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Municipal Engineering

The World's Leading Municipal Publication

January, 1917.

MUNICIPAL BOND SALES

That municipal bonds are the favorites for safe standing investments is demonstrated by the higher prices paid for them; prices which have reduced the net returns to the investor well down toward $3\frac{1}{2}$ per cent. Buffalo recently sold $4\frac{1}{2}$ per cent. bonds at a price netting the purchasing syndicate 3.8 per cent., and the ultimate consumer will net a still lower rate. The reasons to which these favorable prices were attributed by the *Weekly Bond Buyer* are the general prosperity, the Federal income tax and the Postal Savings system, which operate from different angles but all tend to lower the net rate of income expected from municipal bonds.

The market seems to have recovered entirely from the early effects of the war and the rates of interest offered on their face can again be reduced to those prevailing several years ago.

The first instalment of tables showing the prospects for municipal improvements, published elsewhere in this number, reflect the improvement in the situation. Of course, it is not possible at this time to make any accurate predictions regarding work for next year and a good many city engineers do not trust themselves to make even a guess. But the general tone of the reports is good and it will be specially noted that the prospects in most of the cities reporting them are materially better than the performances for 1916.

While 1916 was not quite a record-breaking year in public improvements it was evidently one in which a very large amount of work was done, and the indications are that 1917 will be so far ahead of it that it is likely to be a record-breaking year.

The growth of cities, particularly of manufacturing cities, new and old, has been phenomenal in the past three years, and municipal improvements have not been able to keep up. City after city that has been visited gives all too prominent evidence that it has grown beyond the clothes it has been wearing and must work hard to catch up. This means that in many municipalities the question of cost of doing work will be a secondary consideration and if the money is obtainable at low rates of interest it will be procured and spent rapidly and in large amounts.

Prior to November there was a real scarcity of municipal bonds and the demand was greater than the supply. One of the most prominent demonstrations that 1917 will be be a record-breaking year is the fact that in November many cities and counties voted large amounts of bonds for improvement purposes and many more cities and towns announced definite or tentative plans for large expenditures in 1917 so that the investors will find that the issues of bonds will come nearer to supplying their demands. Money is coming to this country so rapidly, however, that there seems to be no present prospect of the supply fully satisfying the demands.

The only source of delay will be the inability in some cases of the managers of the city's finances to develop as rapidly as their cities, and the consequent mis-management of their departments or failure to recognize the necessity and real economy of prompt and sufficient expenditures upon well designed systems of public improvements.

The engineers and contractors will be found to be better prepared for the larger work demanded than the city councils and controllers.

This condition is not unique for there are manufacturing establishments struggling with their problems of enlargement which show the same lack of capacity in their managers to cope with the whole situation.

MUNICIPAL ENGINEERING FOR 1917

We are not going to make any rash promises for 1917, but this is a good time to call attention to the improvements in "Municipal Engineering" which have been made during the past year and to say that the improvements will continue during 1917. It will not be enough to hold our own, greater improvement will be necessary and we have those improvements developing and appearing each month.

The series of articles on Street Paving, which began in September, will continue until all the standard forms of construction and materials used have been covered. The practical nature of these articles, which are gathered from those most closely identified with the modern uses of paving materials has brought out many compliments for them and all the features will be continued with such additional new features as have demonstrated their value.

Municipaal Engineering is highly pleased with the expressions of appreciation of its improvements which have been coming in large numbers lately, and is putting in its best work to continue to deserve them and, if possible, to increase their number and quality. The street paving series is only one of the good things in progress and in store for early publication, just as fast as space and thoro preparation will permit.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

The Construction and Maintenance of Stone Block Pavements

By R. Keith Compton, Chairman Paving Commission, Baltimore, Md., the Editor and Others.

The maintenance of the stone block is largely taken care of in the original construction, when that is according to modern methods, so that both construction and maintenance are covered in this one article. What is given concerning maintenance refers mainly to taking care of the older pavements, not so well designed or constructed as those of the last five years or so have been.

The methods of construction described are those latest developed—since the revival of interest in the paving material longest in use.

Much of the material in this article is derived from the standard specifications adopted by the American Society of Municipal Improvements at its last convention and from papers before that society, to which we are also indebted for some of the accompanying illustrations.

The practice under the Paving Commission of Baltimore, Md., is outlined in the portion of the article written by R. Keith Compton, chairman and consulting engineer, who has constructed some of the most satisfactory of the modern granite block pavements.

E. W. Stern, chief engineer in charge of highways, Manhattan boro, New York City, makes an interesting contribution to the discussion of maintenance.

THE construction of the granite block pavement really begins with the manufacture of the blocks and a few words on this subject may serve to show what are the practical limitations in exactness of measurements of blocks and of variations from specified dimensions.

The hardest granites, those formerly specified for paving purposes, wear smooth and slippery and any irregularity in texture produces irregularity in wear. Hard and uniform sandstones, such as Medina and Colorado, were more satisfactory for pavements because, while they may wear more rapidly, they wear more uniformly and therefore the pavement actually lasts longer before relaying or reconstruction becomes necessary and is smoother at all times. Study of the softer granites has demonstrated that they have the same advantages as the sandstones in this regard and there is a tendency in modern specifications to use the softer grades, provided they are uniform in texture.

The softer granites have the additional advantage that they split more regularly and more easily and can be dressed at less cost, so that the blocks can have smoother surfaces and joints can be correspondingly narrower and more uniform. Coarse-grained granite, that with hard spots, or segregation of the minerals composing the stone, should not be used, as it will wear irregularly.

Manufacture of Granite Blocks.

Granite occurs in actual layers, which may or may not be horizontal, and the large blocks of stone from the quarry are in one dimension of the thickness of these layers or lifts.

The blocks are broken from the lifts by blasting or wedging them out, the drill holes being located on the lines of the rift and the grain of the stone, which are at right angles to each other and approximately at right angles to beds or lifts.

The large blocks, loosened from the lifts by this blasting or wedging, are split into smaller blocks, say 2 to 5 feet cube, by drilling holes along the lines of rift and grain and driving in plugs and feathers. These smaller blocks are carried to the block yards where they are split into paving blocks. The blocks are 19 or 20 inches or some multiple thereof, measured along the rift, so that with blocks specified 5 inches deep they can be split into an even number of blocks of 5 inches depth, within the allowable variations from 4¾ to 5¼ inches depth. In the other direction, along the grain, the block can be split into eight blocks 8 inches long. The large block, say 80 inches cube, is first quartered by splitting across the middle each way, then each quarter is quartered, and split until out of the small blocks thus produced can be split eight blocks each 8 inches long. Drilling of holes along the lines of cleavage is necessary down to the last operation of cutting the last quartering into its four component blocks. Marking with a hand chisel across the rift is all that is necessary in this operation. The long splits are made along the rift, the next splits along the grain, and only the last splits in the third direction.

When the blocks are reduced to paving-block size, roughnesses are knocked off the faces with a hammer. Usually the sides are the rift, the ends are the grain and the tops and bottoms are parallel to the lift. The splitting being more difficult on this plane, the tops and bottoms are rougher than the ends and sides.

Noting the drill holes, widths of feathers and plugs and irregularities in planes of fracture, the reason for the specification of ⅜-inch joints is clear. Quarries differ also as to ease of splitting on one plane or another or all three, so that uniform blocks are obtained more readily from some quarries than others.

The early specifications required closer joints on the ends of the blocks than on the sides, to prevent undue wear of the joints running in the same direction as the traffic. This is still desirable, but with well placed joint filler is not so necessary as formerly.

The improvements in construction due to the better shape and size of stone blocks now available and the reduction in cost because of smaller blocks, less work on stone, and increase in durability, especially as to continuous retention of the smoother surfaces now available, on account of better methods of laying, are making stone block pavements more popular in districts where stone is available.

Handling the Blocks.

Blocks are handled from the quarry, when possible, by loading them into skips which are carried on cars or wagons to the docks, lifted up by derricks and dumped into the holds of the vessels. When they are handled from vessel to car or wagon and from wagon to street pile they should be handled with the same care as bricks and should not be thrown or dropped. The sharp edges and corners are subject to the same chipping as those of bricks and the weights of blocks are greater and corners are sharper. The ideal way of delivery on the street is by dump truck, as shown in one of the accompanying photographs.

DUMPING GRANITE BLOCKS IN THIS WAY SAVES CHIPPING.

The contractor must ship his blocks all from the same quarry, where they are made according to the same plan of operation, otherwise they may differ materially in width of joints, smoothness of surfaces, squareness of joints, thickness, and depth. He must work closer to specifications than formerly, and, while a variation in depth of blocks of a half inch and in width of 1 inch is allowable according to the standard specifications, the further requirement of a 1-inch depth of sand cushion makes a separation of the shallowest blocks from the deepest blocks advisable. But, still more important is the requirement that the joints shall not exceed ½ inch in width for the upper inch of their depth, which is practically a requirement that the blocks shall be selected for width so that those in a course shall be of the same width. If blocks are carelessly gathered together from different sources, or care is not taken in the quarry to classify blocks according to this requirement, the contractor may find it necessary to spend considerable money in doing this sorting on the street.

When cement grout filler is used the joints may be a little wider because the hard filler protects the edges. With soft filler, if the joints are too wide the horses' shoes will chip and wear the edges too rapidly and the stones round off and become slippery and the surface becomes rough like the old cobble or old-style granite block pavement.

Sand Cushion and Mortar Bed.

The old custom was to even up the inequalities in the subgrade, which was formerly all the foundation required, with a thick layer of sand, in which the block-layer buried the blocks for a large fraction of their depth. It has been hard to teach men to lay blocks on a thin sand cushion, such as the standard specification of 1 inch, but that requirement is now met successfully and if the blocks are very nearly of the same depth, varying not more than say ¼ inch in neighboring blocks, the surface can be made smooth and uniform and, after the blocks have been tamped or rolled into complete bearing, no later displacement of the paving stones need be expected unless occasionally by accident. The sand cushion cannot be made as uniform in thickness as for a brick pavement or rolled before laying the blocks, because of the greater variation in depth of blocks.

Methods of laying sand, sand-cement, and mortar cushions were described in the article in this series on the construction of brick pavements.

The mortar bed has been used by a few engineers for granite block pavements, particularly in Baltimore and in Manhattan. It was used in Brooklyn in one street having 4-inch blocks. The mortar bed adds about 16 cents to the price per square yard in that locality, which may not be justified by the increase in value of the pavement. Where traffic is heavy or blocks are shallow it is more fully justified.

Granite blocks are sometimes set in the green concrete when they are used along the rails of street-car tracks for toothing, etc.

Laying the Blocks.

That straight courses of equal width blocks and with narrow joints are practical in regular work is shown by one of the accompanying photographs, which is but one of many of the same sort accompanying the papers on modern granite pavement construction which were presented to the last convention of the American Society of Municipal Improvements.

The contractor is interested in securing narrow joints, since granite blocks are sold by the square yard as measured in place, and when the joints are narrow the blocks cost him no more but he saves materially on the amount of filler required for the joints. If he is careful to hold the block dealer to the letter of the specifications in the sorting of the blocks, he has only the trouble and possibly the slight additional time to take to insure that his block-layers do their work properly and lay the blocks with the narrowest possible joints and perfectly straight courses. Padding with wide joints to secure yardage of blocks laid is as much against the paving contractor's interest as it is against the pavement's own interest. The only people who benefit by it are the contractor who furnishes the blocks and the block-layer, in case they are paid by the square yard laid.

Ramming of blocks into place is required, all unsatisfactory blocks to be removed with tongs and all low blocks to be raised by taking them out and adding enough sand so that when replaced and rammed they will conform to the regular surface. Pinch bars are not to be used to force blocks into position. No free sand is allowed in the joints.

Fillers for Joints.

In introducing the discussion of fillers the following important points must be noted:

As to grout filling—

1. To sprinkle the blocks thoroly before the grout filler is placed in the joints.

2. To keep the surface wet either by wet sand spread over the entire pavement, after initial set has taken place, or by sprinkling for 4 or 5 days after joints are filled.

3. To absolutely keep all traffic off from the pavement for at least 7 to 10 days after joints are poured with grout.

4. If possible street railway cars should slow up and never set their brakes for a stop along the line of pavement as this has a tendency to break the bond of the joints.

Cement grout must be a true one-to-one mixture and grout must be kept thoroly agitated until it is poured into the joints.

STRAIGHT COURSES AND NARROW JOINTS ARE EASY TO OBTAIN.

Pea stone or gravel should be eliminated from the joints but in any case must never be allowed to fill the joints up higher than 3 inches below the top of the blocks, or pot holes will develop.

As to bituminous filling—

1. The blocks must be clean and free from dust.
2. All blocks must be thoroly rammed. Filler must be heated as hot as possible without burning, so that it will flow freely aud fill joint completely.

The following on construction and maintenance of granite block pavements is by R. Keith Compton, chairman and consulting engineer, Paving Commission, Baltimore, Maryland.

Fillers for Joints.

Only two kinds of filler are satisfactory, namely cement and bituminous, the use of one or the other to be determined by the engineer, after taking into consideration all interests in connection with the improvement. Both fillers have their advantages and disadvantages. Cement filler is more desirable, but at the same time it has the disadvantage of being noisy, and when flushed up even with the top of the blocks the pavement, particularly if it is of very hard granite, becomes slippery. Bituminous filler has the advantage of being less slippery, and the further advantage of enabling the engineer to open the street to traffic at once, but it has the disadvantage of not protecting the edges and corners of the blocks, thus allowing them in a few years to become rounded.

The cement filler should be applied by the machine mixing method rather than by hand, thus doing away with the weakness, as far as possible, of human agency. It should be applied from the mixer to the blocks by means of an enclosed chute so as not to allow the filler to separate.

One of the enclosed photographs shows a machine grout mixer and distributer at work.

The squeegee coat of cement should always be applied, except possibly when the pavement is on a heavy grade, and in this case brooming out slightly the top of the joints is an advantage, as it gives draft animals a foothold.

Where a bituminous filler is used the work should be done preferably during the warmer seasons of the year, when the blocks and other materials are dry and not chilled. This of course is not always possible.

Fine, hot gravel or sand should be used in connection with bituminous filler. If gravel is used a small amount should be first poured into the joints, the block then rammed, then more filler, then more gravel, until the joint is completely filled, and if the desire is to render the pavement noiseless, excellent results can be obtained by allowing the last pouring of the bitumen to run completely over the tops of the blocks about one-eighth of an inch in thickness, this then to be followed with a layer of hot sand or gravel. This gives a most desirable and noiseless pavement, and if properly applied the bitumen should last on top without materially spalling off for a period of two or three years. It can be very cheaply renewed if necessary.

Before the filler is applied the blocks should be thoroly rammed or rolled to a good bed and true surface. The question of rolling rather than ramming the blocks has been considered, but it has never been a success, because the tendency of the roller is to tilt the blocks. Ramming gives better results if every block is well bedded by means of a heavy blow with a rammer, but, like all human agencies, the rammer is liable to miss a few blocks.

Excellent results have been obtained in some municipalities by mixing hot sand with the bituminous filler before being poured.

On standard block streets joints should not exceed ½ inch in width, and where it is possible to do so without materially running up the cost of the granite blocks pavement, the joints should not be over ⅜ inch in width.

Crown.

Technically speaking, the granite block pavement, on account of its non-slippery surface, can be given more crown than the pavement with a smoother surface, such as asphalt or brick, but this does not work out in practice, because with an asphalt street the higher crown is more desirable in order to shed the water more quickly.

As with all pavements, crowns should vary with the grade. A 40-foot street on a 3 per cent grade should have at least a 0.6-foot crown.

Contractor's Steps in Construction.

Assuming that the street is clear, the contractor should first set the new curbs or re-aline or resurface the old, as may be called for in his contract. His grading gang should then proceed to excavate the street to the sub-grade. He should be careful to keep all storm-water inlets along the line clear so that in case of a storm the flow can be diverted into the inlets without serious wash to his sub-grade. After the excavation is made to the sub-grade, all soft spots should be removed and replaced with good material and the sub-grade thoroly rolled with a heavy roller. Any seepage in the sub-grade along the line, such as springs, etc., should be taken care of by tiled drains and carried into the nearest storm-water manhole or inlet. Properly draining the sub-grade is one of the most important items of public work.

After the sub-grade of the street has been rolled and dressed up to a line the proper distance under the finisbed surface of the street and parallel therewith, concreting should commence. In the meantime the sand and crushed stone should be piled along the line on the sub-grade where convenient and also on the intersecting streets at most convenient points, and so located that it can be conveyed to the mixer by means of wheelbarrows. Wherever possible the concreting should be started at the low grade end and continued up grade. Cement should be stored along the line in sufficient quantities to keep the mixer in continual operation, and sufficient cover should be kept on hand to protect it in case of rain or damp weather, otherwise the contractor is liable to lose considerable of this material by it becoming hard from dampness or rain, or becoming lumpy. In the meantime the grading gang should be kept continually at work so that the concreting operation can also continue.

Before the grading on a street has been commenced, the granite blocks should be placed in convenient piles along the curbs so as to avoid the practice of hauling over the concrete base with wagons or carts as far as possible. If placed in convenient piles along the curb most of the blocks can be tossed into the bed of the street and very few of them will have to be wheel-barrowed in.

When granite blocks are laid on a mortar bed it is economical to the contractor and very important for the welfare of the work that the blocks be rammed as soon after being laid in place by the pavers as possible, and that the grouting gang keep up as closely to the pavers as is convenient. Unless this is done the mortar bed will set so hard that it will be impossible to ram the blocks to a true bed and surface, and in case of rain it will avoid loss of money to the contractor in having to take up and relay the blocks.

The writer believes that mixing the mortar bed and grout by machine is a labor saving method, and unquestionably better and more uniform grouting is obtained.

If bituminous filler is used the same methods of keeping up with the pavers should be pursued. In case of cement filler, the contractor should place sufficient barricades and watchman to keep traffic off of the work for a period of at least fourteen days. In case of bituminous filler, traffic can be allowed almost immediately on the work, just so long as it does not interfere with the contractors' operations.

SMOOTH SURFACE OF A NEWLY GROUTED STREET.

During the progress of the several items of the work it is economical to the contractor to remove all debris and surplus material as his work progresses. This will avoid accidents, will make his work more shipshape, and will give the public the impression that the contractor handles his work in a businesslike manner. This may not be always possible, but in any event as soon as the paving is completed and teams can be allowed thereon, the contractor should immediately clean up the sidewalks and street intersections, clear gutters, etc.

Maintenance.

Under the heading of maintenance may properly be included the matter of cleaning. Flushing by means of a hose attached to a high-pressure fire plug is very undesirable, because this force will certainly disturb a bituminous filler from the top of the joints and very likely rupture a cement filled joint. The use of flushing machines with high pressure is equally undesirable from this standpoint. If the street paved with granite blocks is in a desirable business section, patrolmen with hand brooms and hand carts should be employed during the business hours keeping the street moderately clean. After business hours there should be brought into service the street sweeper, preceded by a light sprinkler.

In the matter of repairs record data are very difficult to secure in this country, because improved granite blocks have only been laid within the past 15 or 20 years, and if designed and constructed in the proper manner should and do have a much longer life.

The maintenance engineer should divide his territory into districts, each district in charge of an assistant engineer or inspector, who should make frequent inspection. If any holes develop, no matter how small, they should be repaired at once, because if not repaired they soon grow larger, particularly with cement filler. If the original pavement was laid with cement, the repairs should be made with the same material, blocking the patches off from traffic by the most convenient method.

GROUT MIXER AND DISTRIBUTER FILLING JOINTS IN A GRANITE BLOCK STREET. BROOM-MEN AT THE LEFT INSURE THAT THE JOINTS ARE FILLED FLUSH.

A cement-filled block pavement is more difficult to repair than a bituminous-filled one. It is very bad practice in repairing a hole or a cut to square up the sides and ends, making a straight cut in the pavement. All edges should be toothed in and laid in the same manner as the original pavement, and the same methods pursued in restoring a worn place as are pursued in repairing a cut. With a bituminous-filled pavement this is a simple proposition, but with a cement-filled pavement is very difficult and requires special care.

The Highway Engineer's Department of Baltimore in repairing cuts in block pavements has given this matter special consideration, using a compressed air machine for the purpose. In a recent report Highway Engineer R. M. Cooksey states as follows:

"A great deal of difficulty has been experienced in making proper repairs to cuts in vitrified block and granite block streets where cement filler was used. In order to obtain the best results in the past, stonecutters at the usual high rate of wages were employed for this work. In investigating with the view of outlining a more economical way of handling this work and securing as good if not better results in the workmanship, we tried out a compressed air machine operating chipping hammers for this purpose. This machine had been in use previously by the Water Department for calking pipe joints. After giving this a short trial we decided that it was an economical way in which to handle this work, and we therefore purchased a No. 2 portable compressed air outfit with hose and connections for hammers. Initial cost $345.50. In connection with this there were also purchased two No. 2 Thor chipping hammers at a cost of $70.00, making a total outlay of $415.50.

"After using this machine thru the entire season we find that the cost can be compared as follows:

"Average day's work for a stone cutter was 25 linear feet of toothing in vitrified brick work. The salary paid a stone cutter was $4.50 per day, which would make the cost to the city 18 cents per foot.

"Average day's work for the machine is 300 linear feet of toothing and the total cost of operating the machine, including depreciation, as outlined below, is $8.29, or at the rate of 2.76 cents per lineal foot, so that there was a saving of 15.24 cents per linear foot of trench repaired. As the city's repairs during the year will approximate 10,000 linear feet, you can readily see that the outfit will pay for itself in a very short while.

"The cost for operating the machine for one day on 300 feet of toothing is as follows:

5 gallons gasoline (present price)	$1.05
1 gallon cylinder oil	1.26
1 gallon Polarine oil	.23
1 special laborer	2.75
1 special laborer	2.50
Depreciation	1.50
	$8.29

"I would strongly recommend the use of this machine where there is any amount of trench work in either cement-filled granite block or vitrified block, as there is no doubt about its economical features."

As this machine has been so successfully operated by Mr. Cooksey in repairing cuts and trench work, it might be used with economy in making extensive repairs under the head of ordinary maintenance, that is to say for cleaning the cement out of the ends of the block so that they can be properly toothed in. Unquestionably it is a labor-saving device, accomplishes the purpose for which it was designed and overcomes the objection so often urged by engineers and contractors in making repairs to cement-filled pavements.

The following suggestions regarding maintenance of granite block pavements are made by E. W. Stern, chief engineer in charge of highways, Boro of Manhattan, New York City.

Old Granite Block Streets.

Old granite blocks with ½ to ¾-inch joints that have had the joint filler washed out by flushing with hose, used in cleaning the streets, have been restored to fairly good surface by picking up an occasional depression and re-pouring the joints. We have done this during the past season over a large area which is under heavy traffic.

The joint filler used was asphaltic cement. During a short period the supply of asphalt was exhausted and tar filler was used. This portion of the work has been located and an inspection will be made next spring to ascertain whether the asphaltic cement or the tar filler has given the better result. The method of doing the work was as follows:

The gang, in charge of a foreman, consisted of one paver to do the small amount of paving necessary in adjusting the depressions to grade, and seven laborers. Joints were scraped out and broomed clean, then allowed to dry for a short time. Hot gravel ⅛ to ⅜ inch was then placed in joints until they were nearly filled; joint filler was then poured with a second or even a third pouring when necessary to fill the joints completely.

About 350 square yards was the usual average per day, all in heavy traffic streets. Experience shows that while the joints should be filled flush with the top of the blocks, there does not appear to be any advantage in covering the top of the blocks. Where this has been done the asphalt does not adhere to the top of the blocks but is soon worn off by the traffic.

Improved Granite Streets.

The streets paved with improved granite blocks with ⅜-inch joints are watched closely, and as soon as a slight depression is observed, it is repaired at once. The joint filler used on this class of work is 2/3 (in bulk) hot asphaltic cement with 1/3 hot sand, kept in suspension by frequent stirring. This mixture has given excellent results. Before relaying the blocks, a dry mortar bed ½ inch in thickness, one part portland cement to four parts sand, is spread over the concrete foundation. Immediately before the blocks are laid this mortar bed is slightly moistened with a sprinkling can.

One of our streets, 10th avenue, 40th to 51st street, paved with this class of granite, was badly damaged during the past spring and early summer by constant hauling of excessive loads on steel-tired platform trailers hauled by heavy motor tractors. Large areas in detached patches have been repaired and have withstood these heavy loads for about 5 months to date, without any noticeable damage. Constant personal supervision by the superintendent of maintenance or engineer is necessary to insure a proper care of pavements of all kinds.

A prompt repair of a small defect, especially in heavy traffic streets, is the true secret of maintenance.

H. H. Schmidt, chief engineer of the bureau of highways, Brooklyn Boro, finds it much easier to maintain a block laid with a bituminous filler. In cities it is particularly difficult to manipulate a cement-grouted pavement, especially rapidly growing cities where the great changes make frequent pavement openings necessary. Not only is the cement-grouted pavement more difficult to patch, but the necessity for blocking off the patches so the cement can set is a great impediment to traffic and in many cases is impractical.

THE AUSTIN, TEXAS, DAM

METHODS OF CONSTRUCTION AND OPERATION

By Frank S. Taylor, Austin, Texas.

This description of the design and construction of the Austin dam and the method of operating it is a continuation of an article by the author in MUNICIPAL ENGINEERING *for October, 1916, and shows the points of excellence in the design and some of the practical details of construction and operation.*

This new dam replaces structures which failed, and it withstands successfully the attacks made on it by the elements, tho it was injured somewhat by a record-breaking flood which came before the dam was very far along in construction, so that the injury was not serious and was readily repaired.

THE total length of dam and corewall is 1,535 feet, of which 1,091 feet are spillway, 124 feet bulkheads, and 300 feet corewall.

A typical section of the new portion of the dam is shown in figure 1. As indicated, it is a reinforced concrete structure, having an inclined upstream wall, making an angle of 42 degrees to the horizontal. At a point about 2½ feet above low water level, this slope of the wall ends, intersecting a narrow horizontal bench, and from the upstream edge of this horizontal bench a vertical wall goes straight down into the rock. This vertical wall forms both the lower portion of the deck and the cutoff wall, and in the designation used on the work is termed the "cutoff wall."

The object of the bench is to allow flow of water thru any completed section of the dam during construction, the flat horizontal slab, which runs the entire length of the dam, and covers the upper part of the bench, being omitted until the completion of the work. This top slab covers a space of 4 feet wide, measured horizontally from the upper edge of the cutoff wall to the lower edge of the inclined deck slab. Since the upper edge of the cutoff wall is only about 2 feet above mean low water, a rise of 2 feet will pass water over the cutoff wall thru the opening and thru the dam and a rise of 4 feet would give a thickness of water of 2 feet over the edge of the cutoff wall, which means that as much water would be passed thru and under the dam as would flow over the crest of an ordinary weir, the entire length of the dam, and 2 feet in depth over it. Normally, the total flow of the river was taken thru the sluice gates in the bottom of the dam, later to be described, but, in the case of floods, the openings thru the horizontal bench, together with the area afforded by the sluice gates, would usually take care of the whole river flow at such times, without an elevation in the water level of more than 4 to 6 feet.

The supporting walls are both longitudinal and transverse. The transverse walls are set parallel to the flow of the stream and are 20 feet apart, measured from centre to centre. The longitudinal walls are also spaced 20 feet apart, measured from centre to centre in a direction at right angles to them. These latter walls are not vertical but are inclined, so that they form an angle of nearly 90 degrees with the upstream deck. The slope of these walls is such that the resultant of the forces which they resist, made up of the water pressure acting against the surface of the deck and the gravity component of the deck and the walls themselves, has the same direction as that of the longitudinal walls. The longitudinal and transverse supporting walls intersect in a direction normal to the deck. The deck panels are exact squares, and hence may be reinforced in two directions. The reinforcing steel is, therefore, placed both longitudinally across the length of the dam and transversely up and down the deck. The spacing of the steel is logarithmic, the bars being laid closer and closer together as they get nearer and nearer the middle of the panel.

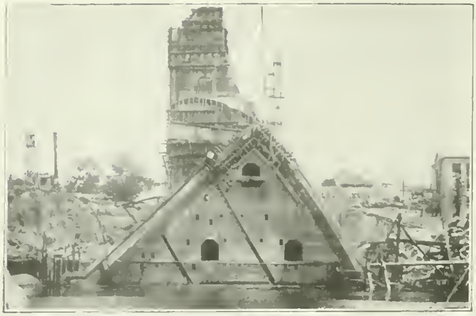
The stresses allowed in the steel are 16,500 pounds per square inch maximum.

All of the steel used was square-rolled twisted bars, of ingot steel, having an elastic limit above 55,000 pounds. The engineers considered the high elastic limit preferable to a high ultimate tensile strength, it being assumed that if stresses were imposed on the steel which would extend it past its elastic limit, the surrounding concrete would probably be crushed to such an extent that the structure would fail, and the only value that the steel could have lies in its resistance to distortion within its elastic limit.

Owing to the difficult character of the foundation, as has previously been stated, it was desirable to make the distance thru the bottom of the dam, measured from upstream to downstream side, as short as possible. In the usual form of design, the inclined deck goes up to the elevation of the crest of the dam, where it joins with the spillway. The form of the spillway is determined by the application of the ordinary parabolic formula, and this gives a certain distance, measured horizontally, from the crest of the spillway down to its toe. As shown in the typical section, figure 1, the spillway was designed in accordance with the usual method, and the sloping deck made to intersect it at some 25 feet further downstream and 6 feet lower vertically than in the customary design. By this method a proper length of theoretically designed spillway was made available, as well as an inclined deck of substantially the total height up to the spillway, and, at the same time, the length thru the dam from front to back was reduced about 25 feet, diminishing in a like proportion the length of the transverse walls, the length of each transverse wall foundation, and eliminating one longitudinal wall. While the saving in material and labor, due to this form of design, for a given factor of safety, was greatly reduced by the adoption of this design, the cost of the form work was increased so that the net saving effected, tho considerable, was not so great as would at first appear.

As shown in figure 2, the vertical transverse walls intersect the deck and the spillway, continuing on up above them in the form of piers, on the top of which are placed reinforced concrete girders that carry a railway track. Between these piers are placed the automatic crest gates, seen closed in the view.

The vertical buttress, or diaphram walls, have four large openings made in each, as indicated in the section. Thru the topmost series of these openings is placed a walkway, with iron railings on either side, so that it is possible to walk thru the new portion of the dam from end to end. Access is provided to the interior by means of spiral stairways, one placed at either end. These pass down thru a stair-well, each well



1. PHOTOGRAPH OF SECTION OF HOLLOW AUSTIN DAM DURING CONSTRUCTION, SHOWING THE SLOPING UP STREAM FACE. NARROW HORIZONTAL BRICK NEAR BOTTOM, THRU WHICH WATER FLOWED DURING THE CONSTRUCTION PERIOD; THE FACE OF ONE OF THE TRANSVERSE WALLS AND THE DOWNSTREAM FACE AND THE SPILLWAY WITH THE CONSTRUCTION FORMS STILL IN PLACE. THE POWER-HOUSE IS ON THE RIGHT.

being formed in a pier, which is of sufficient width to accommodate it.

All the concrete used for making the deck and cut-off wall was rendered waterproof by an admixture of hydrated lime, in the proportion of 8 to 10 per cent (by weight) of the cement, the proportion being varied with variations in the voids in the aggregate. This has proved to be thoroly satisfactory, as were also the tests made of it prior to adopting this as standard construction on the work.

The concrete mixture was approximately 1-2-4, but no defiite proportion of ingredients was used at any time. The proportions were fixed always by making tests of the voids in the sand, stone and gravel. The proportions would be changed whenever the percentage of voids in these materials would show any change. Void tests were made every hour or oftener if indicated as mixing proceeded. The cement used was made by the Texas Portland Cement Company and tested for the requirements of the engineers by the Pittsburg Testing Laboratory. River sand and some river gravel were used for the other constituent parts. Most of the aggregate, however, was broken hard limestone.

Expansion Joints.

An ample number of expansion joints is provided in the new concrete dam, every fifth panel being an expansion panel. There are 28 panels in all. The first five panels, beginning on the east side, are monolithic, then comes an expansion panel, then five monolithic panels, and an expansion panel, and so on, until the west side is reached. These expansion panels have both the upstream deck and the spillway entirely separated from the adjacent portions of deck and spillway on either side of it. A joint is made betwen the two abutting edges of the concrete slabs, which is water tight, but which permits lateral movement of the different sections of the dam without diminishing the tightness of the joint or rupturing any of the masonry. This joint is made of Ingot iron plate, ½ by 8 inches. One-half the width of the strip, that is 4 inches, is cast into the concrete of the abutting edge of a standard panel. This leaves 4 inches of metal projecting out from the surface of the end of the panel. The end of the slab, together with the projecting iron, is painted over with a heavy coat of asphalt. The expansion panel is then cast so that its edge abuts against the edge of the slab of the standard panel. Due to the asphalt coating, the concrete cannot adhere to the metal of the expansion strip, nor to the adjacent concrete, while that portion of the iron strip cast into the standard panel and adjacent to the expansion panel, does firmly grip the metal. In this way, a watertight, sliding joint is formed. Since its construction, the dam has been subjected to temperatures varying from 32 to 90 degrees, and these expansion joints have proven thoroly satisfactory. Before construction was quite completed and when the whole of the dam was still exposed to the sun and atmospheric conditions, it was possible to see the space between the abutting ends of the panels at expansion joints change more than ¼ inch in a few hours.

Corewall.

Owing to the permeable condition of the limestone that forms the bluff on the east side of the river, a corewall joins the end of the bulkhead and passes eastward some 300 feet, forming, practically, a continuation of the dam into the rock. The depth of the corewall is somewhat lower than that of the foundation of the dam, varying from 75 to 90 feet. Without this impermeable, intercepting wall, there would be considerable leakage around the end of the dam, thru the limestone that forms the eastern bluff.

Piers.

The piers which are built on both the old and new sections are of the dimensions indicated in figure 2. Those on the crest of the low section, which are the taller and broader ones, are 22 inches in thickness, while those on the high section are 18 inches thick. The large piers are continuations of the diaphram walls which support the hollow dam section, and the reinforcing steel passes, continuously, from the foundation up to the top of these piers, so that they are amply strong to withstand the stresses produced by the pressure of the crest gates which they support.

