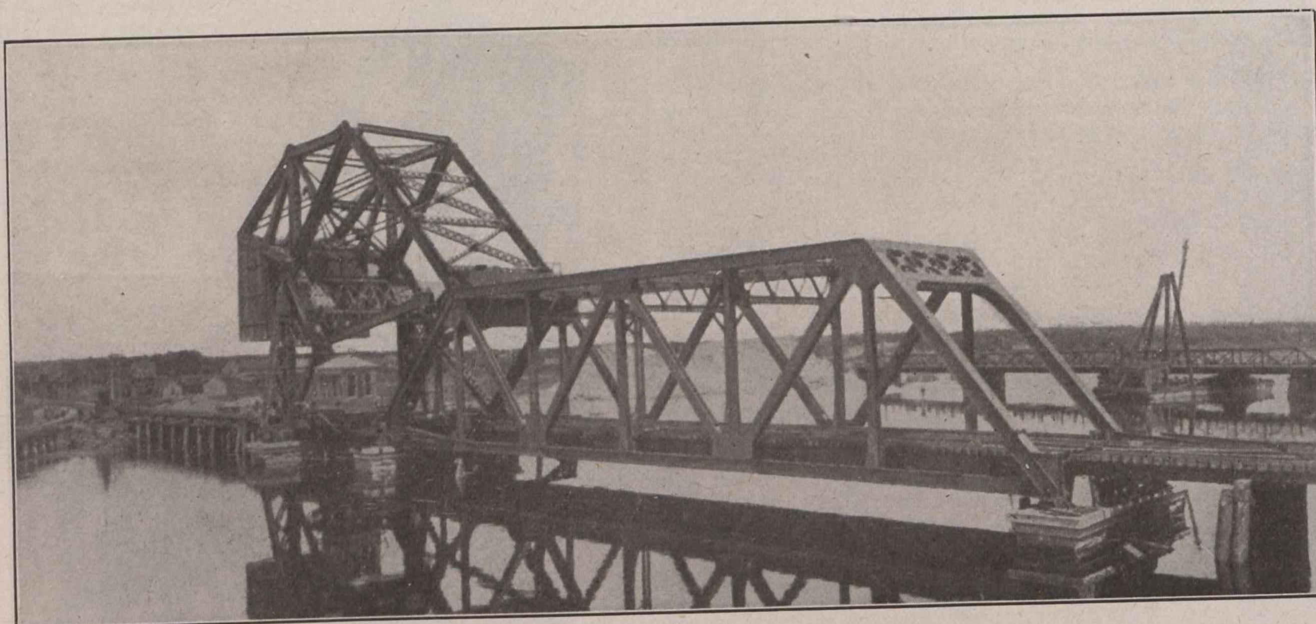
Metropolitan Elevated Railway bridge located beside it. A large percentage of the bascule bridges that have been built have been equipped with electric motors and controlling devices.

Advantages of Electrical Operation

For the amount of horse-power developed, the electric motor is light and compact, and is conveniently reversed, running equally well in either direction. It has no reciprocating parts, and therefore the mechanical wear and internal friction are almost negligible quantities. It is capable of sustaining a heavy overload for short periods, which enables is to take care of the very difficult problem of accelerating a heavy mass and also of operating the bridge against high wind pressures that may occasionally be experienced. It is almost noiseless in operation. Being compact, it can be located close to the point where the power must be used, thus obviating the necessity of having a large engine room with a heavy floor system above the deck of either the swing or bascule span. This makes it possible to locate the bridge operator at the most convenient position from the standpoint of accessibility, or where the best view can be obtained of the river or railway or highway traffic. The motors can be located on a moving portion of the structure while the operator's house is located on the fixed part. This is one reason why the electric motor has been so important a feature in the development of the bascule bridge, as on a number of present designs the leaf motors as well as the motors operating the locks at the extreme point of the bridge, move with the leaf through its entire angular range of motion. Connection can readily be made between the moving and fixed portions of the bridge by means of swinging loops, flexible joints or commutating devices. The electric motor, furthermore, at at present designed and constructed, requires comparatively little attention, and the possibility of its getting out of order and refusing to do its work is very remote where periodical inspection is given.

Standard Electrical Equipment.

The modern bascule bridge requires one or two motors for the operation of the moving leaf, a motor for the front lock, and in some cases a motor for the rail locks. Frequently, moving rail locks are omitted and the end locks are operated by hand power. Each of these motors is ordinarily provided with a solenoid brake and the motors operating the end lock and rail lock are automatically stopped by the current being cut off and the brake being applied when the lock in its travel reaches the end of its motion in either direction. The current is ordinarily cut off from the leaf motors and the brakes applied when the leaf in opening reaches a point beyond which it is dangerous to allow it to travel. The controllers for the operation of the several motors are located in the operator's house conveniently situated, and a switchboard is provided carrying the necessary instruments, switches and circuit breakers or contactors. The motion of the leaf is under the control of the operator at all times except when it reaches the danger point in opening, when the automatic stop acts. The motors for the end locks and rail locks are ordinarily started in the proper direction and run continuously until automatically stopped by the action of the contact switches, which cause the rupturing of the motor circuit at the switchboard. The positions of the bridge leaf and locks are shown to the operator by indicator lights conveniently grouped in front of the controller.



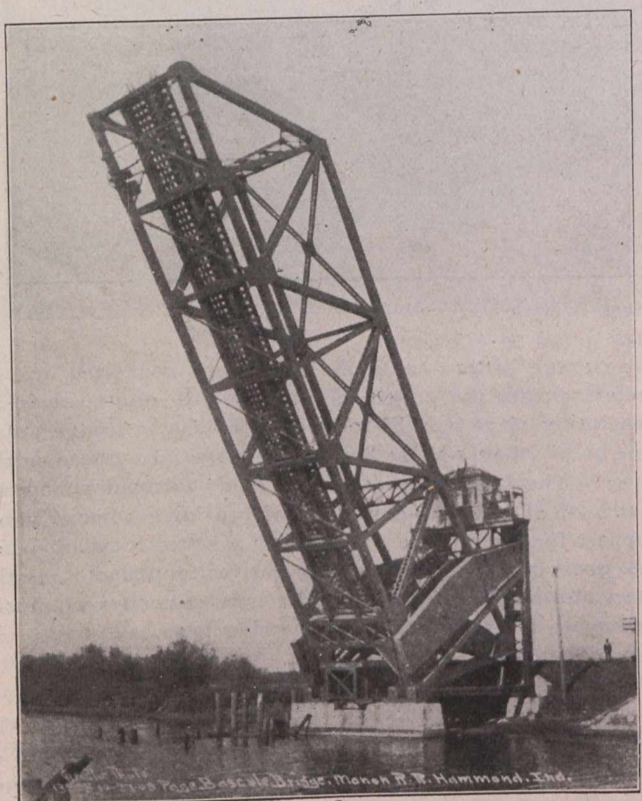
Strauss Bascule Bridge.

Owing to the fact that all the motors are on the moving leaf, it is not usually found feasible to install a mechanical brake, and in order to avoid the possibility of disastrous results attending the failure of the motor brakes to hold the leaf it is customary to install what is called an emergency brake, which will be applied automatically in case the current fails, or may be applied by the operator if desired. This brake is set by springs and ordinarily pulled into release before starting the bridge, and is applied again after the swing is made, not being used as a service brake unless the emergency conditions arise. An electric solenoid has frequently been used for releasing this brake, but a better method has been found in the use of a small electric motor operating a mechanism for releasing the brake, and holding it in release as long as the current is held on the motor. Rupturing the circuit by the operator, or by the loss of current on the line, automatically trips a release and insures instantaneous application of the brake without waiting for the mechanism to go through the reverse motion corresponding to that in releasing. This arrangement is much less liable to derangement than a large solenoid and much simpler to repair in case of trouble.

The equipment for a large swing bridge is somewhat more elaborate than that for a single leaf bascule bridge, owing to the necessity of having a powerful lift or wedge mechanism at each end of the bridge, and the fact that some form of moving rail lock is necessary. Therefore, in addition to the motors required at the centre for swinging the span, a motor is necessary at each end for the lift or wedge mechanism, and an additional motor is usually necessary at each end for the rail locks for the single or double track, as the case may be. On the ordinary swing bridge it is perfectly feasible to use a mechanical brake so that the electric motor brakes and emergency brakes for the swing may be omitted. The operation and control of the wedge motors and rail lock motors is the same as on the bascule spans. The same general arrangement of indicators and automatic stops is applicable to the wedge and rail lock motors.

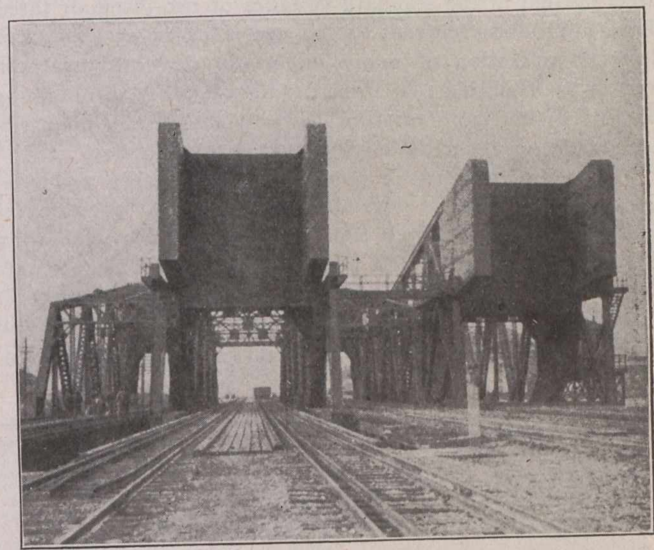
Electric Interlocking.

It will be readily seen that to place the operation and control of a massive drawbridge in the hands of an ordinary and usually low-priced operator involves a possibility of trouble and disaster not pleasant to contemplate. He has before him a few small levers, the indicators and the switchboard equipment, but cannot see the actual motion of any of the devices that are operated, except that of the span itself. Unless some provision is made to prevent it, it is always possible for him to attempt one operation before another is completed, which might under some conditions wreck the bridge,



Page Bascule Bridge; Hammond, Ind.

or bring disaster to railway traffic. To avoid the possibility of such occurrences, a system of electric interlocking has been developed so that the control of each motion in the entire operation of the bridge shall be completely interlocked with the next preceding and with the next succeeding one, if any, and with the railway signals in such a way that current cannot be turned on any motor until the preceding motion has actually been performed. In opening, it is impossible for the operator to turn current on to any of the motors on the bridge until such signals and protecting devices as the railway may provide have been set against trains. It is impos-



Scherzer Eight-Track Bridge at Chicago.

sible to operate the wedge motors until the rail locks have been drawn. It is impossible to operate the swing motors until the rail locks and wedges have both been drawn. In closing, it is made impossible for the operator to drive the wedges until the span has been swung and is closely enough in line to allow the wedges to be safely entered. It is impossible for the rail locks to be driven until the wedges have all been entered, and impossible for the operator to clear the signals for the passage of trains until all of the wedges and all of the rail locks have been fully driven. To attempt to accomplish these results mechanically by interlocking the several levers with each other, would still make it possible for the operator to attempt one operation after the preceding lever had been moved, but before the operation controlled by it had actually been performed.

The electric interlocking is accomplished by the circuits of any one device being held open at all times on a contactor board by the other devices until the proper time for its safe operation. When the other functions preceding the desired operation have actually been completed, the circuits are restored so that the desired motion can be performed by the operator through the proper controller. The same indicator switches on the several devices are ordinarily used for both the electric indication and electric interlocking, and to as large an extent as possible, the same circuits are utilized for the two purposes.

Little attempt is made at electric lighting on railway structures beyond the illumination of the operator's house and providing a sufficient number of lamp openings near the several machinery parts. The government requirements also have to be complied with; these necessitate having red lanterns on the piers and at specified points on the movable spans. On bascule bridges it is required that the red lights at the front ends of the bridges be changed to green when the bridge has nearly reached the open position. This is sometimes accomplished by a lantern, hung as a pendulum, swinging from behind a red glass to a position behind a green glass as the bridge reaches its nearly open position

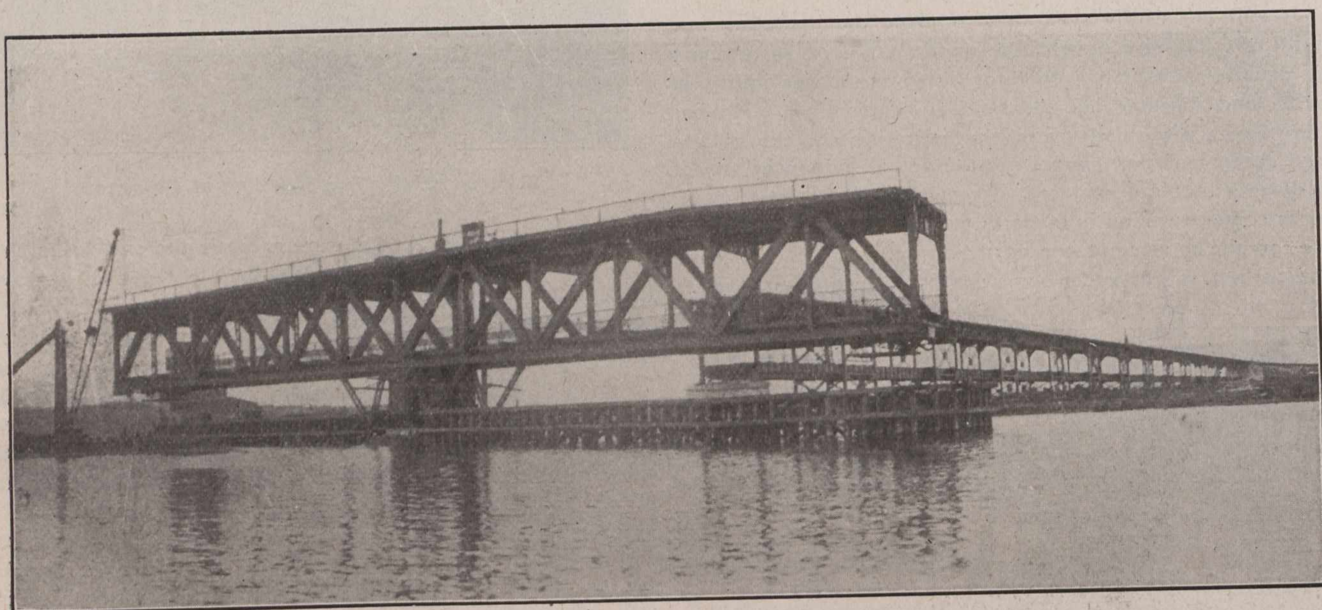
It is preferably performed by a double lantern and extinguishing the red and lighting the green by suitable contacts in the leaf indicator switch.

Generating and Storage Battery Plants.

The adoption of electric power for the operation of drawbridges has usually been contingent on being able to secure direct current at the standard voltages or two-phase or three-phase alternating current at 60 cycles or 25 cycles. The electrical operation of many important drawbridges, however, is so desirable that even the impossibility of obtaining electric current from existing power plants for 24-hour service should not deter the engineers from its adoption.

The improvements in gasoline engine design and construction have made it possible to operate, to a good degree of economy, comparatively small isolated electric generating plants. The use of such a plant makes it possible to obtain all the advantages of electrical operation and control of drawbridges without being dependent on the plants and transmission line of others. Under this scheme two arrangements are possible. One is to have the generating unit of sufficient capacity to supply current direct to the several motors on the bridge as required. The objection to this scheme is that all of the motors on the bridge have a considerable overload capacity and are subject to overloads under a good many conditions. The gasoline engine, on the other hand, has practically no overload capacity other than momentary, and it is therefore necessary to use a large and expensive engine for a comparatively small current consumption. If it is necessary to install the generating plant on the bridge, this means a large engine room and heavy floor construction to prevent excessive vibration. Another plan is to install a storage battery of high enough discharge rate to take care of the operation of the bridge under the most severe conditions and of sufficient ampere-hour capacity to operate the bridge for at least 24 hours without recharging. The gasoline-driven generating unit in this case may be very small, the requirements simply being that it must be able to recharge the storage battery at the desired intervals, it not being necessary for it to supply current direct to the motors on the bridge.

A still better arrangement, however, in the mind of the writer is a combination of the last two plans mentioned. This consists of the installation of a storage battery of a sufficiently high discharge rate to operate the bridge under the most severe conditions of wind and weather, and of sufficient capacity to give the bridge from 24 to 40 openings. The generating plant consists of two direct connected gasoline engine driven units, the combined capacity of which is sufficient to operate the bridge independent of the storage battery, and either of which is available for the charging of the battery. The advantage of this system is that the bridge may be kept in commission even if the storage battery is discharged or out of service for any reason. It is also possible to charge the battery from either generating unit if the other is out of service from any cause. Furthermore, under extreme conditions it is possible to supplement the storage battery by using either or both generating units connected up with it for supplying current to the bridge. The generators and engines in the two units being duplicates, there is small possibility of both being out of commission at the same time. The engines may be started by turning current from the storage battery on to the generators connected up as motors during the period of starting. In either case the generating plant may be located either on the bridge structure or in a power-house built for this special purpose on the shore. The latter arrangement is likely to require more attendants, but has the advantage of providing a more stable support for the storage battery and a better foundation for the generating units. Locating the battery plant on the shore also involves the use of submarine cables for supplying current to the bridge, if it be a swing span.



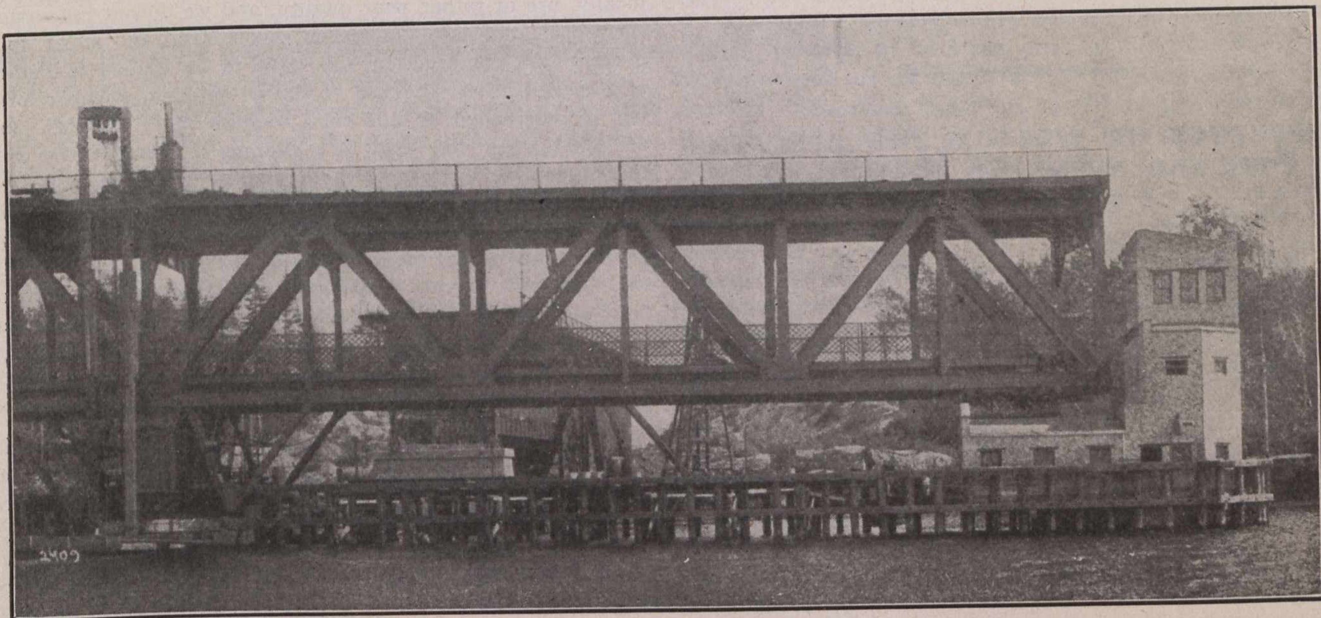
St. Louis River Bridge.

Equipment of the St. Louis River Bridge.