The small piers were cast in place on top of the granite crest of the old dam, and, in order to reinforce them properly and to hold them in place, the vertical reinforcement bars were sunk into drill holes made into the granite and grouted into place, so that these piers likewise are firmly anchored into position.

Bridge.

As shown in figure 2 a bridge is built across the top of the dam, being supported on the piers. This bridge comprises two reinforced concrete beams, each 1 foot thick and 2 feet 6 inches deep, spaced 4 feet apart, center to center, and covered with a concrete slab 8 inches in thickness. On top of this slab are placed standard 6 by 8-inch cross ties, 8 feet long, and a standard-gage railway track is laid on these, the rails coming approximately over the beams. The ties are floored over and a pipe railing is put on the downstream side of the walkway thus formed. The railway track serves to carry a heavy, steel derrick car across the bridge, and a railing on the upstream side is omitted so that there is nothing to interfere with the operation of the tackle of the derrick car in case it is desired to move any portion of the gates for repairs, or lift out heavy trees coming down as driftwood, that might be too large to pass thru the openings.

Crest Gates.

The crest gates, which are placed between the piers that project upward beyond the crest of the dam, on both the high and low sections, are made up of a structural steel frame work, of which the lower portion is filled with concrete, while the upper part is covered with creosoted yellow pine. There are 28 large gates and 26 small ones, making a total of 1,091 feet of spillway. These gates turn about rockers or bascules, which are fastened into the piers at either end of the gate. The large gates, which are placed on the low section of the dam, have, in addition, a middle bascule to support the middle and take the heavy water pressure, due to the great size of the individual gates. These large gates are, of course, continuous from pier to pier, and the middle bascule is placed on a low pier built entirely in the rear of the gate, the bascule projecting forward so that a portion of the rear surface of the gate rests against it. When the gates are vertical and the water is at normal height, the center of pressure coincides in elevation with the point of support on the bascule curve. When the water rises above the normal level, the center of pressure likewise rises, and there then exists a net moment to cause the gate to overturn. As overturning begins, the moment to cause it increases, due to the increase in pressure on the upper portion of the gate, and the diminution in pressure on the lower part. This increase in overturning moment is compensated for by the fact that the gate turning around the bascule is continuously changing its point of support, this point moving from a position at one-third the height of the gate to one very near the middle of the gate when it is, finally, in a horizontal position. In order to prevent the gates from leaving the bascules and being pushed downstream, guide pins are placed at either end of the gate, which pins operate in curved channels of cast iron, set into the concrete faces of the piers. Obviously, when the gates are turned to a horizontal position, the impounded water flows over the spillway crest, the gate being simply a vane in the current. In the case of the large gates, the water reaches an elevation of 65 feet, 9 inches, before overturning takes place. When the gates are in horizontal position, after overturning, the depth of water from the crest to the under side of the gate is 5 feet, 4 inches, while the depth of water from the upper surface to the surface of the water is 8 feet 5 inches, the thickness of the gate itself being one foot.

The small gates, which are 6 feet in height, overturn when the depth of water is 65 feet 4 inches, or when the water is 5 feet 4 inches in depth over the crest. These small gates, therefore, overturn before the large ones do, and, usually, the operation of the small gates gives more than ample discharge over the spillway to take care of normal river flow. Only in case of flood will the large gates open.

When the level of the water in the lake sinks sufficiently, these gates automatically close. This is effected by the counter-weighting provided by the concrete filling in the bottom of the gates, so that the center of gravity of the gates is near the bottom, and there is a continual tendency for gravity to restore them to their normal, vertical position. The small gates close when the water has sunk down to 63 feet 10 inches, or when the level of the lake has dropped some 14 inches below normal. The large gates close at a water elevation of 64 feet 8 inches, or when the level of the lake has fallen to 4 inches below its normal level.

These gates have not only operated in a thoroly satisfactory manner, but have passed one heavy flood, together with some fifty or sixty acres of driftwood that came down the river and accumulated in the lake prior to the full opening of the gates. In this latter respect, their performance is remarkable. When one of the large gates opens and 14 feet thickness of water begins to pass over the crest, the volume and velocity of discharge carry large trees thru the space between the piers, and over the upper surface of the gates, and when the spread of the branches of these trees is greater than the openings between the piers, the force of the water breaks up the limbs and carries the broken trees thru without difficulty.

The advantage of these gates under these particular conditions is obvious, and, by their use, the greater amount of the flood waters is discharged over the low section of the dam, preventing any considerable thickness of water over the crest of the higher section, and, in addition, the lake level undergoes no substantial change between the lowest and highest river stages, the minimum level being about 14 inches

3. THE HOLLOW CONCRETE DAM AT AUSTIN, TEXAS, UNDER CONSTRUCTION. NOTE THE FORMS FOR CONSTRUCTING THE PIERS AND WALLS TO SUPPORT THE CREST GATES AND THE BRIDGE. ALSO THE COFFER DAM BEHIND WHICH THE SLUICE GATES WERE CONSTRUCTED.

below the normal and the maximum level for heavy floods is not more than 34 inches above the normal level.

Obviously, the construction of these gates is strong and massive, due to the great pressures that they have to withstand. The pressure against each of the large gates, with normal elevation of lake level is about 64 tons, while the pressure against each of the small gates is about 8 tons.

Sluice Gates.

There are eight sluice gates set in pairs, each discharging into its own opening; the two individual channels merging into one large tunnel, which passes thru the dam. The gates are each 5 by 6 feet and are operated by pistons working in cylinders, the working fluid being oil under a pressure of 750 pounds per square inch. The cylinders are 12¾ inches inside diameter and the pistons have a 78-inch stroke. The direction of the water is changed on entering the throat of the sluice-gate passageway thru a gradual curve until the direction of flow becomes horizontal, and also, the channels increase in area gradually so that practically no eddy currents are formed until after the two individual channels merge into the single large one, which passes thru the bottom of the dam. Since this single channel is 18 feet wide, and approximately 14 feet high, the total area is 250 square feet, while the area of the openings of the two sluice gates is only 30 square feet each, or 60 square feet for the two. The velocity of efflux thru the sluice gates will be about 60 feet per second, while the velocity thru the main channel will be less than 15 feet per second.

It is to be noted that the oil-pressure cylinders which operate the gates are placed on the outside of the deck of the dam instead of inside the dam, as is usually customary. In this way the cylinders could be placed much nearer to the sluice gates than is possible when the cylinder is inside the dam, and the sluice gates outside, with the thickness of the inset of the deck wall between the two. This, of course, shortens the piston rod, which, when the gate is being closed, acts as a long column, and for a given diameter of rod, it is stiffer, or for a given pressure, a smaller rod may be used. This means that the size of the cylinder may be somewhat reduced. Furthermore, the saving in concrete and form work, effected by mounting these cylinders on the outside instead of the inside, amounted to some $5,000. Not having any inset made in it, the dam is stronger at the bottom than it would be with one. It is true that this method of installation has the apparent objection that the cylinders cannot be inspected or repaired, as they are normally under 60 feet of water. This objection,

2. THE FINISHED AUSTIN DAM, SHOWING THE DOWN-STREAM FACE. THE LARGE CREST GATES ARE SEEN, CLOSED. THEIR SUPPORTING PIERS, WHICH ARE EXTENSIONS OF THE TRANSVERSE WALLS IN THE DAM ITSELF, SUPPORT THE CONCRETE BRIDGE ABOVE.

however, is a purely academic one. The amount of operation of these gates will never be sufficient, in many years, for the element of wear to have any bearing on the subject. An ordinary Corliss engine, in two hours, will make more strokes than these cylinders will in fifty years. Metallic packing is provided so that it is permanent and not subject to deterioration with time, as most organic substances would be. The pistons are of bronze, so that there is no question of them sticking or rusting to the interior of the cylinders, and this is further prevented by the fact that the cylinders are continuously filled with oil.

A Deane, triplex, pressure pump, having a capacity of 40 gallons per minute, under a pressure of 850 pounds per square inch, is installed in the power station and driven by a Western Electric, induction motor, which is belted to the pump. A pressure by-pass is provided so that the pump can work continuously when the gates are being operated and any excess pumpage will pass from the discharge to the suction pipe, the by-pass valve between the two openings when the predetermined pressure for which it is set, has been reached. The high-pressure service pipe, and the low-pressure pipe for return of oil to the suction side of the pump, run from the power house into the dam and pass along the side of the walkway thru the dam, these two pipes forming two of the three railings on one side of the walkway. At each of the branch pipe connections to the gate cylinders is placed a specially designed, high-pressure 4-way valve and the movement of a valve in one direction or the other admits the oil, under pressure, to one end or the other of the operating cylinder it controls, thereby causing opening or closing of the gate.

In order to determine the position of the gates, an indicator is provided on each one, which comprises a section of $\frac{3}{8}$-inch copper wire cable attached to the gate, passing a short distance up the deck, then thru the deck into the inside of the dam. In the hole thru the deck is placed a piece of 1-inch pipe, which extends several feet into the inside of the dam, and it is thru this pipe that the copper wire cable passes. A stuffing box is provided at the inner end of the pipe, so that there is no leakage thru it, and on the inside end of the cable is hung a concrete weight of about 75 pounds. Where a change in the direction of the cable is made, it is properly guided on a pulley. Obviously, any motion of the gate produces a corresponding vertical motion of the weight at the end of the wire cable. Adjacent to the vertical path of this weight is placed a gage having the gate positions marked on it, corresponding to given vertical positions of the weight. In this way, a simple, positive and reliable gate indicator is produced.

The gates themselves are heavy slabs of cast iron, about $1\frac{1}{2}$ inches thick, 5 feet 8 inches wide by 6 feet 8 inches long, the smaller dimension being the transverse one. Heavy ribs are cast at intervals on the outer surface of this gate, tapering from 4 inches high at the end to $7\frac{1}{2}$ inches high at the middle, the thickness of the ribs being $1\frac{1}{2}$ inches. The spacing of the ribs is 12 inches. Each gate slides on a heavy cast iron frame work which is sunk into the concrete. The upper side of the gate frame and the under face of the gate are both lined with bronze strips 2 inches wide by $\frac{3}{8}$-inch thick. These gates have been operated a number of times under varying depths of water, and have proven themselves satisfactory in every particular. The sluice gates and frames were built by the Alamo Iron Works of San Antonio, Texas, while the cylinders with their pistons, and the operating, four-way pressure valves were made from special designs by the Tips Foundry & Machine Works of Austin, Texas.

Ornamental Street Lights in Los Angeles

Single-lamp standards of the type illustrated herewith are having a great vogue in Los Angeles and other communities in the Southwest, and constitute striking evidence of the growth of the artistic spirit in street lighting.

The standards are of Marbelite made by The American Cement Products Company of America.

The light is enclosed in a Moonstone plain ball made by the Jefferson Glass Company of Follansbee, W. Va.

The balls were personally selected by President Landwehr, of the Cement Products Company, and will be used on an extensive installation of this type on Wilshire Boulevard in Los Angeles, said to be one of the most attractive streets in the world.

These standards and balls have proved to be a most efficient lighting unit, and this fact coupled with their artistic merit promises a wide spread popularity for this type of street illumination.

Traffic Census and Pavement Maintenance

A STUDY OF THEIR RELATIONS

By Harry F. Harris, Assoc. M. Am. Soc. C. E., Assistant Engineer of Streets, Trenton, N. J.

It was quite unusual a few years ago to find any definite figures in regard to the cost of maintaining the various types of pavements on individual streets, in the different American municipalities. Buffalo, New York, Washington, D. C., Syracuse, New York, and a few other cities were conspicuous exceptions. But during the last half dozen years the number of cities tabulating such data has increased considerably, due to the fact that the importance of keeping these figures has been repeatedly referred to editorially, in the municipal engineering publications. The value of data of this sort has also been pointed out in numerous technical papers, so that the city engineers quite generally thruout the country have been pretty thoroly convinced that figures of this character are very essential.

However, the point which the writer wishes to emphasize is this: the information relative to maintenance costs is excellent so far as it goes. But, are maintenance cost records of real value without traffic records? It seems that this very praiseworthy idea of keeping accurate maintenance costs should go a step further. We should know under what conditions of traffic the street is placed. For example, a sheet asphalt pavement ten years old laid with Bermudez Lake asphalt on a 6-inch gravel-concrete foundation has an average cost per square yard per year of $0.001 for maintenance in one case; while a street built in the same manner with the same materials, six years old, has an average cost per square yard per year for maintenance of $0.092. Or to illustrate further, if we had data showing maintenance cost with traffic recorded therewith, we could determine within very narrow limts which would be the most economical form of construction for a given degree of traffic.

Having the traffic record would be advantageous for other reasons. We would be able to compare the wearing qualities of our fire-clay vitrified block, for instance, with shale block laid under identical traffic conditions, or still further we could determine up to what point it would be advantageous for us to construct plain macadam, and then to cease this form of construction and lay bituminous carpeted macadam, etc.

The cost of maintenance for a certain degree or intensity of traffic should be known. This is one of the most essential factors affecting maintenance costs, and if we do not have these data in conjunction with our cost per yard per year, our figures convey very little real information to us. It would therefore seem that the time has come to urge the adoption of methods which would result in bringing out information of this sort. Both the American Society of Municipal Improvements and the American Society of Civil Engineers are doing meritorious work in endeavoring to have definite units established for traffic census work. It is very important that we have our units standardized, because by working with arbitrary units the value of the work is reduced, when the records of one city are compared with another using different units.

In the city in which the writer resides, the engineers for some years realized the importance of keeping data of this sort, but until the year 1911, the administration of the city was conducted under the councilmanic form with 28 members, and it was then almost impossible to get any innovations into practice in the engineering department. The value of a new system of this character was difficult to impress upon the average laymen, who made up the committees directing the work of the engineering department. But during the year 1911 the plan of government was changed to the commission form, and, fortunately, a civil engineer of considerable experience was among those elected to office and he was placed in charge of the department of streets and public improvements as director, under which the engineering forces were attached. The value of this kind of data made instant appeal

CITY OF TRENTON N. J.

Department of Streets & Public Improvements

STREET MAINTENANCE COSTS

Kind of Pavement	Date Paved	No. Yds.	Price Per Yd.	Contractor	No. Years Guaranteed	Depth of Wearing Surface	Depth of Binder	Foundation	Depth of Sand Cushion.	Kind of Grout.	Kind of Brick
Trinidad Lake Asphalt	Dec 15, 1903	7110 9	$2.06	Barber Asp Pav. Co	5	2"	1"	Concrete 6"			

Year	No. Yds. Repaired	Price Per Yd.	Contractor	Remarks	Cost of Maintenance: Repairs	Cost per sq. yd. per year	Average cost per sq. yd. per year
1909	11.00	$1.35	Filbert Pav & Con Co.		$14.85	$.00209	$.00035
1910	0 00	0.00	—		0 00	00000	00029
1911	20.57	1.59	Newton Paving Co.		32.70	.00460	.00084
1912	114.20	1.28	City Plant		146.18	.02056	00303
1913	2 42	1.50	Newton Paving Co.		3.64	.00052	.00278
1914	11.84	1.34	City Plant		15 87	.00223	00273
1915	32.21	1.44	City Plant		46 38	.00652	.00304

DIVISION ST From HAMILTON AVE. To ROEBLING AVE.

Form A-3

CITY OF TRENTON N J

ONE-DAY TRAFFIC RECORD

Form 2

12 hrs, from 7 A M to 7 P M. Date ______ 19__ Day of Week ______

Location of observer ______ Ave, St between ______ Ave St and ______ Ave St

Width of roadway between curbs at place of observation ______ yds

Effective traffic width 1 yd. less than full width ______ yds

CONDITION OF SURFACE wet, dry dirty, clean, slushy, covered with ______ in snow ______

WEATHER rain, clear, foggy, dry, snowy, ______

TEMPERATURE ______ F approximate average

KIND OF PAVEMENT ______

QUALITY OF SURFACE new old, even, slightly uneven, very uneven ______

STREET CAR TRACKS, single track, double track, ______

KIND OF RAIL tee grooved girder, flanged girder, ______

KIND OF PAVING IN TRACK AREA ______

APPROXIMATE SPEED OF HORSE VEHICLES ______ miles per hr

APPROXIMATE SPEED OF AUTO VEHICLES ______ miles per hr

REMARKS ______

BETWEEN HRS	Horse Vehicles 1-horse	Horse Vehicles 2-horse	Horse Vehicles 3-horse or more	Total Horse Vehicles	Total Auto Vehicles	Total Number All Vehicles	Tons Horse Vehicles	Tons Auto Vehicles	Total Tons All Vehicles	Total Tons per yd of effective width	Total Vehicles per yd of effective width
7 A M to 8 A M											
8 " 9 "											
9 " 10 "											
10 " 11 "											
11 " 12 M											
12 M to 1 P M											
1 P M to 2 "											
2 " 3 "											
3 " 4 "											
4 " 5 "											
5 " 6 "											
6 " 7 "											
Totals for 12 hrs											

Weight Assumptions:
1-horse vehicles average 1 ton
2 " " " 2 tons
3 " " " 4 "
Auto

______ Observer

FRONT PAGE OF RECORD SHEET.

to him, when the suggestion that such records be made was presented, and since that time maintenance and traffic records have been kept, altho at first the utility of the traffic census was questioned.

A reproduction of the form used for recording the information is shown herewith with the traffic record on the reverse side. The forms for tabulating data collected by observers and the units used are those which the Committee on Traffic of the American Society of Municipal Improvements, recommended for adoption, in 1912. We believe, however, that the weights assigned for the various classes of vehicles should be revised in some particulars, after our experience in using them.

It is quite probable that the lack of data on maintenance costs and traffic records can be ascribed in many instances to obstacles over which the engineering departments have very little control or influence, as for example the condition which obtained in our own city prior to the change in form of government. There seems to be no question but that the more cumbersome forms of administration militate against advanced and progressive ideas in many respects.

The following scheme for recording traffic is presented, as a workable plan, which may be utilized in cities where difficulty is encountered in obtaining help and funds required to collect the data relative to traffic. The idea is simply given for what it is worth. In Trenton this difficulty was overcome in a unique way and the scheme worked very satisfactorily and enabled us to collect valuable information which would have been impossible under any other conditions.

STATION	TRAFFIC CENSUS SURFACE	WET—DRY / CLEAN—DIRTY
	WEATHER	RAIN—SNOW / CLEAR—FOG
DAY / TEMPERATURE	DATE 191 HOUR / °F	A. M. P. M.
1-HORSE / 2-HORSE / 3 OR MORE	HORSE DRAWN	
2-3 PASS / MOTOR CYCLE	LIGHT MOTOR	
4 OR MORE PASS. LIGHT TRUCKS / HEAVY TRUCKS, &c	HEAVY MOTOR	
	OBSERVER	

BACK PAGE OF RECORD SHEET.

The suggestion was made that high-school students who were contemplating or considering engineering as a career or profession might be pressed into service, because the work was primarily engineering and should appeal to them. The idea was presented to the principal of one of the high schools with an explanation of just what the information was to be used for.

The principal thought the idea a capital one, and immediately agreed to co-operate to the fullest extent. He arranged the periods of the classes in such a manner that an ample

CITY OF TRENTON, N. J.

FINAL CONSOLIDATED TRAFFIC RECORD

Form 3

Period observed ______ days of 12 hrs each, 7 A M to 7 P M Date ______ 19__

Days of week ______

Location of observer ______ Ave, St, between ______ Ave St and ______ Ave St

Width of roadway between curbs at place of observation ______ yds

Effective traffic width 1 yd less than full width ______ yds

CONDITION OF SURFACE: wet, dry, dirty clean, slushy, covered with ______ in snow

WEATHER rain, clear, foggy, dry, snowy, ______

TEMPERATURE ______ F approximate average

KIND OF PAVEMENT ______

QUALITY OF SURFACE new old even, slightly uneven, very uneven, ______

STREET CAR TRACKS: single track, double track ______

KIND OF RAIL: tee, grooved girder, flanged girder, ______

KIND OF PAVING IN TRACK AREA ______

APPROXIMATE SPEED OF HORSE VEHICLES ______ miles per hr

APPROXIMATE SPEED OF AUTO VEHICLES ______ miles per hr

REMARKS ______

DAYS	No. of Vehicles Horse	No. of Vehicles Auto	Total Number All Vehicles	Total Tons Horse Vehicles	Total Tons Auto Vehicles	Total Tons All Vehicles	Total Tons per yd of effective width	Total Vehicles per yd of effective width
First day								
Second day								
Third day								
Fourth day								
Fifth day								
Sixth day								
Totals								
Average per day of 12 hours								

Weight Assumptions
1-horse vehicles average 1 ton
2 " " " 2 tons
3 " " " 4 "
Auto " " 1½ "

Compiled by ______

number of recorders was available at all times. The students were used in conjunction with the few men available from the department. In many cases the boys were on the job at 7. a. m., and on Saturday afternoon, as the census was continued for one week. The hourly tally cards used by the students were printed by them in their own shop, which was attached to the school. This printing they volunteered to do themselves, without any suggestion on our part.

Forms used by students are reproduced herewith, as well as the daily and weekly summary forms. The forms for students' use had to be made just as simple as possible, as boys of this age are not expected to use the judgment or have the experience which could be looked for in experienced observers, but taken all together the plan worked out excellently and the work was thoroly enjoyed by the pupils.

It is to be hoped that more thought and study will be given this important factor in the study of road and pavement economics. As matters now stand serious study must be given to the forms and especially the units to be adopted.

SUMMARY OF TRAFFIC RECORD.

W. HANOVER ST. from CALHOUN to PASSAIC.

Year	Av no Auto vehicles per 12 hr day.	Av no Horse vehicles per 12 hr day.	Total no all vehicles per 12hr. day	Vehicles per yard of width	Tons per yard of width	Remarks
1915	410 G	250	558	60.4	80.1	Census taken in early spring

City Planning for Bridgeport, Conn.

By John Nolen, City Planner, Cambridge, Mass., and Frank B. Williams, Attorney at Law, New York.

TO THE student of civics seldom if ever has any city presented problems so numerous, so important, or so varied, as does Bridgeport today. The typical new boom town and its failings we know; the old city and its difficulties are always with us; but not until the advent of the munition business of the present war have we encountered. in an acute form as in Bridgeport, boom city problems and old city problems combined and interrelated.

"Before war was declared in Europe, Bridgeport had a population of about 102,000. Today, it has nearly 150,000, a phenomenal increase of nearly 50% in twenty months. It has not yet reached its maximum, and this gain will undoubtedly continue until the city has at least 200,000 population. * * * One concern, it has been publicly stated, has made an investment in Bridgeport in new factories, land, machinery, etc., of $20,000,000 or more. Other local industries have grown proportionally."

Such growth causes, in Bridgeport, the evils that it causes in any city, new or old, in which it occurs,—rising rents, scarcity of houses, of schools, of play and recreation grounds—scarcity, in short, of all the facilities of city life; and the disorder and immorality that seem so inevitably to follow in the wake of stunted municipal life. No wonder the report asks the pertinent question:

"It has been said that a new man is employed in Bridgeport every ten minutes, and one is tempted to inquire what is being done every ten minutes to provide this new citizen with the essentials of city life?"

These are the problems so commonly found in boom cities. In Bridgeport they are complicated and made more acute and difficult of solution by the problems typical of the old city. The business centre is not only congested, but firmly established and rigidly confined in its narrow limits; the slum areas, also fixed, are still more over-crowded; the inadequate houses, being also in many cases old, are still less able to house decently the increased numbers that crowd them.

Under these circumstances, in Bridgeport as elsewhere, the difficulties to be overcome are, by many people, regarded as entirely housing problems. If housing in its complete sense is meant, this is, no doubt, true; otherwise nothing could be more false. The construction of houses and nothing more is a mere palliative; the only cure is the increase also along right lines, of all the municipal facilities—streets, sewers, parks, etc.; a wise regulation of all future building; and a change, so far as absolutely necessary, in the framework of the old city so as to remove the most hampering of its faults and limitations due to its constructions, such as the narrowness of some of its main thorofares, the congestion of its business centre, etc. This is city planning; and fundamental city planning is perhaps the one thing that cities are slowest to see the need of and do.

Bridgeport not long ago issued a report, by Mr. Nolen, entitled "More Houses for Bridgeport;" and, soon afterwards, a $1,000,000 corporation was formed to build them. The present report shows that she has also begun to face the more fundamental city planning difficulties which beset her.

The following passage from the introduction to the second or legal part of the report, by Mr. Williams, indicates its necessity, its purpose and its scope:

"In order better to meet this exigency, Bridgeport has caused a survey of her situation to be made. The reports of Mr. Nolen and myself now submitted state the results of that survey, with recommendations, based on it, for the improvement of that situation. Mr. Nolen's report is occupied with the physical aspects of the subject, while mine is concerned with its no less important legal aspects. In a democracy like ours, no public enterprise can be accomplished except by methods sanctioned by law.

"This report will first take up the legal problems with regard to the planning of that part of Bridgeport and its environs which is at present within the legal limits of the city. In so doing it will deal first with the question of the city planning agency or executive for the city, its membership and powers: Secondly, with various specific legal powers which the city needs in its planning as follows: the adoption of a city plan, excess condemnation; building regulation and districting; Thirdly, with the financing of Bridgeport's city planning; Lastly, with the planning of greater Bridgeport, so intimately connected with the problems involved in the planning of the present city.

"The legal proposals of this report are all urged as more or less specific aids in carrying out the suggestions contained in Mr. Nolen's report for the improvement of the physical situation in Bridgeport. But this is not their sole purpose. It is hoped that the measures advocated in this report are also those legal measures of which in her planning Bridgeport is most in permanent need."

THE MILL CREEK SEWER

TUNNEL CONSTRUCTION ON THE GREAT ST. LOUIS DRAIN

By E. J. Rossback, 32 Ave. des Champs Elysees, Paris, France.

This article is a valuable practical contribution to contractors' practice in driving and lining drainage tunnels, showing how the work was done by the several contractors to whom the sections were awarded.

The Mill Creek Valley sewer at St. Louis, Mo., was constructed to handle storm waters and intercepts the existing system.

General Features.

The sewer has its beginning at Duncan and Vandeventer streets and follows roughly an east and west line to its mouth in the Mississippi river at the foot of Rutger street. Its total length is 20,040 linear feet, the first 2,000 feet west from the river being open cut and the remainder in tunnel. The tunnel has a section of horse-shoe shape, with pay lines 19 by 19½ feet. The cubic yardage per running foot is 11.75 and the estimated quantity of excavation in tunnel was 208,000 cubic yards.

Description of Sections.

The Carter Construction Company, of New York, the successful bidder on the entire job, divided the work into four sub-contracts, one open cut and three tunnel sections. The American Contracting Company of St. Louis was awarded the open-cut sub-contract, from the river to Broadway, 2,000 feet. The McMahon Construction Company, also of St. Louis, was given the next 5,000 feet, to 18th street: Brocklehurst and Potter Company, of New York, undertook the next 6,500 feet to Virginia avenue, and Thomas Connor & Sons had the sub-contract on the last 6540 feet to the end of the sewer at Duncan and Vandeventer streets. The line of work intersected a railroad, manufacturing and residence district, just south of the main business arteries of St. Louis. This made the disposition of the material excavated somewhat of a problem and expense. Blasting, also, was attended with some restrictions.

Thomas Connor & Sons.

Thomas Connor & Sons found their section to contain 600 feet of soft ground, and 5940 feet of rock.

Their driving was handled thru three working shafts proper. In addition, one connection, known as the Rock Springs connection, was started from a small shaft, and one manhole was sunk just across Vandeventer avenue from the Duncan shaft.

This sub-contract involved approximately 100,000 cu. yds. of excavation (running over the engineer's estimate), 25,000 cu. yds. of concrete and 4,000 cu. yds. of brick masonry.

Work was begun on the shafts about November 15, 1914, the headings were turned about December 15, 1914, excavation was finished July 25, 1915, and the concrete lining was completed on December 20, 1915.

Shaft Construction.

The shaft at Theresa and Chouteau streets is 112 feet deep and has inside dimensions of 12 by 16 feet. The Tamm shaft is 94 feet deep with the same inside dimensions. It was started thru "made" ground and sheet steel piling was driven to the rock. The Duncan avenue shaft was next sunk by the open caisson method. It has a diameter of 16½ feet and is 88 feet deep. The last 34 feet was curved from the vertical to the horizontal on a 25-foot 9-inch radius. The Rock Springs connection shaft was sunk somewhat later. It has an inside diameter of 10 feet and is 94 feet deep, and was also sunk by the open caisson method. Just before completion of the excavation a manhole 6 feet in diameter was sunk opposite the Duncan shaft to serve permanently as a means of access to the sewer. This is 88 feet deep. All shafts were sunk with self-rotating hammer drills. All were equipped with double compartments and single-drum electric hoists, except the Rock Springs shaft and the manhole. The former was equipped with scale boxes and an air-operated hoisting engine of the usual construction type and the latter with buckets.

Tunnel Methods.

The drive west from the Tamm shaft included 400 feet of quick-sand, while that eastward involved 200 feet of soft clay. Both of these soft-ground sections were handled without air pressure. Quicksand in the tunnel roof was supported by grouting and driving sheeting, a small pilot heading being driven in the center of the top of the tunnel section. Much difficulty attended this sheeting work because the quicksand rested on clay which contained limestone boulders. The bench consisted of more or less solid limestone. Great credit is due the contractor for the really ingenious manner in which the difficulty was overcome. Twelve by twelve timbers were placed skin to skin, 12-ft. to 16-ft. wall plates being employed. The spaces between the timbers were tightly calked with oakum. Some idea of the weight supported by these timbers, due to the unequal ground pressure in this formation, may be gained from the accompanying illustration. This shows 5-segment, 12 by 12 timbering with the wall plates carried on solid rock benches. Several segments began to give way and required temporary supports as shown. Part of the timbering west of the Tamm shaft was on rather a sharp curve and the accurate manner in which it was placed speaks well for the ability of the men in charge. The clay east of the Tamm shaft presented a somewhat less difficult task, altho the boulders in the clay made the work troublesome. Three 8-hour shifts were worked most of the time while driving thru the soft ground. One hundred feet of 21 by 9 feet heading, all in soft material, was driven from the Rock Springs shaft. This was timbered

COMPRESSOR HOUSE AND HEAD FRAME, ARMSTRONG SHAFT, BROCKLEHURST AND POTTER.

solid, and the bench, all in rock, removed from the Tamm shaft.

The rock encountered in this sub-contract was partly the characteristic Mississippi limestone prevalent about St. Louis, and partly a tough, silicious, blocky and seamy limestone. The latter gave considerable trouble in the heading, but drilled very well in the bench, due, no doubt, to its horizontal stratification.

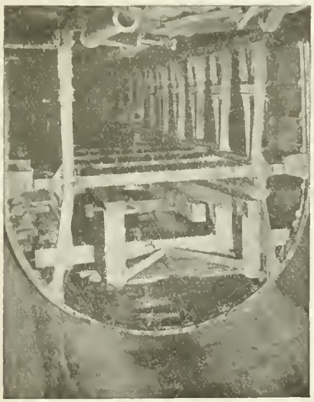
A top heading 7 feet high was driven, constituting about 30 per cent of the cross section, followed by a 3-foot bench and a 9-foot sub-bench. The benches were kept as close as possible to the heading to minimize the length of the wheelbarrow haul from the heading. All mucking was done by hand labor and was the determining factor in the progress rate, the heading being shut down from time to time to allow the bench to catch up.

Drilling the Headings.

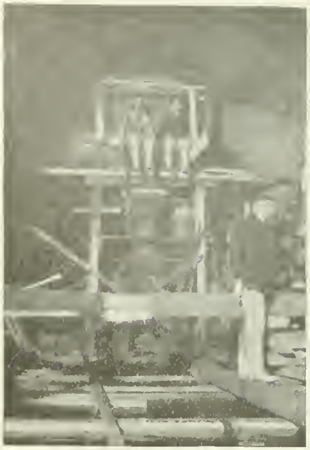
The heading was drilled by two drills mounted on two columns, one on either side. Each drill was operated by a runner and helper. The heading round consisted of from 18 to 24 holes, six to eight of which were center "V" cut holes. Two relief holes in the center of the cut were drilled and shot simultaneously with the cut holes in the hard rock with excellent results. The depth to which the heading holes were drilled varied with the conditions, 8 to 12 feet being the usual range of the cut holes. The heading rounds pulled from 6 to 9 feet as a rule, altho an advance of break of 11 feet was recorded. Six to seven hours were required on the average to drill the heading round. Two self-rotating hand drills drilled the bench and sub-bench, the holes being spaced about 4 feet back and 4 feet apart. This spacing was closer than necessary to break the bench, but was found advantageous in order to avoid sledging. One-inch 60-per-cent forcite was employed in both heading and bench. All shots were fired electrically from a switch on the timber head frame.

Sullivan Liteweight 2⅝-inch water drills were used in the headings at the beginning of the work, but were later replaced in part with mounted water-hammer drills, which proved superior in efficiency in the silicious limestone. This was characterized by flint nodules and presented a really tough tunneling proposition. Six Sullivan "DR-6" type drills were used in this work with excellent results and to the complete satisfaction of the contractor.

The record for driving in rock (made in the section east



PORTABLE STEEL CONCRETE FORMS IN PLACE. BRACING FOR THE ARCH.



HOPPER AT FOOT OF WELL DRILL HOLE FROM SURFACE, AND PNEUMATIC CONCRETE MIXER.

of the Tamm shaft) was 116.2 feet of heading and bench in 13 ten-hour shifts, and average progress of a trifle less than nine feet per shift. The average daily progress in each heading and bench (two 10-hour shifts) was 11.5 feet. The longest drive in one direction from any shaft on the job was approximately 2,000 feet (west of Theresa shaft). This required from January 1 to August 1. Four hundred and two feet of completed tunnel section were driven east from the Tamm shaft in 56 10-hour shifts.

Air Compressor Equipment.

All of the power used was derived from electric current, furnished at 220 volts, three-phase, 60-cycle by the Union Electric Company of St. Louis at a remarkably low rate, somewhat under one cent per kilowatt-hour. The air plants consisted of two class WJ cross compound belt-driven Sullivan air compressors, having a displacement of 1,008 cubic feet per minute each, one located at Theresa and one at Tamm shaft. These machines did excellent work thruout the job, running 48 days continuously without a shut-down on a number of occasions. They delivered air at pressure ranging from 90 to 120 pounds per square inch.

All of the muck was handled from the shafts by team, the hauls being short (not over one-half mile each way from any shaft). Most of the rock muck was crushed either in a plant near the Theresa shaft, consisting of one No. 5 gyratory crusher, or in the one near the Tamm shaft, consisting of a No. 3 crusher. It was then sold, or stored for use as the aggregate for the concrete lining. The balance of the rock muck and the soft muck was dumped in a lot as filling.

Pneumatic Lining Method.

The concrete lining was placed by the pneumatic method, with the exception of the invert, which was placed from cars. The success with which the pneumatic method was attended is shown by the following records. The best performance was the placing of 640 feet of lining in 127 hours of actual operation. In September, 1915, 1,880 linear feet of lining was placed in 46 10-hour shifts, 680 feet of which was placed in 13 shifts, or one week. In October, 1915, 1,753 feet was lined in 46 shifts, which performance is noteworthy because of the

CONCRETE FORMS BULKHEADED, AND CONVEYOR PIPE FROM PNEUMATIC MIXER.

fact that this stretch contains two sharp curves. It may be mentioned in passing that the tunnel section was very closely adhered to in the driving, the overbreak representing not over ¾ cubic yard per linear foot of tunnel. Forty-foot standard steel forms were employed in the pneumatic concreting. The mixing apparatus was furnished by the Concrete Mixing and Placing Company.

The working day consisted of two 10-hour shifts except in the soft ground, as noted previously. An abundance of labor was available at all times, aiding to reduce the cost of the work. Powder was also considerably cheaper when the contracts were made than at this time. In the neighborhood of $40,000 was saved by the Connor Company alone, as against present prices.

The cars used were 1¾ cubic yards water measure. Pipe scaffolds were employed to support the runway from the heading to the end of the sub-bench.

Brocklehurst & Potter Section.

The section of the Mill Creek sewer sublet to the Brocklehurst & Potter Company was the middle 6,500 feet of the tunnel, and was characterized by almost ideal conditions. It was practically dry, all pumping being handled by 7 by 5 by 13-inch air-driven piston pumps at each shaft, operated only between shifts; it was possible to drive the sub-bench and bench 100 feet without losing a ledge, or stratification plane to which to break, thus making mucking less arduous. No soft ground was encountered and the formation was the characteristic Mississippi limestone thruout.

The tunnel was driven from three shafts, one at Armstrong street, another at Montrose, and the third at Ohio street, six headings being operated simultaneously. Eighty thousand cubic yards of rock excavation were involved (3,000 of which were shale). The concrete lining amounted to 25,000 cubic yards.

The Armstrong shaft, 15 by 19½-foot rough, 12 by 12½-foot inside the lining and 95 feet deep, was begun October 29, 1914, and headings were turned on December 17. The Montrose shaft has the same dimensions as the Armstrong and is 79 feet deep. This was sunk by the open caisson method. It was begun on November 25, 1914, and the headings were turned January 5, 1915. The last, or Ohio shaft, also a drop shaft, single compartment, 9 by 12½ feet rough and 6 by 9 feet lined, 77 feet deep; was begun on February 2, 1915, and the headings were turned on March 8, 1915. The first two shafts each contained two compartments. The longest distance between shafts is 1,500 feet.

As on the Connor job, the top heading, bench, and sub-bench system was employed, the heading being 9 feet, the bench 3 feet, and sub-bench 7½ feet high. Hand mucking again proved the limiting factor as regards progress on this job, as on the one described above. The cars were of 1 2/3 cubic yards capacity water measure.

Driving with Hand Hammer Drills.

Of the six headings, one was drilled with Liteweight 2⅝-inch water drills, one with drills of a mounted water-hammer type and the other four with self-rotating hand hammer drills of the DP-33 type, held to the face by hand by two men. In each of the first two headings, the equipment consisted of four drills mounted on two columns and three hand-hammer drills for the benches. Five hand-hammer drills were used in each of the other headings. The bench holes were spaced as on the sub-contract described above. The headings were also drilled in similar fashion, 18 to 24 holes being used. A normal round consisted of 6 center V-cut holes, and two sets of eight holes each constituted the side rounds. The drilling time varied from 4 to 6 hours. A hammer cut was employed at times when the conditions of the heading were suitable.

The average completed tunnel excavation per working shift from the time the headings were turned was 4.4 linear feet for the entire job, and, from the time the cages were installed in the shafts, the average advance per shift was 5.1 feet. An advance or break of 8½ feet in one heading in one shift was recorded, altho the average break in the headings was about 5 feet. Sixty per cent, 1-inch forcite was used on this job also, for heading and bench. The best sustained records were made from the Montrose shaft. The west heading and benches were advanced 1,472 feet in 298 shifts, a progress of 4.95 feet per shift. The east heading and benches were advanced 947 feet in 166 shifts, a progress of 5.77 feet per shift.

Concreting Work.

The lining was placed, as in the case of the Connor job, by the pneumatic method. From July 19 to December 9, 1915, 1,928 working placing hours, 163 forms 40 feet long were concreted. This work involved the handling of 18,000 cubic yards of concrete and extended for a length of 6,261 linear feet. Eight different set-ups of the "gun" were required, the time for the set-ups being subtracted from total shift time to arrive at the above number of hours of placing. Eighty-nine cubic yards were placed per 10 hours of steady shooting and 73 cubic yards per 10-hour working shift, total time. The best work was done when 737 feet of tunnel was lined in 13 10-hour shifts, making a record of 144 cubic yards placed per shift of total time. Four forms were used as against three on Connor's work.

On the other sub-contracts, the concrete mixers were situated in the tunnel and the materials conducted to them by feed pipes dropped thru well-drill holes which had been bored for the purpose of checking the tunnel alinement. On the Brocklehurst and Potter job, the concrete was mixed on the surface and conducted thru the drop pipe to the "gun." The power of the rotator hammer drill was demonstrated interestingly in this connection. One of these pipes, dropped thru a 12-inch hole 57 feet deep, clogged, and the concrete set at a point 38 feet from the top.

After vain efforts to dislodge this mass of concrete, a 38-foot rod of 1-inch-round iron was made into a drill by welding on a ⅞-inch hexagon shank at one end and a cross bit at the other. This was lowered into the hole and put to work with a self-rotating hand drill. The first drill tried failed to make any progress; but when a Sullivan rotator was substituted, the 6-foot concrete plug was penetrated in two minutes. Two sticks of dynamite, 60 per cent, were then lowered to the center of the plug and shot with an electric exploder, shattering the concrete so that what remained was easily removed from the walls of the drop-pipe with a hand churn drill.

Motor Trucks for Disposal.

The muck was disposed of in similar fashion to that noted above. The shale was wasted in a dump. The solid rock was hauled by 5-ton motor trucks, to a crusher plant and storage pile. The haul was 1.3 miles each way, on the average. The trucks gave a splendid account of themselves, working 24 hours per day with the exception of Sundays. The contractor estimates that approximately 25 cents per yard was saved thru the use of the trucks as against teams. This saving was in part due to the self-dumping feature of the trucks.

Ventilation.

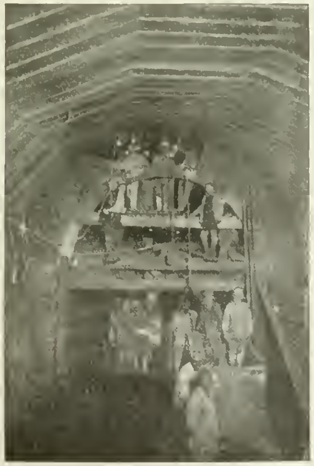
The blower equipment for ventilating the tunnel may be of interest as it is typical of that used on the other sections. It consisted of two electrically-driven No. 5-B blowers, rated at 2,000 cubic feet per minute, one each at the Armstrong and Ohio shafts, and one No. 8-B blower, rated at 6,000 cubic feet, at the Montrose shaft. The air was carried to the face by collapsible canvas tubes hung in hoops at the side of the tunnel. Powder smoke gave some trouble early in the job, but this was soon overcome.

All plant equipment was electrically driven with the exception of the pumps. Each shaft was provided with an electric hoist, and two 1,000-foot class WJ cross-compound air compressors were installed at the Armstrong shaft, air being piped to the other two shafts. The air pressure was maintained at from 90 to 120 pound gage. These compressors also gave noteworthy satisfaction. Only one delay could be charged to these compressors and that was only of a few minutes' duration and was occasioned by the breaking of a belt splice. These machines also operated continuously, at 24 hours per day, for long stretches of time without any sort of a shutdown.

All tunnel excavation was completed on July 15, 1915, concreting was begun on June 20, and finished December 9, 1915.

McMahon Construction Company.

The James T. McMahon Construction Company executed the work just west of the open cut section for a distance of 5,000 feet, 750 of which consisted of soft ground.



12x12 TIMBERS SET "SKIN TO SKIN," AND BEGINNING OF THE BRICK LINING IN SOFT GROUND SECTION.

COMPLETED AND LINED SECTION, MILL CREEK TUNNEL.

This work was handled thru two working shafts, one at 6th street and the other at 12th street.

The sub-contract involved 65,000 cubic yards of excavation 12,000 cubic yards of concrete lining and 3,000 cubic yards of brick masonry. Work was begun on the 6th street shaft on November 29, 1914, and was completed in 11 days. The 12th street shaft was begun on the 25th of November, 1914, and completed on January 1, 1915. The heading west from 6th street was turned about December 1, 1914, and the two headings were turned, east and west, from the 12th street shaft about January 3, 1915. Both shafts are 12 by 16½ feet inside of the lining. The 6th street shaft, 40 feet deep, was arranged for single compartment hoisting and the 12th street shaft, 90 feet deep, had two compartments. Both shafts were sunk with Sullivan class DP-33, self-rotating hand-hammer drills.

Soft Ground and Timbering.

The excavation in the four soft-ground sections carried about 16 cubic yards per running foot and consisted of soft clay, containing many limestone boulders. It was impossible to drive sheeting thru this formation. The section just west of 12th street was very wet, a stream of water pouring down from the top pilot heading. The timbers were 12 by 12 inches, set either skin to skin or on 30-inch centers. The timbering in this section was exceptionally well done and presented a most pleasing appearance. (See illustration.)

The rock on this sub-contract was the characteristic Mississippi limestone, with the exception of a section near the west end of the job, where flint nodules gave difficulty in drilling. A bottom heading 8 by 13 feet was used except in the soft ground section.

Piston Drills in the Headings.

The heading was drilled by four Liteweight 2⅝-inch water piston drills on two double screw columns. For the breakdowns and wings, self-rotating hand hammer drills, class DP-33 were employed. The heading round consisted of 22 to 24 holes, eight of which were center "V-cut" holes. Both cut and side round holes were drilled from 7 to 9 feet deep, giving an average break per shot of 4.5 feet. The heading was shot twice per shift and at times five times in two 10-hour shifts.

The average heading progress was about 18 feet each 24 hours. The breakdowns and wings were shot, as desired, to equalize the amount of muck that could be handled. Jumbo timbers were set up in the bottom heading and the breakdown shot onto them.

The muck from the breakdown was then dropped into 2-yard cars placed below the timbering. The bottom heading system was found to lend itself with special advantage to the handling of the work whenever soft ground was encountered, and it became necessary to drive up and start a pilot heading. Under these conditions, the practice was to drop back and work upon the wings and breakdown, thus maintaining a uniform output of muck from the shaft. The powder cost under this system was also pleasingly low. The powder consumption in the headings was 4 pounds per cubic yard, and in the breakdowns and wings ½ pound per cubic yard.

The Sullivan FF-12 water drills used in the headings gave a very satisfactory account of themselves and easily handled the drilling for two shots per 10-hour shift. In some instances the total time per shift, during which air was on the drills, was as low as one hour and thirty-seven minutes. When the flint nodules were encountered in the heading, a mounted water-hammer drill, class DR-6, was used for a distance of about 150 feet at the western end of the job, and handled this difficult formation to excellent advantage. The self-rotating hand-hammer drills did rapid and efficient work in shaft sinking, in the breakdown, wings and for drilling the boulders found in the clay.

The tunnel excavation was completed about December 1, 1915, altho concreting had begun in certain sections about August 1, the same year. The best week's driving record in the heading was 140 feet. A 5-foot section of heading between 6th and 12th streets, averaged 105 feet per week. Very little trimming was required and the over-break was unusually low; between 6th and 12th streets being under the allowance of 6 inches.

Power Plant.

All of the power used on this job was electric current at 220 volts, 3-phase, 60-cycle, furnished by the Union Electric Company of St. Louis, as was the case on the other sub-co[ntracts]. All equipment, including the hoists, was driven [by] motors. The air plants consisted of one Sullivan WJ cro[ss] compound short-belt-driven air compressor, located at the 12[th] street shaft, and one 628-foot angle compound WJ-3 Sulliv[an] compressor at the 6th street shaft. A second 628-foot WJ also short-belt-driven, was purchased later and used for a ti[me] at the 6th street shaft and then moved to the 12th street sha[ft] when concreting was first begun. These compressors gave t[he] same excellent satisfaction as was recorded on the other su[b-] contracts. The air pressure varied from 100 pounds p[er] square inch gage to 125 pounds.

All muck was handled from the shafts by teams, the ha[ul] from all the shafts to the crusher plants not exceeding o[ne-] half mile for the round trip. The concrete lining was plac[ed] by the pneumatic method with the exception of the inve[rt] which was placed from cars. A record of 50 ¼-yard batch[es] per hour of shooting time was recorded.

This job contained some rather wet sections and abo[ut] fifteen hundred million foot gallons were pumped per mont[h]. A centrifugal pump was employed at 6th street and pist[on] pumps were in use at the 12th street shaft.

The cars used were 1¾-yard water measure. One-inch, [...] per cent dynamite and No. 6 caps were used. All blasti[ng] was done electrically, a switch being placed at the collar of t[he] shaft.

It may be of passing interest to note that the 2,000 feet [of] open cut just west from the Mississippi river contained 50,0[00] cubic yards of very close excavation and 11,000 cubic yar[ds] of concrete work. This work was handled by the Americ[an] Contracting Company.

In concluding, the writer begs to thank the officials of t[he] Carter Construction Company, of Messrs. Thomas Connor [&] Sons, of Brocklehurst & Potter, and of J. T. McMahon Co[n]struction Company, for courtesies received in the preparati[on] of these accounts.

Massachusetts Municipal Electric Plants Show Gains

A largely increased business, with a proportionate growth in income, is reflected in the annual returns of Massachusetts municipal electric light plants, as filed with the Gas and Electric Light Commissioners for the year which ended June 30, 1916. A study of several of the larger plants, which generate energy at their own stations either wholly or in part, shows that the gains in output of the municipal undertakings in the state are fully commensurate with the growth of company business, over the year 1914-15.

In the table of operating data, the amounts and cost of coal used are presented. Prices for fuel vary, of course, with the freight rates, the plants located on tide water enjoying the advantage of lower costs. While a comparison of total costs of energy generated and distributed needs all the factors entering into the local situation to represent a valuable study, yet the appended table of total costs per kilowatt-hour may be of interest. Generally, the larger the volume of energy generated, the lower the cost of production; and the same is true with respect to cost of distribution, power used in the larger units, and lighting supplied in larger quantities per meter, representing the minimum of cost for this item. The lowest cost, that for the Holyoke plant, is due in part to the fact that the energy is in large part hydroelectric, while the comparatively low costs at Taunton and Danvers are due in part to the fact that these plants enjoy the advantage of water-borne coal. Distribution represents, of course, a large factor in the operation of any elctric plant, and the higher figures given represent residential communities, where t[he] energy is used in small units by householders, and the pow[er] load is not an important item. In comparison with the tot[al] cost of production and distribution for the Massachuset[ts] municipal plants it is interesting to note the correspondi[ng] costs, fixed charges excluded, for electric light compani[es] operating in towns and cities of about the same size. The[se] figures, in contrast, form an excellent commentary on t[he] efficiency of management and operation with which municip[al] plants in the state are being conducted.

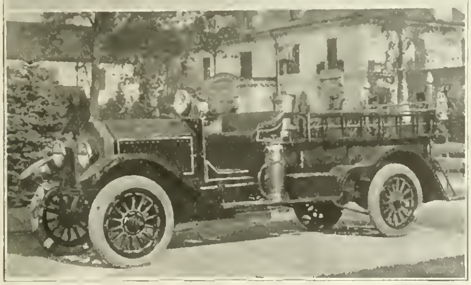
The Taunton plant's showing is also excellent. Here t[he] output was increased 1,300,000 units, or 31.5 per cent, whi[le] expenses were only 15.8 per cent more than for the ye[ar] 1914-15. In this city of foundries and stove works, the pow[er] load gained 830 connected horsepower, a considerable part [of] this being a motor installation in a foundry works whi[ch] recently located in the city.

The Reading plant also shows important increases, esp[e]cially in its lighting load. The kilowatt-hour output increase[d] nearly 25 per cent, the income 21 per cent and the operati[ng] expense 23 per cent. The profit balance from operation [of] $16,279 is 34 per cent on the volume of business done. T[he] North Attleboro plant, under the continued management [of] William Plattner, relied, the past year, principally on pu[r]chased power. Only the Westfield plant, of those under co[n]sideration, showed a deficit from operation, and this depar[t]ment of the town is now about to be reorganized.

FIRE DEPARTMENT

Mistake About "Hoosier" Pump

The surprising demonstration of power efficiency shown in the recent test of the Hoosier Pump at South Bend, Ind., was—thru a typographical error—misrepresented on page 225 of our December issue. Instead of "250 gallons per minute" as therein stated, the Hoosier Pump has a rated capacity of



350 gallons per minute. The record made with a pump of this capacity is one which fire chiefs will appreciate. The pump in question is made by the South Bend Motor Car Works, of South Bend, Ind.

Middletown, Conn., Is Federalized.

Chief Pitt, of the Middletown, Conn., department, is the oldest fire chief in the State in point of years of service, and he is likewise one of New England's most enthusiastic advocates of completely motorized fire-fighting equipment.

The city of Middletown has two Federal trucks in service, one a chemical combination wagon, the other a 7,500-lb. tractor, which has just been installed.

The following tables, compiled by Chief Pitt, are interesting as throwing more light on comparative operating costs of motor apparatus and horse-drawn equipment:

COMBINATION WAGON FOR ONE YEAR.

Gasoline	$23.84
Oil	2.00
	$25.85
Feed	$297.41
Shoeing	44.25
	$341.66
Alarms answered	56..
Miles traveled	500

7,500-LB. TRACTOR PUT INTO SERVICE APRIL 27, 1916.

Gasoline at 25c	22.80
Oil	1.00
	$23.80
Care of 3 horses—	
Feed	$547.84
Shoeing	72.30
	$620.14

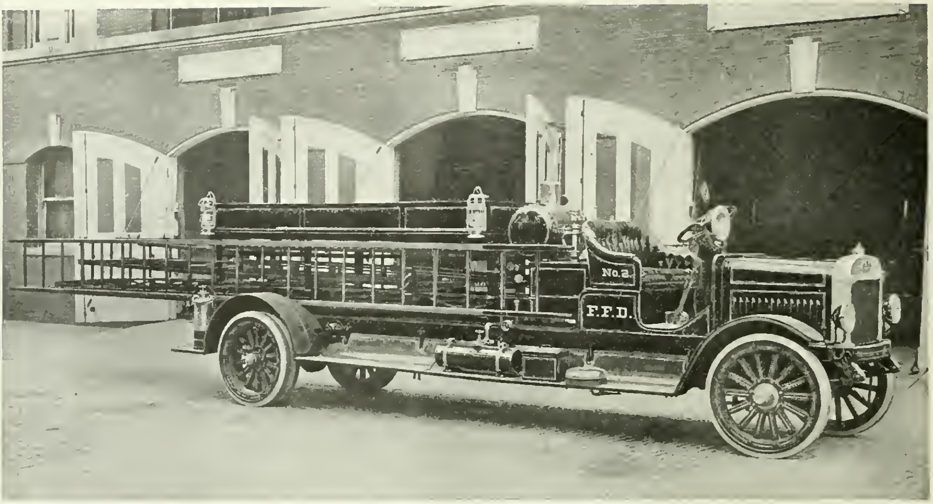
Cost of gasoline and oil for July and August for both the combination wagon and the 7,500-lb. tractor, $2.50.

Trend Is Toward Motorization.

Among the recent installations of Hale motor apparatus are combination chemical and hose trucks (some of them equipped with trussed extension ladders and chemical engines) to the cities of Ashland, Pa.; Excelsior Springs, Mo.; Silver City, N. M.; Monett, Mo.; Moberly, Mo.; New Kensington, Pa.; Claremore, Okla., and Ozark, Mo.

Packard apparatus was recently put into service by the villages of River Forest, Ill.; South Brownsville, Pa.; Baltimore, Md.; Alemeda, Cal., and the boro of Parnassus, Pa. The city of Elgin, Ill., recently purchased two 1½-ton Packard chasses and adapted its old horse-drawn equipment to them "at a slightly lower outlay than was originally planned for investment in a single vehicle."

American-La France motor apparatus is either already in service or are now being built for use by the following Canadian municipalities: Halifax, N. S. (1); London, Ont. (2); Ottawa, Ont. (2); Hull, Que. (1); Lachine, Que. (2); St. John, N. B. (1); Stratford, Ont. (1); Sydney, N. S. (1); Toronto, Ont. (6); Westmount, Que. (1); New Waterford, N. S. (1); Winnipeg, Man. (2). It is noteworthy that most of the



GRAMM-BERNSTEIN 2½-TON COMBINATION CHEMICAL, LADDER AND HOSE TRUCK, AS OPERATED BY THE CITY O FARRELL, PA. A HIGH PRESSURE AIR TANK IS USED INSTEAD OF THE ACID AND SODA COMBINATION.

foregoing are pumping cars. The city of Toronto now operates two combination chemicals, one service truck, three tractors and has placed an order for still another combination. Other recent deliveries of motor apparatus include the cities of Reading, Pa.; Carbondale, Pa.; Hibbing, Minn.; Paragould, Ark.; Murray, Utah; Steelton, Pa.; San Angelo, Tex.; Sharon, Pa.; Altoona, Pa.; Arnegard, N. D.; Hudson, Minn.; Glasgow, Mont.; Ogden, Utah; Hutchinson, Kas.; Waterloo, Iowa; St. Cloud, Minn.; Marion, Ohio; Lakewood, Ohio; Cornwells Heights, Pa.; Dayton, Ohio (5 pieces); Greeley, Colo.; Battle Creek, Mich.; Muskegon, Mich.; Sioux City, Iowa, and Burlington, N. J.

Note how many of the above departments just motorized are for small town service.

What Baltimore Is Doing.

If the board of estimates of Baltimore, Md., grant the request of the fire board, 4 new engine tractors, 7 new ladder truck tractors and 3 new combination chemical and hose tractors will be purchased for the fire department. There are now remaining in the fire department only 161 horses. If the fire board's request is granted only 99 horses will be in service next year. It is stated the tentative inclination of the members of the estimates board is to allow the new motor apparatus.

Fire Department Notes

Officials of the city of Mt. Vernon, N. Y., have systematically built up one of the most efficient fire departments owned by any city of the same size by the gradual process of replacing its old horse-drawn apparatus with motor fire-fighting equipment. The process of elimination and upbuilding began five years ago when the city purchased its first White combination chemical and hose truck and at least one of these modern fire-fighters has been added to the fleet each year since that time.

Schlingmann of Jeannette

Paul C. Schlingmann, present Fire Chief for the City of Jeannette, Pa., was for 23 years in the service of the Pittsburgh department, retiring as a lieutenant in July, 1914. He has been with the Jeannette department ever since the organization of a paid staff, which came about in February, 1915. He report that the change from a volunteer to a paid department ha worked out very beneficially to the community, saving co siderably more in property values than the addition in salarie The Jeannette department is motorized.

Hitchcock of Council Bluffs.

F. G. Hitchcock, well-known fire chief for the City of Cou cil Bluffs, Ia., joined the local volunteer department as a torc boy in 1878. Ten years later he was appointed on the pai fire department as a truck driver, and in 1892 was made Ca tain at the Central Fire Station. After eight more years able service in that capacity he was appointed Assistant Chie and in 1914, at the age of 54 years, was appointed Chief of th entire department. "A good man and true"—as he often ha demonstrated.

Lindsay of Boise City.

C. F. Lindsay, Fire Chief of the City of Boise City, Idah has been connected with the department for 17 years pas beginning at the very bottom and working his way steadil up the ladder. He was Assistant Chief for three years an received his appointment as Chief in 1903. He knows hi business and does it thoroly. Chief Lindsay's ambition the complete motorization of his department and he is accon plishing that end by buying one new piece of apparatus eac year.

Paul C. Schlingmann C. F. Lindsay F. G. Hitchcock

Motor Apparatus in Fire Departments

(*Continued from December number, page 44 of Motor Truck section.*)

In the second column of this table, in describing combinations, *ae* stands for aerial ladder equipment; *ch*, chemical; *chf*, chief's car; *ho*, hose; *h.p.*, high pressure; *L*, electric; *l*, ladders carried on combination trucks; *ladd*, city service hook and ladder equipment; *mot*, motorcycle; *pp*, gasoline pumping engine truck; *sal*, salvage corps truck; *sq*, squad wagon; *st*, steam pumping engine; *sup*, supply wagon; *tow*, water tower; *tr*, tractor; *tr. ae*, aerial ladder truck hauled by tractor; *tr. la*, hook and ladder truck hauled by tractor; *tr. st*, steamer hauled by tractor; *tur*, turret. o in column of "Years service" means that apparatus is new or not yet in service. *p*, pyrene cylinders.

1—Cost of gasoline and repairs. 2—Cost of gasoline, oil and tires. 3—55 gallons gasoline, 3 gallons oil. 4—180 gallons gasoline, 10 gallons oil. 5—40 gallons gasoline, 3 gallons oil. 6—106 gallons gasoline, 4 gallons oil. 7—Difference in cost of repairs in the two machines due to pneumatic tires on one and Dayton airless on the other. Both cars now equipped with Dayton airless. 8—Cost of repairs and gasoline and oil. 9—Materials only; repair work done by drivers or mechanicians in fire department. 10—Cost of repairs for all 28 machines in the department. 11—Cost per horse employed in the department. 12—6 gallons. 13—Sum for four American-La France pumping and combination. 14—These cost figures include all three pieces of apparatus and the cost of gasoline and oil includes also some police apparatus. 15—10 miles of streets in good condition, 5 fair, 15 bad. 16—gallons of gasoline. 17—542 gallons gasoline, 30 gallons oil. 18—121 gallons gasoline, 20 quarts oil. 19—214 gallons gasoline, 75 quarts oil; 20—25 per cent good, 40 per cent. fair, 35 per cent. bad. 21—40 per cent. good, 40 per cent. fair, 20 per cent. bad. 22—Two-thirds good, one-third fair.