One of the most recent installations with which the writer has been connected was the operation and control of a 300-ft. double deck draw span recently built for the Interstate Transfer Railway Company over the St. Louis River near Duluth, Minn. The span weighs approximately 1,152 tons and is swung by two 25-h.p. 500-volt series motors. The wedges at each end of the bridge are operated by a 15-h.p. motor and the four wedges at the centre are operated by a 5-h.p. motor. There are sliding rail joints for double tracks on each deck at either end of the bridge. These, however, are all operated by the end life mechanism so that no separate motor is required. The swing motors are operated through a series parallel controller and the three wedge motors are operated from one special controller, all three being started at the same time and running until automatically stopped by the rupture of the circuit and the application of the solenoid brakes at the end of the motion of their respective appliances. Electric indication is provided for the motion of the draw span and wedge mechanism, and of each of the 16-rail connections. Electric interlocking also, as before described, is employed throughout. This interlocking extends even to each individual rail lock connection on both decks. Through the use of a contact device at the end of the span, it is made impossible for the wedges to be driven until the span is exactly lined up.

No electric power from outside sources being available, it was decided to install a special generating plant for the sole purpose of operating the draw span. To erect a building on the shore for this purpose would have meant additional operating expense on account of requiring an attendant in the power plant in addition to those on the bridge. The bridge, however, being a double deck structure, there was no place either on or above the bridge where generators or storage batteries could be installed. It was even found impracticable to locate the operator anywhere on the draw span where he could see the river traffic and the approaching traffic on both decks of the bridge. A novel solution was found, however, in building a combined power house and operator's house at the extreme end of the protection pier. The operator's room is located in the top story of the building and at sufficient height so the operator can see approaching boats through the structure of the bridge in one direction, and have a clear vision down stream in the opposite direction, and at the same time have an unobstructed view of approaching traffic on both decks of the bridge. The first photograph shows the general view of the draw span and approach spans, with the former swung into a nearly open position. The next shows one-half of the draw span and a nearer view of the operator's house, which can also be seen through the structure in the general view. The operator's house is of brick and fireproof construction. The generating plant, consisting of two 15-k.w. 500-700-volt generators each direct-connected to a 30-h.p. two-cylinder gasoline engine, is in the first story directly underneath the operator's room. The storage battery, consisting of 264 cells, 160-ampere-hour capacity, is in the portion of the building extending under the deck of the bridge when opened. The convenience of this scheme will readily be recognized, especially when it is seen that when the bridge is opened the operator can step from his house on to the deck of the bridge or has easy access to the end wedge mechanism from the roof of the battery room.

Owing to the fact that the operator is not on the swing span, it is not possible to employ the usual mechanical brake. At the same time it is extremely necessary that the span be under control, especially when a strong wind is blowing. This is accomplished by equipping each of the two swing motors with a solenoid brake of sufficient power to retard the motion of the bridge without checking it too abruptly. An additional brake of greater power is installed on each machinery set. This is applied normally by a powerful spring, and each brake is connected with a motor-operated mechanism designed to partially or totally release the same. This motor is connected with a controller in the operator's house, and by its use the operator can apply or release or partially release the brakes at will.



One End of Swing Span; St. Louis River Bridge.

All wiring on the bridge and in the operator's house is entirely enclosed in conduit, there being no open loops even at the motors or controllers. The upper and lower decks of the bridge, all parts of the operator's house, and the government signal lanterns are lighted by current from the storage battery.

Other Recent Bridges.

There are probably about 15 drawbridges in this country at present operated from storage batteries. There is no question that the number will be greatly increased as the merits of this type of installation become better known.

One of the most important and interesting recent installations operated by current from outside sources is the eight-track bridge over the Chicago drainage canal near Campbell Avenue, one view of which is shown herewith. This consists of four independently operated bascule spans, located side by side, two being on the north bank and two on the south bank of the channel. The four spans are controlled from two operators' houses, one on each side of the channel, the controlling, indicating and interlocking equipment being about as described above.

Another illustration shows five double-track bascule spans over the new ship canal near Indiana Harbor, Ind. All five spans are controlled from one operator's house, one common generating and storage battery plant being used for all. Electric power is received from outside sources at 440 volts, three-phase, 60 cycles. All of the bridges, however, are equipped with 220-volt motors. A storage battery is used for delivering current to the bridges, and also for signal purposes, consisting of 128 cells, 160 ampere-hour capacity. This battery is charged from two 40-ampere mercury arc rectifiers. There is also a 35-k.w. motor generator set, which may be used for delivering current direct to the bridges, independent of the storage battery, or may be used for charging the storage battery under emergency conditions. The individual switchboards and controllers for operating the five bridges are conveniently located in the same room with the electric signal machines which control the five double tracks passing over the bridges. The same operators attend to the manipulation of the signal machines and the bridge-controlling devices.

INFLUENCE OF SIZE ON THE OPERATION COST AND OVERHEAD CHARGES OF A TEXTILE MILL.

It is almost too obvious to warrant remark that the larger the mill the less will be the cost per spindle, and the less will be the operating cost, but it is not frequent that the matter of size has such a marked effect as is shown by a recent report of Lockwood, Greene & Co. on the construction of a proposed cotton mill in the southern Appalachian district. The mill in question is to be built in connection with a hydro-electric power development, and the plan necessitated the construction of a dam, a power-house, and a short transmission line, and the mill itself. The primary ten-hour power available for use at the generator terminals was 800 horse-power at the driest season of the year, while 95 per cent. of the time 1,000 horse-power would be available, 60 per cent. of the time 1,700 horse-power, and 55 per cent. of the time 2,000 horse-power. It will be noted that any mill requiring more than 1,000 horse-power would have to build an auxiliary steam plant. Lockwood, Greene & Co. presented estimates on five different developments as follows:—

(A) A development of 10,000 spindles with a wooden dam.
(B) A development of 10,000 spindles with a concrete dam.
(C) A development of 25,000 spindles with a wooden dam.
(D) A development of 25,000 spindles with a concrete dam.
(E) A development of 50,000 spindles with a concrete dam.

The accompanying table shows the estimated unit costs and the estimated yearly cost for power under these various developments:—

Table I.—Estimated Cost per Spindle.

Development.	No. spindles.	Type of dam.	H.P. required.	Total cost per spindle.	Operating power—Cost per H.P. per year.
A	10,000	Wood	500	35.58	.....
B	10,000	Concrete	500	38.00	22.49
C	25,000	Wood	1,000	26.10	.....
D	25,000	Concrete	1,000	27.05	13.12
E	50,000	Concrete	2,000	24.80	.....

The power estimates were based on a 21-ft. fall, although the actual fall under normal conditions is 22 ft. As the same size dam would be required for both developments, B and D, the interest charges bring up the yearly power cost of the former to a very high figure in comparison. Administration, maintenance and repair, interest on investment at 6 per cent., taxes and depreciation, are included in the power cost given in the above table. As regards the type of dam, it is hardly necessary to go beyond a comparison of the estimated cost per spindle to show that the adoption of the concrete dam is the more logical. The mill is to be located on a plateau 100 feet above the river, where there is sufficient room for future development, and where there is perfect drainage. Electrical power transmission makes it possible to utilize the very best location available for the mill. The above costs were based on the adoption of concrete as the construction material for the mill. A quotation from the engineer's report will show how the local conditions favored this type of construction:—

"The type of construction to be used in the mill has received considerable thought. The bricks, which are made locally, are of rather poor quality, and we do not recommend their use, and, as all materials except sand and stone to be used in the construction will have to be hauled a distance of fourteen miles, the use of timber interior construction is not recommended at this time, though more detailed study of this feature may lead to a change of view. There is in the immediate vicinity of the proposed development a large amount of heavy oak timber, but this is not a desirable material for mill construction, although it could be used in the construction of a timber dam. It, therefore, appears to us that the mill might properly be constructed of reinforced concrete, and the estimates have been made upon this basis."

The textile machinery costs were based on a gray goods, 36-in. wide product, to be manufactured of about No. 24 or No. 26 yarn, 64 square, or thereabouts.

As at the present time there is no railroad connection to the proposed location of this mill, the engineers recommended an initial development of not less than 25,000 spindles, which could be operated at full capacity 95 per cent. of the time with the power available from the hydro-electric development, and could be operated on an 80 per cent. load factor the other 5 per cent. of the time. Thus, it would not be necessary to use any coal whatever, as there is sufficient wood immediately available for heating purposes. Lockwood, Greene & Co. further advised that the power house and the mill both be designed for an ultimate increase to 50,000 spindles, to be built at some future date, when proper transportation facilities could be secured for the delivery of coal.

FORESTRY IN GERMANY.*

W. C. Fischer, Canadian Trade Commissioner at Berlin.

Germany has a forest area of 13,995,868 hectares (1 hectare = 2.47 acres) which forms 25.89 per cent., or a full quarter of the total area of the Empire.

The distribution of the German forests over the whole country varies according to the natural conditions of climate and soil, and according to artificial ones, such as the development of economic conditions, prevailing laws and civilization. From east to west, Germany lies within the natural limits of timber growth; in a direction running from north to south there are a few mountain chains that

*Slightly abbreviated from an official report.

rise above this zone, but the conditions of the soil in Germany permits of trees growing everywhere. Even in the barest parts, in the sandy parts of plains, and on the shallow earth of mountains, the hardier species of timber, especially fir and pine trees, find sufficient inducement to thrive. Thus, in the course of centuries, the actual distribution has been fixed by artificial influences such as density of population, growth of property, legal conditions, and the development of industry and traffic. Fewer forests are to be found in districts where the soil is level and fertile, and consequently devoted to agriculture, or where the population is denser and traffic more extensive than in districts scarcely populated and with uneven, barren soil.

Three Chief Timber Districts.

Setting aside the political division of the empire into 26 separate states, the following timber districts may be distinguished:—

1. The North German plain district comprising 49 per cent. of the total forest area, with fir trees as its chief species of timber.

2. The mountain and hill country of Central Germany with pine and beech trees predominating; this district comprises 22 per cent. of the forest area; and

3. The South German district with beech, pine and pitch pine, or 28 per cent of the forest area. Arranged according to these districts, the whole forest area in the German States is owned as follows:—

Crown property	257,302	hectares or	1.8	per cent.
State property	4,489,883	"	31.9	"
Municipalities	2,258,090	"	16.1	"
Corporat's, institutions.	211,015	"	1.5	"
Property in trust	1,446,664	"	10.4	"
Societies	306,214	"	2.2	"
Private owners	5,056,701	"	36.1	"

Predomination of Labor Estates.

Large estates predominate. They offer the greatest security for a systematic and permanent revenue, especially when they take the form of trusts in the hands of public bodies and legal representatives. Of the forest area 64 per cent. is tied property, and 36 per cent. unfettered private property. For purposes of management the forest area is divided into 953,875 units, of which 23,041 consists purely of forest and 931,834 of forest and arable land.

The estates are divided according to size as follows:—

	Of total number.	
Estates under 10 hectares..................	89.9	per cent.
" from 10 to 200....................	9.2	"
" from 200 to 1,000.................	0.7	"
" from 1,000 to 5,000....	0.2	"
" over 5,000	0.3	"

Most of the small estates are situated in the west of Germany, the large forest being in the east.

Small Variety in Species.

The variety of wood species in Germany is not large. Among the numerous indigenous kinds which formerly existed, in consequence of the economic management of forests introduced in the middle of the eighteenth century, only those have been preserved which possess a high economic value, i.e., foliage trees, principally oak and beech, or about 1,000,000 hectares in all. These trees are mostly grown in the plantations of the lower Rhine and Westphalia, but the area devoted to its cultivation is gradually declining, owing to its absorption for agricultural purposes.

Bark wood is likewise declining in extent, because on account of the low prices prevailing for tanning bark. The beech tree (Fagus siviatica L) formerly much grown for fuel has almost lost its importance with the spread of coal mining, and is being displaced to an increasing extent by the better paying conifer. It is mostly to be found in the west of Germany, and on the chalky soil of the south German mountains, and is abundantly represented in the north on the shores of the Baltic from Schleswig Holstein to Pomerania. On account of the good forest qualities of the beech tree valuable species of wood, chiefly oak, maple (Acer L), ash (Faxinus Tourn), as well as conifers are grown with it. In many places horn beam (Carpinus L), elm (Ulmus Tourn) and such soft woods as aspen, poplar (Populus L) are planted. The unpretentious birch is to be found everywhere (Betula L). Finally, the alder (Alnus Tourn) is cultivated as underwood in damp low ground. The beech, including the hardwood species of foliage trees, occupies a total area of about two millions of hectares, soft wood about 0.3 million hectares, mixed foliage tree about 1.2 million hectares, and osier beds 36,000 hectares.

The total area covered by foliage trees amounts to 4.5 million hectares, or 32.5 per cent. of the total forest area, 67.5 per cent. or 9,500,000 hectares, being covered with conifers. The most important species of the latter are the fir and pine, and in the southwest of Germany, the pitch pine mixed with larch. The fir (Pinus sylvestris L) the chief wood represented in the sandy plains occupies about 5,500,000 hectares of ground. It thrives best in the dry districts of northeast Germany (east Prussian fir is highly valued) but flourishes also in those districts which have a considerable rainfall, i.e., in the west and on the plateaus of Central Germany from Nuremberg to the Palatinate; with careful treatment fir trees yield a great quantity of wood even in hilly and mountainous country, although this latter wood is of an inferior quality. According to the locality beech, oak, pine, larch, birch and soft woods are frequently grown with it.

Great Forests of Pine.

The pine (Picea excelsa Lk) forms great forests which cover the mountains of middle and southern Germany, but from time immemorial it has been a native of the plains in eastern Prussia, Silesia and Hanover. About 2,500,000 hectares of ground are covered by pine trees, and this area will continue to increase because the pine is hardy and easily cultivated, and yields a great quantity of timber in a relatively short time. Consequently, in afforestation the pine tree is preferred to others, and is also used as a substitute for the economically inferior foliage tree. The pitch pine (Albies pectinate DC) is usually grown in the Black Forest and the Vosges, but it is to be found everywhere in mixed woods in the northeast of the country. It occupies an area of about 300,000 hectares. The larch (Lacix europea Will) is to be found everywhere intermingled with other woods, but is at its best in mountainous regions.

Management of Tall Timber.

Of the typical kinds of forestry, tall timber predominates throughout about 11,000,000 hectares. Bare clearing with artificial renewal is the general rule for fir and pine trees, seeding in with natural renewal for foliage trees and pitch pine. The cultivation of tall timber necessitates long period of management, great areas of cultivation, systematic management and constant care, but yields most wood and the greatest value per hectare.

Low woods, on the contrary, only occupy about 1,400,000 hectares; they permit the constant cultivation of a small area, but yields less and less valuable timber. They are mostly to be found on the small estates of Westphalia and the Rhine, and as far as conifers are concerned in the east. Middle-sized timber is still more sparsely represented, as its total amount is only 5 per cent. The low wood occupies 6.8 per cent. of the forest area, and consists chiefly of oak bark wood (Westphalia) Rhine provinces, Bavaria, Baden, Hesse and Hesse Nassau. This form of cultivation, however, is to be found everywhere, more especially on small estates; in the east, in fir forests in the shape of alders; in the west, frequently intermingled with wood for agricultural use, as so-called "hill-felling wood."

Increase Through Afforestation.

The yields are largest in the tall timber woods, in conifer woods and in the state forests; smallest in independent private forests. The total production will gradually increase because of constant afforestation, and the cultivation of tall conifers, and because at present the conifer high woods chiefly consist of young trees (48 per cent. under 40 years' growth, 33 per cent. from 41 to 80 years' growth and 16 per cent. over 80 years). In foliage timber these three grades are approximately divided.

Annual Yield.

According to the latest statistics German forests yield annually about 20,000,000 'fest meter' (1 cubic metre solid wood) of timber and 18,000,000 'fest meter' of firewood, making a total of 38,000,000 cubic metres of solid wood (over 7 centimetres in diameter); they also produce about 11,000,000 cubic metres of loppings, 135,000 cubic metres of oak bark and 101,000 cubic metres of osiers.

South Germany yields the most solid wood, especially large timber, namely, about 14,600,000 cubic metres or 3.6 cubic metre per hectare (39 per cent. of the total quantity), whilst North Germany produces 42 per cent. of the total quantity, and the rest of Germany 19 per cent. The pine forests in Saxony and Thuringia yield the highest average amount of timber (about 75 per cent. of the solid wood), the beech forests the lowest. The state forests, occupying 32 per cent. of the total area, yield 43.5 per cent. of the whole timber and 40 per cent. of total wood production; the independent private forests, on the other hand, occupying 36 per cent. of the total area, only yield 25.7 and 26.6 per cent. respectively.

Systematically Organized Administration.

By far the greater part of the German forests are regulated and subjected to a systematically ordered administration, the underlying principle of which is to fill only as much wood annually as is renewed by growth. This aims at bringing the increase of valuable wood to a maximum. For this purpose different scientific and practically tested methods are employed. Those species of wood are reared which in a given locality produce the greatest economical value. Besides woods of only one species, the planting and rearing of mixed forests is undertaken. The principle methods of rearing are thinning in the earlier stages (the age of thickening) and in the older (pole timber) stage, and clearing in the advanced (timber) stage; by removal of badly grown, malformed and valueless trees and undesirable species, strong and well-formed timber is continually produced, and the rate of the growth on the property raised. At the same time a first yield preceding the plantation yield is attained to the advantage of the forest revenue. The instruction given in thinning has been especially developed lately in various directions, and brought more into operation with conspicuous success.

The surveillance is exercised by the proper authorities assisted by experts who have been well and scientifically trained in the practice and theory of forestry.

Laws and Regulations.

Laws and regulations regarding forestry vary in different states. In Prussia every restriction pertaining to private forests have been abolished by the edict of September 14, 1811 (Landeskulturedikt). Measures for the complete replanting of public land are embodied in legal regulations only in special cases in Prussia. More has been done in the replanting of trees by other state measures as follows:

2. Encouragement of the formation of scientific forestry organizations.

3. Organization of Chambers of Agriculture (law June 30, 1894), which have branches of forestry.

4. Cheap, or gratuitous furnishing of seeds and plants.

5. Pecuniary assistance by the state to communities and private landowners in the shape of assistance in planting and premiums.

6. Granting of loans at low rates of interest on the part of communities and provinces, and finally,

7. As the most effective means the purchase and replacing of wastes and barren land by the state or communities.

Compulsory Tree Planting.

On the basis of the law regarding the administration of woods belonging to municipalities in the seven eastern provinces of Prussia (August 14, 1876), municipalities may be compelled to plant trees on non-cultivated lands which can be utilized profitably only for wood culture. Under certain conditions the replanting of trees in private forests may be enforced by the provisions of the law of July, 1875, also in Silesia, and by the law regarding protection against damages by floods in the district near the source of the Oder (September 16, 1899).

Education of Forest Officials.

To enforce the existing regulations in a practical and scientific manner has been one of the first cares of the forest authorities of the federal states if only in the interest of their forest policy. The forest state management in Germany has for centuries past been a model for the science of forestry.

Several high schools exist at which the future state forest officials are educated in forestry, mathematics, law and natural science; these schools are also open to others, and are attended by numerous students from all parts of the empire, and from foreign countries. At the same time the schools are nurseries for the advancement and development of forestry and its auxiliary sciences. There are schools of forestry in Prussia, at Eberswalde and Münden, a high school at Aschaffenburg, and at the university of Munich in Bavaria, a school of forestry at Tharandt, in Saxony, one in Wurtemburg, one at the university of Tubingen, one in Baden (technical high school at Carlsruhe), one at the university of Giessen in Hesse, and a college for the Thuringian states at Eisenach; in addition to this, courses of forestry lectures are held at the agricultural high schools in Berlin, Bonn and Halle. At the nine institutions mentioned above, there are 32 lectures on forestry, 83 other lectures for the education of forest keepers and numerous assistant lecturers.

All the institutions are furnished with abundant means for teaching, with libraries, collections, botanical and experimental gardens, and in some cases with special teaching and instructional districts. The total number of forestry students amounted last year to about 600, of whom the majority were candidates for the State Forest Service. There also exists schools for the lower branches of the service at which theoretical instruction is given in Prussia, Bavaria, Wurtemburg, Baden, Hesse and Meiningen.

Supervision By Board.

The trial of new methods, and the improvement of the existing ones, is supervised by the German Board of Experimental Forestry, which is the outcome of a union of German experimental forestry institutions, with its headquarters at Eberswalde. To this latter union belong nine experimental institutions in Prussia, Bavaria, Saxony, Wurtemberg, Baden, Hesse, Brunswick, Thuring and Alsace Lorraine. The united interests of German forestry are represented by the 'German Forest Union,' the present organ of which is the 'German Forest Council.' At present about 2,200 members belong to the union. Twenty forest unions exist besides for separate countries or parts of a country. Finally, there is a burial club for the foresters, a union of private forest officials in Germany, etc., etc.

National Value Recognized by State.

The national value of the forest, its capacity to produce necessary articles of living economically, to provide opportunities for remunerative labor, to influence favorably the cultivation of land, and to use certain kinds of ground usefully, has made it from times immemorial an object of solicitude on the part of the state. The legislation referring thereto, which is very different in the different states, is specially directed towards the preservation and maintenance of inclosed forests and to the recultivation of planting of waste tracts. In the first place, the state and other public authorities acquire waste land and plant it. Private efforts are supported actively by means of subsidies and loans from public funds, by information, advice, and by the state authorities who take charge of the management. According to the latest reports there were 545,000 hectares of waste land in the whole of Germany suitable for the planting of trees, i.e., about 4 per cent. of the forest area, and 1 per cent. of the total area of the country.

Home Supply Yet Inadequate.

In spite of its considerable home production (about 38,000,000 cubic metres) of timber, Germany is no longer in a position to supply its timber requirements. The industrial development of the empire and the rapid increase of population necessitates more wood than the country can produce. The excess of imports of wood over exports amounted in 1908 (the latest statistics obtainable) to 6,499 tons. The inference is justified that with a continuance of the present rate of development of the empire the requirements and the imports from abroad will continue to increase, and that the assured growth in home wood will not suffice to meet them.

Canada Not a Source of Importation.

Germany receives most of its wood from Austria-Hungary, Russia, Finland and Sweden. The United States also exports a certain quantity to Germany, whereas Canada does not figure in the lists of imports.

TYPES OF WELLS; THEIR COMPARATIVE COST AND MERITS AND METHODS OF PROTECTION FROM POLLUTION.*

Because of their cheapness, convenience, and fancied safety, wells are by far the most popular source of domestic supplies in all regions in which water is found at reasonable depth. If properly located and constructed they afford an ideal source of supply fully justifying their popularity. But if they are carelessly finished or improperly located they are much more liable to pollution than is commonly supposed, and it is with the view of pointing out some of the precautions that should be taken for their protection, as well as of presenting information concerning desirable types, location, and construction, that the following discussion is presented.

Types of Wells.

Although no two wells are exactly alike in all particulars, there are, in reality, only a few distinct forms, the others being simply modifications or combinations of these. The kind of well to be sunk at a particular locality depends mainly on the nature of the material to be encountered, one form being particularly adapted to a certain material, such as sand, while an entirely different form is demanded if rock is to be penetrated. The following tables show clearly and concisely the characteristics and methods of sinking the more common types and point out the conditions to which they are best adapted:

Types of Wells and Conditions to which They are Adapted.

Dug.—Generally circular excavations, 3 to 6 ft. in diameter, dug or blasted by hand and curbed with wood or with stones or bricks laid without cement. Adapted to localities where the water is near the surface, especially where it occurs as small seeps in clayey materials and requires extensive storage space for its conservation. Should not be near sources of pollution.

Bored.—Bored with various types of augers from 2-ins. to 3-ft. in diameter, rotated and lifted (together with the earth) by hand or horse power. Curbed with wood, cement, or tile sections, with open or cemented joints, and more rarely with iron tubing. Adapted to localities where the water is at slight or medium depths and to materials similar to those in which open wells are sunk.

Punched.—Small holes, usually under 6-ins. in diameter, sunk by hand or horse power, by dropping a steel cylinder slit at the side so as to hold and lift material by its spring. Clay is added to incoherent materials like sand to bind them together so that they can be lifted. Adapted to clayey materials in which water occurs as seeps within 50-ft. of surface, but not at much greater depths.

Driven.—Small iron tubes, usually 1¼ to 4-ins. in diameter and provided with point and screen, driven downward by hand or by simple hand or horsepower apparatus. Adapted to soft and fine materials, especially to sands and similar porous materials carrying considerable water at relatively slight depths. Particularly desirable where upper soil carries polluting matter.

California or Stovepipe.—Overlapping sheet-steel casings, 4-ins. or more in diameter, forced downwards by hydraulic jacks and finally perforated by a special apparatus at water strata. Drillings are removed by a long sand-bucket with valve. Adapted to soft materials extending to

*Extract from Water Supply Paper No. 255, U. S. Geological Survey, by Myron L. Fuller.

considerable depths and having several water strata capable of utilization.

Standard Drilled.—Sunk by percussion of heavy drill, 1½ to 12-ins. or more in diameter, lifted and dropped from portable rig or derrick by horse or steam power. Cased with iron pipe in soft materials; usually not cased in rock. Drillings removed by long bucket with valve in bottom. Can be used to advantage in all but the softest materials, but is particularly adapted to rock work, especially at great depths, being cheaper and quicker than other methods of drilling in rock.

Diamond-drill Hole.—Sunk by rotating hollow bit, usually 1¼ to 4-ins. in diameter, with rim fitted with black diamonds. Penetrates by abrasion due to rotation. Drillings removed by water forced down drill and up along outside of rods. Not adapted to water wells because of great cost. Used where cores of materials penetrated are required, or where hole is sunk at an angle with the vertical.

Wood.—Square wooden boxes in wells over 3-ft. in diameter; cylindrical curbs of narrow staves in wells under 3-ft. in diameter. Can be placed in any shallow well, but are never safe and should never be used.

Tiles.—Glazed sewer tile, cement tiles, and porous terra cotta tiles, laid without cement. Adapted to conditions similar to those of rock and brick curb.

Tiles.—Glazed sewer tile and cement tile with cemented joints. Same as cement-lined stone or brick curbs, except that it is more applicable to wells of small diameter.

Heavy Iron Casings.—Iron pipes, 1 to 4-ins. in diameter, with tight joints. Adapted to wells of all depths in which water is obtained from a stratum below the casing, or from strata between cased sections. Not adapted to strongly corrosive waters.

Sheet-iron Casings.—Iron pipes, 4 to 16-ins. in diameter, with snug joints. Adapted to wells of all depths, in loose material, in which it is desired to procure water from a number of strata.

Summary of Advantages and Disadvantages of Different Types of Well Curbs and Casings.

Rock.—Allows all water to enter, thus utilizing all seeps. Material often costs little or nothing. As a rule requires little money outlay for labor. Polluting matter enters readily and well is never safe if near sources of contamination. Affords no filtration and permits dirt and soil to enter. Permits entrance of mice and other small animals at top.

Brick.—Where uncemented it allows all water to enter, utilizing all seeps. Filters out most of sediment. Does not allow small animals to enter. Involves little money outlay for labor. Polluting matter enters readily, and well is never safe when near sources of contamination. Material costs considerable.

Cement-lined Rock or Brick.—Safe from pollution (except that entering at bottom) as long as walls are not cracked. Prevents entrance of sediments. Prevents entrance of animals. Does not impart taste to water. Utilizes water from bottom only. Is unsafe if so shallow that polluting matter can reach its bottom. Costs considerably more than uncemented wells. May require skilled labor.

Wood.—Cheap in many localities. Can be used in wells of very small diameter. Does not taste of iron. Swells tight in wet ground, the water either entering at bottom or (after sudden rises) through shrunken portion at top. Pollution enters readily. Animals gnaw through. Wood rots, giving taste to water and favoring development of bacteria. Expensive in some localities.

Glazed and Cemented Tiles with Uncemented Joints.—Allows all water to enter, utilizing all seeps. Does not give taste to water. Does not require skilled labor. Polluting matter enters readily, and well is never safe if near source of contamination. Soil may wash in through joints. Requires some outlay for material.

Glazed and Cement Tiles with Cemented Joints.—Safe from pollution (except that entering at bottom) as long as joints are tight. Does not require expensive labor. Can be used only in soft materials containing considerable water.

Iron Casings.—Adapted both to rock and to unconsolidated materials. Safe from pollution except that entering at bottom. The cost in large, deep wells is considerable. Practically limited to wells under 14 ins. in diameter. Is subject to deterioration by corrosion and incrustation in some places. Utilizes but one water stratum (except where perforated).

Yield of Wells of Various Types.

If an adequate supply of ground water is available, the yield of a well will depend on the character of the water-bearing material, the facility of entrance of water, the size or storage capacity of the well, and the nature of the pumps.

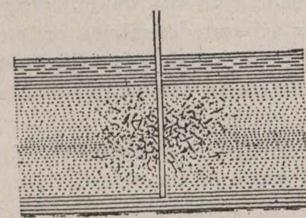


Fig. 1—Diagram Showing Loosening Effect of Shooting Wells.

Character of the Material.—The character of the water-bearing material is of the greatest importance in determining the yield of a well, as it is on the structure and texture of the water-bearing beds that the amount of water which they will give up depends. A close-textured clay, for instance, may hold as high as 45 per cent. and a chalk as high as 53 per cent. of its volume, while an open-textured sand may hold as little as 26 per cent. of its volume. Notwithstanding this a sand will ordinarily yield large supplies, whereas a chalk, and especially a clay, will yield little or no water. In quicksands water is usually present in large amounts, but owing to the absence of good foundations for the curbing and the ready flow of the fine sand through the minutest crevices, ordinary dug wells in such material are generally out of the question, and even driven wells equipped with the ordinary strainers usually soon become clogged. Driven or drilled wells equipped with special screens and sunk by experts familiar with the various methods of handling quicksand are usually the only types entirely successful in such material.

Structures, such as solution passages, bedding planes, or joints, play an important part in determining the yield of a well. A solution passage in limestone may afford inexhaustible supplies where the mass of the rock is practically destitute of water. In other rocks the bedding planes and joints may afford excellent supplies where no water is found in the rock itself. The amount of water present in the pores of different rocks is indicated by the following average porosities: Sandstones, 15 per cent.; shales, 4 per cent.; limestones, 5 per cent.; crystalline rocks, 2 per cent. The water present in the larger openings mentioned, though small in amount in comparison to that held in the pores, is yielded much more rapidly, and, except in sandstones and similar porous rocks, usually affords the principal source of supply.

Facility of Entrance.—The facility with which water enters the well depends in part on the rock features enumerated and in part on the nature of the well. In loose materials water accumulates most easily in stone-curbed and similar types of dug wells, and only less so in tightly-curbed dug wells with open bottoms. Where the water bed is a strong one and the materials are sufficiently consolidated to prevent them from entering the well the water will freely enter an iron casing, open at the bottom. In weak water beds in soft materials, and in quicksands, either perforated casings or casings equipped with long screens are necessary to permit the entrance of the required amount of water. In many of the harder rocks the walls will stand without caving, and casings are, therefore, unnecessary, the water entering at any point without hindrance.

Storage Capacity of Wells.—Where strong water beds exist storage is unnecessary, the water entering from the rock as fast as the pumps demand. Where the supply is derived from weaker beds, especially those having only small seeps, storage is a significant factor, and the type and size of the well are of great importance. The volume of tubular wells of equal depth varies with the square of their diameters; hence a 6-inch well will hold nine times as much water as a 2-inch well of the same depth, and a 3-foot well thirty-six times as much as a 6-inch well. Dug wells are, therefore, of advantage in clays and similar materials where the water enters more slowly than it can be lifted by the pumps, for they permit accumulations that may tide over periods in which the amount used is greater than the supply. For the deeper rock waters dug wells are impracticable, and small-bore drilled wells must be used even where the supplies are slight. To get the best results the wells are generally made as large as can be afforded and sunk considerably below the point of entrance of the water to afford the necessary storage.

Depth of the Water.

The depth of the water is a factor of importance in the determination of the type of well to be sunk. A dug well, for instance, is suitable only when the water is within 30 or 40 feet of the surface, although many deeper dug wells exist. A punched well is commonly limited to depths of 50 feet, and a bored well is with difficulty carried to depths greater than 100 feet. Driven wells are most suitable at depths of less than 150 feet, although they are sometimes successfully extended to depths of 250 to 300 feet, or even to 400 or 500 feet or more, where the conditions are favorable. Jet wells are usually sunk only where it is not necessary to go much more than 100 feet from the surface. Wells of the California type are frequently extended to depths of 1,000, and occasionally to depths of 2,000 feet. Hydraulic rotary wells are successful to depths of 1,000 or 2,000 feet in the proper rocks. The percussion or churn drill may be used for all depths down to 5,000 feet, or deeper if special outfits are provided. Diamond drills have been successfully used to depths of 6,000 feet.

Relative Cost of Wells of Different Types.

So many items, such as accessibility to fuel, cost of labor, trade combinations, knowledge of water conditions, relative availability of different outfits, and local practice, enter into the cost of a well that few definite statements can be made. Instances are not uncommon where wells of certain types have been put down for one-tenth the price demanded for wells of the same type in other regions where conditions are essentially similar. In general, however, if only actual outlay of money is considered, the dug well is the cheapest, for it may be constructed by the owner himself at times when he has nothing else to do. Bored and driven wells do not require expensive rigs, and are often cheaper than dug wells when paid labor is employed in their construction. California wells for deep bores in soft materials are moderately cheap where the proper outfits are available, but unfortunately their use is as yet confined mainly to a single region. The jet process is adapted to the sinking of a large number of adjacent wells in soft materials, especially sand, and is occasionally successful for single wells, although in most places driven wells can be put down at less cost. The hydraulic and rotary processes may be cheaper than straight drilling where there are numerous alternations of hard and soft material. Of the processes in use for drilling in rock the standard rig (percussion drill) is the cheapest, the calyx and diamond systems being generally used only when cores of the rocks penetrated are desired. A more detailed comparison of the methods is given in the subjoined table. Although the relative costs indicated are fairly constant over the country as a whole, the cost of any method

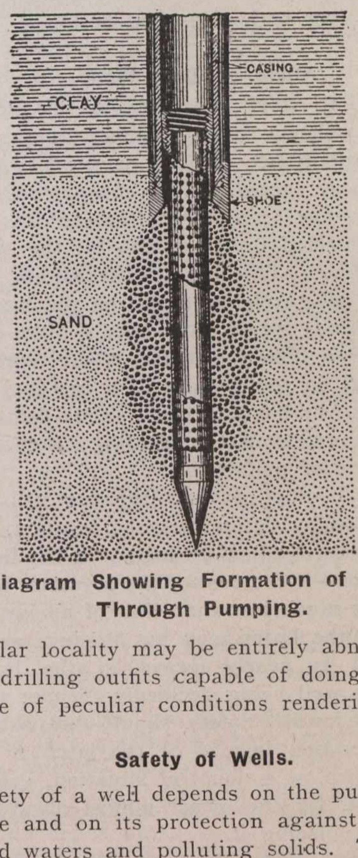


Fig. 2—Diagram Showing Formation of Sand Packing Through Pumping.

in a particular locality may be entirely abnormal, owing to the lack of drilling outfits capable of doing the work or to the existence of peculiar conditions rendering its operation difficult.

Safety of Wells.

The safety of a well depends on the purity of the water at its source and on its protection against the entrance of contaminated waters and polluting solids. The type of well does not affect the purity of the original source; but if the water supply is primarily pure, its maintenance in that condition depends largely in construction that prevents contamination.

Polluting matter finds entrance to wells in a variety of ways. In dug wells it enters through the crevices in the stone, brick, or wood curbing, or possibly through the brick itself; in bored wells it enters through the uncemented joints of the tiling or through cracks between the staves of tubular wooden curbing; and in drilled and driven wells through leaky joints or holes eaten in the iron casing by corrosive waters. By cementing the interior surfaces of stone or brick-curbed wells, by replacing wood by cement or other impervious curbs, and by substituting new pipes for leaky iron casings the entrance of polluting matter through the walls can be prevented. Little or nothing enters the small tubular wells from the top, and they may, therefore, be regarded as free from danger of pollution from this point. The larger open wells should be protected by a water-tight iron or cement cover standing somewhat above the level of the surrounding ground and tightly joined to the curb proper. The sloping of the earth away from the well serves to turn rain water or pump drippings away from it, so that little will penetrate, even if the curb becomes cracked by frost.

A particularly dangerous type of well—the more so because of the fancied security of the owners—is the combination dug and drilled type. Because of a slight saving of expense, drilled wells are frequently sunk in old dug wells, the casing commonly beginning at the bottom of the old well. Although the water encountered by the deep well may be perfectly pure, it is liable to be contaminated, especially after rains, by the entrance of seepage waters into the open well and thence into the drilled well. The remedies are obvious: either the casing should be carried to the surface of the outside ground, or at least above the highest level ever reached by the water, or the open well should be converted into a water-tight cistern by the application of a thick coat of cement over both sides and bottoh.

Open or Dug Wells.

Location.—The chief consideration in the location of open wells and wells in which pervious casings are used, in the order of importance usually ascribed to them by the owners, are: Cost, accessibility, convenience, and safety. The requirements, unfortunately, often conflict. Most houses and barns are located on elevations for the sake of good drainage, sightliness, or other considerations, but wells in such situations are rarely as cheap as the less convenient wells in the hollows. Again, convenience often demands that the well be located near the house, where slops are thrown upon the ground, in the vicinity of a cesspool or privy, or near the barnyard or hogpen, while safety demands its location on high ground at a considerable distance from these and other sources of pollution.

In cases of conflicting requirements it is usually the cost which eventually determines the location, or rather it is the initial cost, for in many instances the final cost of a proper installation—if the cost of the resultant loss of health is considered—is much less than that of an improper installation, although the latter may not produce actual disease.

A safe well is nearly always, in the long run, the cheapest, such a well being decidedly cheaper than the cost of medical attendance. Safety should invariably be made the first consideration instead of the last. A well should never be put down in a doubtful situation, even as a temporary makeshift, for the owner almost always waits until too late before replacing it.

Sources of Pollution.—Open or dug wells may be polluted by material seeping through the ground and curbing or entering from the top of the well. Of the seepage materials, cesspools and privies are the most important source. In most localities the large amount of liquid reaching such receptacles is rapidly absorbed by the earth and becomes a part of the water body feeding the wells. Slops thrown on the surface likewise soak into the ground, and even if the liquid at first evaporates the residue is later taken up by the rain, which sinks into the ground, and is carried downward to the ground-water body. The matter leached from hen-yards, from hogpens, and from the manure-piles near barns, eventually enters the ground and finds its way in one form or another to the ground water below. Drainage from manured fields and from pastures occupied by stock may also be a prominent source of pollution. Much of the polluted water from such sources is purified by passage through the ground, and the danger of pollution of well waters by seepage is commonly exaggerated, yet gross carelessness in locations of wells near privies, cesspools, drainpipes and other filth receptacles is prevalent in many farm districts.

One of the greatest sources of pollution for farm wells is the entrance of material at the top, and dug wells are especially liable to contamination of this sort, though other well types are not entirely exempt.

Of the material entering a well from the open top, dust is an important source of contamination. It is always present in the air, and the amount actually settling is very many times more than the conspicuous dust coatings collecting in buildings. In fact, in open wells, especially in regions where brisk winds are common, the accumulations sometimes amount to several inches in a year. Many wells which are cleaned only once in two years are found to contain as much as six inches of foul-smelling black muck, representing the dust and other refuse entering the well in that length of time.

Small animals, such as toads, mice, moles, and snakes, fall into the well in times of drought when the sources of water they usually depend on have failed.

Except that it keeps the larger animals out and is a convenience in using the well, the ordinary plank covering affords but little improvement over the open well. Crevices almost invariably exist through which the smaller animals may find access, and the dirt washed through the cracks by the pump drippings may be almost equal to that entering through an open top. Moreover, it is a very dangerous type of dirt, as in many places it includes filth from domestic fowls and from the shoes of farm hands and others coming from manured fields, hogpens, or barnyards.

Movement of Ground Water.—When a well is carried downward in porous or semi-porous materials, such as those in which most open wells are located, a level is soon reached below which the ground is saturated with water (at least down to the first impervious stratum). This water body, or ground water, as it is called, has a definite upper surface, known as the water table, which conforms in general with the broader surface irregularities as shown in Fig. 17, but with the difference that the section of the water table is flatter than that of the surface, being far below the ground on hilltops and cutting the surface in valleys. The motion of the ground water is in the direction of steepest slope of the water table, as illustrated in Fig. 18, and as this roughly coincides with the surface slope it follows that the direction of motion of the ground water generally approximates that of the surface drainage.