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Indiana—													
Terre Haute........	chf	Cadillac	7-12	4	38	....	...	...	3,114	297	42.69	60.14	85.50
	chf	Overland	7-12	4	35	....	...	...	2,589	297	....	49.10	85.50
	chf	Chevrolet	7-12	4	22	....	...	...	2,435	297	....	32.50	85.50
	ch ho l	Oldsmobile	7-12	4	36	750	40	20	59	297	11.97	5.20	143.00
	ladd	Seagrave	7-12	4	73	....	...	283	38	297	4.10	25.97	143.00
	ho ch	Pierce-Arrow	1-3	6	48	900	35	20	24	297	....	5.50	143.00
	ho ch	White	7-12	4	40	1,000	35	20	63	297	5.45	17.28	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	38	297	4.00	16.17	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	50	297	....	18.94	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	57	297	....	22.37	143.00
	ho ch	Robinson	7-12	4	40	1,000	35	20	41	297	4.70	15.11	143.00
Vincennes........	chf	Olds	6	1	10	....	...	...	....	....	72.00	187.27	127.54
	ch ho	Webb	6	6	70	900	36	74	123	45	419.00	15.60	....
	ch ho	Buick	1	4	37	950	50	21	....	....	....	....	....
Whiting...........	ch ho	Knox	5	4	50	1,200	36	70	123	45	419.00	15.60	....
Iowa—													
Ames..............	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	....	....	....
Burlington.........	ch ho l	Am.-La France	3½	4	75	1,000	40	32	295	182	13.50	54.00	292.00
Cedar Falls........	ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Cedar Rapids.......	chf	Chandler	2	..	40	0	1	0	228	315	0	....	....
	ch ho	Am.-La France	3	4	47	1,000	40	40	523	247	....	....	....
	pp ch ho	Am.-La France	2	6	125	1,000	40	40	137	278	85.67	....	....
	ch ho	Am.-La France	1	..	47	1,000	40	40	550	220	....	....	....
	ladd	Am.-La France	½	4	70	....	...	235	....	....	....	....	....
Clinton............	ch ho	Am.-La France	1	6	100	1,400	35	32	....	....	....	....	....
Council Bluffs......	chf	Marion	2	6	50	....	6	...	375	200	143.00	56.00	....
	ch ho	Webb	4	4	74	1,000	40	32	283	150	600.00	30.00	300.00
	ch ho	Boyd	4	4	74	1,000	40	32	110	73	150.00	11.50	300.00
Davenport..........	chf	Marmon	2	6	40	0	24	0	725	319	0	43.50	....
	ho	Ford (2)	1	4	...	450	6	32	80	40	0	....	....
	ho	Seagrave	3	6	80	1,000	6	...	210	107	....	....	....
	ch	Ford	1	4	...	0	35	32	80	40	0	....	....
	ch ho l	Seagrave (4)	¼	6	80	1,200	6	32	90	45	0	....	....
	ladd	Seagrave	3	6	80	900	6	231	310	141	....	....	....
	pp ho	Seagrave	¼	6	110	1,200	6	32	90	45	0	....	....
	tr	Seagrave	3	6	80	0	18	313	210	116	0	....	....
Des Moines........	tr	Am.-La France	3	6	80	0	6	177	250	450	100.00	....	....
	ladd	Am.-La F. (4)	3	6	80	0	0	235	250	450	100.00	....	....
	ch ho l	Am.-La F. (6)	3	6	80	1,000	40	25	500e	100e	....	....	....
	pp ho	Am.-La F. (3)	3	6	80	1,000	0	0	450	170	....	....	....
	chf	Chalmers	3	6	50	....	...	...	1,500	999	....	....	....
	ch ho l	Seagrave (4)	..	..	...	....	...	...	....	....	....	....	....
Dubuque...........	chf	Saxon	..	..	...	....	...	...	....	....	....	....	....
	ch ho l	Am.-La France	2	4	70	1,000	70	32	....	....	....	....	....
	pp ch ho	Robinson	2	..	...	1,000	...	...	....	....	....	....	....
	pp ch ho	Am.-La France	2	6	100	1,000	40	32	....	....	....	....	....
Ft. Dodge..........	ch ho l	Pope-Hartford	3½	4	48	1,200	40	36	112	86	77.20	54.52	....
	ladd	Seagrave	1-3	6	79	....	...	307	....	....	....	....	....
	pp ho	Seagrave	1-3	6	79	1,200	...	40	....	....	....	....	....
Grinnell............	ho ch	Am.-La France	3	4	58	1,400	45	40	59	27	0	3.75	....
Iowa City..........	chf	Velie	4	4	45	....	5	...	....	82	20.00	30.00	....
	ch ho	Seagrave	4	6	80	1,200	50	...	....	82	15.00	30.00	....
Keokuk............	pp ch ho	Am.-La France	1½	6	105	1,000	45	40	800	200	....	....	....
LeMars............	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Marshalltown......	ch ho l	Kissel (2)	5	4	50	1,000e	53e	40e	....	....	....	....	....
		Kissel	3	6	60	1,000	56	59	170	124	59.20	65.00	596.27
	ch la	Kissel	2	6	60	....	35	231	140	100	7.80	18.61	....
	mot	Harley-Dav.	2	2	11	....	...	...	2,000	....	24.00	49.26	....
Mason City.........	chf	Ford	..	..	...	....	45	...	....	83	....	....	....
	ho	(1)	..	..	...	....	...	...	....	....	....	....	....
	ae	To be delivered Feb. 15, 1917.											
Muscatine.........	sq		..	..	...	....	...	...	....	....	....	....	....
	ch ho	Am.-La France	3½	6	105	1,000	46	44	....	....	....	....	....
	ch ho	Am.-La France	1-3	4	75	1,000	46	44	....	....	....	....	....
	ch ho	Am.-La F. (2)	½	..	...	....	...	...	....	....	....	....	....
Oskaloosa..........	ch ho	Am.-La France	4	4	72	1,200	40	34	210	104	16.03	21.70	376.00
Ottumwa..........	ch ho	White (2)	2	6	60	1,200e	23e	36e	30	13	10.00	57.00	....
	ae	Seagrave	2	6	80	....	...	360	....	....	....	....	....
Perry..............	ch ho	Am.-La France	2	6	100	1,400	40	32	....	....	....	....	....
Sioux City..........	ch ho	Robinson	4	..	105	1,100	...	...	....	....	....	....	....
	ch ho l	White (3)	4	..	60	1,100	...	...	....	....	....	....	....
	ae	Am.-La France	1	6	105	....	6	177	....	....	....	....	....
	ladd	White	3	..	60	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	1-3	6	105	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	o	..	75	1,100	...	...	....	....	....	....	....
	chf	Haynes	o	..	55	....	...	...	....	....	....	....	....
Washington........	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Waterloo..	chf	Cadillac	3	4	34	....	...	...	....	....	....	....	....
	ladd	Am.-La France	2	6	100	....	...	235	....	....	....	.......[17]	....
	ch ho	Seagrave (2)	4	6	90	1,000e	40e	...	....	....	....	.......[18]	....
	ch ho	Dort (2)	2	4	36	1,000e	40e	...	....	....	....	.......[19]	....
Kansas—													
Atchison...	chf	Chalmers	1	6	40	....	6	...	900	115	12.24	50.56	190.00
	ch ho l	Webb, Thomas	6	6	79	1,500	40	34	164	96	150.64	29.16	370.00
	pp ho	Webb, Thomas	5	6	79	1,200	...	...	221	115	10.63	56.52	550.00
Chanute.....	chf	Hale	3	4	40	200	60	...	100	40	40.00	25.00	....
	ho	Buick	1	4	37	1,150	6	60	75	40	10.00	25.00	....
Ft.-Scott........	ch ho	Am.-La France	1	4	70	1,000	40	40	75	73	....	49.21[8]	306.06
	chf	Dodge	1	4	25	....	3	...	....	73	....	....	....
Independence..	chf	Kissel	4	4	50	150	70	...	190	70	0	....	....
	ho	Buick	1	4	35	1,000	6	38	150	60	0	....	....
	ch ho	South Bend	1	6	140	1,200	6	48	100	40	0	....	....
Kansas City.....	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
		Kissel)											
		Oakland)											
	chf	Chamlers)	3	6	40	....	...	...	....	....	....	....	....
		Thomas)											
		Anderson)											
	ch ho	Robinson	6	6	90	1,000e	210a	180	2.412	....	20.70	876.00a	....
	pp ho	Thomas	1	6	90	1,000	...	30	588	....	....	....	....
	ladd	Kissel, Thomas	2	6	90	....	70	46	2,212	....	....	....	....
Leavenworth.......	chf	Chandler	1	6	40	....	...	...	....	....	....	....	....
	ch ho	Kissel	3	6	70	1,300	40	50	....	134	....	....	....
	ch ho l	White	3	6	70	1,300	40	50	....	134	....	....	....
	ladd	White	1	6	70	....	40	250	....	134	....	....	....
Liberal............	ch ho	Brockway	1	..	...	....	...	...	....	....	....	....	....
Manhattan.........	ch ho l	White	3	6	60	1,200	40	28	....	32	....	....	....
Newton............	pp ch ho	Am.-La France	2	6	105	1,200	46	24	102	44	20.50	33.30	....
Olathe..............	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
Parsons............	chf	Kissel, Anderson	2	4	50	....	73	...	3,000	98	62.00	37.00	196.00
	ch ho l	Kissel, Anderson	1	4	60	1,000	35	36	360	31	20.00	30.00	609.00
	ch ho l	Kissel, Anderson	1	6	75	1,000	40	45	22	77	18.00	34.00	687.80
Pittsburg..........	chf	White	1½	4	200	41	...	...	....	....	....	....	....
	ho	White	1	6	...	1,000	41	...	....	....	....	....	....
Salina..............	chf	Mitchell	6	4	42	400	3	0	1,000	85	....	....	....
	ch ho l	Anderson	5	6	49	1,100	46	44	400	85	....	....	....
Topeko............	chf	White	1	4	30	....	6	...	4,321	3	20.31	95.44	....
	ch ho	Am.-La France	3	4	48	1,250	40	32	319	130	250.06	51.85	....
	tr	Am.-La France	2	6	100	....	6	177	....	....	....	....	....
	ch ho	Am.-La France	1	6	100	1,400	40	32	....	....	....	....	....
	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	....	....	....
	ladd	Speedwell	3	4	50	....	12	156	633	237	210.17	37.13	....
Wichita...........	chf	Mitchell, Lewis	5	6	48	....	...	...	....	262	....	....	....
	ho	Boyd	2	6	79	1,200	...	...	....	....	....	....	....
	ch ho l	Webb	7	4	60	1,000	70	34	....	....	....	....	....
	ch ho l	Seagrave	1	6	79	1,000	45	24	....	....	....	....	....
	ae	Seagrave	4	..	79	....	...	85	....	....	....	....	....
	ladd	Seagrave	2	6	79	....	...	50	....	....	....	....	....
	pp ho	Webb	6	6	72	1,000	800	30	....	....	....	....	....
	ch ho	Boyd	2	6	80	1,000	45	34	....	....	....	....	....
	tr	Seagrave (2)	..	..	...	....	...	...	....	....	....	....	....
Kentucky—													
Ashland............	ch ho l	Seagrave	½	6	125	750	40	275	260	40	....	....	....
	pp ch ho	Seagrave	½	6	125	1,500	40	34	240	....	....	40.59	....
Covington..........	tr	Am.-La France	2	4	70	....	...	...	....	....	....	....	....
Frankfort..........	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Fulton.............	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	....	....	....
Hickman...........	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Hopkinsville........		Has no motor apparatus at present.											
Lexington..........	chf	Jeffery	3	4	40	....	...	...	2,600	122	308.22	44.94	....
	ae	Am.-La France	3	4	60	....	6	260	147	91	51.88	19.05	700.00
	ch ho l	Knox	5	4	50	800	35	36	325	216	126.07	30.46	400.00
	pp ch ho	Knox	5	6	100	1,200	36	36	161	104	120.05	32.38	820.00
Louisville..........	ae	Am.-La France	4	4	70	....	...	260	....	....	....	....	....
	sal	Am.-La France	3	4	70	....	6	32	....	....	....	....	....
	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	....	....	....
	chf	Jeffery	3	4	40	....	...	...	2,600	122	308.22	44.94	....
	ladd	Am.-La F. (2)	1	4	70	....	...	235	....	....	....	....	....
Mayfield...........	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Newport...........	ho		..	4	40	900	...	...	....	....	....	....	....
	ladd		..	4	55	....	...	...	....	127	....	70.00	....
Paducah...........	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	....	....	....
	ho ch	Jeffery (4)	..	4	29	....	...	...	....	....	....	....	....
Louisiana—													
Baton Rouge.......	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	....	....	....
Donaldsonville......	ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	....	....	....
Hammond..........	ch ho	Am.-La France	1	4	70	1,400	35	32	....	....	....	....	....
	ch la ho	Brockway	½	4	42	1,400	40	200	....	....	....	....	....
Houma.............	pp ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Monroe.............	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	....	....	....
Morgan City.......	ch ho l	Am.-La France	2	6	38	1,200	40	24	300	46	140.00	25.00	....
New Iberia.........	ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
New Orleans.......	pp ho	Am.-La France	2	6	200	1,200	6	32	....	....	....	....	....
	ch ho	Am.-La France	2	6	55	1,400	40	32	....	....	....	....	....
	tow	Am.-La France	2	6	100	....	...	...	....	....	....	....	....
	ladd	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	½	6	200	1,200	6	32	....	....	....	....	....
Plaquemine.......	ch ho	Am.-La France	½	6	65	1,400	40	32	....	....	....	....	....
Ruston.............	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
Shreveport.........	chf	Hudson	2	4	60	....	...	...	....	....	....	....	....
	ho	Reo	2½	4	30	1,000	...	...	....	89	....	....	....
	ch ho l	Seagrave	6	4	62	1,200	60	36	....	251	....	....	....
	ch ho l	Am.-La F. (2)	2	4	48	1,200	60	36	....	271	....	....	....
	pp st	Am.-La France	4	6	90	....	...	...	....	70	....	....	....
	pp ch	Am.-La F. (2)	4	4	48	1,200	40	36	....	91	....	....	....
	pp ho	Am.-La France	1	6	136	1,500	0	23	....	180	....	....	....
	tr	Martin	4	4	48	0	0	250	....	....	....	....	....
W. Monroe.........	ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	....	....	....
Maine—													
Bath...............		Has no motor apparatus at present.							....	....	....	....	....
Lewiston...........	ch ho l	Am.-La France	4	4	73	1,200	46	24	700	270	75.00	65.00	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Portland	ho ch	Am.-La France	o	..	...	2,000	70	...					
Rumford	ch ho	Am.-La France	3	6	100	1,400	40	32	....	....	....	....	....
Skowhegan	ch ho	Knox	1½	4	5	1,000	80	41	300	40	3.00	43.50	....
Maryland—													
Annapolis	ae	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
Arlington	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
Baltimore	tr	Am.-La France	3	6	73	....	...	...	....	2,062	....	....	....
	sal	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
	tr	Couple Gear	4	..	...	....	...	...	....	....	....	....	....
	ho h p		1	..	...	....	...	...	....	....	....	....	....
	tr	(7)	1	..	...	....	...	...	....	....	....	....	....
	chf	(1)	1	..	...	....	...	...	....	....	....	....	....
	ho	(17)	..	..	...	....	...	...	....	....	....	....	....
	pp	(13)	..	..	...	....	...	...	....	....	....	....	....
	pp ho	(1)	..	..	...	....	...	...	....	....	....	....	....
	ae	(7)	..	..	...	....	...	...	....	....	....	....	....
	sup	(2)	..	..	...	....	...	...	....	....	....	....	....
	chf	(11)	..	..	...	....	...	...	....	....	....	....	....
	ch ho	(1)	..	..	...	....	...	...	....	....	....	....	....
	tr	(7)	½	..	...	....	...	...	....	....	....	....	....
	ho	(3)	½	..	...	....	...	...	....	....	....	....	....
	chf	(1)	½	..	...	....	...	...	....	....	....	....	....
Cambridge	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Catonsville	pp	Am.-La France	6	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	4	6	100	1,200	6	32	....	...	....	....	....
Crisfield	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Cumberland	ch ho l	G. M. C.	2-3	4	36	800	76	32	....	38	84.76	68.75	223.32
Govanstown	pp ch ho	Am.-La France	3	4	70	1,400	36	32	....	....	....	....	....
Hagerstown	ae	Am.-La France	3	4	76	....	6	177	....	....	....	....	....
	pp ho	Am.-La France	1	6	38	1,200	40	32	....	....	....	....	....
Salisbury	pp ho	Am.-La France	½	6	100	1,200	6	32	....	...	....	....	....
Towson	pp ho	Am.-La F. (2)	3	6	38	1,200	40	32	....	....	....	....	....
Massachusetts—													
Adams		Has no motor apparatus.											
Amherst	pp ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Andover	pp ch ho	Am.-La France	4	4	70	1,400	36	32	....	....	....	....	....
	ch ho	Am.-La France	2	6	100	1,400	40	32	....	....	....	....	....
Attleboro	ch ho	Knox	4	4	48	1,200	46	40	133	32	40.00	.......[3]	....
	ch ho	Knox	6	4	48	1,200	46	40	647	111	75.00	.......[4]	....
	ch ho	Federal	3	4	28	1,000	36	32	74	24	30.00	.......[5]	....
	ch ho	Kelly-Springfield	..	4	30	1,000	56	40	....	....	....	....	new
	tr	Knox-Martin	3	4	40	....	56	190	135	60	12.00	.......[6]	....
Belmont	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
Beverly	chf	Willys-Over.	2	4	30	....	6	...	4,000	164	12.00	....	364.00
	ch ho	Am.-La France	4	4	70	1,000	76	30	600	164	13.50	30.15	....
	ch ho	White	2	6	...	1,000	76	30	600	164	13.50	30.15	....
	tr	Knox-Martin	2	4	...	....	...	...	600	164	50.00	....	....
	pp st	Am. Brit.	4	..	...	....	...	...	16	13	0	30.00	....
Boston	ch ho	Am.-La France	6	..	...	....	...	...	....	....	....	....	....
	ladd	Am.-La F. (4)	4	4	70	....	...	236	....	....	....	....	....
	ch ho	Am.-La F. (3)	4	4	70	1,400	35	32	....	....	....	....	....
	pp ho	Am.-La F. (2)	3	6	100	1,200	6	32	....	....	....	....	....
	ch ho	Am.-La F. (2)	3	4	70	1,400	35	32	....	....	....	....	....
	tr	Am.-La F. (2)	3	6	100	....	6	177	....	....	....	....	....
	ae	Am.-La France	3	6	100	....	6	182	....	....	....	....	....
Brockton	chf	Pope	4	4	70	....	3	...	8,825	145	393.16	260.75	....
	sq	Pope	1¼	4	60	700	48	40	377	231	127.51	53.84	....
	ch ho l	Pope (6)	..	4	60	1,400	46	40	98	90	42.82	16.80	....
	tr la	Pope (3)	..	4	60	....	6	...	95	65	82.65	17.60	....
	tr st	A. & B.	2	4	40	....	...	...	98	76	....	15.20	....
Brookline	ladd	Am.-La France	3	4	70	....	...	236	...	....	....	....	....
	pp ho	Am.-La F. (3)	3	6	100	1,200	6	32	....	....	....	....	....
	tr	Am.-La France	1	6	73	....	...	...	....	....	....	....	....
Chelsea	chf	Hudson	¼	..	76	300	35	...	800	634	0	....	....
	ch ho	Knox	4	..	60	1,000	70	60	1,000	534	....	....	....
	ladd	Robinson	3	..	80	300	40	380	700	534	....	....	....
	pp ch	Robinson	4	..	110	1,200	60	60	800	534	....	....	....
Chicopee	chf	Stevens-Dur.	6	6	40	....	...	...	....	311	100.00	80.00	200.00
	sq	Stevens-Dur.	2	6	40	....	...	...	....	150	....	....	....
	ch ho	Mack (2)	2	4	40	1,000	30	36	....	100	....	....	....
	ch ho	Knox	2	4	40	1,000	30	36	....	100	....	....	....
	ladd	Robinson	1	6	80	....	...	225	....	....	....	....	....
	pp ch ho	Knox	5	4	90	1,000	...	36	....	100	....	....	....
	pp ch ho	Robinson	1	6	110	1,000	...	36	....	100	....	45.00a	....
Clinton	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Concord	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	½	4	70	....	...	235	....	....	....	....	....
Dedham		Has no motor apparatus at present.											
Easthampton	chf		..	..	...	2,000	...	...	....	50	....	....	....
	ch ho	White	3	..	...	....	40	48	142	....	....	....	....
	tr	Knox	..	..	...	....	...	224	....	....	....	....	....
Everett	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Fall River	ae	Am.-La France	2	6	100	....	6	177	....	....	....	....	....
	pp	Am.-La F. (3)	1	..	...	....	...	...	....	...	....	....	....
	pp ho	Am.-La F. (2)	1	6	100	1,200	6	32	....	....	....	....	....
	ch ho	Am.-La F. (4)	1	4	70	....	35	32	....	....	....	....	....
	ae	Am.-La F. (2)	1	4	70	....	...	182	....	....	....	....	....
	tr	Am.-La France	1	6	73	....	...	...	....	....	....	....	....
	ch	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	....	....	....
Fitchburg	ch ho l	Am.-La France	4	4	48	1,250	46	32	409	282	215.60	33.14	600.00
	ch ho l	Am.-La France	2	4	48	1,250	46	32	443	....[7]	15.00	36.04	....
	chf	Cadillac	¾	8	31	0	6	0	....	....	....	....	....
Franklin	ch ho	Comb. Lad. Co.	2	4	36	800	35	40	250	50	10.00	....	....
	pp	Water'us on Cad.	1	4	40	....	...	...	50	50	....	....	....
Gardner	chf	Buick	..	4	40	....	...	...	150	....	....	....	....
	ch ho	Knox (2)	..	4	50	1,000	40	48	210	76	475.00[8]	....	400.00
	tr	Knox	..	4	40	....	...	...	50	23	407.00[8]	....	700.00
Holyoke	tr	Am.-La F. (2)	3	6	73	....	...	...	....	....	....	....	....
	ch ho	Am. La F. (2)	3	4	70	1,400	35	32	....	...	....	....	....
Hopedale	pp ch ho	Am.-La France	½	..	...	....	...	...	....	...	....	....	....
Hull	pp ho	Am.-La F. (2)	4	6	100	200	6	32	....	....	....	....	....
Lawrence		No motor apparatus.											

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Lenox	ch ho	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
Lexington	ch ho	Am.-La France	5	4	70	1,400	35	32	....	....	....	....	....
Lincoln	ch ho	Brockway	1	..	...	....	...	...	....	....	....	....	....
Lowell	pp	Robinson	½	6	110	1,200	35	50	....	....	....	....	....
	chf	Oakland (2)	5	4	30	....	6	...	....	....	....	....	....
	chf	Buick	2	6	40	....	...	...	....	....	....	....	....
	sal	Knox	6	4	40	200	...	20	519	263	....	....	....
	ch ho	Knox	4	4	40	1,000	35	32	411	172	....	....	....
	ch ho	Robinson	½	4	90	1,000	35	32	294	183	....	....	....
	ch ho	Robinson (2)	½	4	90	1,000	35	50	....	....	....	....	....
	ch ho	Seagrave	4	6	80	1,100	35	32	288	179	....	....	....
Lynn	chf	Chalmers	6	..	...	....	...	...	....	....	....	....	....
	chf	Pope-Hartford	2	..	...	....	...	...	....	....	....	....	....
	chf	Buick	1	..	...	....	...	...	....	....	....	....	....
	sq	Pope-Hartford	5	..	...	....	...	...	....	....	....	....	....
	ho	Federal (6)	3	..	...	....	...	...	....	....	....	....	....
	ch	Pope-Hartford	..	..	...	....	...	...	....	....	....	....	....
	ch	Knox	..	..	...	....	...	...	....	....	....	....	....
	ch ho	Knox	3	..	...	....	...	...	....	....	....	....	....
	ch ho	Seagrave	3	..	...	....	...	...	....	....	....	....	....
	ch ho	Federal	3	..	...	....	...	...	...	....	....	....	....
	ladd	(3)	3	..	...	....	...	...	....	....	....	....	....
	ae		3	..	...	....	...	...	....	....	....	....	....
	pp ho	Ahrens-Fox	3	..	...	....	...	...	....	....	....	....	....
	tr st	A. & B. (5)	3	..	...	....	...	...	....	....	....	....	....
	tr la	Knox-Mar. (4)	3	..	...	....	...	...	....	....	....	....	....
Malden	chf	Knox	5	4	40	....	...	...	....	249	....	....	....
	ch ho	Knox	..	4	60	950	35	...	864	....	....	....	....
	ch ho	White	..	..	...	....	...	...	784	....	....	....	....
	ch ho	Seagrave	1	6	90	1,000	40	...	....	....	....	....	....
	ladd	Seagrave	1	6	90	....	...	325	163	....	....	....	....
	ladd	Knox	7	..	...	....	...	...	....	....	....	....	....
Marblehead	pp ho	Am.-La France	4	4	75	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
	ch ho	Am.-La France	..	..	...	....	...	...	....	....	....	....	....
Maynard	ch ho	Am.-La France	3	4	60	1,200	40	30	127	11	6.20	19.27	....
Medford	ladd	Am.-La France	4	4	70	....	...	235	....	....	....	....	....
Melrose	chf	Studebaker	3½	..	22	....	...	...	1,750	99	....	....	....
	ch ho		5	..	...	800	120	...	200	....	....	....	....
	ch ho	Studebaker	3	..	60	1,000	120	90	268	....	....	....	....
	ladd		¾	..	80	....	...	298	183	....	....	....	....
Milford		Has no motor apparatus at present.											
Milton	ch ho	Am.-La France	1	6	105	1,100	70	32	160	50	....	....	500.00
	ladd	Am.-La France	1	6	105	....	...	235	50	13	....	....	280.00
	pp ho	Am.-La France	½	6	105	1,200	40	250	20	4	....	....	400.00
New Bedford	chf	Locomobile	5	4	30	....	...	...	....	....	....	....	....
	ho	Locomobile	1	..	...	....	...	...	....	....	....	....	....
	ch ho	Locomo. (3)	..	..	...	....	...	...	....	....	....	....	....
	ch ho l	Locomobile	..	..	...	....	...	...	....	....	....	....	....
	pp	Ahrens-Fox	..	..	...	....	...	...	....	....	....	....	....
	pp	Robinson	..	..	...	....	...	...	....	....	....	....	....
	pp	White	..	..	...	....	...	...	....	....	....	....	....
	pp	Webb	..	..	...	....	...	...	....	....	....	....	....
Newburyport		Has no motor apparatus at present.											
Newton	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Norwood	chf	Ford	2	4	22	....	6	...	....	....	....	....	....
	pp ch ho	Maxim	1	6	75	1,200	40	42	....	....	....	....	....
Peabody	pp ch ho	Am.-La France	o	..	...	....	...	...	....	....	....	....	....
	chf	Chandler	½	6	60	0	2	0	....	....	0	....	....
Pittsfield	ae	Am.-La France	4	4	75	....	6	177	....	....	....	....	....
Quincy	chf	Kissel	o	6	45	....	...	...	....	....	....	....	....
	ch ho	Am.-La France	6	4	60	1,200	40	30	....	....	153.85	60.75	....
	ch ho	White	1	6	60	1,200	70	30	....	....	.75	60.26	....
	ch ho	Kissel	3	6	60	1,200	70	30	....	....	55.00	27.50	....
	tr st	A. & B.	2	4	60	....	...	...	....	....	142.75	11.35	....
Randolph	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Revere	chf	Chalmers	¾	4	30	....	...	...	....	319	....	....	....
	ch ho l	Am.-La France	7	4	50	500	70	25	....	319	....	....	....
	ch ho l	Kissel	5	4	48	1,000	50	25	....	319	....	....	....
Rockland	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Salem	chf	Buick	1	4	...	....	...	...	....	....	....	....	....
	ch ho	Am.-La France	4	4	70	1,000	70	30	....	....	....	....	....
	ladd	Robinson	1	4	...	....	35	350	....	....	....	....	....
	pp ho	Robinson	2	6	...	1,000	...	20	....	....	....	....	....
	pp ch ho	Robinson	2	6	...	1,000	35	20	....	....	....	....	....
Somerville	ch ho	Am.-La France	4	6	100	1,400	40	32	....	....	....	....	....
Spencer		No motor apparatus.											
Springfield	ae	Couple Gear (3)	6	..	120	....	...	...	....	....	....	....	....
	ch ho	Couple Gear (2)	6	..	120	....	...	...	....	....	....	....	....
	tr	Couple Gear	5	..	120	....	...	...	....	....	....	....	....
Swampscott	ch ho	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Taunton		No motor apparatus.											
Wakefield	chf	Buick	3	4	35	....	...	...	....	....	....	....	....
	sq	Peerless	2	6	60	....	6	...	800	80	100.00	15.00	....
	ho	Columbia (2)	7	14	40	....	30	24	100	40	50.00	5.00e	....
	ch ho	Peerless	..	..	...	....	30	24	75	20	50.00	5.00	500.00
	ladd	Peerless	2	4	48	....	30	300	100	40	5.00	10.00	500.00
	pp ho ch	Webb	3	4	88	1,000	30	32	150	50	100.00	20.00	500.00
Waltham	chf	Rambler	5	4	40	....	...	...	1,597	160	131.00	157.06	300.00
	ch ho	Am.-La F. (2)	4	4	70	....	40	32	365a	119a	210.48	56.83a	771.00a
	ch ho	Am.-La France	3	4	70	....	140	52	202	112	197.00	32.27	636.00
	pp ho	Am.-La France	1	6	100	....	...	32	130	46	....	75.88	1,079.00
Watertown	chf	Oldsmobile	1-3	8	40	....	6	...	735	41	0	47.78	310.00
	ch	Rambler-local	1-6	4	35	200	53	...	37	14	0	1.90	....
	ch ho	Locomobile-local	4	4	45	1,200	76	36	681	79	0	62.66	480.00
	ladd	Maxim	1	6	66	200	46	312	629	114	0	65.25	480.00
Wellesley	ho	Gen. Motors	2-3	4	35	1,000	6	35	150	47	....	18.75	300.00
	ch ho l	Seagrave	4	6	89	1,200	82	48	510	130	65.71	72.80	600.00
Winthrop	chf	Buick	3	4	25	....	6	...	....	160	80.00	....	....
Woburn	pp ch ho	Am.-La France	½	4	48	1,450	52	37	....	....	....	....	....
	ladd	Am.-La F.	1-12	6	72	1,000	52	330	81	....	....	....	....
	pp ho ch	Am.-La France	1	6	72	1,750	56	47	....	....	....	....	....
	chf	Cadillac	1-12	4	30	150	25	0	....	....	....	....	....
	ho	Winton	2	6	48	650	6	0	150	....	....	....	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Worcester	chf	Thomas	6	6	40	....	...	...	....	...	....	....	....
	chf	Buick (4)	3	4	28	....	6	...	1,400	231	9.92	70.78	225.00
	ch ho	Am.-La F. (2)	3	4	70	1,400	35	32	....	....	....	....	....
	ladd	Am.-La France	2	4	30	....	40	249	56	28	0.38	6.98	435.00
	pp ho	Am.-La F. (2)	2	6	100	800	6	32	213	70	0.80	36.45	1,200.00
	ch ho	Am.-La F. (2)	2	4	70	1,400	35	32	....	....	....	....	....
	pp ho	Am.-La F. (2)	½	6	72	800	6	22	213	70	....	....	....
	sq	Pope-Hartford	6	4	30	800	18	...	1,093	291	181.06	46.35	435.00
	ho	Netco (2)	..	..	40	800	6	30	....	....	....	....	....
	ch ho l	Pope-Hart. (2)	..	..	...	....	...	...	....	....	....	....	....
	ch ho l	Netco (2)	..	6	35	800	6	30	337	183	40.75	33.59	435.00
Michigan—													
Adrian	ch ho	Gramm-Bern.	o	4	50	1,600	40	26					
	pp ch ho	Am.-La F.	2½	6	100	1,200	40	36	325	75	23.00[9]	22.56	333.00
Albion	ch ho	Am.-La France	o	6	65	1,500	46	45	....	36	....	....	....
Alpena	ch ho l	Studebaker	..	4	40	1,000	50	2	235	106	5.00	16.65	300.00
Ann Arbor	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
	ladd	Am.-La France	1	4	70	....	...	236	....	....	....	....	....
Battle Creek	chf	Jackson	5	4	50	....	3	...	....	166	27.00	....	....
	ch ho	Am.-La France	5	4	72	1,000	40	...	....	166	0	....	....
	ladd	Am.-La France	3	6	105	....	40	...	....	165	0	....	....
	pp ch ho	Am.-La F. (3)	4	6	105	1,000	40	46	....	165	0	....	....
Bay City	ladd	Am.-La France	3	4	70	....	...	235	....	....	....	....	....
	ch ho	Am.-La F. (2)	2	6	100	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	1	6	93	1,350	4	36	....	....	....	....	....
Benton Harbor	ch ho	White	2½	6	75	1,700	76	35	96	92	0	26.37	324.00
Cadillac	none												
Crystal Falls	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Dowagiac	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Flint	chf	Buick	6	4	36	....	...	...	....	....	....	....	....
		Buick	1	6	56	....	...	...	3,047	275	....	....	....
	ch ho	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La F. (2)	4	6	72	1,000	6	32	400	118	....	....	....
	ae	Am.-La France	4	4	48	....	6	332	....	66	....	....	....
	pp ho	Am.-La France	2	4	48	1,000	40	32	742	275	....	....	....
Grand Rapids	chf	Jackson	..	..	...	....	...	...	....	....	....	....	....
	chf	Cartercar	5	4	25	....	...	...	4,000	621	3,000.00[10]	110.00a	116.80[11]
	sq	White	3	..	60	....	...	...	....	....	....	....	....
	ladd	Couple Gear (3)	3	..	...	....	...	1,630e	300	....	....	120.00e	....
	tr st	Couple Gear	3	..	...	....	...	...	200	....	....	75.00	....
	tr st	Christie	3	..	...	....	...	...	200	....	....	75.00	....
	ae	Couple Gear	..	..	...	....	...	...	....	....	....	....	....
	tr	Couple Gear (6)	..	..	...	....	...	...	....	....	....	....	....
	ho	Various (12)	4	..	45	1,200e	...	...	350	....	....	30.00e	....
	ch	Olds (2)	5	..	45	250e	70e	40e	2,000	....	....	75.00s	....
	ladd	Various (2)	3	..	...	....	...	1,630a	300	....	....	120.00s	....
	pp	Seagrave	1	..	79	....	...	...	1,000	....	....	50.00	....
Hillsdale		Have no motor apparatus.											
Holland		Have no motor apparatus.											
Iron Mountain	ch ho	White	o	..	...	60	1,400	40	50	....	....	....	....
Ironwood	pp ch ho	Am.-La France	3	6	105	1,100	40	40	300	106	66.00	....	....
Jackson	ch ho	Am.-La F. (2)	4	4	70	1,200	40	25	....	....	....	....	....
	ladd	Am.-La France	3	4	70	....	40	235	....	....	....	....	....
	chf	Jackson	4	4	50	30	3	...	....	....	....	....	....
	pp ch ho	Seagrave (2)	..	..	...	1,000	40	25	....	....	....	....	....
Lansing	ch ho	Olds	5	4	60	1,000	40	42	323	111	10.97	37.42	438.00
	ch ho	Olds	5	4	60	1,000	40	42	290	98	71.05	39.50	438.00
	pp	Robinson	4	6	110	1,000	...	36	154	69	74.58	63.91	1,095.00
Marquette	chf	Ford	2	4	22	....	...	...	3,000	77	0	....	....
Menominee	chf	Jeffery	1½	4	38	0	3	0	....	....	....	....	....
Muskegon	chf	Saxon	½	3	...	....	...	...	....	....	....	....	....
	ch ho	Am.-La F. (2)	1-12	6	100	1,400	40	32	....	....	....	....	....
Petoskey	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	....	....	....
Pontiac	chf	Ford	2	4	22	....	25	...	....	115	151.33	40.07	180.00
	ch ho	Am.-La France	5	4	75	1,200	40	36	....	91	150.59	20.63	540.00
	ch ho	Seagrave	2	4	80	1,500	50	36	....	72	13.50	2.89	360.00
Saginaw	chf	Hudson	3	6	32	....	...	...	....	....	....	....	....
	ladd	Am.-La France	1	6	72	....	...	331	....	....	....	....	....
	pp ho	Seagrave	2	6	102	....	...	30	....	....	....	....	....
	ch ho	Seagrave	1	6	79	....	...	32	....	....	....	....	....
	pp ho	Webb	5	6	72	....	...	32	....	....	....	....	....
St. Joseph		None as yet. See list of prospective purchases.											
Traverse City	chf	Buick	½	6	45	200	40	...	2,000	24	0	12.00	190.00
Minnesota—													
Aurora	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Buhl	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
Cloquet		Have no motor equipment at present.											
Detroit	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Duluth	ch ho	Am.-La France	5	4	70	1,000	40	28	150	43	191.82	23.40	457.32
	ch ho	Am.-La France	3	6	100	1,200	40	28	495	157	269.99	66.00	....
	ae	Am.-La France	2	6	100	....	...	318	125	61	35.85	42.45	....
	ladd	Am.-La France	1	6	100	....	40	251	450	156	28.95	48.90	....
	chf	Kissel	1	6	40	....	...	...	....	....	385.00	212.78	....
	ladd	White	½	6	70	....	40	261	70	20	....	....	....
	pp ch ho	Am.-La France	2	6	100	1,200	40	28	320	106	52.81	63.43	....
	pp ch ho	Am.-La France	2	6	100	1,200	40	28	287	108	27.80	70.80	....
	ladd	Am.-La France	1	4	70	....	...	236	....	....	....	....	....
Eveleth	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	....	....	....
Hibbing	chf	Velie	3	4	40	....	16	...	1,108	92	28.00	67.00	162.00
	pp ch ho	Waterous	¼	6	72	1,000	50	32	72	24	4.00	15.50	729.00
	ae	Am.-La F.	1-12	6	78	....	...	215	82	3	0	9.75	546.50
	ch ho	Kissel	3	6	60	1,000	60	32	212	92	103.00	31.72	364.50
Hutchinson	ch ho	Brockway	1	..	...	....	...	...	....	....	....	....	....
Mankato	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Rochester	pp ho	Am-La France	4	6	100	1,200	6	32	....	....	....	....	....
	ae	Am.-La France	½	4	70	....	...	177	....	....	....	....	....
St. Cloud	ch ho	Am.-La France	3	4	70	1,400	35	32	....	....	....	....	....
S. St. Paul	pp ch ho	Waterous	..	4	70	1,200	40	...	....	....	....	....	....
Stillwater		No motor-driven apparatus in department at pres.											
Virginia	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	....	....	....
	ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	....	....	....
W. Minneapolis	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....

(To be continued in the February Number.)

ROADS AND PAVEMENTS

Canvas Belt Reduces Cost of Finishing Concrete Road

Frank F. Rogers, commissioner for the Michigan State Highway Department, tells of a considerable saving in the cost of finishing a concrete road by the use of a strip of 12-inch canvas belting which is drawn rigidly back and forth across the pavement, thereby producing a surface which in many respects is superior to that obtained by the old methods of hand-finishing.

The canvas strip is 12 inches wide and 3-ply. It is laid transversely across the pavement, projecting a little way beyond the forms on each end so that the workers can maintain a firm grip on it. After the surface has been struck off with the template, two laborers, one on each side of the road, drag the belting slowly back and forth, and gradually work it forward. They keep pace with the mixer by merely using the belt for a few minutes at intervals of from 20 to 30 minutes. The men using the template fall back and do this while the mixer is being moved forward. Thus the need of three finishers is eliminated, effecting a saving of close to $1.00 per hour.

It is said that this belt finishing process thoroly levels all ridges, does away with the wavy or corrugated surface left by the template, fills all hollows and secures as uniform a finish as could be desired. The smaller pebbles are worked down and firmly imbedded in place in the concrete and a gritty surface is produced without flushing excess water to the top or forming a film of neat cement on top. The uniformity is, however, the most noticeable result of the operation.

The road under construction is 18 feet wide and is being built according to the standard specifications of the Michigan State Highway Department which eliminate joints except at points where the work is stopped for more than 30 minutes. The stipulation is very favorable to the use of the belt for

finishing, inasmuch as it does away with the necessity for the frequent use of the bridge at joints and this can be satisfactorily accomplished only from a bridge.

By the omission of joints, some slabs over 150 feet in length have resulted. It is the belief of the department that if joints are omitted the cracks will form at approximately the same intervals at which joints are customarily placed and that such cracks can then be maintained in the same manner as joints. The early maintenance cost and the construction costs are thereby reduced to no small extent.

The idea of finishing by belt process originated in Wayne county, Michigan, only recently. After a thoro trial by the authorities there, it was suggested by them to the State Highway Commission and its first use by that department is on the road described in the foregoing.

Record Road Building in Ohio

With the $750,000 worth of contracts awarded December 21, covering some 38 miles of road improvement, the total of contracts awarded by the Ohio State Highway Department reaches 610 miles which will cost over $800,000.

Shoddy Paving in Chicago

Two investigations, more or less secret in their nature, were made of paving conditions in Chicago during the paving season of 1916. One of these covered the work under contract and the other the work done by the city forces.

In each case evidences of poor work were found. In the case of contract work this consisted of hastily constructed work, skimping of materials in mixtures and insufficient thickness of basis or tops. In that of city force work it consisted of lazy and careless employes, poor organization of forces, waste of materials and over-measurement of work done so as to make good showing of unit costs.

That both methods of doing work are equally poor, seems to indicate that the fault is in the general management of the city's improvement work, or in the inability of the management to control political employes or interfere when political contractors are found to be skimping their jobs.

All of these reasons have been assigned for the conditions found.

Itemized Cost of Concrete Paving

E. R. Conant, chief engineer of Savannah, Ga., has worked out the cost of constructing 31,503.06 square yards of concrete paving during 1916 in details of items, making a statement which will be of much interest and value to other engineers and to contractors. The cost of curbing is not included.

The conditions under which the work was done were as follows:

Proportions for Concrete: 1:1½:3; average thickness 6¼ inches; one-course pavement.

Price of material delivered on work:

Cement, approx., 1/3 at $1.63 per bbl.; 2/3 at $1.75 per bbl.

Crushed stone, approx., 1/3 at $2.64 per cu. yd.; 2/3 at $2.68 cu. yd.

Sand, approx., 1/3 at 70c per cu. yd.; 2/3 at 80c per cu. yd.

Tar paper expan. joints at 74 to 96 cents per roll.

Coal at $3.60 per ton.

Lumber at $20.00 per M.

Labor: White, gang consists of foreman at $4.00 per day, 20 men at $1.75 and 10 men at $1.50, 9 hours constitute a working day.

Hired Teams: One mule and cart combined is valued at $1.50 per day. Number used per day varied from 6 to 1.

Concrete Mixer: Batch type. (Austin cube No. 13).

The cost in cents per square yard for each item was as follows:

Labor—	
Watchman	1.654
Grading	8.678
Handling cement	0.615
Handling sand	2.675
Handling crushed stone	3.756
Spreading concrete	2.248
Operating mixer	3.908
Finishing surface	1.346
Making expansion joints	0.532
Covering pavement	0.688
Moving equipment	0.597
Cleaning up	2.014
Removing trees	0.222
Resetting curb	0.107
Total labor	29.040
Hired Teams—	
Grading	1.461
Moving equipment	0.122
Cleaning up	0.417
Covering pavement	0.062
Total teams	2.062
Materials—	
Cement	56.075
Sand	5.646
Crushed stone	39.216
Expansion joints (2-ply tar paper)	0.884
Coal	0.412
Tools and hardware	1.896
Lumber	0.290
Use of equipment	2.158
Total materials	106.577

Total cost of pavement per square yard, $1.37679.

The 31503.06 square yards of paving required 5459.48 cubic yards of concrete so that the cost of concrete per cubic yard was $7.95 in place.

The pavement is in one course. Savannah is south of the heavy frost line and there are never more than two or three days of freezing weather together so that there is no danger of pavements being heaved by frost.

The natural soil is most favorable for maintaining a good surface, being sand and lime, giving perfect drainage.

Concrete was thoroly well mixed at least one minute in the mixer for each batch.

Grade pegs were set for 6-foot squares, and the consistency of the concrete was such that only shovels were used for grading the concrete between the pegs.

When a sufficient length of concrete was laid the surface was rolled with a galvanized metal cylinder and a 1-inch rubber garden hose was dragged back and forth over the surface.

Joints were formed by using boiler-metal plates with tarred paper between, which were withdrawn after the next section had been carried far enough forward to hold the tar paper straight in place. The concrete was still fresh enough to fill the crevices left by the withdrawal of the steel plates. The paper stood 1 to 1½ inches above the surface. A split float was used on the joints which gave them beaded edges. The transverse joints were laid 35 feet apart and there were also joints along the curbs. The extra paper at the joints protects the edges of the concrete slabs until they receive practically their full strength before the traffic crushes the paper completely.

Pavements laid eight months ago show no signs of hair cracks or any other kind and the edges have not broken or chipped.

Motor Vehicles Carry Increased Traffic in Diminished Number of Vehicles

Among the most difficult problems presented to road builders and road planners is that of street traffic. The increase in the volume of this traffic has been almost sensational during recent years, especially since the use of the motor vehicle has become general. While this increase is quite obvious in all cities, the statistics of street traffic in London are unusually complete and the reports of the London Traffic Branch of the Board of Trade bring out some remarkable facts. The number of horse-drawn cabs licensed by the metropolitan police decreased from 11,404 in 1905 to 2,385 in 1912, while during the same period the number of motor cabs increased from 1 to 7,969. During the same period the motor omnibuses increased from 13 to 2,908, while the 3,623 horse-drawn omnibuses in 1903 have entirely disappeared. Some remarkable statistics are given as to the number of vehicles passing certain points at certain hours and during the day, but the surprising feature of these statistics is that the total number of vehicles licensed in 1913, including tramway cars, was actually 203 less than in 1903. No better illustration is afforded of the enormous increase in the service rendered by motor vehicles owing to their higher speed and greater flexibility.

Good Roads Notes

Nearly 400 miles was built under the postoffice appropriation bill of 1912 and about 170 miles in national reservations. Besides these constructions with national funds, the engineers of the U. S. Office of Public Roads and Engineering made recommendations as to improvement of roads in thirty-two counties after studies of the local conditions, inspected specific roads in 113 communities and assisted seven state departments having the road question in charge.

Of the $2,000,000 bond issue of Cook county, Ill., for good roads $800,000 will be spent in 1917. At the last meeting of the county board committee it was decided to improve the following roads: Higgins road, from the Mannheim road to the county line; Wheeling road, from Glencoe to Wheeling; Ninety-fifth street, from Western avenue to Keene avenue; Keene avenue, from Archer avenue to 119th street; Lake street, from the county line to the village of Melrose Park; 147th street, from Forty-eighth avenue to the village of Orland; Tinley Park road, from 147th street to Tinley Park; Irving Park boulevard, from the Wolfe road to the city limits of Chicago; Thornton to Lansfield road. The following roads will be improved with the aid of the state: Dempster street, from Evanston to Milwaukee avenue; Lincoln avenue, from the city limits northwest to Morton Grove. The work is to be started early in the summer.

Paving Done in 1916 and Proposed for 1917.

Yardage laid, cost and city's share for 1916. Yardage in prospect, estimated cost and city's share for 1917.

Data from City Engineers' Offices; obtained in December, 1916.

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Alabama—							
Albany	....	0	....	....	0	....	....
Florence	8,500	10[4]	....	....	B	....	....
Gadsden	15,000	0	0	0	18,341[2]	1.46[1]	0
Montgomery	45,000	....	....	....	4,000	6,000	....
Tuscaloosa	15,000	0	....	....	20,000	25,000	0
Arizona—							
Douglas	14,000	28,000	98,000	....	80,000	175,000	....
Phoenix	25,000	88,735	197,564	0	....	....	....
Tucson	25,000	67,219	192,620	26,448	45,000	130,000	18,000
Arkansas—							
Ft. Smith	35,000	26,000	28,000	15,000	9,453	13,000	13,000
Hot Springs	20,000	4,000	14,000	12½%	25,000	....	....
California—							
Berkeley	65,000	69,660	117,800	....	110,800	248,000	....
Los Angeles	320,000	691,813	....	....	....	....	....
Pasadena	44,000	35,035	26,524	....	....	....	....
Petaluma	8,000	4,000	4,550	....	95,243	42,561	....
Pomona	15,000	1,872	1,390	250	....	....	....
Richmond	17,000	....	....	....	250,000	....	....
San Bernardino	18,000	42,539	31,647	0	....	....	....
San Diego	80,000	52,123	....	0	....	....	0
San Francisco	420,000	472,251	931,980	83,134	500,000	1,000,000	....
San Luis Obispo	8,000	10,000	11,000	11,000	30,000	35,000	25%
Santa Ana	12,000	104,698	55,831	0	....	....	....
Santa Barbara	18,000	15,000	45,700	5,000	82,000	123,000	2,000
Santa Monica	9,000	82,368	154,000	....	....	....	....
Stockton	40,000	194,200	373,296	0	220,000	400,000	0
Colorado—							
Boulder	12,000	0	....	....	25,000	70,000	0
Colorado Springs	35,000	0	....	....	0	....	....
Ft. Collins	12,000	24,793	38,451	6,264	....	....	....
Connecticut—							
Ansonia	18,000	4,850	....	4,284	5,200	17,500	17,500
Danbury	25,000	16,000	17,000	....	....	....	....
Danielson	3,500	0	....	....	7,000	....	....
Derby	10,000	....	....	....	1,800	4,500	2,000
Enfield	12,000	10,600	....	all	....	....	....
Greenwich	2,000	26,951	67,591	all	50,000	100,000	all
Hartford	120,000	....	....	....	48,540	....	....
Manchester	18,000	2,727	4,066	4,066	3,400	3,000	3,000
New London	20,000	....	....	....	6,300	19,000	....
Putnam	8,000	6,000	5,000	5,000	1,000	....	....
Stamford	33,000	14,652	25,000	....	....	....	....
Wallingford	13,000	9,750	15,000	15,000	7,000	10,500	....
Willimantic	13,000	0	5,000	....	1,800	5,000	5,000
Winsted	9,000	9,801	15,474	all	7,000	11,000	all
District of Columbia—							
Washington	360,000	180,285	600,000	50%	200,000	700,000	60%
Florida—							
Gainesville	8,000	0	....	....	20,000	39,000	13,000
Pensacola	30,000	0	....	....	0	....	....
Georgia—							
Americus	11,950	20,000	26,000	7,000	16,000	18,750	4,750
Atlanta	184,000	187,835	279,657	52,649	100,000	200,000	60,000
Augusta	45,000	0	....	....	....	....	....
Brunswick	12,500	7,500	....	....	....	....	....
LaGrange	8,000	3,000	....	....	0	....	....
Cedar Falls	6,500	0	....	....	0	....	....
Cedar Rapids	45,000	42,259	69,154	....	....	....	....
Centerville	7,770	0	....	....	0	....	....
Charles City	8,000	0	....	....	20,000	....	....
Clinton	26,800	22,608	58,465	2,500	....	....	....
Creston	7,500	67,350	128,415	0	4,000	7,000	....
Davenport	48,154	109,425	218,425	21,206	100,000	....	....
Dubuque	43,000	30,635	64,721	....	200,000	400,000	....
Forest City	2,000	26,080	41,720	....	....	....	....
Ft. Dodge	23,000	65,000	130,000	15,000	....	....	....
Ft. Madison	10,000	53,782	124,067	20,147	....	....	....
Greenfield	1,500	24,978	43,300	....	....	....	....
Keokuk	16,000	36,696	42,074	87,992	....	....	....
Knoxville	3,000	some	....	....	....	....	....
Marshalltown	16,000	45,770	56,302	1,540	60,000	83,000	3,000
Mason City	20,000	164,700	338,386	....	100,000	185,000	....
Mt. Pleasant	4,000	some	....	....	....	....	....
Muscatine	16,000	14,507	9,509	....	0	....	....
Oelwein	7,200	32,000	60,705	4,800	7,500	13,000	0
Sioux City	62,000	297,000	453,705	175,000	250,000	....	....
Waterloo	34,000	23,910	53,500	0	50,000	100,000	0
Webster City	6,000	16,622	27,426	0	15,000	25,000	0
Kansas—							
Arkansas City	12,000	26,132	47,299	11,689	40,000	....	A
Atchison	16,600	18,000	30,000	4,500	10,000	15,000	2,500
Chanute	10,000	3,500	5,161	1,500	2,500	3,700	1,200
Coffeyville	14,000	....	....	....	4,000	....	....
Erie	1,500	25,000	53,000	....	20,000	40,000	....
Emporia	11,000	9,875	17,550	2,952	10,000	18,000	3,000
Hutchinson	20,000	....	....	....	75,000	....	....
Independence	13,000	7,833	16,137	6,772	....	....	....
Iola	11,000	34,000	42,840	....	....	....	....
Leavenworth	20,000	0	....	....	85,000	125,000	30,000
Manhattan	6,856	39,930	62,480	62,480	16,500	....	16,500
Ottawa	9,127	18,718	46,265	11,648	7,600	17,000	1,500
Parsons	17,000	6,208	13,074	962	22,000	31,480	2,500
Pittsburg	19,000	70,197	119,950	A	60,000	....	....
Rosedale	10,000	15,000	15,000	....	42,000	75,000	....
Salina	15,000	47,461	79,000	¼	30,000	60,000	¼
Topeka	50,000	110,120	247,590	81,465	75,000	172,500	51,750
Wellington	7,000	80,005	150,556	73,624	13,000	25,000	10,000
Wichita	70,000	50,327	116,402	....	75,000	....	....
Kentucky—							
Lexington	50,000	51,000	124,743	10,200	140,000	100,000	100,000
Louisville	265,000	160,480	414,838	119,980	196,000	450,000	190,000
Owensboro	18,000	60,000	18,000	18,000	70,000	115,000	14,000
Louisiana—							
Lake Charles	16,000	20,000	29,000	0	50,000	90,000	0
Shreveport	48,000	65,000	....	....	200,000	....	....
Maine—							
Lewiston	30,000	7,987	....	....	8,000	....	....
Portland	63,050	13,135	25,436	25,436	....	....	....
Maryland—							
Baltimore	558,485	66,226	95,780	95,780	37,928	145,526	....
Frederick	11,000	4,897	4,630	4,504	13,230	11,035	11,035
Havre de Grace	5,000	5,500	5,500	5,500	5,500	5,500	5,500
Massachusetts—							
Brookline	34,000	39,907	25,354	25,354	50,000	65,000	....
Fitchburg	43,000	27,149	45,639	45,639	....	70,000	....

Savannah	75,000	51,184	87,000	32,000	....	....	....
Waycross	15,000	35,236	5,721	1-3	43,000	17,000	1-3
Idaho—							
Boise	20,000	48,395	106,972	29,000	....	....	....
Coeur d'Alene	8,000	0	....	....	8,000	....	1-7
Lewiston	7,500	2,746	4,036	....	3,830	5,745	....
Pocatello	16,000	0	....	....	20,570	41,600	6,240
Illinois—							
Ardmore	1,600	......	....	....	20,600	....	....
Aurora	36,000	26,000	57,660	9,640	25,000	55,000	8,250
Belleville	27,000	70,000	113,400	19,000	70,000	125,000	20,000
Berwyn	15,000	38,577	90,800	11,000	132,800	288,000	....
Cairo	18,000	8,039	2,739	0	30,000	21,000	0
Canton	12,000	3,570	6,670	1,662	0	....	....
Champaign	17,223	30,000	111,521	900	90,000	253,000	....
Chicago	2,521,822	2,536,000	6,860,000	300,000	2,000,000	6,000,000	....
Chicago Heights	20,000	125,000	273,000	....	55,000	....	....
Cicero	4,500	94,587	198,184	15%	94,000	200,000	15
Danville	35,000	42,000	98,700	24,675	40,000	94,000	23,500
Decatur	45,000	85,561	230,000	....	....	....	....
DeKalb	9,000	17,595	38,632	10-25%	....	....	....
E. St. Louis	85,000	29,300	....	0	175,000	350,000	0
Flora	3,000	0	....	....	32,464	80,372	0
Freeport	22,000	19,144	35,800	10%	40,000	70,000	10
Galesburg	24,514	17,760	47,645	3,266	75,000	206,250	12,375
Granite City	15,000	13,500	27,000	7,000	20,000[7]	45,000	....
Harvey	7,000	0	....	....		....	....
Hinsdale	5,000	5,952	11,343	....	5,600	....	....
Joliet	36,000	141,551	317,015	19,020	77,865	152,687	9,161
La Grange	6,000	23,171	42,000	....	170,000	200,000	....
La Grange Park	2,500	32,000	12,280	....	....	....	....
Lincoln	12,164	0	0	0	22[3]	60,000	A
Lyons	2,500	......	....	....	5,000	....	....
Madison	6,000	0	....	....	0	....	....
Mattoon	15,000	32,269	77,000	7%	32,000	80,000	7
Moline	30,000	50,295	127,944	8,760	50,000	130,000	0
Morrison	2,000	44,000	100,000	25%	....	....	....
Oak Park	31,400	187,185	490,300	....	60,700	163,000	....
Ottawa	10,000	14,100	35,082	0	8,500	175,000	....
Pana	6,000	0	....	....	0	....	....
Paris	10,000	7,244	10,286	0	0	....	....
Peru	8,000	31,078	77,911	12%	....	....	....
Rockford	55,000	159,491	275,456	92,387	....	....	....
Rock Island	25,000	70,990	200,824	9,100	....	....	....
Springfield	66,000	26,397	53,381	4,172	130,000	244,600	6,960
Sterling	10,000	11,640	28,788	5,757	36,735	90,000	....
Streator	17,000	15,964	25,827	....	17,000	....	....
Taylorville	7,912	0	0	0	0	0	0
Indiana—							
Anderson	30,000	30,290	43,979	0	10,000	....	....
Bedford	12,000	0	....	....	5,000	....	....
Brazil	10,000	7,834	9,825	1,413	7,470	11,205	....
Connersville	10,000	38,041	55,955	6,823	....	....	....
Crawfordsville	12,000	4,108	5,210	869	13,500	20,250	3,500
Elkhart	23,000	38,050	88,950	....	33,500	....	....
Frankfort	9,500	19,540	49,720	4,734	....	....	....
Goshen	10,000	38,714	78,610	16,403	40,000	82,000	18,000
Huntington	15,000	5,300	14,051	....	10,000	....	....
Jeffersonville	10,000	0	....	....	0	....	....
Lafayette	21,000	2,660	....	0	....	....	....
La Porte	13,500	38,325	68,218	12,421	....	....	....
Linton	10,000	0	....	....	0	....	....
Logansport	22,000	44,618	104,736	26,800	27,300	84,000	25,000
Madison	8,000	12,800	25,868	7,000	17,000	34,000	....
Marion	25,000	2,130	6,788	C	20,000	40,000	A
Michigan City	22,000	25,871	45,098	12,225	45,000	....	....
Muncie	28,000	22,000	39,000	4,000	....	....	....
New Castle	15,000	25,298	56,165	10,000	....	....	....
Peru	15,000	0	....	....	0	....	....
Portland	6,600	......	....	C	....	....	....
Richmond	25,000	29,120	51,452	11,912	8,000	14,000	3,000
Shelbyville	11,000	......	....	....	....	....	....
South Bend	67,500	74,782	150,846	26,877	77,183	154,155	....
Terre Haute	70,000	2,286	1.53	A	47,830	92,500	17,500
Vincennes	18,000	107,506	193,777	36,587	100,000	225,000	31,000
Wabash	9,000	19,516	52,200	12,000	0	....	....
Iowa—							
Boone	14,000	0	....	....	60,000	....	....
Britt	1,440	36,234	83,994	....	....	....	....
Burlington	25,000	30,085	55,793	....	....	....	....
Greenfield	13,000	2,800	....	....	5,000	....	....
Lawrence	100,000	8,595	....	all	....	....	....
Lynn	100,000	64,920	88,470	all	60,000	81,300	all
Methuen	12,000	......	....	....	22,000	2.50	2.50
Middleboro	9,000	3[4]	18,000	....	12,000	....	....
New Bedford	114,000	113,795	....	....	....	....	....
Newton	43,113	60,000	39,000	39,000	60,000	42,000	42,000
N. Adams	22,000	0	....	....	5,000	8,000	8,000
Norwood	12,000	34,000	66,170	52,195	45,000	45,000	26,500
Orange	5,500	0	....	....	0	....	......
Pittsfield	40,000	0	....	....	....	....	......
Revere	28,000	19,170	30,000	30,000	40,000	100,000	100,000
Saugus	10,000	4,000	2,000	2,000	5,000	5,000	5,000
Southbridge	15,000	14,200	21,100	19,000	18,000	22,000	....
Wakefield	13,000	5,000	6,250	2,250	10,000	12,000	8,000
Watertown	18,000	18,000	24,000	24,000	18,000	25,000	all
Webster	12,000	400	249	249	....	....	....
Weymouth	14,000	1,918	2,077	2,077	5,000	8,000	8,000
Michigan—							
Albion	9,000	5,900	8,960	8,960	6,000	9,000	9,000
Alpena	12,000	4,409	6,300	6,300	....	....	....
Ann Arbor	20,000	12,000	28,000	13,000	....	....	....
Battle Creek	30,000	72,346	96,350	40,456	....	....	....
Bay City	50,000	25,961	48,717	12,467	20,000	40,000	20,000
Benton Harbor	14,000	0	....	....	45,000	94,500	A
Boyne City	4,500	11,577	15,860	3,990	8,658	11,544	2,888
Cadillac	10,000	2,600	4,472	1,849	29,111	44,152	11,000
Coldwater	6,500	13,367	22,817	½	0	....	....
Detroit	820,778	976,173	2,399,220	....	1,000,000	2,500,000	....
Escanaba	15,000	0	....	....	40,000	52,000	10,400
Flint	80,000	108,000	245,400	60,000	150,000	340,000	80,000
Grand Haven	7,000	9,000	9,300	....	15,000	32,000	0
Grand Rapids	140,000	108,035	237,953	....	....	....	....
Hillsdale	8,000	14,950	10,000	19,000	12,000	35,000	¾
Holland	12,000	9,500	20,415	5,000	14,000	25,000	8,000
Kalamazoo	50,000	46,866	76,600	16,180	40,000	75,000	25,000
Ludington	10,000	700	1,054	20	40,000	30,000	20%
Manistee	12,000	0	....	....	2,656	0.80[1]	0.80[1]
Marquette	12,500	5,110	4,662	4,662	25,000	15,000	15,000
Monroe	10,000	2,910	5,789	2,689	....	....	....
Muskegon	40,000	7,810	16,087	4,526	30,606	56,287	10,853
Minneapolis	301,000	392,897	900,000	30	300,000	750,000	30%
Negaunee	6,800	13,900	14,996	14,996	13,000	....	....
Niles	5,500	0	....	....	....	....	....
Owosso	10,000	5,720	12,592	5,036	7,000	16,540	6,216
Port Huron	20,000	7,620	13,860	5,000	8,000	....	....
Saginaw	60,000	6,980	17,500	5,800	24,000	70,000	25,000
Sault Ste Marie	13,500	5,874	18,085	6,028	....	....	....
Ysilanti	10,000	37,056	57,115	....	....	....	....
Minnesota—							
Albert Lea	11,000	......	....	....	....	....	....
Austin	10,000	......	....	....	....	....	....
Bemidji	8,000	10,006	11,207	1-3	10,000	11,200	1-3
Chisholm	10,000	16,300	29,340	29,340	....	....	....
Duluth	100,000	110,000	340,000	70,000	20,000	70,000	20,000
Eveleth	9,000	20,986	57,831	½ & A	....	....	....
Hibbing	12,000	4,687	18,422	18,422	40,000	110,000	110,000
Mankato	15,000	9,339	12,327	467	....	....	....
Rochester	10,000	50,366	88,810	10,000	....	....	....
St. Cloud	15,000	33,226	81,500	0	25,000	57,500	0
Stillwater	10,970	5,797	8,945	4,865	7,000	17,500	2,500
Virginia	18,000	2,627	61,754	60%	18,000	55,000	60%
Mississippi—							
Greenwood	9,000	8,430	14,009	6,875	40,000	80,000	32,000
Laurel	14,840	50,000	88,400	....	10,000	....	....
Vicksburg	25,000	48,902	161,563	....	0	0	0
Missouri—							
Brookfield	8,000	1,000	1,320	....	....	....	....
Cape Girardeau	15,000	19,526	16,570	0	30,000	....	0
Carthage	11,000	0	....	....	25,000	1.40	0
Columbia	12,600	19,917	26,913	692	6,009	12,310	200
Fulton	5,500	5,636	12,262	0	50,000	....	....
Independence	13,500	12,511	16,889	0	50,000	80,000	0
Jefferson City	16,000	25,500	40,900	0	....	....	....
Kirksville	9,000	3,280	5,000	0	15,000	32,000	0
Moberly	15,000	1,040	1,612	0	8,000	12,000	0
Poplar Bluff	12,000	6,000	9,000	0	20,000	30,000	0
St. Louis	800,000	452,700	1,061,000	80,000	600,000	1,400,000	50,000
Sedalia	20,000	19,807	28,570	0	34,000	46,000	0
Springfield	45,000	66,314	72,214	15,132	45,000	67,500	....

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Montana—							
Anaconda	16,000	75,511	161,145	0	50,000	110,000	0
Billings	14,000	35,893	99,439	0	20,500	55,000	0
Butte	100,000	22,586	79,337	....	29,000	....	....
Great Falls	30,000	29,066	53,110	....	....	....	....
Helena	18,000	4,500	10,400	....	23,400	41,000	14,000
Livingston	6,000	5,379	14,396	....	0	....	....
Nebraska—							
Beatrice	10,000	36,100	85,000	20,000	40,000	95,000	22,500
Columbus	6,000	0	....	....	54,000	110,000	28,695
Fairbury	6,000	0	....	....	50,000	....	....
Fremont	11,000	66,231	104,278	26,126	30,000	....	....
Hastings	15,000	84,989	170,000	....	129,000	1.75	....
Lincoln	55,000	139,937	296,500	0	....	....	....
Nebraska City	6,000	0	....	....	20,000	40,000	10,000
Norfolk	10,000	100,000	180,000	40,000	50,000	75,000	....
New Hampshire—							
Laconia	13,000	......	....	....	10,000	....	....
Portsmouth	12,000	0	0	0	14,000	45,000	46,000
New Jersey—							
Bayonne	65,000	99,000	175,000	15,000	90,000	180,000	16,000
Bloomfield	20,000	30,000	75,000	....	50,000	125,000	....
E. Orange	42,000	16,401	41,408	....	....	....	....
Elizabeth	85,000	72,000	208,000	75,000	80,000	220,000	85,000
Harrison	15,000	18,612	33,970	25,021	20,000	42,000	....
Irvington	23,000	10,918	22,829	....	24,940	58,000	....
Jersey City	313,500	147,047	292,901	261,314	74,800	145,860	100,000
Montclair	26,000	68,300	188,600	½	190,000	470,000	½
New Brunswick	31,000	100,905	256,967	25%	....	....	....
Passaic	70,000	29,773	53,825	13,500	44,000	71,000	25,000
Ridgewood	7,000	48,430	50,000	38,000	30,000	25,000	25,000
S. Amboy	10,000	0	....	....	20,000	....	....
Summit	10,000	......	....	....	7,900	....	....
Trenton	105,000	80,000	....	....	64,000	....	....
Union	22,000	30,000	45,000	....	15,000	25,000	....
W. Orange	17,000	8,200	....	....	17,500	....	....
Nex Mexico—							
Roswell	8,000	7,337	14,179	....	1,160	28,500	....
New York—							
Albany	110,000	150,921	312,512	100,000	114,000	250,000	80,000
Albion	6,100	2,600	11,000	11,000	28,850	102,000	80,000
Amsterdam	36,000	7,510	27,900	13,950	45,000	130,000	65,000
Auburn	37,000	7,000	....	....	16,000	40,000	27,500
Batavia	14,000	20,000	61,000	1-3 & A	10,000	30,000	1-3 & A
Binghamton	56,000	18,322	39,804	½	....	....	....
Buffalo	480,000	267,446	916,730	183,160	270,000	920,000	185,000
Cohoes	25,000	13,897	45,434	36,756	11,000	40,000	35,000
Elmira	45,000	38,916	81,437	....	32,000	....	....
Fredonia	5,000	0	....	....	4,200	2.85[1]	1-3
Fulton	12,000	115,000	8,500	3,500	10,500	20,000	8,000
Geneva	15,000	32,250	....	1-3	21,000	75,000	1-3
Gloversville	21,000	14,450	25,210	¼	....	....	....
Hudson	13,500	35,000	45,000	30,000	....	....	100%
Hudson Falls	6,000	1,700	4,725	2-3	....	....	....
Ithaca	20,000	3,881	7,716	1-3 & A	4,400	13,200	1-3 & A
Jamestown	38,000	19,947	48,418	3,360	....	....	....
Johnstown	12,000	510	1,020	340	20,000	30,000	10,000
Kingston	26,000	42,062	35,332	35,332	....	....	....
Little Falls	13,000	14,112	37,470	18,735	....	....	....
Lockport	20,000	8,500	20,000	1-3	9,000	22,000	....
Mamaroneck	7,290	4,154	11,216	....	....	....	....
Middletown	17,000	6,200	17,324	5,800	....	....	....
New Rochelle	34,500	95,486	162,227	162,227	....	....	....
Niagara Falls	48,000	22,715	94,000	10,000	50,000	200,000	15,000
N. Tonawanda	13,600	1,384	2,453	....	16,000	....	....
Norwich	8,500	3,360	8,514	1-3	....	....	....
Olean	20,000	1,770	4,424	170	23,600	....	....
Oneida	9,800	4,874	15,729	5,243	6,000	22,880	7,627
Ossining	14,000	D	....	1,100	....	....	....
Oswego	25,000	7,259	30,351	10,000	7,000	29,000	9,500
Plattsburg	12,000	0	0	....	3,600	8,000	5,000

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Sq. Yds.	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Pennsylvania—							
Allentown	65,000	46,860	91,550	19,200	....	....	....
Bethlehem	16,000	37,738	53,441	17,814	....	....	....
Blakley[6]	7,000	....	....	....	50,000	2.60[1]	1-3
Bloomsburg	8,000	0	....	....	6,000	....	....
Bradford	15,000	4,799	22,962	4,150	23,700	80,000	....
Butler	26,000	2,948	....	1-3	....	....	1-3
Carbondale	19,000	40,000	....	....	38,500	....	....
Carlisle	11,000	......	....	....	12,000	21,000	1-3
Chester	60,000	40,000	90,000	20,000	....	....	....
Coatesville	20,000	......	....	....	1,000	....	....
Connellsville	15,000	24,815	51,580	1,560	29,230	64,854	....
Dickson City	9,000	See Blakley.					
Du Bois	14,000	4,144	....	all	10,000	....	all
Duquesne	15,727	2,475	7,526	0	....	....	....
Erie	80,000	32,929	55,396	5,925	75,000	13,500	5,000
Farrell	14,000	14,700	23,373	....	15,000	....	....
Franklin	10,000	0	....	....	13,000	27,000	5,000
Freeland	8,000	2,000	1,200	1,200	10,000	5,600	....
Greensburg	15,000	10,218	22,405	7,468	11,300	....	....
Greenville	8,500	0	....	....	8,700	....	....
Hanover	10,000	......	....	....	20,000	45,000	15,000
Harrisburg	64,000	30,700	52,000	....	4,000	8,000	....
Hazleton	30,000	16,064	18,126	18,125	17,000	30,900	1-3
Homestead	21,000	1,100	2,560	2,560	....	....	....
Jermyn	7,000	See Blakley.					
Jessup	7,000	See Blakley.					
Johnstown	68,000	8,939	16,919	6,970	....	....	1-3 A
Juniata	6,500	11,716	22,131	7,377	15,000	25,000	8,125
Lebanon	21,000	31,000	89,000	16,000	30,000	90,000	20,000
Monongahela	12,500	2,370	5,375	2,576	4,700	10,000	2,500
Norristown	32,000	11,400	25,650	7,500	10,000	25,000	7,000
N. Braddock	15,345	6,665	13,332	4,444	10,000	22,000	7,333
Northampton	10,500	11,394	....	all	10,700	....	all
Oil City	20,000	728	3,168	1,181	1,000	....	....
Olyphant	10,000	See Blakley.					
Pittsburgh	625,000	171,064	438,700	....	....	....	....
Pittston	20,100	6,670	19,312	6,437	12,000	39,960	13,320
Rankin	7,500	5,800	17,000	1-3	12,000	30,000	1-3
Reading	115,000	63,236	118,435	103,000	....	....	....
S. Bethlehem	19,973	15,812	9,788	all	....	150,000	all
Steelton	......	......	....	....	....	150,000	1-3
Throop	8,000	See Blakley.					
Titusville	9,000	0	....	....	9,000	16,000	16,000
Waynesboro	10,000	7,292	3,499	2,476	15,000	10,500	7,500
Wilkes-Barre	75,000	42,736	113,458	A	50,000	135,000	A
York	50,000	14,888	27,543	....	15,300	....	....
Rhode Island—							
Pawtucket	52,000	22,465	....	....	....	....	....
Woonsocket	41,000	30,500	93,013	....	30,000	....	....
South Carolina—							
Charleston	35,340	52,000	....	....	....	....	....
Columbia	50,000	12,725	16,025	....	13,000	....	....
Florence	10,000	12,936	18,551	18,551	14,000	21,000	21,000
Greenville	35,000	90,000	215,000	110,000	65,000	130,000	65,000
Greenwood	8,000	80,000	156,000	½	6,000	7,500	½
South Dakota—							
Aberdeen	14,000	0	....	....	5,000	....	....
Lead	8,125	1,597	5,082	2,127	2,020	6,599	3,737
Mitchell	8,000	31,257	68,601	....	27,480	....	....
Sioux Falls	23,000	157,943	295,433	0	65,000	120,000	0
Watertown	9,000	375	559	0	....	....	....
Tennessee—							
Chattanooga	80,000	84,078	183,300	79,140	24,120	51,000	20,000
Jackson	16,000	22,791	46,721	1-3	28,000	57,400	1-3
Memphis	135,000	12,850	29,710	½	....	....	....
Texas—							
Amarillo	18,000	68,297	124,270	40,000	10,000	18,000	6,000
Austin	36,000	58,932	121,779	60,823	50,000	100,000	45,000
Cleburne	16,000	0	....	....	50,000	87,500	0
Dallas	135,000	160,850	375,488	60,000	868,127	1,965,837	200,000

Port Jervis	10,000	5,586	....	6,000	....	....	....
Poughkeepsie	32,000	26,300	71,000	....	....	....	....
Salamanca	10,000	47,317	140,000	38,960	40,000	120,000	40,000
Utica	87,000	38,256	116,880	38,960	40,000	120,000	40,000
Watertown	28,000	9,581	32,784	16,392	25,000	35,000	½
Watervliet	17,000	0	0	0	....	350,000	1-3
North Carolina—							
Asheville	20,000	58,771	90,648	....	....	....	....
Charlotte	50,000	70,000	91,450	....	10,000	15,000	3,500
Durham	28,000	10,000	23,800	3,800	....	....	....
Fayetteville	10,000	32,890	21,000	7,000	0	....	....
Greensboro	23,000	27,100	32,078	17,100	15,000	18,000	9,500
Raleigh	25,000	150,000	242,400	52%	100,000	161,000	½
Wilmington	35,000	1,400	1,750	1,750	7,500	15,000	15,000
North Dakota—							
Bismarck	7,000	25,000	66,000	20%	170,000	370,000	20%
Fargo	22,000	35,712	106,240	109,907	100,268	300,000	20%
Grand Forks	13,500	9,739	27,007	....	10,000	....	....
Mandan	5,000	51,088	180,180	0	....	....	....
Ohio—							
Ashtabula	25,000	11,616	33,828	4,296	2,100	13,900	278
Barberton	15,000	7,400	16,050	....	....	....	....
Bellefontaine	9,000	6,000	16,300	....	....	....	....
Bowling Green	6,000	7,825	11,400	429	20,000	30,000	2% & A
Cambridge	15,000	8,954	20,986	7,731	23,225	74,765	16,329
Canton	73,000	66,160	176,728	41,693	155,853	533,635	163,300
Chicago Junction	3,600	11,320	19,340	2%	8,300	16,000	....
Cincinnati	485,444	89,320	384,491	279,596	....	....	....
Circleville	8,000	10,952	20,062	3,384	12,000	1.86[1]	....
Cleveland	750,000	297,214	....	....	....	....	....
Conneaut	9,000	14,924	31,320	5,406	23,000	60,000	9,000
Coshocton	12,000	10,787	16,997	3,400	....	....	....
Delaware	10,000	12,000	21,600	2%	3,000	5,400	2%
E. Cleveland	20,000	45,332	115,794	79,992	18,666	63,000	48,600
E. Liverpool	25,000	12,548	38,863	32,818	43,380	157,096	76,324
Findlay	20,000	38,480	7,968	19,356	32,685	61,629	14,995
Fostoria	12,000	2,638	4,273	1,500	5,000	14,280	2,000
Galion	8,175	18,334	45,521	11,380	13,000	....	¼
Ironton	15,000	33,355	47,080	11,216	....	....	....
Jackson	6,500	0	....	....	3,000	5,000	2[illegible] & A
Lakewood	31,000	40,135	100,518	2[illegible] & A	....	....	....
Lancaster	13,000	20,936	26,110	5,770	17,499	24,123	6,021
Lorain	36,000	10,300	33,110	....	50,000	....	....
Marion	30,000	32,921	112,227	5,500	40,000	145,000	7,250
Massillon	18,000	12,173	17,406	8,868	....	....	....
Norwalk	8,000	11,000	26,000	1-3	9,000	20,000	....
Oak Hill	1,500	0	....	....	11,497	23,008	5[illegible] & A
Piqua	15,000	59,488	165,695	25,000	....	....	....
Ravenna	6,500	6,400	15,000	7,000	12,000	25,000	14,000
Tiffin	14,200	16,800	36,507	3,500	15,000	....	2% & A
Toledo	215,000	169,368	....	....	....	....	....
Urbana	10,000	34,000	81,000	2% & A	....	....	....
Van Wert	8,500	25,136	64,279	....	0	....	....
Warren	22,000	41,478	117,000	28,900	70,230	287,400	24,900
Washington C. H.	8,000	46,585	104,246	49,041	26,000	....	....
Wooster	8,000	7,184	14,994	....	20,000	45,000	....
Xenia	12,000	29,000	91,000	....	33,000	....	....
Youngstown	80,000	57,949	111,409	....	....	....	....
Zanesville	30,000	29,500	53,375	22,747	47,438	105,057	35,768
Oklahoma—							
Durant	8,000	15,730	28,700	0	32,000	60,000	0
Enid	18,000	0	....	....	500	....	....
New Wilson	3,000	0	....	....	15,500	28,000	0
Sapulpa	17,000	26,731	58,838	0	36,000	....	0
Shawnee	18,000	0	....	....	30,000	67,000	0
Oregon—							
Astoria	17,000	49,558	100,000	....	47,000	....	....
Portland	250,000	206,124	398,723	....	110,260	260,000	....
Salem	16,000	16,395	17,757	....	40,000	....	....