From the laws of occurrence thus outlined it appears that low points are the most favorable for obtaining water by open wells, as the water movements converge in that direction, and the water table is nearer the surface there than elsewhere. Sewage, being to a large extent simply water to which a certain amount of foreign polluting matter has been added, follows the same laws of motion as the ground water, converging in an identical manner toward the low spots, which are, therefore, points of danger where sources of contamination occur on the adjacent slopes.

(To be continued.)

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

Copies of these orders may be secured from the Canadian Engineer for a small fee.

12341—November 19—Authorizing the Hydro-Electric Power Commission of Ontario to erect its low tension line across the track and wires of the G.T.R. Co. at Hillyard Street, Hamilton, Ont.

12342—November 21—Approving the location of the G.T.P. Co.'s Regina-Moose Jaw Branch from the East Line of Section 26, Township 17, Range 20, to East Line of Section 28, Township 17, Range 23, west 2nd Meridian, District of Assiniboia, Sask., mileage 0 to mileage 20.3.

12343—November 21—Authorizing the C.N.R. Co. to open for the carriage of traffic the deviation of its main line of railway from mileage 12.2 Slate River to Kakabeka Falls, on Port Arthur subdivision, a distance of 9.76 miles.

12344—November 21—Recommending for the approval of the Governor-in-Council the Rules and Regulations governing the Transportation Department of the Grand Trunk Railway Co.

12345—November 21—Approving location of the C.N.R. Co.'s line of railway through Townships 29 to 32, Range 9, west Principal Meridian, Manitoba, mileage 127.92 to 151.10, reckoned from abandoned junction with the C.P.R. Co.'s main line, Winnipeg.

12346—November 21—Authorizing the C.N.O.R. Co. to erect telegraph wires across the wires of the North River Electric Co. at Station 534:8.5, Parish of St. Andrews, County of Argenteuil.

12347—November 21—Approving plan dated September 23rd, 1910, showing the C.N.O.R. Co.'s Standard Crossing over Highways; and rescinding Order No. 10098, dated April 7th, 1910.

12348—November 21—Approving resolution of the Central Vermont Railway Co. authorizing C. E. Dewey, General Freight Agent, and J. W. Hanley, General Passenger Agent of said company, to prepare and issue tariffs of the tolls to be charged for all traffic carried by the company upon its railways or in vessels.

12349—November 21—Authorizing the C.P.R. Co. to use and operate bridges Nos. 4.9 and 12.2, on Eganville Section of its line of railway.

12350—November 21—Authorizing the C.N.R. Co. to construct a spur track on lane between Ninth and Tenth Streets from the North Line of McTavish Avenue, to the South Line of Princess Street, Brandon, Man.

12351—November 21—Approving plan dated September 21, 1910, showing the C.N.O.R. Co.'s Standard Crossing over Highways; and rescinding Order No. 10091, dated April 7th, 1910.

12352—November 22—Granting leave to the Trenton Electric and Water Company, Limited, to erect its electric transmission line across the track of the G.T.R. Company at Lot 36, Concession 2, Township of Sidney, County Hastings, Ont., and rescinding Order No. 12280, dated November 15th, 1910.

12353—November 22—Approving location of the C.N.R. Co.'s line of railway through Townships 3:-27, Ranges 8-9, west 3rd Meridian, Sask., mileage 25.81, to mileage 45.54.

12354—November 22—Authorizing the Hydro-Electric Power Commission of Ontario, to erect transmission wires across the wires of the Bell Telephone Company at Lot 9, Concession 2, Township of Dorchester.

12355—November 24—Authorizing the C.P.R. Co. to construct a spur for the use of the Lumber Manufacturers' Yards, Limited, Moose Jaw, Sask.

12356—November 23—Authorizing the C.N.O.R. to construct a bridge over the Trent River in the town of Trenton, Ontario.

12357-9—November 23—Authorizing the Niagara, St. Catharines & Toronto Railway Co. to erect its transmission lines across the wires of the Bell Telephone Company at three different points in the Township of Thorold, County of Welland, Ontario.

12360-1—November 23—Authorizing the Seymour Power and Electric Company, Limited, to erect its electric transmission line across the G.T.R. between Stirling and Campbellford, at Lot 13, Concession 1, Township of Rawdon, County of Hastings, Ont.; and at Lot 12, Concession 5, Township of Seymour, County of Northumberland, (approximately 31 2-3 miles from Belleville).

12362-7—November 23—Authorizing the corporation of the town of Maisonneuve to lay a gas pipe under the C.N.Q.R. at Second Avenue, Maisonneuve; and under the Montreal Terminal Railway at Fifth Avenue; Third Avenue; Fourth Avenue; Second Avenue; and First Avenue, Maisonneuve, Quebec.

12368-72—November 23—Authorizing the corporation of the town of Maisonneuve, Que., to lay a water pipe under the Montreal Terminal Railway at First Avenue; Fifth Avenue; Second Avenue; Fourth Avenue; and Third Avenue, Maisonneuve, Quebec.

12373—November 23—Authorizing the corporation of the city of Montreal to lay a sewer under the C.N.Q. and Montreal Terminal Railway Companies, at St. Antoine Boulevard, Tetreaultville.

12374—November 23—Authorizing the Niagara, St. Catharines, & Toronto Railway Co. to erect transmission lines across the wires of the Bell Telephone Co. to Ormonde St., Thorold, Ont.

12375-6—November 23—Authorizing the Hydro-Electric Power Commission of Ontario to erect its transmission line across the track and wires of the Michigan Central Rd. Co., at Lot 28, Concession X.S., Norwich, County Oxford, Ont.; and erect its low tension line across the wires of the Bell Telephone Co., at Sherman Ave., Hamilton, Ont.

12377—November 24—Approving alteration of a small portion of line of railway of the Western Canada Power Co., Ltd., from Ruskin to Stave Falls, being an extra width of twenty-five feet on each side of its right-of-way, required from John MacDonald, between Stations 67.00 and 71.00.

12378—November 24—Authorizing the C.P.R. Co. to construct an industrial spur for the Continental Oil Co., in Block "O" east of Pearce St., and north of Notre Dame St., Bengal, Alberta.

12379—September 13—Authorizing the C.N.Q.R. to temporarily connect its lines and tracks with the lines and tracks of the National Transcontinental Railway at Cap Roude, mileage 2.4 from Quebec Bridge; that the temporary connection be protected by a semaphore to be installed by the C.N.Q.R.

12380-1—November 24—Authorizing the Hydro-Electric Power Commission of Ontario to erect its transmission line across the wires of the Bell Telephone Co. at Lot 22, Concession 2, Township of Brantford, County of Brant, Ont.; at Lot 1, Concession 3, Township of N. Easthope, County of Perth, Ont.; and at Lot 8, Concession B., Township of London, County of Middlesex, Ontario.

12383—November 25—Authorizing the Tillsonburg, Lake Erie and Pacific Railway Company to construct a branch line of railway for the Ingersoll Nut Company, Limited, Ingersoll, Ontario.

12384—November 24—Approving the character of the proposed work in connection with drain proposed to be constructed along and under the C.N.R. Co.'s right-of-way, in the village of L'Orignal, Ontario.

(Continued on Page 760).

WORKMEN'S COMPENSATION ACT.

Manitoba's New Legislation—When the Employer is Not Liable.

The following summary of the Manitoba Workmen's Compensation Act, compiled by Messrs. Oldfield, Kirby and Gardner, of Winnipeg, will be found of value:—

To Whom an Employer is Liable.

"The provisions of this Act shall apply only to employers who employ in their trade or business at the time the accidental injuries occur, five or more workmen, or who usually or from time to time employ in their trade or business five or more workmen."—Sec. 2.

This is not limited to manual labor.—Sec. 3 (b).

Exceptions:—An employer is not liable to an employee who is:—

1. Receiving over twelve hundred dollars per year whose work is not manual labor.—Sec. 3 (b).
2. Only casually employed.
3. Not employed for the purposes of the employer's trade or business.
4. An outworker—that is, a person doing piece-work on premises not under control of employer.
5. A domestic servant.
6. A farm laborer.—Sec. 13.

For What Accidents an Employer is Liable.

"If in any employment to which this Act applies, personal injury by accident, arising out of and in the course of the employment, is caused to a workman, his employer shall, subject as hereinafter mentioned, be liable to pay compensation in accordance with the first schedule to this Act."—Sec. 4.

Exceptions:—An employer is not liable to an employee where:—

1. The employee is disabled for less than two weeks.—Sec. 4 (a).
2. An injury is attributable to the employee's drunkenness.—Sec. 4 (c).
3. There is only partial disablement caused by serious or wilful misconduct of the employee.—Sec. 4 (c).

Special Liability:—Where the injury is caused by the personal negligence or wilful act of the employer, or of some person for whose act or default the employer is liable, the employee may claim under this Act, or independently of it, as he chooses. In all other cases the claim must be made under this Act.—Sec. 4 (b).

For What Compensation an Employer is Liable.

The first schedule of the Act covers this under two heads.

Where death results from the injury:—

(1) $1,500 is a maximum where there are dependants, such as wife, children, father, mother, etc., residing in the province.

(2) $100 is a maximum to cover medical attendance and burial where no dependants.

Where total or partial incapacity for work results from the injury:—

(1) No compensation for first two weeks.

(2) After first two weeks 50 per cent. of the usual earnings not exceeding $10 per week for journeymen or adult employees, or $6 per week for apprentices.

General Provisions of Act.

All disputes shall be settled by arbitration, for which provision is made under the second schedule of the Act.—Sec. 4.

An employer is entitled to:—

(1) Notice of accident within fourteen days.

(2) Notice of claim within three months.

(3) And arbitration proceedings within six months.

Failure to give the notices is not an absolute bar, but failure to commence proceedings is fatal.—Sec. 5.

Any agreement to contract liability out of the Act must be approved in writing by the Attorney-General.—Sec. 6.

A principal or main contractor is liable to a sub-contractor's workmen.—Sec. 7.

The Act comes into force on January 1st, 1911, but does not apply to accidents happening before that date.—Sec. 15.

ONTARIO'S PETROLEUM WELLS.

Decline in Oil Yield — Statement of Production — Statistics for Three Years.

The petroleum wells of Ontario last year yielded 14,723,105 Imperial gallons of oil, valued at $559,478. The quantity given is that returned to the Department of Trade and Commerce, Ottawa, for purposes of the Dominion Government bounty of 1½ cents per Imperial gallon. This is a decrease of 3,756,442 gallons, as compared with the production of 1908, or 25 per cent.

The decline in the oil yield continues to manifest itself in the records of production. There was a diminution in the output of every one of the fields, but the rate of decline in the newer districts of Tilbury and Romney was greater than in the older districts of Petrolea and Oil Springs. Already the production has sunk to less than one-half of what it was fifteen years ago, and if the falling-off is maintained the supply of domestic petroleum will tend to become relatively insignificant, unless new reservoirs are opened up. Even now more crude oil is imported into the country than is produced here. The fields of Lambton county have already had great longevity, and are unique among the oil-producing regions of the world, because of the small individual production of the wells, which is only a few gallons a day, and of the economy with which they are operated. Being of shallow depth, many wells may be worked by one engine on the "jerker" system, and so give a profit, which if not large is constant.

Statement of Production.

Mr. W. J. Harvey, supervisor of crude petroleum bounties for the Dominion Government, furnishes a statement of the production in 1908 and 1909:—

Field.	1908. bbl.	1909. bbl.
Lambton	265,368	243,123
Tilbury and Romney	201,283	124,003
Bothwell	39,228	38,092
Leamington	9,334	5,929
Dutton	13,743	9,513
Thamesville	......	......
Comber	......	......
Total	528,959	420,660

As will be seen from the above statistics, the reduction in the yield of the respective fields was as follows: Lambton, 22,245 bbl.; Tilbury and Romney, 77,280 bbl.; Bothwell 1,136 bbl.; Leamington, 3,405 bbl., and Dutton, 4,230 bbl.

Price of Crude Fluctuates.

The average price for Petrolea crude during the year was about $1.33½ per bbl. It opened in January at $1.44 per bbl., at which figure it remained until May 4th, when it dropped to $1.39. On May 11th it fell again to $1.34, on June 25th to $1.29, on July 16th to $1.26, and on October 21st to $1.24, at which it closed the year. The price of Tilbury crude is on a parity with that of Petrolea, but freight by rail to Sarnia from the shipping points must be allowed for. At the beginning of the year the price at Tilbury was $1.27 per bbl. It dropped on May 4th to $1.22, on May 11th to $1.17, on June 25th to $1.12, on July 16th to $1.09, and on October 21st to $1.07, at which figure it remained until the end of the year. The average for Tilbury oil for the twelve months was perhaps $1.16 per bbl. These prices are irrespective of the Dominion Government.

The refineries, of which there are two in Ontario, the Imperial Oil Company's at Sarnia, and the Canadian Oil Company's at Petrolea, distilled a total of 35,530,918 gallons of crude last year. Of this, 16,015,527 gallons, or 45 per cent., was domestic, and 19,515,391 gallons imported.

Statistics for Three Years.

The following statistics covering three years ending with 1909, show the quantity of crude oil distilled annually and quantities and value of the several products. It will be seen how the production of domestic crude has steadily gone down during the period covered by the table with the exception of 1907, the first full year for the Tilbury-Romney field:—

The product is shipped entirely to the United States, where it is used in the manufacture of porcelain goods and enamelled ware. The superior qualities of the Ontario feldspar enable it to compete with the product of the United States quarries, and to obtain a price which will pay for the long haul to the potteries of Newark, N.J., and East Liverpool, Ohio. So far, the attempts made to export feldspar to England have not been successful, ocean freights being so uncertain as to make it difficult to quote prices delivered.

SOCIETY NOTES.

The Canadian Clay Products.—The annual convention of the Canadian Clay Products Manufacturers' Association will be held in Toronto, on December 14, 15 and 16. The following is the official programme: On Wednesday morning, December 14, a meeting of the executive committee will be held at ten o'clock. At 2.30 addresses of welcome will be given by representatives of the Mayor and the local clay-working manufacturers. Replies to the addresses will be made by President McCredie and Vice-President Miner. Thursday morning will be devoted to the problems connected with drain tile making and to hollow ware. Mr. Geo. E. Bigelow, an Ohio tile manufacturer, will address the convention. Prof. W. H. Day, of the Ontario Agricultural College, will discuss the tile drainage problem as it was developing in Ontario. In the afternoon attention will be devoted chiefly to "Kilns" and "Power Problems." Several speakers have been invited to speak on "Kilns." John W. Ball, of Toronto, will give practical talks on kiln troubles, while Mr. Broadwell, of Kingsville, and Mr. Chas. A. Millar, of the Standard Brick Company, Limited, has consented to describe the Hydro-Electric power installation, which is entirely electrical, and to emphasize its advantages. On Friday morning the first hour and a half will be devoted to discussing, "Which Pays the Better: Piece Work or Day Work." Mr. S. J. Fox, M.P.P., has been invited to open this discussion, and Messrs. W. N. Freeborn, of Brantford, and J. S. McConnell, of the Milton Pressed Brick Company, have agreed to speak on the subject. From 11.30 to 1 o'clock on Friday will be devoted to the election of officers for the ensuing year and to the choice of convention centre for the following year.

Output of Wells.

Schedule.		1905.	1907.	1909.
Crude produced	Imp. gal.	22,131,658	27,621,851	14,723,105
Crude distilled	"	33,821,998	34,961,700	35,530,918
Value crude produced	$	898,545	1,049,631	559,478
Value distilled products	"	2,196,678	2,568,464	2,501,384
Illuminating oil	Imp. gal.	16,433,588	18,319,233	17,902,254
Lubricating oil	"	3,402,977	3,931,767	3,856,778
Benzine and naphtha	"	2,827,971	4,132,239	3,930,691
Gas and fuel oils and tar	"	5,788,251	5,632,608	4,687,588
Paraffin wax and candles	lb.	4,077,610	5,132,394	7,092,278
Workmen employed	No.	469	435	436
Wages paid	$	280,701	265,316	261,014

The Canadian Engineer

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CONTENTS OF THIS ISSUE.

THE INDUSTRIAL ENGINEER.

What is an Industrial Engineer? What does he engineer, how does he engineer it, and what results does he obtain? We all know the function of the civil, the mechanical, the electrical or the mining engineer—those men who study and harness for the use of mankind the forces of nature. They are the appliers of "Applied Science." But this does not tell us about this comparatively new species, the "Industrial Engineer." Perhaps a concrete example may best illustrate the functions exercised by him. The following case is chosen from one of many among the records of the firm of industrial engineers, Lockwood, Greene & Co., of Boston, as a typical problem presented by a large manufacturing concern, and illustrates the broad field of endeavor covered by the industrial engineer.

The case in question is that of a large corporation owning three textile mills, which, on account of various factors and on account of peculiar market conditions, had not been earning the dividends which they should for some time. The owners wished to know what could be done in order to put their properties on a firm footing. To do this the engineers approached the problem in the following manner:; First, they obtained by means of a detailed inventory the value of each mill separately. Second, they considered the possibility of the profitable running of the mills as a whole or as separate units. Third, they prepared plans and made recommendations for the reorganization and rearrangement of all the mills, either as separate units or together. Fourth, they submitted an estimate of the cost to put each mill or to put the entire property into first class shape. Fifth, they prepared estimates on the amount of capital required to operate the plant as a whole or each mill as a separate unit. Sixth, they made recommendations as regards the manner of selling the output.

It will be seen from the foregoing that the engineers had to study the problem from four sides; that of the mill architect and designing engineer as regards placing the value on the plant, from that of the operating engineer, from the point of view of the financier, and last, but by no means least, from the point of view of the merchant. From the foregoing we may possibly formulate a more or less accurate idea of the function of the industrial engineer and the broad field of endeavor which he undertakes. He is not only the engineer of the forces of nature, but he must be the engineer of human beings, and in addition he must have a thorough working acquaintance with those intangible but most necessary factors of business, finance and selling. In a word, he may be likened to the coach of the football team, upon whom rests the task of developing team play.

A team may, of course, get together and make a creditable showing without the assistance of a coach, but in competition with the more highly specialized teams, developed through proper coaching, the uncoached team will be at a big disadvantage. In these days of keen competition in business it is only the manufacturer who is operating on the most efficient basis, who has the most effective team play, the most balanced plant, who will in the long run be able to last through the game and come out victorious in the end.

DEVELOPMENT OF ELECTRICAL PLANTS IN THE UNITED STATES.

In a recent report issued by the United States Census Department the central electric light and power stations of the United States are referred to, and the remarkable growth of this industry is shown in the fact that the cost and equipment of such stations represented $1,096,913,622 in 1907, or double that of 1902. The horse-power capacity more than doubled—4,032,365, against 1,830,594, while the output of stations in 1907 was 5,862,276,737 kilowatt-hours, against 2,507,051,115 in 1902.

Due allowance being made for more complete returns than in 1902, the figures are significant, showing that conditions are changing, and the growth in the United States is an indication of what we in Canada may expect proportionately.

The number of incandescent lamps in use in 1907 was 45,991,836, against 19,636,729 in 1902, and of arc lamps 635,815, against 419,561. The incandescent lamp has largely superseded the arc lamp for street and other lighting purposes, since it has been found that better service is secured by the distribution of a larger number of comparatively small lamps.

A comparison of the number of reports received from municipal stations in 1907 with the number received in 1902 shows an increase of 53.6 per cent. as compared with 23.4 per cent. for the commercial companies. The municipal stations are practically exempt from the consolidations that so frequently occur among commercial companies, and this fact no doubt accounts in large part for the proportionately greater increase in the former class of stations. Not only was there a large increase in the number of municipal stations, but an analysis of the reports shows that, although 33 municipal stations which reported in 1902 had become commercial stations in 1907, 113 stations which were reported as commercial in 1902 had become municipal in 1907.

The claim has been made, and sustained by what appears to be reasonable argument, that the drift of these public utilities is from municipal to commercial, but the results of the census do not furnish corroborative evidence of this. On the contrary, there appears to be a distinct field for municipal electric stations, not only because of a feeling which may exist in many localities that these public utilities should be owned by the cities, but because many of the places in which municipal plants are located do not present sufficient inducement for the investment of commercial capital.

Of the six classes of stations grouped according to dynamo capacity, the largest income is shown for the class smallest in numbers, stations having a kilowatt capacity of 5,000 or over. In 1907 more than one-half of the total income was reported by this class, which naturally embraces the stations in the large cities. The next largest income is shown for the next lower group by kilowatt capacity and the next higher in number of stations; but the group ranking third in the amount of income reported is that which comprises the stations of smallest dynamo capacity, which, however, includes nearly two-thirds of the total number of stations. Almost 5 per cent. of the total income was reported by stations not equipped with generating apparatus. The proportions of the total income from lighting reported for the different classes of stations vary but little from the corresponding proportions of total income, but in the case of income from stationary motor service and all other electric service the proportions show decided variations. This results from the fact that the income from each of these two classes of service increases as the dynamo capacity of the stations grows larger. In 1907 the smallest stations, those with a dynamo capacity of less than 200 kilowatts, reported but 1.4 per cent. of the total income for motor service, while the stations of largest dynamo capacity reported 61.8 per cent. In the case of income from all other electric service the corresponding proportions were 1.2 per cent. and 69.7 per cent.

There is a marked difference between the commercial and the municipal stations in respect to the proportions of income reported by large and small plants. While the commercial stations show their largest proportions for the two classes of highest individual capacity, the municipal stations show their largest proportions for the two of smallest lowest individual capacity. The gross income for the class of dynamo capacity for municipal stations represented more than one-third of the total, while that for the class of next higher dynamo capacity was nearly as much as the total for all the remaining classes. The two classes together reported 67.6 per cent. of the total income and 92.6 per cent. of the total number of stations.

DETERMINING THE ACTUAL VALUE OF TEXTILE MILL PROPERTY.

Lockwood, Greene & Co., engineers of Boston, Mass., were recently called upon to value two textile mills belonging to a certain corporation and because of their peculiar equipment and the rather unusual market conditions at the time of the examination, the conclusions of the engineers in placing a final value on the properties contains matter of interest to mill owners and manufacturers in all lines of industry, but particularly to those connected with the manufacture of textiles.

The mills will be designated as No. 1 and No. 2. From a detailed investigation the actual physical value of the two plants was determined as

	Mill No. 1.	Mill No. 2.
Value of factory buildings, machinery and all other equipment	$671,000	$462,000
Value of lands and tenements	138,000	31,000
Totals	$809,000	$493,000

For determining the so-called "actual value" of these properties the following quotation from the engineer's report is given: "It is to be understood the values are those of a plant which is being operated and not as a plant which is closed down for an indefinite period. Were we to consider the value of the properties as idle properties, we could only assign to them such values as the lands, buildings and machinery might bring at a sale. We do not, however, under the existing circumstances consider the properties to be idle for any great length of time, the present shut-down being merely such a closing as is thought to be necessary because of the existing market conditions. On this basis we have estimated the values of the different properties. We must call attention again to the producing capacity of the No. 1 Mills. This plant is not a balanced plant at present.

As before stated, there are installed 40,432 spindles with but 613 looms, while 29,736 spindles only are being operated to supply these looms. Ordinarily on goods of this class

27,000 spindles would supply 613 automatic looms indicating to us that the spinning frames are running at a slow speed (making the cost of production greater) and that the real rating of the mill based on its producing capacity should be 27,000 spindles.

There is space in the buildings to increase the capacity to 900 looms, perhaps to 950 looms, with all necessary preparatory machinery, some of which is now in the mills in a partly erected condition.

The itemized values given for Mill No. 1, therefore, represent a mill with a producing capacity of 27,000 spindles and 613 looms, having enough building area and part of the required machinery for a mill of 40,000 spindles.

We estimate the value of machinery not in use, not including one of the steam-turbine units, which, however, is idle, to be $45,000, if new, with a present value of $32,000.

The value of a new plant like Mill No. 1 would be approximately $27 per spindle without land or tenements.

At same rate of depreciation assigned to the plant, the present value of such a 27,000 spindle mill would be approximately $576,000.

The combined value of a new 27,000 spindle plant and same amount of unused new machinery as now in Mill No. 1 would equal approximately $774,000 without land or tenements.

The present depreciated value would be approximately $608,000.

We must also call attention to the valuation which has been given to Mill No. 2. This plant was originally designed for a woolen mill and the present equipment is part for the manufacturing of woolen goods and part for cotton goods. We have based our itemized valuation upon the assumption that the plant would be run on goods for which the machinery installed is adapted and that the plant as a whole would be operated in that way, although at the time of our examination only the cotton machinery was in operation and we believe that the remainder of the plant had been closed for some time, in fact, was closed because there was no demand for the goods which could be manufactured. On this basis, therefore, it is not possible to give Mill No. 2 the value as a producing plant which has been assigned it in the itemized statements. There are but 18,000 spindles in operation. If based on this capacity the plant would have a value of practically $450,000 if new and a present depreciated value of about $225,000 exclusive of the land.

RAILWAY SIGNALLING.

Sir,—In your issue of October 20th, 1910, page 545, we noticed a discussion of the Central Railway Club of Canada, in connection with the operation of the Whyte Highway Crossing Signal. It is mentioned that the operation is not perfect, because the illumination for the light was taken from the same source as the power for the bell and if the bell failed the light was gone also.

We would like to draw the attention of the railway engineers and the municipalities, where protection is required, of several instances where we have the bell and light circuits operating separately, for example, the Whyte Signal on the G.T.R., at Bronson Avenue, Ottawa; therefore, this imperfection, as discussed, has been overcome.

In designing our highway crossing signals we endeavored to keep in mind the most essential features demanded in an automatic apparatus of this kind; namely, the highest order of protection possible to the public at all times, both day and night, therefore, in considering these conditions it was found absolutely essential to give a distinctive visual, as well as an audible, warning.

Our audible warning consists of a loud, rapid stroke 12" gong having a deep tone, with the mechanism thoroughly protected by weatherproof iron case.

Our visual indication is given by a large cast iron sign "Railway Crossing Danger," the letters of which are 6" in length and raised ¼" from the background. The background of this sign is painted a bright signal red and the raised letters are a pure enamel white. This whole sign is completely illuminated at night, making it legible fully one hundred yards from crossing.

To meet the question, to provide a warning signal for those who cannot read and for those who are hard of hearing, we decided to use a large 6⅜ Ruby lens, which is accepted the world over as a signal of danger: this red light can be seen fully half a mile.

By the above features, we believe we have covered every phase to be required in an automatic signal for the protection of the public at level crossings. Our light indication may be operated separately from the bell circuit, and while it is feasible to do so, and when such is done, we would not recommend such indication being given by any other source than electricity, as we have learned by experience that moving parts with slides and other complications always have a tendency to give a false indication, which, in this class of apparatus, is conclusively dangerous to the public for instance, in a heavy sleet or snow storm moving parts, such as the dropping of letters to indicate the word DANGER, on the approach of a train, would be so covered that it would make it impossible to read, whereas in the Whyte Signal our red lens is protected and though it be covered with ice and snow it would be impossible to block the red light, also the illumination of the sign "RAILWAY CROSSING DANGER" is reflected from above and therefore not exposed to weather conditions.

In view of the criticism made in your paper in connection with our product, we submit the above for your consideration.

The Whyte Railway Signal Co., Ltd.,
F. C. Whyte, Secretary.

CHICAGO'S SHIP AND DRAINAGE CANAL.

The Engineering Society of the University of Toronto were afforded a highly instructive address and a rare opportunity on December 12th, when Mr. Isham Randolph, C.E., delivered an illustrated address on Chicago's Ship and Sanitary Canal. While the address was exceedingly comprehensive, it was evident, as Mr. Randolph said, that so vast an enterprise could not be justly dealt with in one address. In fact, Mr. Randolph said the subject could be treated to more advantage under several heads, as, metropolitan, state, interstate, national, and international. In the course of his address Mr. Randolph said Chicago is but 74 years old and the great problems arising from sudden growth may be well imagined. I first took charge of Chicago's work in 1893, a few months after the great fire. At that time Chicago was a straggling sort of a city of about 400,000 population. Streets, in many cases, were below water level and tremendous operations have taken place to put them in their present condition. Lake Michigan has always been Chicago's source of drinking water. The first lake tunnel ran two miles into the lake, but this was later regarded as insufficient and it was run 2 miles further out. At present there are several running out 4 miles from shore. In 1886 there was a commission appointed concerning this matter of sewage. This commission considered three propositions, (1) an intercepting sewer for conducting sewage to southern part of the lake, (2) a settling basin land filtration plant, but as this affected territory belonging to Indiana that state raised objection to this, (3) carrying the sewage down the Illinois valley. But with the failure of these propositions the present problem arose. In 1889 the Legislature of Illinois passed a sanitary law, which materially affected Chicago's problem. Whereas 20,000 cubic feet of water per minute was obtainable, they planned a channel for obtaining 600,000 cubic feet per minute.

This canal was to be 200 feet wide on the bottom and 18 feet deep, but in reality it was 202 feet wide at bottom and 22 feet maximum depth. Through the rock the channel was 160 feet wide at bottom and minimum depth was 22 feet. In the rock there was a slope of 2¾ inches per mile and in the clay and sod a slope of about 1½ inches per mile. The cut was made through the rock with a channelling machine and was taken out in 3 stokes with widths at the bottom of 160 feet, 161 feet and 162 feet respectively, these offsets being allowed for the proper manipulation of the channelling machine. I was connected with this work for over fourteen years and it assumed enormous proportions during that time. One might reasonably ask whether this enormous expenditure was merited, for the sanitary district of Chicago has an area of only 356 square miles .64 of 1 per cent. of the area of the State of Illinois. This comparatively little area expended $63,000,000 for this prodigious undertaking. The report of the health commissioner of Chicago will perhaps tell whether this really was a paying proposition. The report says that in 1891 Chicago had about the highest death rate from typhoid of any city. The result of these sewage improvements was that from 64.1 per 100,000 population, the death rate in Chicago for typhoid decreased to 23.5 per 100,000 population. And from having the highest death rate of any city it now has about the lowest, having only 15.6 per 100,000 death rate. According to the report of the health commissioner, 11,148 typhoid deaths had been prevented in 9 years by this system. I wish Toronto had a drainage canal.

The Chicago ship canal is eventually 200 feet wide, 26 ft. deep in mid-stream and 18 ft. deep at the banks, and some 28 miles long. Mr. Randolph has many exceedingly interesting slides of the works, a remarkable feature being the description of the many various appliances used and in some cases devised for the first time to facilitate in the excavating and dredging on this work. Among some of the most interesting slides were those of the Brown level conveyer, which would often complete its operation in 52 seconds in handling 10,000 pounds. At Lockport there are seven gates, interesting from size. They fill gaps of 32 feet, are 20 feet high, have a weight of 62,000 pounds. Two men can raise and lower them in 15-foot pressure of water. The "Bear" trap dam at Lockport is also a remarkable feature—it is 160 feet on the crest, has 12 feet oscillation and the hinges are anchored 20 feet. The placing of this interesting type of structure at Lockport met with much opposition from commissioners and engineers alike and they predicted it would be a failure. It is, however, a decided success. There is also on this canal the so-called "Butterfly" dam, the only one of its kind in the world. It is 184 feet long, 34 feet high and has a pressure on the bottom, when closed, of 3,776,000 pounds. Mr. Randolph solved the hard problems of successful dredging by using the hydraulic dredge. This wonderful machine worked so well that another was built on the works. With the hydraulic dredge the contractors were able to remove 1,400,000 cubic yards of material at a cost of about 5 cents a yard. The Mississippi Navigation Commission following the example of Mr. Randolph has since employed the hydraulic dredge and this is making the navigation of the Mississippi possible. The dredge as used on the Mississippi cost $150,000 and 1,500 yards an hour can be removed with it. The cableway, an invention which was conceived on this Chicago's work, is another mechanical aid that has helped the work of excavation in engineering. The aerial dump has done marvels since its invention. Such appliances and the channelling machine, which on the Chicago work cut a gash of ⅜ inch and did 100 superficial feet a day, have made the work of excavation less tedious, and in some cases, at all possible.

In the Panama they are far exceeding now work done on the Chicago canal. This year they have excavated 135 million cubic yards. They excavated only 66 million last year and only 37 million cubic yards the year before last, so a tremendous progress is shown in the speed of excavating. Bridge work over the Chicago River has been very extensive. Eleven of the rolling lift type have been built across the Chicago and more will be built. The principle of this very efficient bridge is that as the channel span opens the approach span drops. This type has been found very satisfactory.

THE ALBERTA CLAY PRODUCTS COMPANY WORKS.

There has recently been opened at Medicine Hat, Alta., a clay products plant.

The industry at the time of its opening, employs 325 hands, owns and operates two and a half miles of private railway, and turns out an excellent class of sewer pipe of all sizes, up to 36 inches in diameter, pressed brick, glazed and fire brick, darin tile, wall piping, flue lining and all kinds of fireproofing. The use of natural gas, a cheap and convenient fuel, enables the company to overcome the handicap of distance and freight rates, and to compete successfully in distant markets.

The history of the plant is a part of the history of Medicine Hat, and a very forcible demonstration of the advantages of the wonderful natural resources of the power city, which only awaits the development of a local market to become the most important manufacturing centre of the West.

The company secured a valuable clay bed of 320 acres, eight miles east of Medicine Hat, the deposit being 90 feet in thickness; and have constructed a railroad two and a half miles in length from the mine to the main line of the C.P.R. At the mine the track is sunk to the bottom of the vein, thus permitting face working. Small gravity cars each of which hold 55 lbs. carry the clay up to the bottom dump railroad cars. Later on a steam shovel will be installed.

Completed, the plant is one of the most pretentious piles in the West. It includes one building 80 x 256 feet, four storeys in height, for sewer pipe equipment, and for drying floors; a dry press brick department two storeys high 40 x 70 feet; an engine room 34 x 47 feet; a sewer pipe press room three storeys high, 55 x 68 feet; a machine shop, 30 x 50 feet; a boiler room, 100 x 25 feet; a clay bin, 140 x 48 feet and 30 round down draught kilns, 14 of which are 40 feet in diameter.

Only the most improved machinery is used throughout At the works the clay is carried on an elevated track 20 feet high into the clay shed and is conveyed thence by automatic carriers to the drying pans where the shale is ground to dust. The drying pans in both the pipe and brick plants are of the 9-foot Eagle make, having gravity discharge. Thence, the material is elevated to the fourth floor and is

(Continued on page 753).

HYPOCHLORITE TREATMENT AND VARIATIONS OF FLOW.

Recently in connection with the Toronto water supply, there have been complaints made by the public of taste in the water, alleged to be due to the hypochlorite treatment then in vogue.

No one doubts the efficacy of the chemical treatment as a method of practically eliminating the germs which are considered in the light of unwelcome strangers to Lake Ontario water. Daily analyses of the water published from time to time show that, at any rate, there is little or no risk of typhoid from drinking the treated water. At the same time, the public strongly, and rightly so, object to a water which is tainted with the flavor of the sick room.

Dr. Naysmith (the city bacteriologist) has satisfied himself that as long as the mixture of chlorine does not exceed .5 parts in 1,000,000, no taste results. This applies to Lake Ontario water particularly. When the amount exceeds this proportion, say, .6 parts in 1,000,000, the presence of free chlorine is marked.

There is no doubt but that the amount of chlorine which a given character of water is capable of absorbing without taste is fixed. The amount varies, to a large extent, with the organic content of the water.

Recent investigations in connection with the complaints of over-dosing the water at Toronto have shown that the fault is due to a lack of any method of regulating the supply of chlorine to meet the night flow as compared with the day flow. In fact, just as much chlorine has been added throughout the night as has been throughout the day, when the consumption of water is at its maximum.

It is most important that any method adopted for adding chlorine to water should be "fool-proof," and that the apparatus employed should be self-regulating, so that the amount of chlorine liquid may always be in the exact proportion to the flow of sewage.

In this issue we give a cut of an automatic appliance recently introduced by Messrs. Nixon & Mannock, which is said to fulfil the above requirements.

Along with the cut we also publish a description from Easdale's recent book on "Sewage Disposal Works."

AUTOMATIC HYPOCHLORITE PLANT.

A new apparatus for the purpose of adding chlorine to water has recently been introduced by Messrs. Nixon and Mannock. As will be seen from the illustration, Fig. 155, it is based upon the application of the Venturi principle, and involves the use of a Venturi tube, as previously described under the heading of "Measuring Apparatus." In fact, the same Venturi tube can be utilized to serve both for measuring the flow of the effluent, and for applying the sterilizing agent in direct proportion to the flow of the effluent.

The apparatus consists of a cylinder C, the top of which is connected by means of a pipe fitted with a three-way cock to the "Upstream" end of the tube A. A similar connection is made from the bottom of the cylinder to the "throat" B. A piston of the type used in the Kent Standard Water Meters, and provided with a counter-balance weight, works in the cylinder by means of the difference of the pressure on the two sides of the Venturi tube. The chemical solution (e.g. a 5 per cent. solution of chlorine) is supplied to the under side of the piston, and the pressure on the upper side of the piston being greater than the pressure on the under side, the chemical is forced down by the piston and injected through the injection tube and regulating valve into the effluent at the "throat" of the Venturi tube. As the flow of the effluent through the Venturi tube produces a difference of pressure which varies as the square root of the velocity, the rate of injection will also vary in the same proportion. The injection is thus in exact proportion to the flow, and any variation of the flow will automatically cause a corresponding variation in the rate of injection.

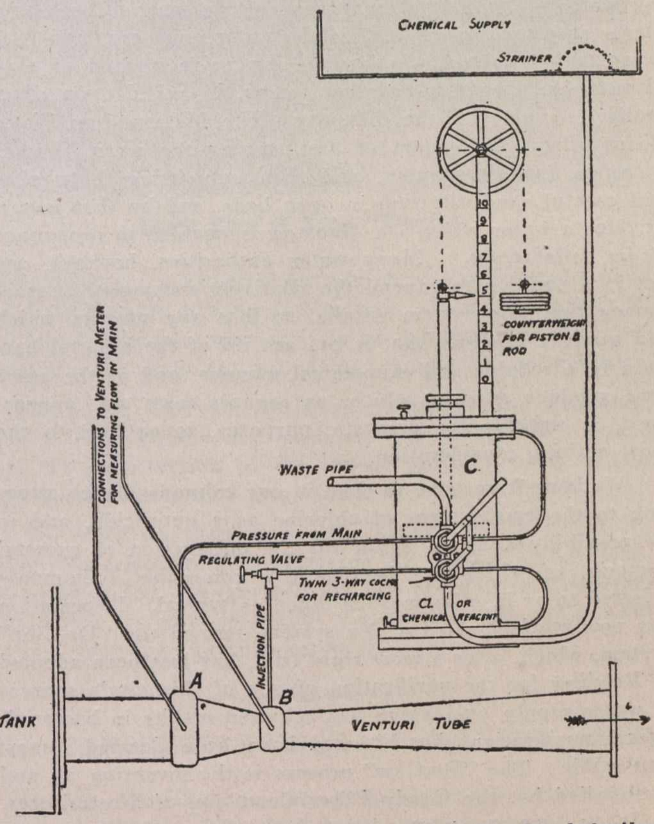

Fig. 155.—Nixon and Mannock's Apparatus for Injecting Chemical Solution.

When the chemical re-agent is exhausted, the piston will be at the bottom of the cylinder, and the pointer at zero. In order to recharge the cylinder with the chemical, the three-way cocks must be reversed by means of the hand lever, thereby cutting off pipes A and B, and simultaneously connecting the top of the cylinder to the waste pipe, and the bottom to the supply from the chemical storage tank, which is fixed at such a height that the head will rapidly force the piston up and re-fill the cylinder with the chemical. The three-way valves are then reversed, and the apparatus is again in full working order. The apparatus shown is applicable to the treatment of 1,000 gallons per hour, and will only need recharging once per day of 24 hours.