Denison	30,000	25,828	28,674	7,168	....	....	....
Greenville	10,000	550	622	622	....	....	....
Houston	125,000	259,969	423,925	145,705	40,000	90,000	40,000
Paris	15,000	24,110	59,729	28,301	....	....	....
Port Arthur	20,000	0	....	....	60,000	140,000	1-3
San Antonio	130,000	245,900	550,000	248,000	60,000	140,000	60,000
Texarkana	20,000	2,470	5,367	....	....	....	....
Waxahachie	10,150	20,000	28,500	7,000	200,000	300,000	¼
Wichita Falls	16,000	29,000	36,000	12,000	30,000	37,500	12,500
Utah—							
Ogden	32,000	35,786	81,481	....	....	....	....
Provo	10,000	7,042	8,077	761	....	....	....
Vermont—							
Montpelier	8,000	4,478	....	4,478	9,000	14,000	....
Rutland	15,000	2,029	8,300	5,300	....	....	....
Virginia—							
Clifton Forge	6,000	3,000	2,400	2,400	5,000	5,000	5,000
Danville	28,000	8,000	8,500	8,500	....	....	....
Newport News	20,000	....	....	....	....	....	....
Norfolk	89,612	12,375	....	96,956	....	....	....
Staunton	12,000	5,000	14,700	14,700	....	....	....
Suffolk	15,000	9,200	9,811	9,844	5,000	5,350	5,350
Washington—							
Aberdeen	18,000	21,490	44,441	....	....	....	....
Bellingham	30,000	114,600	213,700	0	....	....	....
Centralia	10,000	8,214	9,539	300	20,000	24,000	0
Everett	25,000	15,213	31,438	0	15,000	30,000	0
Olympia	10,000	4,205	11,500	....	....	....	....
Seattle	348,600	319,576	765,014	6,580	282,500	680,000	10,000
Spokane	140,000	55,206	117,708	7,762	10,000	17,000	....
Tacoma	104,000	3,409	8,147	0	....	....	....
Vancouver	10,000	3,900	6,740	0	0	....	....
Walla Walla	20,000	116,607	102,827	668	....	....	....
West Virginia—							
Bluefield	18,000	4,926	7,397	1-3	8,000	12,000	1-3
Charleston	30,000	121,884	286,744	....	....	....	....
Fairmont	16,000	20,100	16,900	1-3 & A	....	....	....
Martinsburg	11,500	0	....	1-3	200,000	250,000	1-3
Moundsville	12,000	5,096	6,735	2,600	14,000	18,000	75,000
Parkersburg	30,000	42,957	74,000	16,300	60,357	95,900	5,380
Wisconsin—							
Appleton	18,000	13,095	34,636	11,567	7,000	16,800	5,500
Baraboo	7,000	9,000	11,500	6,000	6,000	9,000	4,500
Beloit	20,000	72,437	117,895	18,980	0	....	....
Chippewa Falls	1,000	......	....	....	5,000	12,500	1-3
Eau Claire	20,000	16,168	27,473	....	40,000	....	....
Fond du Lac	20,000	24,285	47,137	7,902	47,000	90,000	20,000
Grand Rapids	7,500	13,983	23,673	8,209	11,300	22,308	8,769
Green Bay	30,000	0	....	....	22,000	....	....
Janesville	11,000	14,388	16,972	....	46,000[9]	....	....
La Crosse	32,000	3,522	6,838	4,181	....	....	....
Madison	32,000	49,168	109,565	20,000	50,000	112,000	20,000
Marshfield	6,000	33,954	62,970	....	....	....	....
Menasha	7,000	13,000	24,000	14,000	15,000	26,000	....
Menomonee	5,036	10,168	14,080	14,079	....	....	....
Oshkosh	35,000	13,546	31,150	1,170	50,000	80,000	20,000
Portage	6,000	0	....	....	35,000	60,000	¼
Racine	47,500	66,796	159,204	34,775	88,048	209,113	55,965
Superior	50,000	27,366	49,065	0	50,000	80,000	0
Waukesha	10,500	11,013	10,132	3,594	....	....	....
Wausau	19,000	16,226	28,433	14,216	18,000	30,000	15,000
West Allis	12,000	46,300	92,530	22,113	50,000	....	....
Wyoming—							
Cheyenne	0	....	....	....	10,000	20,000	20,000
Rock Springs	6,000	0	0	0	....	....	....

A, intersections of streets; B, business part of city; C, additional pavement laid by township within city limits; D, repair work; G, gravel; O & S, oil and screenings; S. O., Standard oil; T, Topeka mixture.

Absence of any entry in the columns of work "Proposed for 1917" indicates that no plans have yet been made for 1917. (1) indicates cost of grading is included; (2) cost of curb or curb and gutter; (3) cost of drainage inlets; (4) cost of drains or sewers. If none of these four symbols appear the cost figures given include them all.

1 Per square yard.
2 Contract awarded.
3 Linear feet.
4 Miles.
5 Blocks of street.
6 Includes boros of Blakley, Dickson City, Jermyn, Jessup, Olyphant, Throop.
7 Will lay considerable in 1917.
8 Old brick or macadam foundation.
9 Kind not yet decided.

(To be continued in the February Number.)

MISCELLANEOUS

Meetings of Organizations

January 17-18 at the society house, New York. American Society of Civil Engineers. Charles Warren Hunt, secretary.

January 18-19 at Washington, D. C. American Forestry Association. P. S. Risdale, secretary, 1410 H street, N. W., Washington, D. C.

January 18-20 at Purdue University, Lafayette, Ind. Indiana Engineering Society. Charles Brossmann, secretary, Merchants Bank building, Indianapolis, Ind.

January 19 at New York. American Society of Engineering Constructors. J. R. Weinburger, secretary, S. Ferry building, New York.

January 20 at Kansas City, Mo. Western Paving Brick Manufacturers' Association. G. W. Thurston, secretary, 416 Dwight building, Kansas City, Mo.

January 22-23 at Hotel Astor, New York. The National Civic Federation. V Evert Macy, president, Metropolitan Tower, New York.

January 23-25 at New York. American Wood Preservers' Association. F. J. Angier, B. & O. R. R., Baltimore, Md., secretary.

January 31-February 1-2 at Washington, D. C. Annual meeting of the Chamber of Commerce of the United States.

February 5-9 in Mechanics building, Boston, Mass. American Road Builders' Association and Road Show. E. L. Powers, secretary, 150 Nassau street, New York.

February 7-15 at the Coliseum, Chicago, Ill. The tenth Cement Show. Cement Products Exhibition Co., 210 S. LaSalle street, Chicago, Ill.

February 8-10 at Hotel LaSalle, Chicago, Ill. American Association of Engineers, headquarters, 29 S. LaSalle street, Chicago, Ill.

February 8-10 at Hotel LaSalle, Chicago, Ill. American Concrete Institute. Harold D. Hynds, secretary, 1418 Walnut street, Philadelphia, Pa.

February 12-14 at Chicago, Ill. American Concrete Pipe Association. E. S. Hanson, secretary, 538 S. Clark street, Chicago, Ill.

February 19-24 at Kansas City, Mo. The Southwestern Concrete Association and Exhibit. Saturday is good roads day. Charles A. Stevenson, chairman exhibit committee, 1433 W. Tenth street, Kansas City, Mo.

May 7-11 at Hotel Jefferson, Richmond, Va. American Water Works Association. J. M. Diven, secretary, Troy, N. Y.

May 8-10 at Washington, D. C. National Fire Protection Association. Franklin H. Wentworth, secretary, 87 Milk street, Boston, Mass.

The Northwestern Road Congress

The Northwestern Road Congress held in Chicago December 7 and 8 was an enthusiastic gathering favoring better roads and was supplied with many good addresses by state highway officials and other road experts and good roads enthusiasts. A sentence in the address by H. G. Shively, chief engineer of the Maryland State Highway Commission, is significant. He said that the eastern states are far behind those of the west in the good roads movement because the western states are not using the trunk line system connecting the good roads of one state with those of another.

A. D. Gash, chairman of the Illinois State Highway Commission was elected president for the ensuing year, succeeding John A. Hazlewood, the head of the Wisconsin State Highway Commission.

There were many excellent exhibits in connection with the Congress. Prominent among them were the following:

The Asbestos Protected Metal Co., of Pittsburg, Pa., represented by R. George Miller and their local dealer, G. A. Sellar of the Sellar Supply Co., with the Pittsburg paving joint, a premolded all-asphalt joint material, which has demonstrated its practicability.

The Dunn Wire-Cut-Lug Brick Co., with the most generally used form of brick for paving now in the market.

The Illinois Paving Brick Publicity Bureau, representing the paving brick interests of the state.

The Pioneer Asphalt Co., of Lawrenceville, Ill., with their Pioneer paving cement for asphalt pavements, Pioneer road asphalt for road treatments and for asphaltic concrete, and the Pioneer paving joint compound.

F. J. Lewis Mfg. Co., of Chicago, Ill., with road tars, road building machinery, coal tar paving pitch, road oiler, portable heating tanks, pouring cans and the like.

The United States Asphalt Refining Co., with Aztec asphalt for all paving and road treatment purposes.

The Koehring Machine Co., of Milwaukee, represented by G. E. Hillsman, district manager, Chicago, Ill., with the well-known Koehring mixer which gives "more batches per day."

The Russell Grader Mfg. Co., Minneapolis, Minn., with road scrapers, graders, plows and other road construction machinery.

Add Another Paving Joint

By a typographical error the Pittsburg paving joint, made by the Asbestos Protected Metal Co., of Pittsburg, Pa., was omitted from the list of premolded joint materials used for making expansion joints along curb and across the street in brick and concrete pavements. The list will be found on page 128 of the October number of MUNICIPAL ENGINEERING in the article on the construction of brick pavements.

Personal Notes

E. L. Wells is the city manager at San Angelo, Tex. H. M. Garden is city engineer.

Frank I. Bennett, formerly an alderman, has been appointed

Commissioner of Public Works of Chicago, Ill., to take the place of William R. Moorhouse, who resigned in November.

C. C. Huffine is the city engineer of Frankfort, Ind., taking the place vacated by the death of R. H. Boynton.

Geo. H. Royle, Trenton, N. Y., is head of the construction department of Mercer county roads.

Geo. A. Johnson, consulting engineer, New York, will serve as engineer in the reconstruction and rearrangement of the Bayonne, N. J., water system.

Henry Welles Durham, county engineer of Bergen county, Hackensack, N. J., who has been absent on leave with his regiment, the 7th New York Infantry, at McAllon, Texas, has returned to his office, having come back to New York with his command, which has been mustered out of active duty with the United States Government.

Allen Kisinger is the new city engineer at Norwood, O.

Raymond W. Parlin has been appointed deputy commissioner of the New York street cleaning department.

The U. S. Office of Public Roads and Rural Engineering has appointed the following district engineers: L. I. Hewes, Washington, Oregon and Idaho; C. H. Sweetser, California, Nevada, Arizona and New Mexico; J. A. Whittaker, Montana, Wyoming, Utah and Colorado; E. O. Hathaway, the Dakotas, Minnesota and Wisconsin; J. C. Wonders, Nebraska, Iowa, Kansas and Missouri; J. D. Fauntleroy, Arkansas, Louisiana, Oklahoma and Texas; J. T. Voshell, Michigan, Illinois, Indiana and Kentucky; J. T. Bullen, Florida, Georgia, Alabama, Mississippi, South Carolina and Tennessee; Guy H. Miller, Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island and Vermont, and H. K. Bishop, Pennsylvania, Ohio, West Virginia, Virginia, Maryland and North Carolina.

Jesse Taylor

Jesse Taylor, perhaps the most prominent advocate of good roads in Ohio and well known over the country as the managing director of the National Highway Association, died at Jamestown, O., December 7.

Mr. Taylor was a banker, who became interested in good roads and started a little periodical to help in the campaign, which developed into the magazine now known as *Better Roads and Streets*, to which he has devoted a large share of his time for several years.

His enthusiasm and push made him a leader in the good roads movement in many lines and carried him into many states, and his name was a household word in Ohio in the good roads movement.

Technical Schools

There will be nine vacancies in the Engineering Experiment Station Research Fellowships of the University of Illinois for the next school year. The appointments to fill these vacancies will be made in the spring of 1917 and applications should be made before February 1. Allowance of $500 is made to each holder of a Fellowship and about half his time is devoted to work in the special department to which he is assigned, the remainder being available for graduate study. Full information can be obtained from the Director of the Engineering Experiment Station, Urbana, Ill.

The sixth annual road school of the Wisconsin Highway Commission will be held at the State Capitol, Madison, Wis., the work of January 29. Registration this year will probably be higher than the 700 of last year.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

January 9: Leading draftsman, ordinance department at large, in the Frankford Arsenal, War Department, Philadelphia, Pa., at $2,400 a year.

January 16: Supervising mining engineer and metallurgist in Bureau of Mines, Department of Interior for service in the field at $4,000 a year.

January 17-18: Aid qualified in chemistry in the Bureau of Standards, Department of Commerce, for duty in Washington, D. C., at $600 to $840 a year; assistant examiner, Patent Office at $1,500 a year; mechanical draftsman in Patent Office, Department of Interior, Washington, D. C., at $1,000 a year; surveyor and transitman in the General Land Office, at $100 to $110 for transitman and $125 to $150 a month for U. S. Surveyor.

January 23: Architectural draftsman in Office of Public Buildings and Grounds, Washington, D. C., for 6 months at $130 a month.

Garbage Contract Is Let

F. G. Royster, of Norfolk, Va., was given the contract to handle the by-products of the municipal garbage reduction plant by the board of control Friday. Royster bid $57,000 for 6,000 tons of fertilizer, the highest ever received by the city and some $9,000 higher than last year.

Tenth Cement Show

The tenth annual cement show will be held by the Cement Products Exhibition Co., at the Coliseum, Chicago, February 7-15, 1917.

This year the show will all of it be contained in the Coliseum, which will be quite a convenience for both exhibitors and visitors. This decision makes it necessary to concentrate space to some extent, but the advantages will offset any slight inconveniences suffered on this account.

The number of exhibitors is large, amounting to 161 at the date this is written. They cover all branches of the field, cement, cement workers' tools, cement roofing, cement products machines, publishers of periodicals, dump wagons, reinforcing, meters, steel, molds, artificial stone, steam and gasoline engines, concrete road machinery, protection joints, expansion joints, bags, cement placing machinery, tile machinery, waterproofing, cement vaults, post molds, cement decorations, fillers, elevators and conveyors, motor trucks, concrete mixers, sand, gravel and stone, electrical machinery, sack baler, forms for curbs, gutters, foundations, walls, etc., joint fillers, excavators, buckets, silos, paints, crushers.

Publications Received

The revised general specifications for bridge work of the Illinois State Highway Department for 1917 have been issued and can be obtained by those interested from the department at Springfield, Clifford Older, bridge engineer.

A progress report on the Oxford Pike concrete service test road in Philadelphia has been issued by William H. Connell, Chief of the Bureau of Highways, which is available by those interested on application to him.

The publications of the Committee on Unemployment of the Mayor of New York are obtainable of the Secretary of the Committee, Room 2028 Municipal Building. They include for free distribution the report of the committee of January, 1916, and the new 32-page report on planning public expenditures to compensate for decreased private employment during business depressions; also for sale the new report on dock employment in New York, 50 cents and on how to meet hard times, being a program for the prevention and mitigation of abnormal unemployment, 25 cents.

MACHINERY AND SUPPLIES

The Garbaget

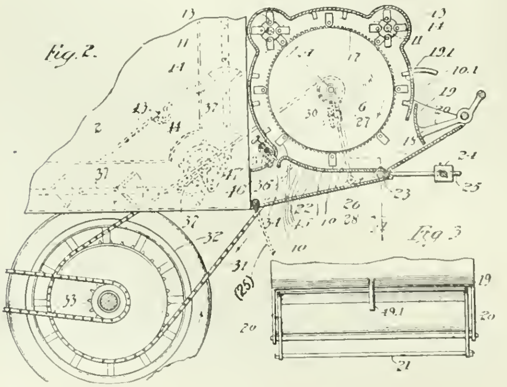
An idea has been developed by Edwards B. Stuart of Chicago into patentable form which, when it is worked out in the form of the necessary machine at work, may revolutionize the disposal of garbage.

In brief, it is a motor-driven machine which travels about the city collecting garbage and changes the collected materials, as rapidly as they are fed into the machine, into a dried and powdered form, which is ready for the extraction of the grease from it and, either with or without that operation, for use as a fertilizer.

The idea is distinctive, the only approach to it a portable garbage and refuse destructor, tried unsuccessfully a few years ago, which did not attempt to utilize the valuable constituents of the garbage. The principal object of the garbaget is to make this utilization possible, next, of course, to disposing of the garbage with the least possible danger of nuisance. A distinctive idea demands a distinctive name and the inventor has devised "garbaget," an evolution from the garbage-eating propensities of the machine.

The accompanying drawing gives some idea of the construction and method of operation of the machine. The garbage is dumped into the trough or chute at the rear of the machine at 18, which opens by the weight of the garbage can on a bar connecting the arms operating the closing plate. When the can is emptied and removed the opening is closed automatically. Once the garbage is inside it is rendered entirely innocuous in every respect before it emerges from the apparatus.

In the small compartment at the rear is mounted a cylinder, on the outside of which are mounted swinging hammers



which strike on teeth projecting from the inner surface of the encasing cylinder, so that the garbage introduced as above described is pounded by a flail-like motion and thoroly comminuted. Two smaller shafts in the upper corners of the casings, at 11, mounted with hammers operating between those mounted on the larger cylinder, aid in the reducing process and in thoroly mixing the mass. The lever 25 serves to throw the garbage comminuting apparatus in gear with the driving chain run by the sprocket on the rear wheel of the motor truck. A perforated plate with one end movable separates the chamber of comminution from a chute leading to the large storage chamber forming the larger part of the apparatus. The finely divided garbage passes thru the perforations in this plate and a small opening along one edge, or can be dumped by moving the free end, either into the storage chute or to the ground or a small vehicle or box beneath.

From the chute the fine garbage is carried by a bucket conveyor up and across the top of the storage chamber, where trap doors permit its deposit in the storage chamber. In the rear of this elevator shaft is a door above the crusher chamber, thru which the material not to be crushed can be dumped into the conveyor for deposit in the storage chamber.

In the bottom of the storage chamber is a device for discharging the hot gases from the motor of the truck into the material in the chamber, so that it is dried by the heat thus applied. Drainage devices are provided for collecting the oil condensing on the walls of the chamber from the hot gases after they pass thru the garbage.

The oxidation of the garbage, resulting during the process of pulverizing it, is reported to remove all objectionable odors, so that the machine can operate on the city streets and alleys without appreciable nuisance.

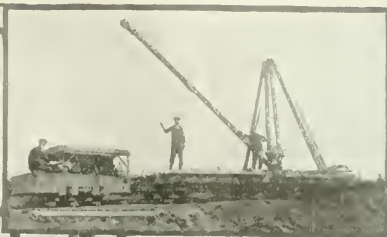
Any material which cannot be broken up in the crusher is forced against the movable side of the division plate above referred to, and the motion throws the crushing apparatus out of gear, thus preventing damage to it.

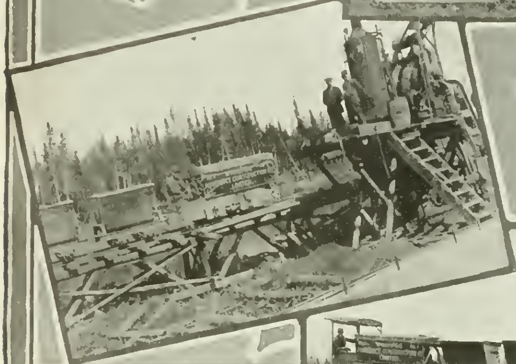
The removal of moisture from the garbage by the heat reduces volume, and especially weight, and increases the carrying capacity of the machine as compared with one collecting raw garbage.

Gasoline Locomotives in Contract Work

It is a notable fact that contractors handling big construction work are coming more and more surely to the regular use of gasoline locomotives whenever haulage between two fixed points is a problem. Extremely low working cost, speed and dependability are three of the great determining factors in their decision.

Time was when the use of small locomotives of this sort was largely confined to industrial service and mining transportation, but current and thoro investigation shows them now in





The upper picture shows The Plymouth Wrecking Train, mentioned in the Winnipeg installation.

The one on the left shows one of the Plymouths waiting for a load at the concrete mixer.

In the picture at the right is another Plymouth at another mixer.

The lower picture gives a clear idea of the trestle work used for the tracks. All these pictures were taken on the Winnipeg Aqueduct job.

general use in road building, in gravel pits and brickyards, as well as on construction work.

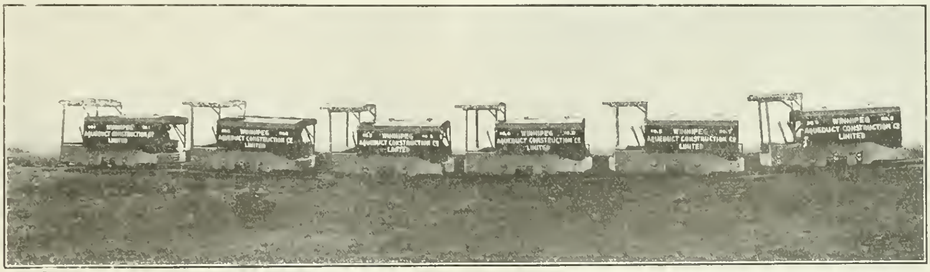
Typical Gasoline Locomotive.

A typical engine of this type has as one of its main features a friction drive for variable speed-transmission. A 4-cylinder vertical engine at the right of the tank drives a face wheel or friction disk at the left. Against the face of this disk runs the rim of the wheel on the transverse shaft, this wheel being fitted with a fiber ring. Speed is varied by merely shifting this wheel laterally along its shaft so as to ride against the higher or lower speed portions of the disk. A sprocket chain from this shaft drives a countershaft with chain drives to both axles.

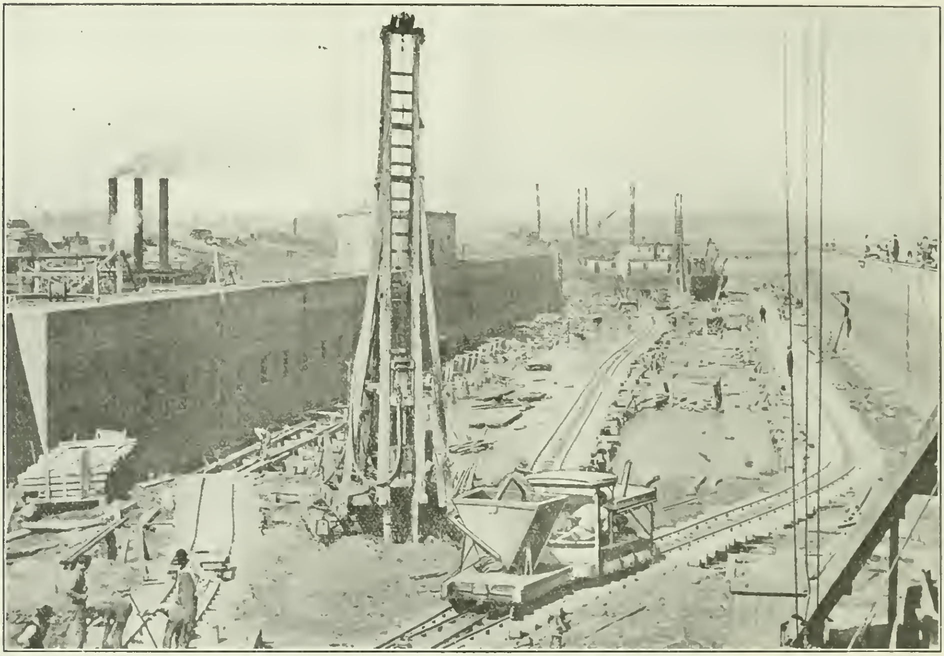
The frame comprises four heavy castings which impart weight and stability. Pockets in the end castings provide for convenient coupling to cars of different heights. In the 3-ton locomotive there is a 23-h. p. engine (at 1,000 r. p. m.) driving a 23-inch friction disk and 22-inch fiber-faced wheel. It is mounted on four 18-inch steel wheels, with a 30-inch wheelbase. All bearings are fitted with flexible roller bearings, except that double-row ball bearings are used for the shaft of the friction disk.

Speed and Pulling Statistics.

The machine has a maximum speed of approximately 10 miles per hour, and a drawbar pull of 1,200 pounds at 5 miles per hour. It carries 20 gallons of gasoline and 50 gallons of



THESE SIX PLYMOUTHS WERE IN THE FIRST SHIPMENT SENT THE WINNIPEG AQUEDUCT CONSTRUCTION CO., LTD., IN 1915. BEFORE THE CLOSE OF THAT SEASON THREE ADDITIONAL PLYMOUTHS HAD BEEN SENT THIS SAME CONCERN.



DAM NO. 48 IN OHIO RIVER SHOWING THE PLYMOUTH LOCOMOTIVES AT WORK ON GREAT PROJECT.

water and consumes from 5 to 6 gallons of gasoline in the course of a 10-hour working day.

The 6-ton machine has a 50-h.p. engine, giving the same maximum speed, but a drawbar pull of 2,400 pounds at 5 miles per hour.

The locomotives are built for tracks of 24 to 56½-inch gage and with or without a cab, according to the character of the service which they are expected to perform. In service the mechanism is protected by curtains.

Among the larger and more recent construction jobs upon which these engines have been used are the Louisville & Portland canal lock at Louisville, Kentucky; the Ohio River dam No. 48; New York State highway work; the Boston dry-dock and the Halifax harbor works.

The Winnipeg Aqueduct Job.

There are no less than nine such gasoline locomotives (all of the Plymouth type) now helping the Winnipeg Aqueduct Construction Company, Ltd., of Winnipeg, Manitoba, Canada, do its share in building the $13,500,000 project now under construction in the Lake of the Woods regions. This project is an aqueduct nearly 100 miles in length, and is intended to furnish Winnipeg with a daily supply of 100,000,000 gallons of water.

The work involves the building of a construction railroad 102.4 miles long, a diversion dyke and channel, 85 miles of concrete aqueduct, a 250,000,000-gallon reservoir and 2.3 miles of 4-foot cast iron pipe. Of the $13,500,000 contract, the Winnipeg Aqueduct Construction Company has nearly $4,000,000 of the award, and, as previously stated, the nine Plymouth locomotives are busy as little bees hauling material from one point to another, dumping concrete from the mixers to the forms and generally making themselves useful.

Bad Tracking Conditions Overcome.

The work where the gasoline engines are doing daily duty lies almost entirely in muskeg. This is a peat bog, saturated with water, covered with moss, with roots and decayed wood below and various underlying soils. Ofttimes the "Plymouths" are up to their hubs in the mire and the workmen on the job have declared that no other type of outfit could stand the extraordinarily heavy work imposed upon the dimunitive locomotives.

Details of the Concrete Haul.

In the concrete work the ground is so soft that the contractors have been forced to place stationary mixers at suitable points. From the mixer an elevated log trestle curves both ways to met a track laid on the top of the dump along the south side of the excavation. A short track also runs the entire length of the gravel platform. The Plymouth trains—composed of three to four steel hopper cars holding ¾ cubic yard of concrete—take the concrete from the mixers, run along about half a mile of level track on either side of the mixers to the dump, making the trips in an unusually short time, with the season's average consumption of ½ gallon (Imperial) gasoline per hour.

J. B. McLean's Testimony.

Commenting on this long haul for concrete to the dumping point, Mr. J. B. McLean, manager of the Winnipeg Aqueduct Construction Company, states: "The concrete has been successfully handled in this manner for a distance of ½ mile on either side of our mixing plant. No difficulties have appeared in this long transportation, there being no segregation of the materials and no difficulty in dumping the concrete, even at the extreme ends of the work.

"At the beginning of last season we ordered six of these locomotives. In September we found that we could use another one, and, as we are opening two additional camps this season, we have ordered two more from the J. D. Fate Company, of

Plymouth, Ohio. This will make nine of these locomotives which we have on one job up to date.

"We can speak very highly of the satisfaction which these machines have given us. They are able to pick up their loads quickly, get away without fuss or bother under full power and speed, and also return to the mixer in record-breaking time that makes our long hauls of concrete possible. They have cost us very little for repairs, and, for the amount of power they generate, they are not expensive as to gasoline consumption. They have literally done everything the makers promised they would do."

Hauling Gravel and Handling Wreckage.

Another duty imposed upon the little locomotives on the Winnipeg aqueduct job is the hauling of gravel to the concrete mixers. This material is brought from near-by pits to the mixers and the engines manage to keep these busy.

One of the unusual features of the work they are doing there, however, is the handling of a wrecking train. With such unstable tracks the small dump cars and even the larger and heavier regulation freight gondolas topple over into the mire. A wrecking crane is rigged up on a flat-car and the Plymouth is "First aid to the Injured" quite frequently during the course of the day. One of the accompanying illustrations shows the Plymouth wrecking train and crew, and gives some idea of the log trestle track over which it and its eight companion engines are forced to travel.

How Ohio River Contract Company Broke World's Concreting Record.

Two other little gasoline locomotives of the same type recently enabled the Ohio River Contract Company to break a world's record in concreting, and, at the same time, brought about a condition that was unusual in construction work in the building of Dam No. 48 across the Ohio river, just below Evansville, Indiana.

The unusual condition to which reference is made is that the contractor was forced to *decrease* his speed in order to comply with the contract and specifications, whereas customarily exactly the opposite prevails, the contractor being more often compelled to pay forfeit for not completing the job within the stipulated time limits.

This dam is being built under United States government supervision and is the longest movable dam in the world, as well as the only one constructed upon a shifting sand foundation.

Saves Them $44.00 Every Eight Hours.

The Ohio River Contract Company states that it has replaced six mules with each gasoline locomotive, with a driver to each mule, two locomotives and two drivers now doing far more work in less time than the twelve mules and twelve drivers formerly accomplished, and, coincidentally effecting an actual saving (by a daily record of costs) of $44.00 in haulage cost every 8 hours. Furthermore these locomotives are run both day and night, thus doubling the working hours of the

THE PLYMOUTH TAKING A TRAIN OVER THE BOG AND MIRE OF LONG BEACH.

NOTE LOCOMOTIVES RUNNING ALONG TRESTLE—OHIO RIVER DAM 48 JOB.

mules, which must, naturally, have some rest out of the twenty-four hours.

What L. P. Eichel Says.