A feature of this apparatus is that it is self-starting, and should the flow cease, the injection will also automatically stop, the static head on both sides of the piston being equal. There is absolute immunity from danger or over-injection of the chemical by this system, and this is a valuable factor in the treatment of potable water. Where absolutely necessary, the same firm can supply a dechlorinating apparatus. By means of the indicator, the works manager is constantly informed of the exact amount of chemical injected, and the scale readings can be compared with those of a Venturi Meter operated by the same Venturi tube. This apparatus can be supplied of a larger size, and provided with automatic re-charging gear for larger installations.

WATER PURIFICATION AT READING.

The "De-Clor" System.

The effective removal of pathogenic bacteria from drinking water is, without a doubt, one of the most difficult problems at present presented to the water engineer, and it is exceedingly doubtful whether the expensive method of slow filtration in open sandbeds can, alone, be relied upon effectually to cope with the difficulty. The Metropolitan Water Board adopt the system of first storing the river Thames water in huge reservoirs, and then submitting it to slow and careful sand filtration in open beds, and by that means produce a water which Dr. Houston is enabled to pronounce to be satisfactory. Many water authorities, however, are not in a position to expend the relatively enormous sums of money that this system entails, so that any process which can produce evidence that it can get rid of the excretal bacteria in a reliable and economical manner, and at the same time produce a water which, as regards taste and appearance, is suitable for domestic purposes, is entitled to the most serious consideration.

We have from time to time in our columns drawn attention to the employment of chlorine as a germicide, and to its possibilities as an agent for the destruction of excretal bacteria, of which the bacillus coli communis (commonly referred to as b. coli) may be taken as typical. Information has now reached us of a new system, termed the "De-Clor" system, which, after a most rigid trial, has just been adopted at Reading for the purification of one of this city's sources of water supply, and which has achieved results in bacteriological purification that hitherto have been deemed almost impossible. The "De-Clor" process is the invention of, and is supplied by, the Candy Filter Company, of Westminster.

In the "DeClor" filter system a minute dose of chlorine is injected by an automatic apparatus into the water on its way to a special filter, where sufficient time is given for the chlorine to destroy the bacteria, the chlorine being then immediately and totally removed by a non-soluble filtering agent. The results of a six months' working of the "De-Clor" system at Reading show that, whereas the crude river Kennet water always contained b. coli in 1 c.c., and frequently in 1-10th c.c., the purified water never contained b. coli in 100 c.c.; as regards other bacteria, the average total number in the crude water was 4,156 per c.c., and in the filtered water only 33 per c.c. The following report of the meeting of the Town Council of the Reading Corporation, on October 27th, appeared in the Reading Observer of the 29th ult.:—

Waterworks Committee.

At a meeting of the Waterworks Committee on October 12th, the waterworks engineer submitted a report in which he said: "You will remember at your meeting on March 17th, 1909, I submitted a report upon the necessity of the provision of additional filtration at Southcote works, subsequent to which you recommended the Council to make an arrangement with the Candy Filter Company, Limited, of Victoria Street, London, for the installation of one of their filters at this station for a trial period of six months, and that if it was approved it should be purchased; an agreement was entered into with the Candy Filter Company, Limited, who erected one of their filters in accordance therewith. This filter was formally taken over by you for its trial period, commencing upon May 9th last, and this will expire upon November 9th next, and as the duty performed by the filter has been, in every way, so satisfactory, your chairman agreed that I should report at this meeting upon its working. I therefore now have to inform you that the period covered by this report upon its working is twenty-one weeks, during which samples of water have been regularly collected each week for bacteriological examination, and every four weeks for chemical analyses. These have been sent to the Royal Institute of Public Health, who, through their principal, Prof. Wm. R. Smith, M.D., have furnished the results of their examinations. The bacteriological examinations show the average number of colonies per c.c. in the river of raw water has been 4,156, with the b. coli communis always present in 1 c.c., and frequently in 0.1 c.c., while the water from the Candy filter shows an average number of colonies per c.c. of only 16, while the b. coli communis has been always absent from 100 c.c. The results of the chemical analyses have been equally satisfactory, and offer no evidence of the presence of free chlorine which is introduced into the water in course of the process of filtration as a bacteria-destroying agent. When the rate of filtration is considered—i.e., 32,000 gallons per square yard of filtering area per twenty-four hours—as against the usually accepted rate of sand filtration—viz., 400 gallons per square yard in the same time—the results cannot but be considered remarkable. The special carbon in the filter, which is the media adopted for the removal of the free chlorine, has only been removed once in five months, and can be recarbonized upon the spot, after which it is again fit for use. The filter can be washed by an upward or reversed flow of water in under thirty minutes, and the result of an examination of water immediately after this operation shows the efficiency of the filter is unimpaired. From the results of my observations and practical tests, coupled with the figures shown by the reports of the Royal Institute of Public Health, I unhesitatingly recommend you to purchase this filter and adopt this system of final filtration at Southcote works, and to add to it other filters from time to time as occasion warrants. It is a system which lends itself to this method of addition such as no other system I know of, and, as before stated, in my first report (March, 1909), the provision of sand filter-beds would certainly be double the cost per 1,000,000 gals. to say nothing of at once using up all the spare ground and the impossibility of extension without the purchase of additional land in the immediate future. Since writing the foregoing I have received from Prof. Wm. R. Smith, M.D., principal of the Royal Institute of Public Health, a report, which is submitted herewith, upon the results of the examinations of samples of water from Southcote works, at the conclusion of which he states: 'From a consideration of these results, both chemical and bacteriological, I have no hesitation in recommending the use of the Candy filter for effective filtration purposes.'" The committee recommended that the report of the waterworks engineer be approved, and that, in accordance therewith, the "Candy" filter referred to in his report be purchased.

The report was agreed to.

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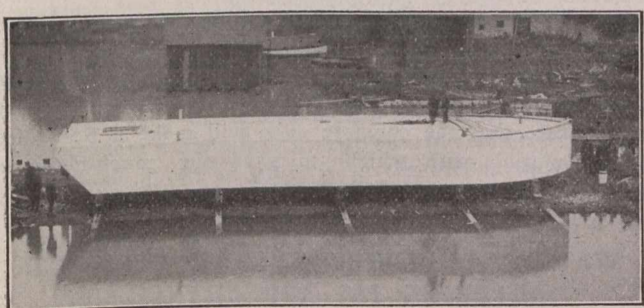
*From the Surveyor and County Engineer.

CONCRETE SECTION

REINFORCED CONCRETE SCOW.

There was launched at Port Dalhousie, Ontario, on November the 9th, a novel craft, constructed entirely of reinforced concrete, the largest of its kind yet built, and the first to be constructed in Canada. The vessel is a familiar type of deck scow with flat bottom, rounded bow, and a square stern with a rake to the latter; and was built for general use in the maintenance work on the Welland Canal. The over-all dimensions are, length, 80 ft.; beam, 24 ft.; and sides, 7 ft. high. The deck is crowned two inches, and a small rail at the bow produces the appearance of "sheer." The hull is divided into eight compartments by a longitudinal bulk head and three cross bulk heads. Access is obtained to any part by means of a double hatchway through the deck at the stern, and openings 2 ft. by 2 ft. 6 inches through the cross bulk heads. Five concrete "timber heads" are provided for towing and mooring purposes, and are constructed with a view of raising the scow in the event of it ever becoming necessary to do so, heavy reinforcement extending into the bottom of the scow being used. Two oak wales, 6 inches by 8 inches, are to be fastened along each side to serve as fenders. Weep holes are provided through the bottom beams, and four six-inch holes through the deck for pumping.

The deck, bottom, sides, and bulk heads are 2½ inches thick reinforced with ¼-inch steel wire running longitudinally and transversely. In addition to the bulk heads, the shell is supported by beams and posts, generally six inches by eight inches, and reinforced with larger sized round steel rods. In all twelve miles of ¼-inch wire and about four tons of larger reinforcement were used.



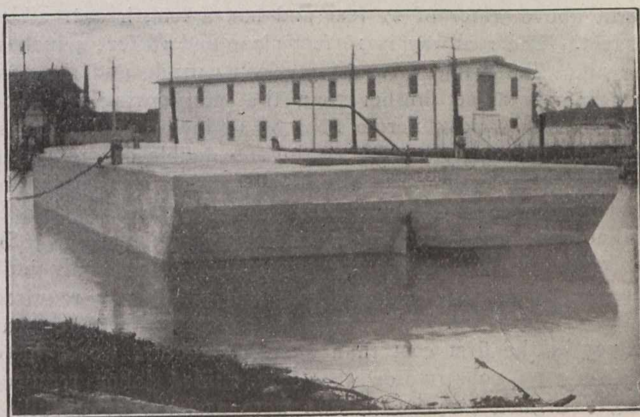
Scow "Pioneer" on Skidway.

The concrete was placed in the usual manner in reinforced concrete work. A platform was first laid on blocking about three feet above the level of the canal bank, upon which the bottom of the scow was constructed, the bottom beams were next built, the interior forms erected, and the posts, sides and bulk heads completed, after which, for convenience, the interior forms were removed and the forms for deck and deck beams erected, and both completed. The scow was then stripped, given a coat of grout, and launched on five ways in the usual manner.

The interior forms were built as far as possible in uniform sections, and can be used again in similar work.

Before launching a careful examination failed to disclose any cracks, and tests with water poured in a few of the interior bays showed no leaks. The draught as figured during the design was 2 ft. 8 inches, or a displacement of 130 tons; it actually is a little less, being 2 ft. 6 inches forward, and 2 ft. 8 inches aft, leaving plenty of freeboard when carrying any load it would be practical to place upon the deck. The scow is, however, designed to carry a working load, which would sink it to the deck.

Since the scow has been in the water, now three weeks, no sign of a leak can be found, and the interior is as dry as before launching. The success attending its construction



Stern View of Scow "Pioneer."

would indicate a wider field for reinforced concrete, and some new departures in marine architecture. Such information as was kept of the cost showed it to be less than for steel construction, and indicates promising commercial possibilities.

Mr. W. H. Sullivan, Assistant Superintending Engineer, made all calculations and designs, and personally looked after the construction of the vessel which, as the photographs show, is a very fine sample of concrete work.

The work was done under the supervision of Mr. J. L. Weller, Superintending Engineer of the Welland Canal, who, it may be stated, inaugurated the use of reinforced concrete poles which are now so rapidly superseding the old wooden ones in electrical transmission work.

THE CONCRETE BRIDGE AT WESTON, ONT.

On December 8th, the formal opening of the Wadsworth Bridge, at Weston, Ont., took place. A party of engineers, commissioners and county officials inspected the bridge in the afternoon and in the evening attended a banquet at the Central Hotel, Weston, at which Warden Pugsley presided as toastmaster. Messrs. R. P. Coultson, S. P. Foote, R. J. Bull, the commissioners, were among those present. The bridge was designed by the firm of Messrs. Barber and Young, Toronto, and Mr. E. C. Lewis was the contractor. Mr. P. Gillespie, of Toronto University, in a few remarks, stated that the County of York had made an important move in adopting permanent construction on highway bridges. Furthermore, no more permanent material could be used in structural work than reinforced concrete, which, although of comparatively recent growth, has proven most satisfactory when properly handled. The failures in the use of reinforced concrete work may be traced to faulty design or faulty construction. From remarks and statements made by Messrs. Barber and Young, engineers, and from the inspection of the bridge it is evident that the structure is of considerable interest. To say that there has been considerable opposition to the use of reinforced concrete in such structures would be putting it far too mildly and even at this day concrete workers are being hampered by many who oppose its use. We venture to suggest, however, that it may not now always be because of ignorance that this form of construction is opposed by certain people—they may have some personal gain in view by so doing. The commissioners are to be congratulated for allowing this type of structure to be built as are also the engineers for the success which has accompanied their work. The bridge is of special interest, as it is said to be the longest span concrete arch in Canada. It measures 118 feet 6 inches clear span, has an average height above water of 27 feet and has a length over all of 178 feet. The roadway is 16 feet clear and 18 feet 4 inches over all. The bridge has a 6 per cent. grade and the east springing is 8 feet higher than the west springing. The bridge has a solid concrete floor of 13 inches in thickness, supported by concrete posts resting on double concrete arch ribs, which are an important factor in giving it its strength. Careful calculations for curvature and tests have been made, so that very little need be taken simply for granted. So that while the bridge has the appearance of a lightly built structure, it is fully expected to stand all that is required of it. In this particular case a concrete structure was cheaper in the first cost than a steel structure would have been, in the construction the only skilled labor required being two good carpenters, who were assisted by unskilled labor. The concrete used was for the abutments, approximately a 1:3:5 mixture, in the arch ribs, spandiel posts and walls a 1:2:4 mixture and in the railings a 1:2:3½ mixture. In order to prevent the discoloration effect caused by efflorescence so often in smooth concrete surfaces, a cement wash was applied to the surface and clean sand blown upon it, giving it a rough surface resembling natural stone. In the structure, 535 cubic yards of concrete were used, and 20 tons of steel rods. The total cost, including engineers,' and contractor's work and inspection of bridge was $10,300. Mr. E. C. Lewis, contractor, is to receive $8,000 of this. The fill to the approaches is protected by rip-rap to above the high-water mark, similar to the walls used in constructing the banks to canals in some parts of the country.

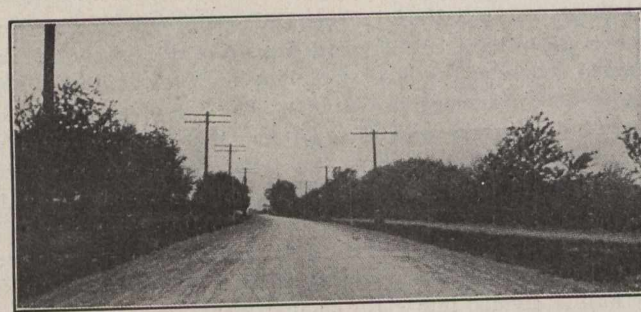
A NEW ROAD SURFACE OF CONCRETE CUBES.

A distinctly new type of concrete pavement, consisting of a wearing surface of small concrete cubes, is being experimented with in this country and in England.

The cubes are laid not too close together, and with no attempt to break joints or keep the rows straight, upon a suitable foundation of broken stone or upon an old gravel or macadam road which has been levelled up with a thin layer of sand or screened gravel. After laying, the cubes are rolled lightly to give them an even bearing, the joints filled with a sandy loam which is well broomed in, and the pavement brought to an even surface by rolling. A well rolled shoulder or berm of gravel along the sides has been found sufficient to keep the cubes in place on country highways.

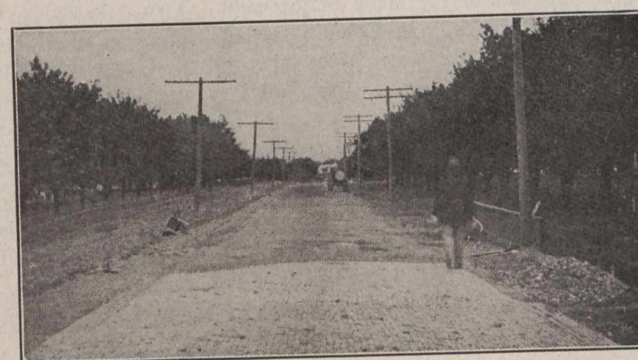
At Greece, N.Y., in 1909, Mr. J. Y. McClintock, county superintendent, laid 1,600 linear feet of this concrete cube pavement. For the work two-inch gravel concrete tubes were used, made of a mixture containing approximately two barrels of cement per cubic yard of concrete. The cubes were cast in a machine making sixty-eight at one operation, and with which a gang of eight men could turn out approximately 25,000 cubes per day.

After one year's service the pavement is to-day in as good condition as when laid, and the county is now laying an additional mile of pavement of similar construction. The cost for materials and labor in making, and for hauling and laying the cubes, was approximately fifty-one cents per square yard for the pavement laid in 1909.



Concrete Cube Pavement, Ridge Road, Greece, N.Y.

To demonstrate the value of concrete as a paving material for country highways, the Nelson Brothers Paving & Construction Company of Minneapolis recently laid 5,500 square feet of pavement at Minneapolis, in which was a short stretch of this cube pavement.



Section of Unrolled Concrete Cube Pavement.

This type of pavement is as yet in the experimental stage, but the results obtained to date have been highly satisfactory, and indicate that the concrete cube will make a first-class, cheap material with which to pave our much-neglected country highways.

WATERPROOFING CONCRETE WITHOUT ALTERING ITS APPEARANCE.†

By Cloyd M. Chapman*.

While in search of a suitable material, coating or treatment to be applied to the surface of porous outer walls of concrete block or monolithic structures to prevent the absorption of water during rain storms, and the consequent dampening of the inner surfaces of these walls, a series of tests have been undertaken by Westinghouse, Church, Kerr and Company of New York. The purpose of these tests may be stated as follows:—

To find a material which, applied to the surface of a structure already completed, whose walls were of such porosity as to absorb water during rain sufficient to dampen the interior of the walls, would render that outer surface waterproof without materially altering the natural color or appearance of the concrete blocks or monolith.

†Read before the National Cement Users' Association.

*Engineer, Westinghouse, Church, Kerr and Company, New York, N.Y.

There are a number of processes upon the market which claim to accomplish this desired result; in fact so great is their number and so wonderful their claims that we were at a loss to know which to select and so decided to test them all. To fulfil the requirement that the appearance of the structure should not be altered it was necessary that the waterproofing material be of the nature of a colorless solution or wash, and not of the nature of a paint or enamel. This requirement at once eliminated from consideration the many so-called waterproof paints and cement coatings containing pigments of whatever nature. For however closely a paint may approach the natural color of the concrete it always changes the appearance of the surface to which it is applied, as a concrete structure is not of one color throughout. We secured 19 samples of compounds made by 14 manufacturers, which the makers claimed would do just what was required. The method of testing was as follows:—

A number of cubes, about 3 ins. each way, were molded with a depression on one side large enough to hold about 40 cu. cm. of water. These cubes were made of a rather dry mixture of one part of Portland cement and three parts of crushed granite, by volume. The crushed stone was screened through a 5 mesh screen, and contained all sizes of particles from impalpable powder to pieces just passing the screen, all as it came from the crusher. The resulting cubes were very porous and absorbed water greedily. After these cubes had thoroughly set, being kept moist while setting, and had dried out, they were tested for porosity by filling the depression with water, and noting the time required for the cubes to absorb it. As the cubes were hand-molded and rammed, they were not all of the same density, and any cubes which required more than one minute to absorb the water were rejected and not used in the tests.

After allowing the cubes to again thoroughly dry out, the side having the depression or cup was given a liberal soaking coat of the waterproofing compound under test. Only the one surface of the block was coated. No compound was applied to the block except to the inside of the cup and the remaining flat surface around the cup. This first coat was allowed to dry and a second liberal coat or as much as the concrete would absorb, applied. In some cases very little compound would be taken in at the second application. In other cases it appeared to take as much for the second as for the first coat. After a second coat had dried a test of its efficiency was made as follows:—

Thirty cu. cm. of water were placed in the cup, a watch glass placed over it to prevent evaporation, and the bowl left undisturbed until the water was wholly absorbed by the concrete. The time of placing the water in the cup was noted and the time when it was completely absorbed. As the size of all the cups was the same and the amount of water measured, the area of surface exposed to the action of water was the same in each case. All other factors being approximately equal the efficiency of the waterproofing compound was proportional to the time required for the water to pass through it into the porous body of the block.

After this test the cubes were placed on a roof exposed to the action of the weather for a number of months, and again tested as before with 30 cu. cm. of water, and the time required for complete absorption noted. Again they were placed on the roof where they are now awaiting further tests. The action of the weather does not seem to improve many of them.

Of the 19 samples tested, on the first test, that is before being exposed to the weather:

5 required less than 1 hour to absorb the water;
4 took more than 1 hour, but less than 1 day;
7 stood more than 1 day, but less than 1 week;
3 held the water for more than 1 week.

After exposure to the weather for several months the following results were obtained:—

7 stood less than 1 hour;
11 more than 1 hour, but less than one day;
1 held the water for more than 1 day, in fact, 9 days.

In the case of one compound only one coat was applied, as the maker stated that one coat was all that was needed; one coat would do the work perfectly and any more would be useless. This article, after exposure to the weather, lasted just 27 minutes.

Now, as to the appearance of the treated surfaces. All of the makers presented their samples with the claim that they would not alter the color of the concrete. Of these 19 preparations, 9 darkened the concrete surface to which they were applied, 1 made the surface lighter and the remaining 9 had little, if any, effect upon the color.

THE ALBERTA CLAY PRODUCTS COMPANY WORKS.

(Continued from page 748).

sifted through Chicago piano wire screens and drops to the presses via bin of 240 tons capacity.

The equipment in the sewer pipe department includes, in addition to the dry pans above mentioned, a wet pan and one large sewer pipe press all manufactured by Taplin-Rice-Clerklin Company, Arkon, Ohio. The pipes are subjected to 40 tons pressure in this press, and after trimming, are conveyed to the various drier floors in the most efficient manner, three gravity elevators and one power elevator being installed for the purpose. The drying building is heated by steam coils, 40,000 feet of one and a half inch pipe being utilized. These coils connect with two crone double automatic steam traps taking the condensed steam from the basement and conveying it automatically to the boilers under high pressure.

After four days in the drying houses the pipe are conveyed to the kilns, where they are subjected to intense heat for 72 hours, at 2500F., salt is applied, this coming in contact with the silica on the clay forms a glaze.

The kilns are brick, bound with iron. Each contains 12 fire boxes in which natural gas is burned; and a perforated floor above a four-foot basement, which communicates directly with a stack. One stack 75 feet high is built for every four of the larger kilns, with independent flues 42 in. across for each kiln, and one 56 feet high for every two of the 30-foot kilns, with an independent flue of 30 inches diameter. A small flue is made over each fire pocket to hasten the operation of cooling. The kilns are turned every week.

In the brick department are two presses with a capacity of 40,000 brick each, daily. The clay is pressed dry and burned in the kilns for a period of 14 days, resulting in some of the best building material ever marketed in Alberta.

The power is furnished by three high pressure 150 horse power boilers and a 400 horse power Murray Corliss engine with a 16-foot fly-wheel.

Among the unusual features of this plant is the complete machine shop which has been provided and which is operated by a gas engine. It contains drill, press, forge, lathes and all other equipment necessary to permit of repair work being done on the premises.

The foundation of concrete for the building was put in under contract by A. P. Burns.

(Continued on page 759).

NOTES ON THE USE AND COST OF CONCRETE BLOCKS IN ROADWAY CONSTRUCTION.*

By George C. Wright.†

This paper is in the nature of a description of a system of road surfacing which is new in this country, and is taken in the main from a report of Mr. J. T. McClintock, made to the Highway Commission of New York State.

Macadam used to say that if one could get stone broken into cubes of uniform size of about 1 inch square, and once get them laid, the ideal road would be secured. The increasing difficulty of maintaining a macadam surface composed of irregular shaped fragments of varying size under the conditions of rapidly moving vehicles emphasizes the importance of the remark of the father of stone roads.

The general use of Portland cement for most purposes of construction naturally leads to the thought of the possibility of taking stones as they come from the crusher in irregular shapes and square them up by means of Portland cement. The low price at which Portland cement can be secured brings the cost of such treatment within reason. It appeared probable that if the wearing surface of a highway could consist of 2-in. cubes placed closely together and made of either Portland cement with gravel or broken stone, or vitrified shale, or asphaltic concrete, or bitulithic concrete, or iron furnace slag, that the following results might be obtained: Comparative freedom from dust, smoothness of surface, good footing for horses and wheels, pliability permitting of changes in the base due to freezing and thawing, and movement due to the contraction and expansion.

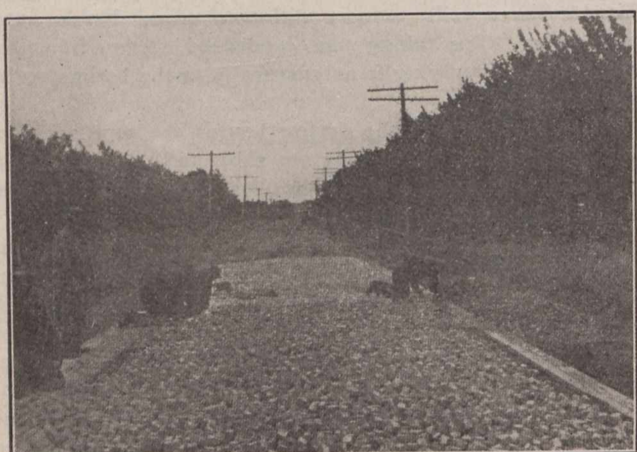


Fig. 1.—View of 2-in. Concrete Cubes on Experimental Road.

As these cubes could be supported on any suitable local stone or gravel, the cost per mile for first-class road would evidently be very much below that of ordinary paving brick and more lasting than any of the asphaltic or bitulithic mixtures, and further, the maintenance would be simplified and reduced in cost.

The State Highway Commission authorized the expenditure of $2,250 for the purpose of making a preliminary demonstration with the following results: On the Ridge Road northwest of the city of Rochester, N.Y., the original trap rock surface 2 inches thick was worn completely off at the centre and nearly so at the sides of the 16-ft. macadam roadway, leaving exposed a good solid lower course of rather large size broken Medina sandstone, resting on a good gravel foundation.

The existing surface was somewhat rough and knobby, and over this was spread as thin a layer as possible of screened gravel, which was rolled down with a 12-ton roller, so that in spots it was 2 inches thick, and in other spaces over the knobs it was of no measurable thickness. The resulting surface had a crown of about 4 inches in 16-ft. width. On this bed so prepared was placed directly a wearing coat of 2-in.

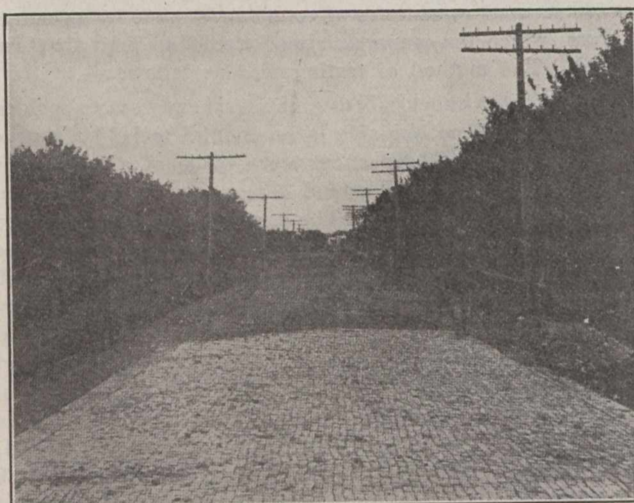


Fig. 2.—Cubes in Place on Road.

cubes for a width of 15 ft., being laid close together by hand, with the edges held up temporarily by 2-in. planks laid lengthwise with the road (Fig. 1*). On the cubes was spread a small amount of fine, somewhat loamy gravel, which was broomed in, after which the heavy roller was slowly passed over the whole of the surface, forcing the cubes to take a full bearing on the supporting gravel. The edges and roller wheel was supported by the planks, then the side-planks were pulled up and moved ahead and coarse gravel ¾-in. to 1½-ins. in size was placed along the sides next to the cubes on the shoulder for a width of about 2 ft. Outside of this a finer gravel was spread, feathered off to a width of about 3 ft., more of the fine loamy gravel was spread on the top and broomed and flushed in until the space between the cubes was thoroughly filled, the gravel on the shoulders was wet and the whole surface thoroughly rolled with the heavy roller (Fig. 2).

A stretch of road 1,800 ft. long was surfaced with cubes. On 1,600 ft., Portland cement gravel concrete cubes were used, on 200 ft. vitrified shale cubes 2¼-ins. in size were used. For a length of 100 ft. a concrete sunken curb 6 x 9 inches in dimension was used in place of the gravel shoulders. On 100 ft. in length the joints between the cubes were filled with Portland cement grout instead of the fine loamy gravel. For 60 ft. on which the joints were filled with the fine gravel, and light asphaltic road oil was sprinkled over.

A machine for making cubes which is an adaptation of the ordinary cement brick machine was used. This machine made 68 cubes at one operation, resting on a wooden tray, and the tray was carefully placed on a drying rack without disturbing the freshly made cubes. The cubes remained in racks 24 hours, and were then dumped in a pile. This pile was thoroughly sprinkled twice each day.

*Read before the National Cement Users' Association.
†Consulting Engineer, Rochester, N.Y.

The number of cubes made was about 7,000 upon the first day, but within a few days the same gang was able to make with ease 26,000 cubes. Various sizes of screens were tried from ½ to 2-in., but it was found that the ½-in. screen gave a product that could best be handled in the machine. Experience showed that the concrete had to be rather dry in order to avoid settling and bulging of the cubes before the concrete set. Seven men and a foreman did all the work. The amount of cement used averaged 2.2 barrels to a cubic yard of concrete. The area covered with cement cubes was 2,652 square yards, upon which was laid all of the 730,000 cubes manufactured, except about 5,000 kept for repairs. The cost of cement cubes laid was as follows:—

Cement, 0.88 barrels	$0.121
Cost of factory	0.107
Labor of manufacture	0.161
Gravel, 50c. per cubic yard	0.024
Carting	0.027
Laying	0.072
Total cost per square yard laid	$0.512

There were placed on shoulders 219 cubic yards of gravel covering 1,800 square yards, costing $2.12 per cubic yard rolled in place, or 26 cents per square yard.

In considering these figures as the basis for estimating cost it is obvious that there might be reductions made in cost of cement by using a reduced quantity, and in reduced cost of carting, the cost of the factory might be distributed over many more square yards, the cost of labor by use of concrete mixer and other labor saving devices. The cost of gravel in pit is usually nearer 10 cents per cubic yard than 50 cents, which was paid here. The cost of laying was very much reduced as the men became experienced, and this could be still further reduced by paying for it on the basis of piece work.

THE PLYMOUTH CORDAGE COMPANY.

When the Plymouth Cordage Company was established at North Plymouth, Mass., during the first quarter of the nineteenth century, it is hardly to be expected that the directors of the company, level-headed and far-seeing as they must have been, hoped or even dreamed that before the close of the century, then only in its youth, their industry would have expanded until it had become the largest cordage works in the world. But such has, however, been the case, and while the life and genius of two generations has been expended in this development, no small credit is due to the judgment of the managers in securing the best engineering skill obtainable for the design of the modern plant, which replaced the one destroyed by fire in the early eighties.

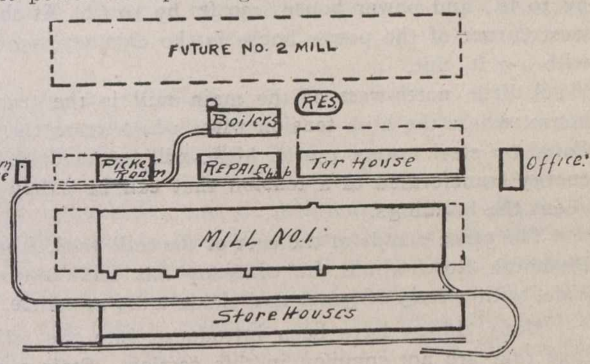
In the design of a manufacturing plant the utmost care must be used to secure the greatest economy in the use of power and convenience in operation, since, as every mill man knows, the size of the dividends depends upon the successful solution of these problems. That they were successfully solved by the Plymouth Cordage Company is evidenced by the prosperity of the company and the reputation of the product of the plant.

Although they are operating the largest cordage works in the world they have been obliged to run the plant nights, in order to meet the demand for their goods. This made it necessary to again increase their capacity and, as thousands of tons of their binder twine is used every year in the Dominion of Canada, they decided to secure additional capacity by the erection of an entirely new plant, within the Canadian borders.

Under these conditions it is natural to suppose that they would consult the engineers whose skill had assisted in the prosperity of the American plant, and accordingly Lockwood, Greene & Company, of Boston, were called upon to design and superintend the construction of the Canadian works.

Location.—Having decided to establish their new works in the Dominion of Canada, and after engaging their engineers for the design of the plant, the next important step was the choice of location. After critically examining many well recommended sites, where advantages were great, and conveniences abundant, they selected Welland, Ontario, as the place most suitable and possessing more advantages than any of the others.

It is neither necessary nor desirable to mention all of the considerations which influenced their decision, but a few of the more important ones were; transportation by rail and water, there being six railroads giving sufficient competition for securing low rates, and the Welland Canal, from which vessels can discharge their cargoes directly into the company's storehouses, to be built at the canal bank; cheap and abundant power for operating their works; natural gas for



fuel; and other favorable points not easily found united in the proper proportion to be utilized to the highest degree.

Property.—The company purchased 187 acres of land and obtained several houses which have been continually occupied by some of those engaged in the construction of the works. A portion of this land is occupied by the mill site, other portions reserved for future expansion of their own plant, or for sale to other industries, should they so desire. Other parts have been laid out into streets and lots, and they are now building cottages for 88 families, in order to have homes for some of their help, when the machinery is ready for starting. These cottages are being built modern and up-to-date in every particular; they are arranged for steam heating, have bath rooms, with modern plumbing throughout, and are electric-lighted.

The main body of the property is about a half mile square, and is bordered on the east by the Grand Trunk and Wabash lines of railroad, and on the south by the Michigan Central, Canadian Pacific, Pere Marquette, and the Toronto, Hamilton & Buffalo Railroads. The following sketch will illustrate this:—

Buildings.—The most southerly of the buildings is a large warehouse, fronting the siding, and having a platform 12 feet wide for ease in handling stock. The warehouse itself consists of eleven sections, 60 ft. square, making a building 668 ft. long with an oil platform 77 ft. long at its west end. North of this is a passageway 60 ft. wide, and then the main mill, 634 ft. by 114 ft. 400 ft. of this building is two storeys high, and the balance is the rope room, one storey high. This mill building is one of the most solidly built and rigid buildings on the American Continent, and is the strongest and most substantial mill in Canada. During a long experience we have visited a great many mills, and have probably critically examined one hundred or more, and we have many times observed vibrations and trembling, usually not very severe, but in some cases sufficient to be very annoying, and at times dangerous. The architects and engineers have proportioned this building so that vibration is reduced to a minimum, and, considering the fact that the materials used are brick and timber, have succeeded beyond any construction known in Canada.

The Plymouth Cordage Company's mill in Welland has been built on principles established by large experience in the past, and from the designs of architects and engineers whose mills, although sometimes criticized as having an excess of strength, are known to be rigid and are recognized as standard, for such construction, the world over.

The floor space occupied by the present plant aggregates about four acres and besides the building already mentioned, includes the small buildings located just north of the main mill, from which they are separated by a fifty-foot passageway. They are four in number: the tar house, 300 ft. by 50 ft.; repair shop, 150 ft. by 50 ft.; picker house, 105 ft. by 50 ft., and power house, 130 ft. by 50 ft. At the north-west corner of the power house is the chimney, 150 ft. high with a 7 ft. flue.

A little north-west of the main mill is the transformer house, where the high tension wires which cross the Welland Canal on steel towers 150 ft. high, will be received, and the energy transformed to a tension that can be safely handled about the buildings.

The office stands at the east of the mill yard, fronting on Plymouth Road which the company has laid out 100 feet wide, with a strip of grass and shade trees at centre.

Many things have been introduced into the mill buildings that are not common in this section. Stair towers are built of brick with automatic fire doors, making them fireproof. Water closet towers, built upon the rear of building, are provided with modern, up-to-date plumbing, and are lined with enamelled brick, practically water-proof. They are artificially ventilated by fans, and are absolutely sanitary. The windows are glazed with ribbed glass, for the better diffusion of light, and about 30,000 sq. ft. of glass for these buildings was imported direct from England especially for this job.

The power-house will contain three horizontal tubular boilers, and will furnish steam for heating the plant and for other purposes. The entire plant will be heated by the blower system, using a Sturtevant fan, 14 feet in diameter. The heating plant is located in the power-house, and ducts or tunnels distribute the heat to all of the different buildings.

The power-house contains the compressed air apparatus for the yard locomotion, and also two steam fire pumps, each capable of delivering 1,000 gallons of water per minute. These are directly connected to the hydrant and sprinkler systems that are installed in the yard and buildings, according to the most exacting requirements of the insurance inspectors. Ordinarily the hydrants and sprinklers will be under pressure from the city water-works, which will maintain a constant pressure direct from the city pumps of 100 lbs. In case of fire, this pressure will be increased as desired by the working of the company's fire pumps, which will draft from a concrete-lined and covered reservoir, carrying a supply of 250,000 gallons of water for fire purposes.

As already mentioned the power for operating the entire equipment will be received electrically. It will be generated at De Cew Falls, and transmitted in as nearly a straight line as possible, and delivered to the transformers at 22,500 volts. It is then reduced to 500 volts and taken to the different buildings through underground conduits, and upon entering the building is divided into the desirable circuits and applied to the 19 motors at the most advantageous points. Lighting circuits are also run through all of the buildings, and a perfect system arranged, sub-divided for the greatest convenience.

The nineteen motors mentioned above consist of four 100-horse-power, four 75-horse-power, seven 50-horse-power, and the others smaller, each motor operating some group of machines in such a manner that any section could be run independently if desired.

The lighting of the plant is effected by the use of 71 arc and 450 incandescent lamps.

Materials.—It was the desire of the owners that all stock for the construction of the buildings be procured in Canada if possible. Timber for the support of the floors and roofs was of Douglas fir from British Columbia, and was all shipped from Vancouver. A portion of the roofing plank came from the same place, and a portion of it from the Georgian Bay district of Ontario. It was necessary to import hemlock plank from the States, as Pennsylvania hemlock is superior to any they were able to find of Canadian growth. The maple flooring is of Canadian manufacture. All the cement used was Atlas Portland, which is an American cement. This was because the Canadian manufacturers of cement were so busy that they were not able to deliver the quantities required. No brick yard could be found in Canada where there was any assurance of being able to secure the quantity desired without many annoying delays. About four million bricks were used, and they were secured in Buffalo. The company supplying the brick varied the regular brick manufacturer's rule and kept their kilns running all winter.

The roof covering is what is known as tar and gravel. The columns for supporting the building are of long leaf Georgia pine, turned and polished and bored through the centre from end to end for ventilation and proper seasoning.

The Plymouth Cordage Company's plant at Welland is the first large industry coming to the writer's notice, for which no provision has been made for the storage of coal. None will be required for the 1,200 horse power used, as the flow of water from Lake Erie through the Welland Canal, after bearing those large ships, which at a short distance from the canal seem to be rolling smoothly along on dry land, plunges down through the De Cew power plant, turning the wheels that generate energy that is then passed back over a wire to turn the wheels of the factory. Neither will coal be required for heat, for the Cordage Company proposes to burn gas from their own wells.

THE PRACTICAL USE OF THE AUTOMOBILE FIRE ENGINE AS A FIRE-FIGHTING APPARATUS.*

By Chas. S. Allen, Chief Fire Department, Trenton, N.J.

In compliance with your request that I prepare and submit a report on the practical use of the automobile fire engine as a fire-fighting piece of apparatus, I beg to submit the following as my opinion of such type apparatus. In preparing this article I have decided to be as brief as possible, as I do not consider that a long tiresome topic read before this

*Read before the International Association of Fire Engineers.

convention is as beneficial as a free and open discussion of the point at issue. The fire departments of this country are to-day confronted with the problem of choosing between the auto, and horse-drawn fire apparatus. The departure from the horse which has been the propelling power for so many years, and which has been considered the only safe and reliable means of hauling our apparatus, does, naturally cause a doubt in the average chiefs mind as to the practicability of such a change; and still a greater doubt exists when we consider the proposition of substituting the gasoline motor, in place of steam power for the operation of our pumps, yet notwithstanding our doubts, present indications point to a rapid change in this direction in the near future. Manufacturers of fire apparatus in this country have been watching carefully the development of the gasoline motor, for the express purpose of introducing this feature into the fire department service. A great deal of time and money has been expended in this direction, and fairly good results have been obtained thus far, but I feel safe in predicting still greater results in the near future. And while the manufacturers are doing this I feel that we as chiefs of department have a duty to perform in this direction; I feel that we should view this matter in a broad and liberal light; not allowing preference or prejudice to sway us in what we believe to be our duty to the builder, and for the best interests of the fire service in general. They should have the benefit of our knowledge and our hearty support and co-operation in perfecting and improving this type of auto, fire apparatus; which now seems designed to revolutionize the fire service of this country. The auto. fire engine as constructed to-day, has, without question, many advantages over the horse-drawn apparatus; and yet we find by experience that the auto. engine has some disadvantages that must not be overlooked in their future construction. In my opinion the first, and most serious objection to the present type of auto apparatus is the excessive weight of the load now being carried on pneumatic tires, the various makes of auto engines now in use will weigh from 80 to 90 hundred loaded; this in my judgment is overloading the pneumatic tire and is a question to be seriously considered in the future. The desire of some departments to have the auto. engine equipped with large heavy chemical tanks in addition to its present load is wrong and should be discouraged in every case; as you cannot carry the entire equipment used at a fire on one piece of apparatus, and do it safely; and I might say such a combination does not work well, as the chemicals are wanted in front of the building, and the engine should be at the hydrant, connected and ready for immediate use should the chemicals fail; therefore, I do not recommend such a combination.