Leslie P. Eichel, purchasing agent for the Ohio River Contract Company, states in a recent letter: "This has been a very wet season, and we have had to place concrete at short intervals, at great speed, to keep ahead of the 'rises.' In placing the concrete into the floor of the lock, the two Plymouth locomotives had to operate a maximum round-trip distance of 1,600 feet, with a stop for loading concrete at the mixer and a stop for dumping the material, the average time of which was, for each locomotive, less than 4 minutes, day and night, for 22 days. This time included all breakdowns to concreting machinery and other delays caused by similar mishaps.

"Each train pulled 1¼ yards of concrete over a trestle-way for a distance (round trip) of 600 feet, including both stops, and for several hours one locomotive made the journey in one minute. However, as the United States government permits only 45 cubic yards an hour we were not permitted to maintain this speed any consecutive number of hours. It was one of the first cases on record where the contracting officer had to cut down the speed under which a contractor was working.

"We placed with these two Plymouth locomotives—using one only half the time and two the remaining half—9,810 cubic yards of concrete in 269 hours, including all breakdowns to concrete machinery and other delays. This is a rate of 36.5 batches per hour. In one 12-hour shift, or rather in one 12-hour run, as shifts have to be changed every 8 hours, on the 1,600-foot run we placed 513 cubic yards with the two locomotives, including all breakdowns to concrete machinery and other delays. (We never deduct for breakdowns and delay.)

"On a shorter run, with one locomotive, we placed 475 cubic yards in 12 hours; on the long run (1,600 feet), 355 cubic yards in 8 hours with two locomotives.

"We could go on indefinitely. Unfortunately our working season, so far, has been very short. Otherwise we would have had other record-breaking figures to present you.

"The saving to us, per locomotive, per 8-hour shift, is estimated by our office to be $22. One locomotive takes the place of six mules on a day and night run.

"At Louisville we are testing out a Plymouth in comparison with a number of steam dinkies. We are certain the little locomotive will win out."

Pertinent Cost Figures.

The following data were given out by Mr. Eichel from his daily itemized cost record:

Labor cost per hour, Plymouth Locomotives...	$0.37½
Labor cost per hour, horse-driven power	1.40
Difference in cost per hour for labor, in favor of Plymouth Locomotive	1.02½

Cost per ton mi. hauling with Plymouth, 200 ft.	.1339
Cost per ton mi. hauling with Plymouth, 300 ft.	.1041
Cost per ton mi. hauling with Plymouth, 400 ft.	.0950
Cost per ton mi. hauling with Plymouth, 500 ft.	.0870
Cost per ton mi. hauling with Plymouth 600 ft.	.0819
Cost per ton mi. hauling with Plymouth, 700 ft.	.0783
Cost per ton mi. hauling with Plymouth, 800 ft.	.0761
Fuel cost, per hour, gasoline.................	.1100
Lubricating oil cost, per hour................	.0400

"We consider these small engines," he says further, "much cheaper to operate than any other system on account of less labor in operating, increase in work done per hour and plant erection to permit operation. In comparison with horse-driven power the locomotive is undoubtedly much cheaper. We are particularly favorably impressed with the friction drive on our Plymouth engines and fully believe that the expense of replacing the fiber rim on same is less than the cost of transmission lubricants for most gear-driven locomotives.

U. S. Government Engineer Says.

E. H. Wise, junior engineer of the War Department, United States Engineers' office, under whose direction the Government dam work on the Ohio River Contract Company's job was done, supplements the contractor's statement as follows:

"Between August 6 and October 3 (269 hours) a total of 9,136 yards of concrete was placed in the lock floor at an average rate of 36.5 batches per hour. All of this was handled by two Plymouth gasoline locomotives, the major portion by Locomotive G-1, which handled 7,472 batches and traveled 1,434 miles, and the remainder by Locomotive G-2, which handled 2,338 batches and traveled 233 miles. The maximum haul was 790 feet, and the minimum haul 215 feet.

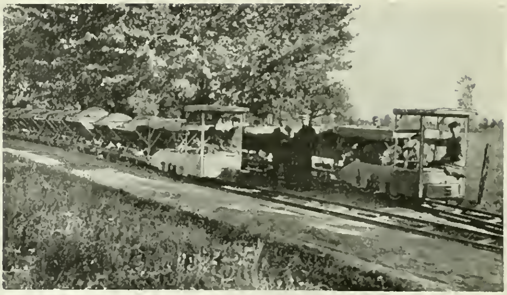
"Each locomotive pulled a single truck carrying 1-yard bottom-dump concrete bucket. There was a slight down-grade in the track for about 150 feet adjacent to the mixer, the remainder being level."

New York State Highway Contract.

The adaptability of the gasoline locomotive to different requirements in road building is shown by the experience of Phelan and Sullivan, general contractors of Utica and Syracuse, New York. This concern hauled gravel 2¼ miles—which is a pretty fair haul—and accomplished it at a cost of only 5 cents per cubic yard, far below what a contractor, who is depending on horse and wagons, could expect to do the same work for.

Phelan and Sullivan's two locomotives were first employed on state highway work in New York state where they had the contract to build the Syracuse-Bridgeport road. Inasmuch as they had secured the contract at a pretty close figure it was essential that they find some means of reducing normal costs. Every item was gone over and it finally was decided that


PLYMOUTH TRAIN TAKING ON LOAD AT GRAVEL PIT.


TWO PLYMOUTH TRAINS MEETING ON TRIPS TO AND FROM GRAVEL PIT.

in hauling lay the best point of attack. After an investigation it was decided to supplant teams with some form of power. Various power-driven machines were given consideration, the gasoline locomotive finally being selected to solve the problem. With what success this was accomplished is best told in the words of Mr. L. D. Sullivan, of Phelan and Sullivan, himself. He says:

"Both of the little locomotives have given perfect satisfaction and really are doing more than was guaranteed for them. We are hauling gravel on a 24-inch gage railway and, at present, are hauling a distance of 2¼ miles. The machines make ten trips each per day with nine 1½-yard cars, making a total of 270 cubic yards of gravel per day.

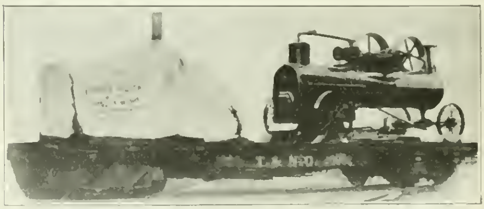
"The cost of operation is $13.50, which includes two runners at $2.50 each, and two brakemen at $2.00 each; 20 gallons of gasoline and 1 gallon of oil, all of which makes the total cost of the haul (approximately 2¼ miles) 5 cents per cubic yard.

"We have two slight grades of approximately 1 per cent on this haul, and we have hauled twelve loaded cars up these inclines without putting the locomotives under any apparent strain. On other work the engines serve steam shovels, handling cars of excavated material."

Paving Equipment for Cuba

One of the largest single shipments of paving equipment on record is that just made to Messrs. Torrance & Portal, of Havana, Cuba, who have secured extensive paving contracts in Havana and Cienfuegos.

The shipment made by the Iroquois Works of The Barber Asphalt Paving Company consisted of six cars routed by way



of Key West, Florida, carrying two 3-unit asphalt plants, two 2,000-gallon and one 1,000-gallon steam heated melting kettles, 4 tandem rollers, 2 portable boilers and engines, fire wagons, paving tools, etc.

Contracts already secured by the Havana firm for paving in which Trinidad lake asphalt will be used, total about 400,000 square yards. One of the Iroquois plants is to be located at Havana and the other at Cienfuegos.

Dynamite in Road Improvement

By J. B. Stoneking, M. E.

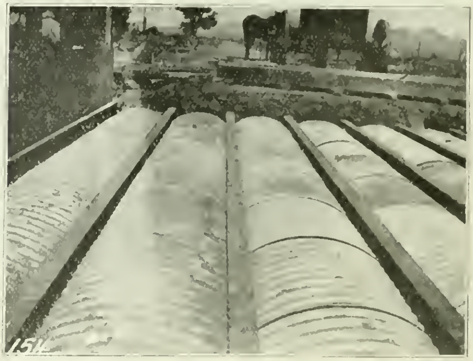
There is such a heavy increase of traffic on all roads in this country, more especially on the main trunk highways between cities and towns of importance and the roads leading from the more populous country districts into the markets, that a very necessary and radical change has been forced in road building and improvement methods. Not many years ago, plain gravelled and water-bound macadamized roads stood the wear and tear of the then comparatively light and slow-moving vehicles. Light surfacing was the rule and materials which would stand up under that traffic were found to be inadequate when subjected to the abrasion and hard pounding of our heavier and rapid-moving vehicles of the present day.

Since the development and perfecting of the auto truck for hauling and delivery purposes, the slow wide-tired wagon has been largely replaced. This type of traffic has spelled the doom of earth roads, and tears holes in lighter, more easily worn surfacing with amazing ease and rapidity. It has also caused a cry to be raised for easier grades. The lighter pleasure automobile is almost as hard on road surface as the truck, and the higher speed has increased the number of bad accidents on sharp curves and steep grades. These causes have not only made a heavy, wear-resisting road surface necessary, but in the rebuilding and improvement now being done the roads are widened, grades reduced, sharp turns and dangerous curves eliminated.

The vast amount of work to be done, coupled with the high cost and shortage of labor, has led to the development of successful labor-saving road machinery of many different and highly specialized types. One of the labor-savers adopted from quarry, railroad, and mining work and applied with success to road building is the low-freezing, slow-acting, heaving, low-grade dynamite for earth work in deepening and widening cuts, widening curves around hill sides and points, blasting out stumps, boulders, and trees, and in making side and outfall ditches for drainage. Considerable saving is accomplished by its use in loosening material in conjunction with steam shovels, graders, scrapers, and other machinery.

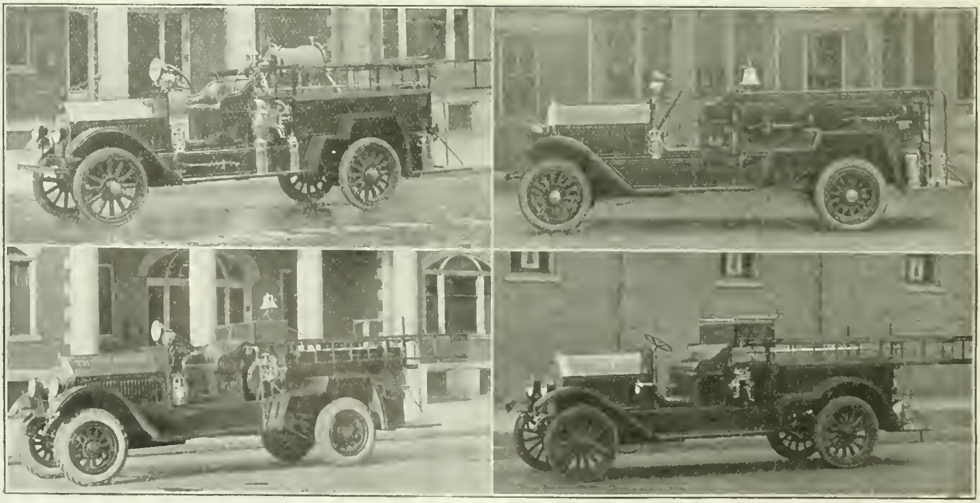
Corrugated Iron in Bridge Flooring

The accompanying photograph shows the placing of part circle pure iron corrugated for use in concrete bridge flooring. On this layer of the corrugated iron will be placed concrete which will be filled above the I-beams to form a wearing surface for the bridge floor. The pure iron used is particularly adaptable to this purpose because it can be formed exactly to suit the conditions and, tho somewhat exposed, being in



contact with the air below, the purity of the iron and the galvanizing insure an indefinitely long life for the metal.

The bridge is one built under the supervision of County Surveyor L. M. Bunce, of Butler County, California, in Supervisor J. C. Albertson's district. The arches shown are of 14-gage American ingot iron, 22 inches span and 4¼ inches rise.



SOUTH BEND "DOUBLE DUTY" FIRE APPARATUS.

TYPE C H 60-4 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF GREENFIELD, IND.

TYPE H 90-6 "DOUBLE DUTY" HOSE WAGON AS OPERATED BY CITY OF CLEVELAND.

TYPE C H 90-6 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF THREE RIVERS, MICH.

TYPE C H 95-4 "DOUBLE DUTY" COMBINATION AS OPERATED BY CITY OF MANITOWOC, WIS.

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ROADS FOR THE FUTURE

The perennial contest between the road and the vehicles proposed for travel over it is on again in greater force than at any time in the past. Just now the motor truck user is almost daily increasing the load on his truck and the size of the truck, and he is doing the same with the trailers, which are daily becoming more common, following the English practice of many years.

It has been but a very few years since American roads have been good enough to carry this heavy traffic, and just as soon as they are good enough the heavy loads come.

So far as the truck itself is concerned, this increase in loads has a limit, at least so far as unit pressure on the road is concerned, because the resilient tire, which is necessary to protect the truck-driving machinery from excessive vibration and shocks, has its limit of load which it can carry. Consequently it is comparatively easy to guess what the weights on individual wheels will be and so to design the pavement or road to carry them. Pavement it must be on the main traveled roads because only pavements with good foundations will carry them.

We are beginning to collect data about the relations between amount of traffic and life of road service so that we are better able to compute the life of pavements in terms of amount of traffic. We can approximate the life of a road in years by estimating the future amounts of traffic. Whether one surface is more economical than another, whether a pavement will wear out before the bonds issued to pay its cost have been paid, are questions, the answers to which depend, under these conditions, upon our good judgment in foreseeing the increase in amount, not individual weight, of traffic.

If we are to continue to use our present best pavements on our streets and roads we must limit the weights upon individual wheels, and, particularly on trailers, the character of the tire.

If, as now seems inevitable, motor trucks are to take a large proportion of the local freight business away from the railroads, is it not just and right that this use of the roads by but one class of business be paid for by that business? Should motor trucks with heavy loads not pay heavy enough license fees to cover their wear of the roads? The railroad furnishes its own road-bed and we would think it presumptuous for them to ask the state to build it for their free use. The light motor car pays its share, probably, of the upkeep of the roads and of the extra quality of surface demanded by that traffic. The cost of both is made much higher by the comparatively small number of heavy motor trucks and trailers. The special class of traffic should pay the extra cost of the road to carry it.

If, later, the trailer traffic should develop to such an extent as to demand thru lines of steel runways it should pay for the construction and maintenance.

It is not good business to restrict permanently development in any legitimate direction, but it is good business to put the cost of providing for that development upon the traffic which is growing, and any restrictions put upon that traffic should be only such and for such time as may be necessary to make reasonably accurate estimates of the direction and amount of the development and to design and construct the ways to carry it. It is not yet certain, for example, that, except under very peculiar circumstances, the heaviest loads which have been carried are those which will be found economical to carry on the comparatively small units of truck and trailers. We may not need to find better materials for our roads than our present best when the truck traffic man finds his most economical form of vehicle and weight of load. And we may not be required to put any restrictions on the traffic—other than the few that are required to fit the two parts of the one machine together, the particular transmission gear requiring attention being the tire and the road surface at and under the point of contact.

MAKE IT WATERPROOF

You may have passed it by without remark when you read the paper, but you cannot miss it in the abstract on page 53 when five engineers writing on five different subjects all lay stress on the necessity of waterproofing the road surface. That is why their words on this subject are collected together. We all think we know it, but how many of us do the best we know about it? The new traffic in weight and speed makes waterproofing the road the most important detail in its construction, just as choice of material and foundation are the most important in its design.

The Design of Bituminous Pavements

By the Editor.

The use of asphalt mixtures for the surfaces of pavements began over fifty years ago with the use of asphaltic limestone or sandstone in Europe and has developed until the bituminous pavement in all its various forms together is the most widely used of any.

Beginning in this country with the asphalt-sand mixture to which the term asphalt pavement has been applied, using natural asphalt, boiled to remove the water, the number of materials with which asphalt is mixed, the kinds of bitumen, asphalt or tar, the proportions and methods of treatment have become legion.

It is true that the most satisfactory compounds thus far used have been those approaching the original limestone-asphalt rock and the original sand-asphalt mixture, with improvements developed in practice, and this article is mainly devoted to those two classes of pavement, the more detailed discussion of others being left to future articles in this series.

NO TIME will be spent in discussing the differences in chemical and physical properties of bitumens other than may become necessary in special cases. It will be assumed that asphalts are natural in their origin, each one requiring a certain, small or large, amount of refinement or distillation to prepare it for use in or on pavements and that tar is an artificial product of the destructive distillation of organic products, orginally of vegetable origin, tho now mainly occuring as minerals.

The design of bituminous pavements must take into account the differences in composition of these various bitumens, and many of the failures of bituminous pavements have occurred because the designers did not know enough about the qualities of the materials they used, or the proportions and and methods of mixing of the ingredients to give the best results. It must be admitted that the present knowledge of all these matters is far from complete and any new mixture or any new material, whether bitumen or aggregate, must be tested by actual use before the conclusions of theory can be accepted or rejected. This lack of knowledge, while still immense, has been filled to a very great extent by the results of chemical research, observation and experiment, so that it is no longer necessary, as it was twenty-five or thirty years ago, to depend upon the instructions of a few men familiar with the use of certain mixtures of a single class of asphalts with a limited number of combinations of aggregates. Nevertheless, the recurring of the best results is still a matter of expert design and supervision of construction and it is worth the while of any municipality to secure such expert advice with reference to the design and construction of its asphalt pavements. Whether this shall be obtained thru a regular employe of the city with a chemical laboratory, or thru the occasional employment of an outside expert, would depend upon the amount and continuity of the laying of asphalt streets by the city.

Even the experts may make mistakes, because of the large residuum of ignorance regarding many of the complicated problems arising, both chemical and mechanical, but a city is safer with their advice, even if they may sometimes be responsible for failures of pavements.

Classification of Bituminous Pavements.

The varieties of bituminous pavements have become so great in number, and they have been devised in such an independent manner that there has been much confusion in the nomenclature, pavements of the same or like ingredients and methods of mixture receiving different names, according to the method of approach of the designer. The American Society of Municipal Improvements has made earnest efforts to clear up these differences and definitions derived from its standard specifications should be adopted as fixing the standard nomenclature for the various classes. These specifications cover the standard pavements of the various classes which have proved successful for the classes of traffic for which they are designed.

Sheet Asphalt pavement is composed of a binder course of stone or stone and sand with asphalt, on which is placed a wearing surface of sand, limestone or portland cement dust, and asphalt, its prominent characteristic being that its wearing surface is a sand-asphalt mixture with a small proportion of fine stone dust.

Bitulithic pavement is a mixture of stone, sand and bitumen laid and finished with a seal coat of fine material aggregate and bitumen, the leading characteristics being the "inherent stability" of the aggregate and the careful proportionment of ingredients and filling of voids.

Bituminous Concrete pavement is of many varieties, ranging from such mixtures as the so-called topeka and the modification of the topeka mixture adopted by the American Society of Municipal Improvements down a rather indefinite distance, the leading characteristics being that the mineral aggregates are broken stone properly dried and heated and mixed with sufficient bituminous cement practically to fill the voids, the surface being finished with a seal coat. The various grades of bituminous concrete vary from a mixture of broken stone, sand and asphalt, according to definite specifications as to proportions of material of various named sizes, and as to filling of voids, down to plain mixture of broken stone and bituminous cement in which the lowering of the cost of the mixture seems to be the principal purpose and its adaptation to the probable traffic secondary.

Bituminous macadam is usually of the nature of a plain macadam pavement treated with asphalt or oil, sometimes by application to the surface of the completed macadam pavement and sometimes during the processes of construction. The line between bituminous concrete and bituminous macadam is not closely drawn, tho there is a tendency to apply the term bituminous concrete to roads laid by the mixing method and bituminous macadam to those laid by the penetration method. This is not strictly correct, however, because in true bituminous concrete the filling of the voids is an important factor and not all roads laid by the mixing method are properly designed in this regard, so that they are, many of them, really no better constructed than those done by the penetration method, and should be classed as bituminous macadam.

Oiled roads are of any ordinary road material and run from those which are as good as bituminous macadam down to those on which a minimum of oil is used, the object of the latter being to lay the dust and of the more copious treatments to hold the surface materials of the road in place for a greater or less length of time, according to kind and amount of oil used and the changes in temperature and the number and length of rain storms.

The Design of Asphalt Pavements.

The first asphalt roads were constructed of natural asphalt rock, the ingredients of which were in proper proportions to produce reasonably good wearing surfaces. These rock asphalts were limestone or sandstone impregnated with asphalt. When they were not properly proportioned they were brought up to standard by adding the lacking material, whether stone or asphalt, and the fine stone added was either limestone or sandstone, according to which would produce the best wearing surface. Artificial asphalt pavements were developed in this country, using Trinidad asphalt as the base, that material containing a considerable proportion of mineral matter, but not enough to produce a pavement when used by itself. To correct the slipperiness which was a characteristic of the pavements laid with European natural asphaltic limestones, sand was made the principal mineral ingredient, a percentage of finely ground limestone being included, to retain the good qualities of the European pavements.

After some years other natural asphalts were introduced and since the discovery of the qualities of petroleums with asphaltic base many so-called artificial asphalts have been developed, ranging in source from the residuums of petroleum to the heavy asphaltic oils in which the asphalt is the principal product and the light oils are the by-product.

Each asphalt, each flux, each sand, each limestone or cement dust, has its characteristics, and to produce the ideal asphalt pavement they must be known thoroly, and the effect of each upon the others in a mixture must be known quite as thoroly. Asphalt chemistry is an exceedingly complicated study and it has taken fifty years to arrive at our present state of incomplete knowledge. Less time has been taken with the study of the other materials and in some respects their characteristics and effects in the mixtures are not so well known as those of asphalt. It is not surprising, therefore, that many mistakes are made in mixtures and in handling.

In the early days progress was slow because it was not possible to go far from the standard materials and methods without serious results. Sand is the material which should come from the locality of the pavement, if possible, in order to reduce cost, but in those early days it was considered necessary to carry sand many miles from a uniform deposit, the characteristics of which were known, rather than take a near-by sand of less uniformity which had not been tried. This condition has been improved, but many bad pavements are due to lack of expert advice as to the materials to be used, i. e., proper use has not been made of the advance in our knowledge concerning asphalt pavement ingredients. The standard specifications of the American Society of Municipal Improvements give specifications for the qualities of the paving mixture, particularly as to quality of asphalt and proportions of the various ingredients as to materials and the various sizes thereof, being specifications for the pavement rather than specifications for each of the individual ingredients. It will be assumed in this article that these specifications or their equivalent are followed. In several cities they are followed with another provision added, making two classes of asphalt pavements, one in which natural asphalts are used, meaning those requiring a small amount of refining; and one in which artificial asphalts are used, meaning those produced by distilling off the lighter oils, leaving the asphalt as a refined residuum of the process.

The Variables in the Problem.

In designing the mixture for an asphalt street there are a number of variables which must be considered.

A heavily traveled street with too soft a mixture will rut, mark or wave. A lightly traveled street with too hard a surface will crack and then will be disintegrated by water and frost. A coarser sand with softer asphalt and less of it would be needed than on a heavily traveled street. A pavement, devoted to motor traffic, which is somewhat soft will be softened still more by any oil which may drop on it from the passing vehicles and may then rut or wave.

An asphalt pavement hardens with age, and the nature of future traffic must be anticipated, as well as that of the present be considered. A harder mixture is required in a warm climate and a softer mixture in a cold climate for the same conditions of travel.

Temperature of materials in process and of the mixture as delivered on the street are important. A temperature which may be needed for one asphalt will harden another asphalt too much and may even ruin another. A temperature which makes one asphalt so fluid that it separates from the mixture may make another mixture so stiff that it can not be properly raked, rolled or compressed.

Differences in penetration or ductility, or both, of the asphalt used, differences in the amount and grading of stone dust and in the quality and grading of sand all have their effect on these characteristics, and the expert can fit the one to the other if he knows the present traffic, the tendencies of the traffic to change and the possibilities of sudden change upon the improvement of a street or road heretofore unimproved. The design of the mixture is thus largely a matter

SHEET ASPHALT SURFACING OVER OLD BRICK PAVEMENTS ON SIXTH STREET, COLUMBUS, O., $1\frac{1}{2}$-INCH BINDER AND $1\frac{1}{2}$-INCH TOP, 1912.

RESURFACING OLD GRANITE BLOCK PAVEMENT WITH ASPHALT ON THIRTIETH STREET NORTH OF MT. VERNON STREET, COLUMBUS, O., 1915.

of judgment led by an expert knowledge of characteristics of ingredients and mixtures.

Consistency of Asphalt.

The sand in an asphalt pavement wearing surface has no material stability and the stability of the pavement depends upon the stability of the mixture with asphalt, as tempered by the stone dust and such other fine material as it may contain. The penetration of the asphalt cement used in the paving mixture has come to be one common measure of its ability to produce a stable mixture for the wearing surface.

The standard specifications of the American Society of Municipal Improvements provide that the penetration of the asphaltic cement at 77 deg. F., shall be from 30 to 55 for heavy traffic streets and from 55 to 85 for light traffic streets. In each of these classes the variation allowed is 25 to 30 points, and this variation is allowed because the variations on account of sand and asphalt used, stone dust, and climatic conditions are not provided for in the specifications, but are left to the judgment of the designer and he must have this amount of lee-way on account of these various causes for variation.

With horse traffic softer asphalts were suitable, but with motor-driven traffic a harder consistency is required.

A soft pavement will shove, push or roll under the effect of motor-driven wheels and tho asphalt pavement for modern traffic must be as hard as it can be made without putting it in danger of cracking from cold weather contraction. Slow-moving, heavily loaded vehicles produce more of the effect than light, swiftly moving automobiles, and the effect is more pronounced on grades. A slight wave is soon expanded by the greater action of the traffic upon the irregular surface thus formed, even tho the wave is at first almost indistinguishable.

It may be necessary to vary penetrations upon the same street on account of differences in grade and differences in kind of traffic. In an article by F. P. Smith, he calls attention to a bituminous concrete pavement on a hill with heavy horse traffic going up which soon developed large waves, whereas on the other side of the street, where the traffic was down hill and was composed of empty trucks and light delivery wagons, there was practically no wave formation. Street car tracks shortly divided the traffic into the two streams.

For a heavy traffic street, largely motor-driven, in the North the penetration would probably range from 30 to 40 and in the South from 5 to 10 points lower so that the pavement would not become too soft in hot weather. A street which is always in the shade should have a softer asphalt-cement than one always open to the sun.

Cold weather cracks disappear in warm weather if they are not filled with street dust to prevent re-union, provided the traffic is sufficient to do the welding. Also, cracks are not so difficult to repair as are rolls or shoves, so that there is a tendency toward harder asphaltic cements. Repairs must be attended to promptly in either case. Into cracks will run water and dirt, and the water and frost will disintegrate the pavement. Shoves and waves will become worse in summer and will spread so as to make larger areas to repair. It is considered by many asphalt engineers that it is safer to err on the side of too hard than too soft a pavement.

Defective or light foundations are the cause of many waves and shoves, since any slight depression in the foundation starts a low spot in the asphalt surface, which rapidly develops into a shove, where one would not otherwise occur.

While these shoves or waves are not numerous in asphalt pavements they are very troublesome when they do occur and sometimes it has been very difficult to ascertain their cause. They are far more common in bituminous concrete and especially in bituminous macadam pavements.

The standard specifications assume a relation between penetration and ductility of an asphalt sample. An asphalt cement having a penetration of 50 deg. F. must have a ductility of not less than 30 at the same temperature and each change of 5 points in penetration must be accompanied by a corresponding change in ductility of 2 centimeters. How close this relation may be is not yet definitely known. The two tests do not follow each other exactly when applied to different asphalts.

Some asphalts are more brittle at low temperatures than others. Some have greater differences at high and low temperatures than others. Some are more liquid than others at high temperatures. All these things must be considered in connection with the conditions under which a given pavement will exist in designing the mixture and deciding what asphalts can be used.

The Binder Course.

The binder course seems to be an essential of the good asphalt pavement. A wide-spread attempt to lay asphalt pavement without binder led to failure. The sand-asphalt mixture does not join thoroly enough with the concrete base, even when that is rough, and the action of traffic on the layer of pavement directly in contact with the concrete is such as to break it or wear it with undue rapidity.

The relative merits of open and closed binders have been discussed fully and not all points in controversy have been fully settled. It is enough to say here that the closed binders, in which the voids in the stone mixture are fairly well filled with asphaltic cement is the most popular at the present time. Asphalt is not a very good conductor of heat, and the wearing surface protects the binder from sudden and even from very great changes in temperature, so that the binder retains its resiliency more uniformily than the surface, and thus aids in keeping the pavement up at all times to its average condition, which is naturally that for which it is designed.

Too soft a binder will exaggerate any tendency in the surface to shove or become wavy and the movability of the stones in the open binder is one of the objections to its use. Again, if water gets into the binder to stay permanently, whether thru lack of sub-soil drainage, so that water comes up thru the foundation, it finally loses its bond and movement of its parts induces the formation of waves. The foundation and sub-base may be softened even more than the binder coat and thus cause settlement and defects in the surface.

Drainage.

The asphalt pavement is so smooth that the necessity of good surface drainage is not always recognized. The crown should be sufficient to shed water surely in case there may be any slight inequalities due to irregularities in laying or compacting the surface, and may be reduced somewhat as the grade of the street increases, being sure to retain enough to turn the water promptly to the gutters. On streets with practically flat grades, catch basins or sewer inlets should be inserted at intervals between street corners so that the gutters, at least, may have fall enough to carry off the water. The gutters must be kept clean, also. No matter how nearly waterproof the pavement may be there is always chance for water to seep into and under it from pools in the gutter thru the joint between pavement and curb or pavement and gutter, if of other material than asphalt. It will also drain down thru joints in the curb and around inlet castings, posts, manhole covers, etc.

Thoro compression of binder and surface courses by longitudinal, cross and diagonal rolling aids in making the pavement waterproof and in making it a stable unit and should also be demanded in the specifications accompanying the design. Too much attention can not be paid to this detail.

Thickness.

The standard specifications leave the question of thickness of binder and wearing surface to the judgment of the designer, the relative importance of the two under the local conditions being determined by him. In general it may be said that the total thickness of the two is about 3 inches, and that the tendency is to make the wearing surface as thick as possible without reducing the binder enough to lose its effect.

From the tables giving data regarding construction of asphalt pavements in 1916, to be found elsewhere in this number of MUNICIPAL ENGINEERING, it will be seen that the thickness varies in the cities reporting from 1 inch in a single coat in Hazleton, Pa., to 4 inches in Washington.

The variations in distribution of thickness between binder and wearing surface are shown by the following data from 105 cities in the table. Single coat: 1 city uses 1 inch thickness: 2 use 1½; 1, 1½ to 2; 20, 2 in.; and 1, 2 to 3 in. Most of the use of the single course is in Southern states, but it is also used in some cities in Washington and occasionally in other Northern states. Two coats: Binder ¾ in., surface 1½ in., 1 city; 1 and ½, 1 city; 1 and 1½, 21 cities, a popular combination in Ohio, Indiana, Michigan and Iowa; 1 and 2, 14 cities; 1 and 1½ or 2, 3 cities; 1 or 1½ and 2, 1 city; 1 and 1½, 1 city; 1½ and 1, 1 city; 1½ and 1½, 20 cities, 1½ and 2, 11 cities, popular in Illinois, 1½ and 1 to 2½, 1 city; 1 and 1½ or 2, 2 cities; 1 and 2½ in Washington, D. C.,2 and 2 in Nashville, Tenn., on old base; 0 to 1 and 1 to 2, in one city.

The most popular combinations are, single coat 2 inches thick, 20 cities; 1 in. binder and 1½ in. surface, 21 cities; 1½ in. binder and 1½ in. surface, 20 cities. These figures give a very fair idea of the standards of practice in this regard, but no information as to the reasons for adopting these standards.

LAYING BITULITHIC SURFACE OVER OLD MACADAM, COMMONWEALTH AVENUE, NEAR CHARLESGATE WEST, 1916.

THE DESIGN OF THE BITULITHIC PAVEMENT.

The object in the design of the bitulithic pavement is to produce a true bituminous concrete wearing surface, uniform in composition thruout its mass from top to bottom, which has a maximum of density or low percentage of voids in the mineral aggregate, which latter is so graded as to produce an inherent stability in same, independent of the bonding qualities of the bituminous cement, which is used in sufficient quantity to coat all the particles of the mineral aggregate.

The inherent stability of the aggregate is obtained by the interlocking of the bituminous coated particles of mineral aggregate, they keying into each other so as to tend to resist displacement by the strains of traffic, and to obtain this result extreme care must be observed in prescribing the proportion of each size of particles of aggregate to be used.

The screen grading required can not be calculated by any known rule and even Fuller's well known formula for portland cement concrete will not give maximum density in a bituminous concrete. The grading varies with the shape and maximum size of the crushed particles; therefore, a close study should be made of the mineral aggregate using a screen and void tests on which to base a screen grading which gives maximum density and the percentage of bitulithic cement to fill the remaining voids and well seal the surface.

Stone cubes or prisms of equal size could be laid to lock together and produce a maximum of density and inherent stability, but would produce a very inferior wearing surface, quickly abraded and ravelled by traffic. On the other hand, if too little coarse stone and an excess of mortar is used, the mixture is yielding to traffic and, lacking inherent stability, causes trouble by shifting; hence the attempt is to produce a mean, which is appropriate for the traffic.

For instance, on a level road subjected to automobile traffic exclusively a coarser maximum size stone and a larger proportion of same can be safely used than on a similar street exposed exclusively to horse-drawn iron-tired vehicles. Again on a steep hill where a rough surface is of prime importance, the size of the maximum size stone may be increased and the proportion of the mortar decreased, thus causing the coarser particles to protrude somewhat and give better footing for the horses. Great care must be exercised in this, however, as decreasing the mortar to that extent naturally decreases the waterproofness of the surface; hence while this can be done on a steep grade, a change in the mixture back to normal must be made at the foot of the hill, where the water will not drain off rapidly.

The surface of the pavement can also be made relatively rough or smooth by varying the size of the aggregate used in the surface finish. This finish or seal coat can be applied:

(a) By first rolling the wearing surface until it has received ultimate compression and then covering it with hot bitumen spread by a squeegee machine and covering same with stone chips or coarse sand and rolling.

(b) By first spreading the wearing surface mixture in the usual manner and then before rolling spread over it a very rich mixture of the fine aggregate and seal coat bitumen, and then thoro rolling the seal coat and wearing surface mixture in one operation.