The tire problem is one with which you are all familiar and is subject to the same condition and danger as the ordinary automobile in use. I might say that during 3½ years service with the auto we have never had but few failures during that time from any cause whatever.

Another proposition that is giving the manufacturers considerable anxiety is the solution of the pump problem, the various types now used on autos are not as satisfactory as we would like, and we must admit that weight, and space are two important factors to be considered in the construction of an auto engine. The ideal pump for this work should be light and compact; of larger capacity, and so geared to the motor that the power may be applied as direct as possible; and one requiring the least possible energy to operate; as under present conditions we find no spare energy when pumping up to full capacity, while our present pump has given us excellent service and no trouble, yet I feel that the present types of pumps used can, and will be, improved upon in the near future.

The above subjects cited are merely matters that will have to be dealt with in future construction, and the gradual development of the auto. engine.

There is no question but that the auto. engine has many advantages over the horse-drawn apparatus; and some, that are worthy of consideration.

The first to be considered is a comparative statement of companies using the two types of apparatus; and for your information I will state that two companies were selected for this purpose, one auto. company with a crew of seven men, the other an engine company with a crew of nine men, both companies located in the same district and doing the same work. The cost of the auto. company including salaries, supplies, and repairs for a period of ten months was $5,921.60 while the cost of the engine company for salaries, supplies and repairs for the same period of time was $9,015.21 or a saving of $3,093.61 in favor of the auto. company.

These figures tabulated show:

Cost of maintenance of engine company	$ 885.41
Cost of maintenance of auto. company	151.60
Total saving of	$ 733.81
Salaries paid to engine company, 9 men	$8,129.80
Salaries paid to auto. company, 7 men	5,770.00
Total saving in salary	$2,359.80
Total cost of engine company	$9,015.21
Total cost of auto. company	5,921.60
Saving in comparative cost of maintenance	$3,093.61

The difference in cost of maintenance as you will note is the employment of two less men on the auto. company and the cost of feeding, shoeing and caring of four or five horses of the engine company. In fact when the auto is idle there is no expense attached to it; while the engine company has a fixed charge of expense at all times. The saving of two mens' salary is a large item of expense without impairing the efficiency of the company, and I might say that we get better results from seven men on the auto, than we do with nine on the engine company. Another good feature of the auto is the dispatch in reaching fires; this you all know is a very important factor; and I have no doubt that chiefs who are using the auto as a conveyance have had this feature brought forcibly to their attention. The auto in responding to a call in the busy or congested section of your city, and running at a speed of 15 or 20 miles an hour is always under absolute control, and is less liable to accident than the horse-drawn apparatus going at a much less speed.

In using auto, apparatus geared for high speed, good judgment and care must be used, if accidents are to be avoided.

Driving an auto. engine at high speed through your city does not pay, and the practice should be discouraged, as the small amount of time saved does not warrant the risk taken.

Another good feature of the auto. engine is the efficient service rendered in the early stages of the fire; you are not delayed with low steam pressure, a poor fire, or an incompetent stoker, as frequently occurs with the engine; but as soon as the auto is connected, and the water is turned on, in less than one minute you have the full capacity of your engine if you wish; the stream is just as good the first minute as it will be at any time of the fire; and we find it a decided advantage to have a stream that will cover an area of from 200 to 225 feet right at the beginning of a stubborn blaze.

The auto. engine for travelling through the snow, and hill climbing, is a decided success.

During the past winter we had considerable snow in our section of the country and all of our auto. apparatus was given a severe test in responding to calls; and I might say that we were able to go through snow drifts; where four horses would not take the same load. In fact the performance of the auto. in the snow was far beyond our expectations; and we have no hesitancy in saying that it is the only safe apparatus to use in snow.

At this point I wish to call your attention to our method of using the auto. engine in our city.

The company is given a large territory on account of its dispatch in reaching fires, they get to work quickly and put it out if possible, if not, and it is a fire that is going to require a large portion of your department to subdue, then the auto is kept to work on this fire until all of the heavy machinery arrives and gets to work, then the auto is immediately withdrawn and returns to a central point to protect a large portion of the city left bare. By this method the auto is not required to do much pumping, as we find it to our advantage to keep such apparatus ready and free to render service in any part of the city on short notice; auto. engines used in this manner you will find a valuable auxiliary to your department.

I think thus far I have covered all of the important points about the auto. engine that would be of interest to this association; and in conclusion I wish to say that we have used in our city a Webb Motor fire engine for the past ten months, which has given very good service. We have had tire trouble three times during that time, defects that were due to manufacturer and was replaced free of charge. We had transmission gear trouble once, due to a defect that has since been corrected and will not happen again, all other little minor details were taken care of by the operator at slight expense. In expressing my opinion of the auto engine I will say that present indications point to its general use in fire departments in the near future, with many improvements, no doubt, over the present type, and I would therefore advise fire departments not to discard your engines, but keep them all, and as soon as the opportunity offers put in one or two pieces of auto apparatus, and give them a fair trial, and arrive at your own conclusion, the more departments using them the quicker we can determine their value in the fire service. We have given many demonstrations for the benefit of other cities and shall continue to furnish such reliable information as we may have bearing on this subject, and hope to see the auto. engine perfected, and in general use; relieving the horse of his dangerous and arduous duties in the near future.

ALBERTA'S RAILWAY AND BOND TANGLE.

The Alberta and Great Waterways tangle is likely to become a historic feat of financing. Bonds amounting to $7,500,000, and guaranteed by the provincial government, were sold in London for the purpose of building a railroad into the Peace River country. Then came the charges of corruption, the dissolution of the Cabinet, and the collapse of the transportation scheme. The new premier, the Honorable A. F. Sifton, naturally thinks that the sum of $7,500,000 raised in London is too good a thing to dissipate idly. He knows that the government guaranteed the bonds, and that a breach of that guarantee would irreparably damage his province's credit.

The following are three clauses of a bill the premier has introduced in this connection:—

1. The province of Alberta hereby ratifies and confirms the guarantee by it of the said bonds, and the premier of Alberta is hereby empowered and instructed to execute a guarantee on behalf of the province of said bonds.

2. The whole of the proceeds of the said bonds and all interest thereon, including such part of the proceeds of the said sale as is now standing in certain banks in the name of the premier of the province, or otherwise, as follows: $6,000,000 and accrued interest in the Royal Bank of Canada; $1,000,000 and accrued interest in the Union Bank of Canada, and $4,000 and accrued interest in the Dominion Bank, is hereby declared to form a part of the public revenue fund of the province of Alberta, free and clear of any claims thereon or thereto by the Alberta and Great Waterways Railway Company, their successors or assignees, and together with all accrued interest thereon shall, to the extent to which they are so held, be forthwith paid over by the banks and by any other person holding any parts thereof, to the treasurer of the province without any set-off, counterclaim or other deduction whatever.

3. Notwithstanding the form of the said bonds and guarantee thereof, the province of Alberta shall as between itself and the Alberta and Great Waterways Railway Company be primarily liable upon the said bonds to the several holders thereof, and the province shall indemnify and save harmless the railway company and its assets and undertakings from any and every claim made under the said bonds or any of them.

We are told that Premier Sifton proposes to build roads and bridges in Alberta with the money raised in London to build a railroad. If this is so, a somewhat dangerous precedent is created in borrowing money for one purpose and ultimately using it for another. Every effort should be made by the Alberta Government to use the money for the construction of a railroad, even though the proposed Alberta and Great Waterways line is no longer to be reckoned. But it is not to be plain sailing for the premier, as one of the chartered banks may fight the province with a view to preventing it from taking $6,000,000 of the Alberta and Great Waterways funds from their bank, they understanding that they were to be protected to the extent of $375,000, which they advanced to the railway company on the strength of the sale of the bonds. Whatever be the outcome, it would aid the maintenance and effect the betterment of Alberta's credit abroad, if the borrowed moneys were utilized, as they should be, for railroad building.

POWER REQUIREMENTS FOR TUMBLING BARRELS AND SAND SIFTERS.

In the majority of cases the foundryman, although familiar with the total amount of power required for his entire plant or for different departments in his plant, seldom really knows the actual power which it takes to drive each individual machine.

In a recent investigation by Lockwood, Greene & Co., Boston, Mass., engineers and architects for industrial plants, there was occasion to determine the actual power required for the tumbling barrels and for the sand sifters in an iron foundry. This investigation was conducted in connection with determining the feasibility of replacing three separate power plants with one central plant in a large manufacturing concern.

The tumbling barrels in question were arranged two barrels on a shaft, the size of the barrels being 36" and 48" in diameter. As a rule, the load is but one barrel but about 25 per cent. of the time both are being run. It was found that the average power demand was 4.3 h.p. while the maximum with both barrels loaded was 5.8 h.p. The shafting with the barrels running light required 2.75 h.p., with the smaller barrel filled and the larger one empty the total power necessary was 4.15 h.p., while with the larger barrel filled and the smaller one empty 4.45 h.p. was required. It was decided that a 5 h.p. squirrel cage induction type motor would be ample for driving these two barrels.

Regarding the sand sifter, this had a driving pulley 12" in diameter with 6" face and a speed of 630 R.P.M. The power consumption of the sifter running light was 0.38 h.p. The momentary maximum load with both sides of the sifter full was 1.3 h.p. A 3 h.p. motor would be fully ample for this service.

SPEED ON STEAM ROADS IN GREAT BRITAIN.

The average speed of trains in England is a good deal in excess of that of trains here, as will be seen from a selection given below. The times given are start to stop, regular schedule—the only basis of comparison:

Railway.	Miles.	Per Hr.
Great Western—London-Bristol	118	59.0
Great Western—Leamington-Ealing	100⅜	59.6
North Eastern—Darlington-York	44¼	61.7
North Eastern—York-Newcastle	80½	58.9
Great Northern—Grantham-Doncaster	50½	58.2
Great Northern—Peterboro'-London	76¼	57.9
North Western—London-Birmingham (9 trains daily)	113	56.5
North Western—Willesden-Birmingham	107½	57.0

The following long runs make pretty good time:—

Railway.	Miles.	Per Hr
Great Western—London-Plymouth	225¾	54.6
North Western—London-Rhyle	209¼	52.9
Great Central—London-Sheffield	164¾	55.8
North Western—Willesden-Coventry	88½	57.7
Great Central—London-Leicester	107½	57.5
Caledonian—Forfar-Perth	32½	60.9
London & South Western—London-Andover	65	57.5
Midland—London-Leicester	99	56.5

In France they run expresses between Calais and Paris and the latter city and Marseilles whose average rate of speed is higher than that of any of the English trains.

THE ALBERTA CLAY PRODUCTS COMPANY WORKS.

(Continued from page 753).

The buildings and grounds are lighted by 235 thirty-two candle power electric lights furnished temporarily by generator. The wiring and installation work was done by the Alberta Electric Company, of Medicine Hat, under the supervision of foreman E. W. Brewster. As soon as the city power plant is completed, connection with the city transmission lines will replace the generator.

Mr. George Limbert, who has had twenty years' experience in the business in Red Wing, Minnesota, and Arkon, Ohio, is the superintendent of the plant, with sub-foreman in each department.

Fuel is supplied by a natural gas well having a capacity of 3,000,000 cubic feet every twenty-four hours and a pressure of 555 lbs., which is reduced to 10 lbs. for use in the kilns. The well was drilled by the city of Medicine Hat and the product is one of the purest forms of marsh gas ever encountered. It is of approximately the same flow and pressure as all the wells of this depth in the Medicine Hat district, which is famous throughout the continent. It is the most extensive field yet discovered and offers unlimited possibilities for the development of cheap power and for domestic utility. Th city controls the output and has established a system, whereby gas may be furnished to manufacturers at the exceptionally low cost of five cents per thousand feet.

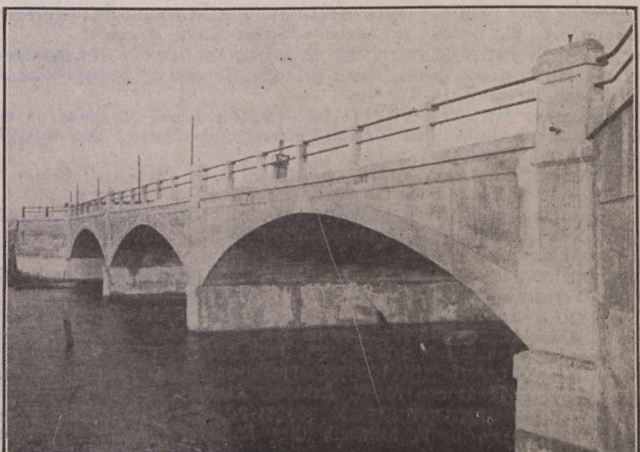
MANITOBA PROVINCIAL BOARD OF HEALTH AND RIVER POLLUTION.

The board passed a resolution, stating that it viewed with apprehension the pollution of the waterways of the province by raw sewage, and expressed the view that legislation should be enacted without delay prohibiting any person, corporation or municipality from placing or discharging any solid or liquid sewage or other poisonous matter into any navigable or other waters within the province, except under conditions to be definitely determined.

The board was particularly impressed with the fact that the pollution of the Red and Assiniboine rivers especially, has become so acute at some points as to constitute a menace to public health and has reached a stage at which the necessity exists for purification and sewerage disposal plants ought to be established.

NEW INCORPORATIONS.

Winnipeg, Man.—Hygienic Ice Co., $200,000; W. A. Windatt, J. Leslie, A. W. Humber. Exhibition Land and Development Co., $5,000; C. R. Ross, J. Yates, T. Jones. Pioneer Land Co., $5,000; J. Riddell, J. N. Davidson, R. Ferguson. Suburban Estates, $40,000; J. W. Manchester, T. A. Connell, A. H. Oakes. Commercial Union Association, $20,000; W. Cameron, W. B. Conley, M. R. Blake.



Concrete Arch Bridge over Little Calumet River, Gary, Ind.

This bridge has three 60-foot spans, with a total width of roadway and tracks of 64 feet, carrying an interurban railway and horse traffic.

ENGINEERING SOCIETIES.

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

Chairman, A. E. Doucet; Secretary, P. E. Parent. Meetings held twice a month at Room 40, City Hall.

TORONTO BRANCH—
96 King Street West, Toronto. Chairman, A. W. Campbell; Secretary, P. Gillespie, Engineering Building, Toronto University, Toronto. Meets last Thursday of the month.

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

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

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

MUNICIPAL ASSOCIATIONS.

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

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

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

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

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

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

CANADIAN TECHNICAL SOCIETIES.

ALBERTA ASSOCIATION OF ARCHITECTS.—President, E. C. Hopkins, Edmonton; Secretary, H. M. Widdington, Strathcona, Alberta.

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

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

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

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

CANADIAN CEMENT AND CONCRETE ASSOCIATION.—President, Peter Gillespie, Toronto, Ont.; Vice-President, Gustave Kahn, Toronto; Secretary-Treasurer, R. E. W. Hagarty, 662 Euclid Ave., Toronto.

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

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

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

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

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

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

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

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

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

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

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

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

EDMONTON ENGINEERING SOCIETY.—President, Dr. Martin Murphy; Secretary, B. F. Mitchell, City Engineer's Office, Edmonton, Alberta.

ENGINEERING SOCIETY, TORONTO UNIVERSITY.—President, A. D. Campbell; Corresponding Secretary, A. H. Munroe.

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

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

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

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

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

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

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

ONTARIO LAND SURVEYORS' ASSOCIATION.—President, H. W. Selby; Secretary, Killaly Gamble, 703 Temple Building, Toronto.

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

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

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

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

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

ORDERS OF THE RAILWAY COMMISSIONERS OF CANADA.

(Continued from Page 743).

12385—November 26—Authorizing the C.N.Q.R. Co. to open for the carriage of traffic the Montmorency Branch of its line of railway from Hedleyville Junction to the pulp mill of the Montmorency Lumber Company, a distance of 7.62 miles.

12386—November 26—Authorizing the Montreal & Southern Counties Railway Company to open for the carriage of traffic that portion of its line of railway extending from its station at St. Denis St., St. Lambert, to the town of Longueuil, a distance of 3½ miles.

12387-8—November 25—Authorizing the Hydro-Electric Power Commission of Ontario to erect its low tension line across the track and wires of the Woodstock-Thames Valley & Ingersoll Railway Company at the city of Woodstock, Ont.; and its transmission line across the wires of the Bell Telephone Company, at Lot 1, Concession 14, Township of London, County Middlesex, Ont.

12389—November 25—Authorizing the Western Canada Power Co., Ltd., to erect transmission wires across the C.P.R. between Pitt River and Westminster Junction, at a certain point.

12390—November 21—Approving the right-of-way plan of the Edmonton, Yukon and Pacific Railway Company, where the same crosses through the west half of Block 13 of the Hudson's Bay Co.'s Reserve, Edmonton, reducing the width thereof from 49½ feet on the north side of the centre line to 25 feet.

12391—October 13—Authorizing the C.P.R. Co. to run and operate its trains over and upon the G.T.R. Co.'s spur to the Horseshoe Quarry Co.'s premises and sidings thereto in Lot 21, Concession 17, Township of Blanshard, County of Oxford, (now in the town of St. Mary's), and to construct an industrial spur for the Horseshoe Quarry Co. to, and connecting the G.T.R. Co.'s spur to the Horseshoe Quarry, said spur to be completed within three months from date of this Order.

12392—November 28—Authorizing the Western Canada Power Company, Limited, to erect its transmission line across the track of the C.P.R. Company, New Westminster Branch Line at a certain point.

12393—November 26—Authorizing the C.N.O.R. Co. to construct its railway across the public road between Lots 15 and 16, Junction Gore, Township of Gloucester, County Carleton.

12394—October 26—Approving location and detail plans of the proposed station building to be erected by the G.T.R. Co. at the corner of McGill and Youville Streets, Montreal, Quebec.

12395—November 28—Authorizing the C.P.R. Co. to construct a temporary spur for the Algoma Steel Bridge Co., across the tracks of the Winnipeg Electric Railway Co., and to join the same at Louise Bridge, and that all trains of the C.P.R. Co. before making the crossing be brought to a full stop and flagged over the crossing, said spur to be constructed within three months from the date of this Order.

12396—November 28—Authorizing the C.N.O.R. Co. to divert and cross by means of an overhead structure, the public road at station 656.56, Parish of St. Andrews.

12397—November 28—Authorizing the C.P.R. Co. to construct, within three months from date of this Order, an industrial spur for Messrs. Boyd and Fordham, Vancouver, B.C.

12398—November 28—Authorizing the C.P.R. Co. to construct an industrial spur for Wm. H. Wortman, Parish Lot D.G.S. 45, St. James, lying between Saskatchewan and Dublin Avenues, Winnipeg, Man.

12399—November 28—Directing the C.P.R. Co., within ninety days from the date of this Order, to install an improved type electric bell at crossing of Princess Avenue by said railway in Lachute, Quebec.

12400—November 28—Authorizing the corporation of city of Woodstock, Ont., to lay a water main along Tecumseh Street under the siding of the C.P.R. Co.'s tracks, across said street to works of James Stewart Manufacturing Co.

12401—November 26—Authorizing the Canadian Light & Power Co. to erect transmission lines across the wires of the Bell Telephone Co., at Melocheville, P.Q., Beauharnois Canal Crossing.

12402—November 14—Directing that the Vancouver, Fraser Valley & Southern Railway Co. insert a diamond in the track of the Vancouver, Victoria & Eastern Railway & Navigation Company, at the crossing of the V., F. V. & S. Ry. with the V. V. & R. Ry. & N. Ry.; that said crossing be protected by an interlocking plant, derails, and home and distant signals on lines of both companies on each side of said crossing.