This latter, known as the mixed method seal coat, seems preferable on level streets, and by getting a somewhat better bond with the surface mixture produces a closer, more waterproof and therefore more durable surface.

Mineral Aggregate.

This may be either crushed stone, gravel, crushed oyster shells or any other mineral product which is of durable wearing qualities and has a surface with which the bitumen can become suitably bonded.

The actual screen of a gravel aggregate consisting largely of oval particles will be a very different grading from that used with crushed oyster shells, which when laid on the street lie down flat.

The material used must be clean, such as clay in gravel and inseparable dust in some limestone. If not clean as soon as the seal coat is worn off by traffic and the larger stone surfaces are exposed, the rain and water from sprinkling carts will penetrate these dust shells, tending toward loosening stones from the bituminous mortar and starting ravelling.

A coarse grained granite or trap will shatter under iron-tired vehicles, while a softer but tougher fine-grained trap or limestone will wear down evenly. All laminated stones are to be avoided since if they happen to be exposed with the laminations vertical, they are liable to absorb water rapidly and shatter under traffic.

Bitumen.

Bitulithic cement is a blending of high grade asphalts in an endeavor to obtain the good points and discard the weaknesses of each.

The quantity used in the mixture depends upon:

(a) The percentage of voids in the aggregate;

(b) The character of the aggregate;

(c) The maximum size stone used.

For instance, in a limestone mixture the screenings in the mortar "eat up" more bitumen than can be carried by the fine sand in a straight gravel mixture. Again, in a mixture using $1\frac{1}{4}$-in. as a maximum size of aggregate there is less mortar used than when using $\frac{3}{4}$-in. as a maximum, since the total surface area of the aggregate in the former is less and less bitumen is required to cover it. However, as a general rule 7-8 per cent. of bitumen by weight is used in the surface mixture exclusive of the seal coat. This at first sight seems to be much less than the usual 10 per cent. bitumen in sheet asphalt mixtures, but when it is remembered that the bitulithic surface weighs 250 pounds per square yard and the sheet asphalt 200 pounds and that an average of 2 pounds seal coat bitumen is used on the bitulithic and not specified in sheet asphalt, the total quantity is about the same in both cases.

The penetration of the bitumen is naturally dependent upon the climate, varying from 50 in the extremely hot arid climate of parts of Arizona to 100 in Northwestern Canada. The penetration can be safely made somewhat softer than that used in sand-mixture pavements on account of the interlocking of the mineral aggregates, thus relieving the bitumen of some of the strain of holding the particles of aggregate in position.

As ductility is a measure of the cementing strength of the bituminous cement, this is kept as high as is consistent with other characteristics of the bitumen and with the climatic conditions to be withstood. For instance, the most ductile bitumens are also the ones which change most in penetration with changes in temperature. On the other hand, less ductile bitumens while very stable in penetration with changes of temperature are lacking in cementing strength. Therefore the problem is to make the "blend" which will conserve to the highest practicable degree the all important factor of cementing strength and yet obtain as much stability of penetration as possible.

Temperature of Mixture.

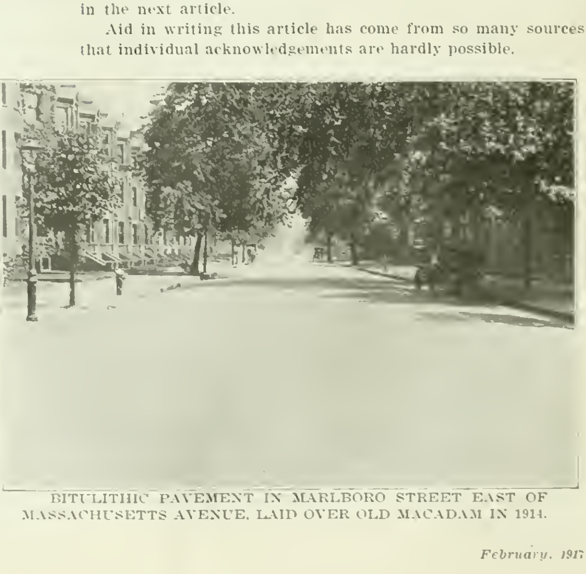
In order to facilitate working on the street and insure compression, this is held as high as practicable and avoid injury to the bituminous cement, the exact temperature depending among other things upon the length of haul or rather upon the length of time the material is in the wagon or truck for the bitumen when spread in thin films on the mineral aggregate will harden more rapidly at any given temperature than it will at the same temperature when in a large body, as in the melting tanks at the plant. Ordinarily 250 deg F. at the street will make the mixture work properly unless weather is cold or a strong wind blowing when 275 or 300 deg. may be necessary.

Compression.

This is an extremely important feature. The roller should be of the usual 3-wheel type, rated at 10 tons, i. e., 22,400 pounds exclusive of water and coal, with 24-inch face on the rear wheels. The roller should be kept in operation continuously until the pavement is thoroly compressed. It is manifestly absurd to provide a mixture which is capable of being compacted to such a dense mass, unless it is actually so compacted on the street. A careless or lazy rollerman can spoil any mixture but the best rollerman can not make a good pavement with a poor mixture.

Other types of bituminous pavements will be considered in the next article.

Aid in writing this article has come from so many sources that individual acknowledgements are hardly possible.



BITULITHIC PAVEMENT IN MARLBORO STREET EAST OF MASSACHUSETTS AVENUE, LAID OVER OLD MACADAM IN 1914.

BRICK SEWERS

By J. F. Springer, New York City.

The author of this article has gathered together some brief descriptions of recent methods of using brick in sewer construction in some instances in combination with concrete, which will be of interest, and has added some illustrations showing standard simple construction by methods in use since brick sewer construction was begun, so that together he has quite well covered the construction of the sewer barrel itself under ordinary conditions.

BRICK has long been the standard material for sewer construction, especially where the diameter is larger than 2 to 2½ feet. If the inner surface of the sewer is left unlined it will be best perhaps to rate the roughness as greater than that of a properly finished concrete sewer. This consideration will naturally affect the carrying capacity. Brick construction will often be economical because of local conditions. The most important of such conditions will ordinarily be the cost of the brick themselves.

Standard Dimensions.

The standard brick will have the dimensions, 2¼x4x8¼. There will be variations from this even where the bricks all come from the same mold, since under-burned, medium-burned and overburned bricks disclose corresponding degrees of contraction. Generally, the more a brick is burned, the greater will be the shrinkage. The medium-burned are the better quality and will probably be the most uniform in size.

Attention has been directed to the importance, in laying, of apparently small differences in dimensions. A brick that is full 8¼ inches long, has a very considerable advantage over one 7½ inches long. When one longer brick is placed, there has been put in position 10 per cent more lining than when one shorter brick has been laid. Again, when a brick 2¼ inches thick has been placed, we have an advantage of 12½ per cent over a 2-inch brick. Taking the two dimensions in combination, the laying of an 8¼x2¼-inch brick has an advantage of 23¾ per cent over the laying of a 7½x2-inch brick, since the corresponding areas are $18\frac{9}{16}$ square inches and 15 square inches. The thickness of the mortar has not been included in the estimates. The width of the brick is a consideration which affects the thickness of the sewer wall. It is also important. A two-ring sewer of brick 4 inches wide will be, say 8½ inches thick in wall, while a 3½-inch brick will reduce the wall thickness, say to 7½ inches. The one sewer will have a wall thickness over 13 per cent greater than the other. It is well to be on the alert as to exact actual sizes of the brick being used.

Porosity of Sewer Brick.

The brick employed in sewer construction should have only a very moderate absorption capacity. An imperfectly burned brick may absorb one-third of its own volume of water in the space of 24 hours. This is entirely too porous. Brick burned very hard may absorb as little as 2 or 3 per cent. This brick is otherwise undesirable. We are not able to secure a brick that is non-absorptive; we must take an intermediate product and use a brick having an absorptive capacity between 10 and 20 per cent, by volume, in the space of 24 hours. It is understood that the specifications of the New York City authorities permit rejection if the absorption exceeds 16 per cent.

If one desires to carry out an absorption test, it is quite a simple matter. The first thing to do after securing fair, average samples, is to make sure we are starting with dry brick. We may put them in an oven for a considerable period, maintaining the temperature at, say 100 or 125 degrees, Fahrenheit. If there is any uncertainty as to whether the bricks are really dry, we may remove them and weight them collectively. We then replace them in the oven and after a time reweigh. If the weights are now the same as before, the bricks were dry when first removed and are dry now. The dry bricks are now placed in a tank whose walls are non-absorptive, and which is provided with a vertical gage glass equipped with a suitable scale. The bricks are left in water in the tank for, say 24 hours. The difference in the readings on the scale when the bricks were first submerged and now will show what volume of water has been absorbed. The result will be a little too large, perhaps, because of evaporation in the meantime. To check this procedure, we may carefully dry the surfaces of the bricks after the 24-hour period of submergence with the aid of blotting paper or other absorbent and then weigh them collectively. The increase in weight will indicate the amount of water absorbed.

Quality of Brick.

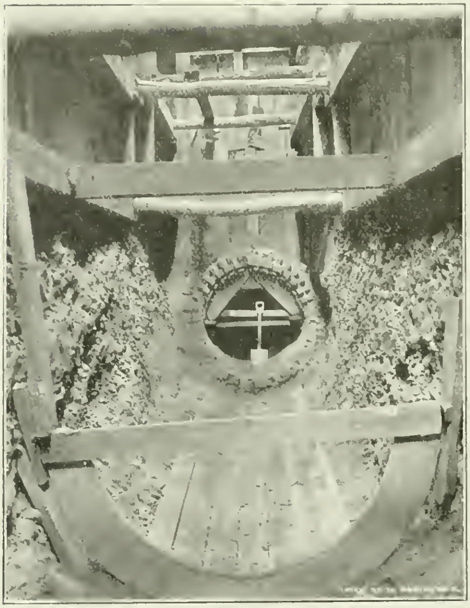
The texture of the brick is a further consideration. It should be uniform and rather dense. We may test roughly for a proper combination of both qualities—that is, for proper texture—by striking a sample brick sharply with a trowel, the brick being held loosely in the hand. If there is a clear ringing sound, the texture is probably good. Density may, of course, be tested by weighing, and uniformity of texture by ocular observation of fractures. The color indicates quality to some extent. A perfect brick from certain given materials will have its own peculiar color. Variations from this color are to be shunned where the ingredients are the same.

Speed of Laying.

The cost of laying brick in a sewer will naturally turn on the cost and expertness of labor; but it depends also on the location of the work at the moment. The brick of the inner ring will ordinarily cost more to lay than those immediately back of it. In the arch, however, this difference is lessened by the fact that the inner ring of the arch is laid upon a center of wood or other material. A good mason will place from three to six bricks per minute, if not delayed by irregularities in his supplies. Proper service will require perhaps 3 to 4 tenders to each mason. Naturally, special conditions will introduce wide variations.

Mortar for Brick Laying.

The mortar that goes into the brick sewer is very important. The sand should be clean. That is, it should not be mingled with clay and loam. The reason underlying this requirement is that the binding material in the mortar, the cement, cannot perfectly interpenetrate such materials. Consequently, wherever there is a bit of clay or loam, there is a spot where some particles are only weakly held together. If dirty sand only can be obtained the sewer contractor should provide for washing it clean. Another requirement is that the sand shall have sharp and angular edges—that is, should not be rounded. Whether angular grains are really better than rounded ones is perhaps open to some doubt. However, the sand should at least consist of various sizes of grains so proportioned in amounts, that when the mortar



CIRCULAR FIFTY-FOUR-INCH, TWO-RING, BRICK SEWER UNDER CONSTRUCTION. IN BACKGROUND END OF COMPLETED SECTION WITH ARCH FORM STILL IN PLACE. IN FOREGROUND TEMPLATE READY FOR LAYING BRICK COURSES OF INVERT TO LINE WITH PLANK CRADLE FOR BOTTOM COURSES. NOTE SHEETING AND BRACING ABOVE AND SOLID MATERIAL BELOW.

is made and hardened, we will get a very dense material. The proportion of cement should be generous. Upon it depends the strength of the resulting mortar. The formula 1:2 or 1:1½ will, if the sand is properly graded, produce a dense mortar reasonably impermeable to water.

The resultant mortar will measure but little more than the loose dry sand, notwithstanding the addition of cement and water. Thus, for a 1:2 mortar, if the cement is heavy (108 pounds per cubic foot), 2 cubic feet of sand will produce but 2.20 feet of plastic mortar. If the cement is light (95 pounds per cubic foot), the 2 cubic feet of sand will yield only 2.11 cubic feet of mortar. The cement and water more than fill up the voids. In poor mixtures where there is lack of cement, the resulting mortar may even be less in volume than the sand. That is, the cement and water seem unable to fill the voids in the loose sand, and instead may cause the grains of sand to come closer together, compacting the original volume of sand. In fact, when the cement is a little less than one-third the volume of the loose sand, the final mortar will have the same bulk as the sand originally had. We have a fairly good rough test of the quality of the mortar in consequence of the foregoing. If the volume of the final plastic mortar is distinctly greater than the volume of the loose dry sand, then we have a rich mixture.

Number of Bricks in the Arch Rings.

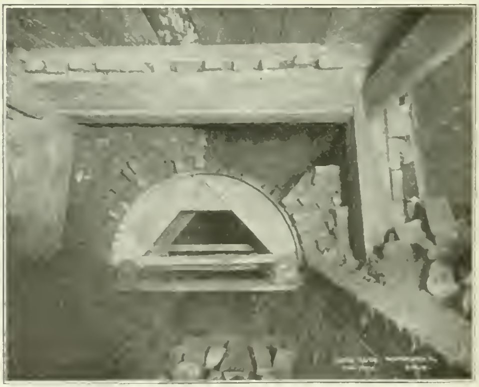
It will readily be understood that, if brick is continually placed back of brick in the arch, the radial layers of mortar will get thicker and thicker as ring of brick is added to ring. If there are quite a number of rings in the arch, this thickness of mortar will become undesirably great. To overcome this difficulty the arch may be divided into a number of short arcs. These may be bulit out to depths of two and three bricks, segments of two bricks alternating with those of three. Upon these segments others may be built out as if starting anew. The number of brick in the new segment will contain one more than the number in the old. This was the method employed in the construction of the Walworth Run sewer at Cleveland, Ohio. At the crown of the arch, the sewer was four or five bricks thick. The thickness of the arch increased to the springing lines. The interior was circular, the diameter being 10¼ feet. The inner arch brick were laid in Flemish bond in alternate headers and stretchers. The sewer varied in dimensions at different locations.

Standardizing Sewer Brick Laying.

Not long ago an attempt was made at St. Louis to standardize the laying of brick in sewer construction. The brick work involved totaled, as Mr. C. L. French in effect tells us, some 10,000 cubic yards, all but 6.6 per cent. of which made use of common brick. As 430 common brick went into a cubic yard, the test involved a total of over 4,000,000 brick.

The bricklayers were each able to lay, on the average, 11.05 cubic yards of brick work per day of eight hours. This means nearly 600 bricks per hour per man—a brick every 6 seconds or a trifle longer. This seems extraordinarily fast work for such a long job. The bricklayers were $9 men. Apparently a serious effort was made not to waste their time. This required that they should not have to wait for laborers. On the other hand, it was deemed just as expensive to have too few bricklayers on the spot.

It was found to be important to have the mortar just right all the time. It was mixed by machinery at a cost of less than $0.01 per cubic yard for power. From the machine, the mortar was dumped into barrows and these delivered, attention was given to "planning the work so that a certain number of bricklayers could be constantly employed," this resulting in keeping the best men. "The importance of this feature is nearly always underestimated by contractors. The difference between work done by a good man and an average man is at least 10 per cent, and where full time can be made, the very best men are obtainable." It would seem that no great effort was made to push the men; but "proper working room,



THREE-RING BRICK SEWER. INVERT COMPLETED IN FOREGROUND. ARCH FORM IN PLACE. NOTE METHOD OF BLOCKING UP ARCH FORMS. BLOCKS EASILY REMOVABLE FOR DROPPING THE FORM TO MAKE IT EASY TO MOVE FORWARD. NOTE STRENGTH OF SIDEWALLS NECESSARY TO CARRY WEIGHT FROM ABOVE.

sufficient materials in right place, and safe working conditions" appear to have been the prominent things kept in view. With reference to the safety item, it may be noted that brick baskets were employed instead of slings.

In spite of the high wage paid to the bricklayers, the average cost per cubic yard of common brick for materials and labor was $6.90.

It may be added, as a matter of practical interest, that the mortar formula followed on this work was 1:3. Such mortar, as we have substantially found already, would just about equal in volume the dry sand employed.

A Method of Moving the Arch Center.

The arch of a brick sewer is ordinarily laid on a wooden center. A rather novel method of handling such a center was employed in constructing a brick storm sewer at Cedar Rapids, Iowa. The sewer is something over a half mile long and divided into a five-foot and a six-foot section. The grade is 0.25 per cent at the upper end, but this drop is increased to 1 per cent for the final 1,000 feet.

The movable center was 14 feet in length and had seven semi-circular ribs, covered with lagging 2 by 4 inches in section. However, as well as one may gather, the semi-circle was not fully completed, the bottom 3 inches being omitted. This arrangement permitted the form to be dropped a trifle after the brickwork above it was all in place.

The form was mounted on wheels, two in front and one to the rear. A track was laid on the invert in the following manner: Cross-ties of 4 by 6-inch material were chamfered at the ends to fit the curvature of the invert and carried a track or roadway of 2 by 10-inch planks.

When the form is in place the wheels are wedged up to elevate the form. So, in removing, the blocks are withdrawn, whereupon the whels drop on the tracks and the whole form whereupon the wheels drop on the tracks and the whole form put in place on the track to cause the single rear wheel to rise and bring the crown of the wooden arch form at its rear end up to the level of the inner curve of the finished brick arch at its outer edge. Having the rear of the form in place, the forward wheels, two in number, would be blocked up to bring the front end of the form into exact position. In using this form, one hour or more was allowed to the newly finished brick arch before the form was moved on to the next position.

Vitrified paving blocks, square or nearly square in section, were employed on this work. Cement mortar was used to bind them together.

There were two rings, laid without brick bond between them. In the inner one, the longitudinal joints were in thickness about ¼ inch; in the outer ring about ½ inch. Cement mortar was spread over the surface of the invert and sides. This surfacing was smoothed until the maximum projections were not larger than ⅛ inch. In order to prevent the ground water from penetrating the arch, it was covered over on the exterior with a cement mortar made on the formula, 1:2.

There are now in use metal forms which are collapsible and removable in a manner somewhat similar to that above described. A photograph of a Blaw collapsible steel form shows the manner in which they are used.

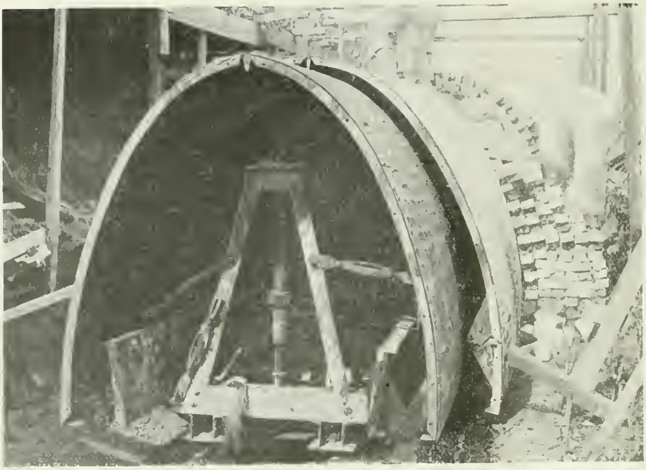
Foundations for Brick Sewers.

A brick sewer will at times require a foundation. The underlying soil may be unequal to the support of the bare sewer. In such cases one method of meeting the difficulty is to spread the under surface of the sewer and thus secure a broader footing. This may result in a heavy demand for material for the lower half of the sewer. It is not necessary, usually, that the added material be brick. If conditions favor its use, concrete is a very proper material. The brick-work may be continued all around, thus forming the lining of the lower half. The concrete used for foundation purposes will, naturally, be a rather lean mixture unless some special conditions require a rich material. The Walworth Run sewer, already referred to, is an example illustrative of a big wide base of concrete. The section of the bore is circular. Corresponding to a 10¼-foot inside diameter, the base has a width of a little over 20 feet. The underlying blue clay was found to be plastic and to have a supporting power of only 2 tons per square foot. The minimum thickness of the concrete beneath the two rings of the invert was made 1½ feet. But the concrete itself was carried on a wooden cradle consisting of oak sleepers 3 by 12 inches in section, and oak planking 3 inches thick. The sleepers were placed at intervals of not less than 4 feet, center. This sewer had various sizes. Corresponding to them were various widths of the concrete foundation up to 30¾ feet for the 16½-foot sewer size. Roughly, the width of the base was double the bore for all sizes.

TWO-RING EGG-SHAPED SEWER. INVERT COMPLETED. ARCH-FORM IN PLACE READY FOR WORK. A PIPE SEWER CONNECTION SET AT SPRINGING LINE READY FOR BRICKING INTO THE ARCH. NOTE METHOD OF SUPPORTING ARCH FORM ON SIDEWALLS OF INVERT.

Some years ago Philadelphia built some egg-shaped sewers. Some of them were provided with a concrete foundation or cradle. The base was greatly widened out and was carried, some of it on piles whose heads penetrated slightly into the base, and some of it on a timber flooring carried by piles. Where the piles were in direct contact with the concrete, reinforcing bars were imbedded in the concrete. These were equivalent to ¾-inch square bars and were laid transversely at intervals of 1 foot, center to center.

Another Philadelphia sewer is that which derives its name from Mill Creek. The section is semi-elliptical or parabolic. The arch is of brick and the invert of stone blocks, the arch and invert being carried by a broad base or foundation of rubble masonry.



NINE-FOOT TELESCOPIC SEWER FORM, HORSE-SHOE DESIGN, BLAW TYPE, USED BY READY AND CALLAGHAN COAL CO., CONTRACTORS, ON CHICAGO CONTRACT.

Cross-Sections of Brick Sewers.

A Lancaster, Pennsylvania, type of construction has a four-ring circular arch of brick with a slightly curved invert of one ring. At the center of the invert a 24-inch semi-circular gutter or channel is provided to take the dry weather flow. The narrow channel, well filled, will have a better flow than a wide channel with the same volume spread thinly over the surface.

There are very numerous sections which engineers have used in sewer construction. Brick lends itself very well to a great diversity. The circular sewer is undoubtedly strong and provides a good flow when the liquid contents are in only moderate amount. The egg-shaped form is doubtless an improvement in giving facility of liquid movement when small quantities of dry-weather flow of sewage are to be disposed of. Prof. R. DeL. French concludes that when a circular sewer is filled no more than 35 per cent of its height, the corresponding egg-shaped sewer is superior.

The capacity of a sewer naturally turns on the velocity of flow. One of the variables on which the velocity depends is the smoothness of the inner surface. In this respect brick is to be rated as somewhat inferior to concrete, it being common to grant concrete from one to three points advantage over brick. Metcalf and Eddy in "American Sewerage Practice," recommend for the values of the factor representing the roughness of the channel in Kutter's formula for the flow in sewers, 0.012 and 0.013 when concrete is the material, and 0.014 and 0.015 and even larger numbers when brick is the material, the smaller factor giving the larger flow.

Repairs to Brick Sewers.

As a brick sewer wears, the roughness increases, the value of the factor naturally increases and the velocity consequently decreases. The mortar is eroded out of the joints, particularly in the invert. It may disintegrate and drop out of the arch. As to accumulations on the surface, brick is not the only material affected by them. It is quite important, in view of the foregoing, to know if it really be possible to restore the joints and to give the whole surface a cement or a cement mortar finish. The breakdown of the joints means deterioration of the sewer itself in addition to the loss of capacity thru the increased roughness. Cement mortar will strengthen the sewer walls and give them smoothness if applied as lining of the eroded brick so that it will be sure to adhere.

There are two methods of applying cement or cement mortar that call for attention. By the one method, the material is mixed by the aid of steam and then driven thru a transmission line and out of a nozzle in a jet. Superheated steam is used to produce the jet and project the material. The surface to be coated is bombarded by the grout. Adhesion is understood to be promoted by this action, and also the density of the coating. The crevices will be filled up and a surface layer put on. The coating may be built up layer by layer to any reasonable thickness. The sewer, whether new or old, may be treated. It will be necessary in the case of old constructions to remove slime and other accretions. The impact of cement mortar will ordinarily result at first in the adhesion of the cement alone, the sand rebounding. But, after a little, the cement coating gets thick enough to hold the sand. There will thus undoubtedly be a thin layer of pure cement against the brick surface, and on top of this the layers of mortar. The steam method may also be used for lining with concrete. The material falling to the ground may be recovered and used again.

There is an alternative method which operates also by a jet, only in this case the driving power is furnished by compressed air. This method may be utilized to coat with cement or with cement mortar. We have results similar to those described.

The steam method is particularly attractive, because no additonal special apparatus is required beyond the machine which mixes and then atomizes the material and the transmission hose or pipe. Steam is required, superheated steam, but that is a very easy requirement to fill. It is not necessary to have the plant close to the point of use. In fact, it may be located upon the surface and at some considerable distance, if need be. A rubber hose may be used for transmision, particularly if rounded pebbles be employed as aggregate in the concrete. The superheating of the steam is necessary or advisable for several reasons. In the first place, steam has driving power when it is steam and not when it has condensed to water. Consequently, thruout the pipe line, it must be hot enough to avoid danger of condensation. Some of the heat goes into the pipe itself. Indeed, a preliminary to operation is the sending thru the line of a gust of steam to clear out the pipe and heat it up somewhat. When operating, steam should be pretty hot as it emerges at the nozzle. Otherwise, it may be expected to condense betwen the nozzle and the surface which is being coated, thus creating a cloud of vapor and obscuring the vision of the man handling the nozzle. Eighty pounds pressure will be sufficient for many usual cases.

The compressed air system which has been referred to as suitable for cement and cement mortar uses a portable apparatus which discharges dry material into a discharge hose, water being added subsequently to the material leaving the machine proper. Whether a considerable length of hose is practicable, I do not know.

There is still another system, referred to at the close of my article on "Methods of Concrete Sewer Construction," in MUNICIPAL ENGINEERING for August, 1916. The procedure employs compressed air and is adapted to concrete as well as to grout. The materials, including the water, are all more or less mingled prior to leaving the machine. This system may be advantageously used where large amounts of material are to be placed in position.

To sum up: If we want to put in a very heavy lining of concrete, the last mentioned system is especially suitable. If we want to fill in small cracks, and put on a thin layer of cement, cement mortar, or pebble concrete, the steam system is a good one; or if we want to fix up cracks and then put on a thin coat of cement or cement mortar, the system is suitable which drives dry material from the machine by compressed air, adding water as a final contribution.

At St. Louis, those in charge of the sewer work investigated the suitability of one of the systems adapted for putting on thin layers of cement or cement mortar, with a view to use on large old sewers of brick and ashlar. The cleaning and other preparation of the surfaces was one of the problems. The wire brush was the first thing tried but was abandoned. The sand blast was also experimented with, but had to be discarded because of the lack of sufficient compressed air to operate properly. This is not to be regarded as in any way condemning the sand blast. They didn't have enough air. The procedure actually employed was "to pick and scrape the mortar out of the joints with a tuck-pointer's tool. Many old sewers, however, are too thickly covered with foreign growths to be susceptible to any scarifying method except the sand blast." Whether the trowel should be used in smoothing off the coating depends upon the advisability, in any particular case, of spending the small sum necessary. If the utmost capacity of the sewer is needed, troweling will probably be advisable. It is thought that the advantage of troweling, over leaving the coat as deposited by the machine used, amounts to about 0.002 in the factor for roughness in Kutter's Formula. That is not to be understood as necessarily meaning that the values 0.012 and 0.031 for concrete are to be cut down to 0.010 and 0.011. Hardly. Rather should we say that only after troweling are the figures 0.012 and 0.013 really justified. Under the conditions in St. Louis, this decrease from 0.015 to 0.013 appears to result in an increase in the velocity, and therefore of the capacity on this account, amounting to about 9 per cent. Increase in the area of cross-section of the sewer due to cleaning would increase the capacity also. No increase in the fall in the sewer would result probably, so there would be no change in discharge on that account. The change in the factor of roughness of 0.002 is a notable one, although it may not always mean a 9 per cent change in the velocity. In the experimental work at St. Louis, a sharp-cornered metal float was used. It was proposed to use a round-cornered wooden float in subsequent work.

Mr. L. Chivvis, the engineer reporting the St. Louis investigation, appears to believe that it is possible to repair and renew to proper usefulness many old and decaying brick sewers, sewers constructed, it may be, before the advent of portland cement. He refers to old St. Louis sewers in which the damage is limited to the joints between the bricks, stating that the erosion has extended to an extreme of several inches of depth in the invert and to a minimum of next to nothing in the arch.

It would appear then, since there must be old brick sewers all over the country, that it is a matter of very considerable importance, if it is really possible not only to restore and improve capacity, but to prolong the life of such structures.

If the sewer is nearing collapse and in consequence it becomes necessary to put in a concrete lining of considerable thickness, we shall have to remember that the result will be a smaller sewer.

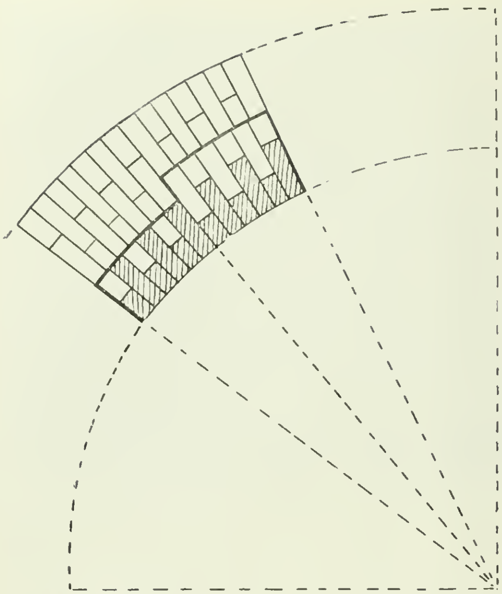
Waterproofing a Sewer.

Before leaving the consideration of these mechanical procedures for applying cement mixtures, a word may well be said as to the rather evident applicability of two of them to the purpose of adding an outside roofing coating to brick sewers. Such a coating is added not so much to increase the strength of the arch, altho it probably does do that to a measurable degree, as to prevent the filtering in of ground water. A comparatively thin coat will be all that will ordinarily be added for this purpose. If used at all, the mixture should be either a pure cement grout or a rich cement mortar. A dense layer will probably satisfy expectations, if no more is expected than a reduction of the permeability. If, however, we wish to go further and make the coating really waterproof, that is, non-absorbent, we may use the method recently developed by the United States Government. This method adds oil to the cement mixture, a certain simple technique being followed in making the addition. It is not enough to use any convenient mineral oil. On the contrary, the oil should conform to certain specifications. A letter directed to Superintendent of Documents, Washington, D. C., and accompanied by ten cents will pay the charge for a post-free copy of Bulletin No. 230 of the United States Department of Agriculture, entitled, "Oil Mixed Portland Cement Concrete." This document will supply detailed information on the use of oil with concrete.

Brick Inverts in Concrete Sewers.

It is of interest to note that brick has been used for the purpose of lining the invert of a concrete sewer. The object in view was to provide a better wearing surface. An example in this connection is afforded by sewer work lately carried out at Toronto, Canada. In one section (No. 4) of the main Garrison Creek storm overflow sewer, three sizes of circular sewer

STANDARD HALF-ROUND SEWER FORMS USED ON 42-INCH TO 72-INCH BRICK SEWERS ON ATLANTA, GA., CONTRACTS BY C. W. LANE & CO. BLAW TYPE.



METHOD OF JOINTING BRICK MASONRY IN WALWORTH RUN SEWER, CLEVELAND, OHIO.

were constructed, 8.00, 9.50 and 9.25 feet diameters. The influence of a steep grade on capacity is shown by the fact that the smallest size of sewer carries the full capacity of either of the others. Thus, the 9½-foot sewer with a grade of 1 in 300 has a capacity no greater than the 8-foot sewer with a grade of 1 in 108. The object in view in varying the grade and size was to avoid a stratum or strata of sand, disclosed by preliminary borings. Even so, the sand reached, at some points, a level just above sub-grade and at others a level up to the springing line.

Part of this portion of the sewer was constructed in open cut and part in tunnel, the total length of 3,425 feet being nearly equally divided between the two. A square concrete base was given to the sewer where it was in open cut. This was to secure the structure against settlement in the sand. In the tunnel divisions, sand was in evidence part of the way, so that a square base was here employed. But for nearly 1,100 linear feet of the tunnel, a circular base was used, the sand being absent. The concrete was made in accordance with the formula 1:3:5.

The radial thickness of the masonry was, in general, the same in the arch as in the invert, with the increases due to the square base where it was employed. The arch concrete was made 18 inches thick; the invert concrete 13½ inches, thus providing 4½ inches radially for the brick lining. This lining was constructed of hard red shale brick. Steel forms were used for part of the work. These took care of the invert semi-circle at one operation and of the arch semi-circle at another. It was necessary, naturally, to use a larger diameter for the invert in order to provide room for the brick lining. In certain work in open cut a 60-foot section of form would be set in the invert and the concrete poured. The turnbuckles would be released after the concrete had set sufficiently, and the steel section drawn ahead to the next location. The brick lining was now put in place. In order to provide for the support and for the moving ahead of the arch form on small wheels a wooden track was provided, consisting of 2-inch planking supported by cross pieces, 6 by 6 inches in section, which rested on the brickwork.

It will be noted that here in the open cut construction the brick lining of the invert was in place before the arch concrete was poured. In the tunnel construction, on the other hand, the brick were placed after all concrete was in position.

In excavating the tunnel, the upper half was first removed from an entire section, the lower half, the bench, being left in place. As the excavation of the upper half went on, the arch concrete was quickly put in place. That is to say, a section of 12 to 15 feet was excavated, when the lining would be put in. The next section would then be excavated and so on. The bench continually provided support for the arch form and for the track on which ran the muck cars.

When the entire section of tunnel had received its arch lining of 18 inches of concrete, the bench was removed in a series of sections of 12 or 15 feet length, these sections alternating with similar sections of bench left undisturbed. As bench support for the track was taken away, trestlework was substituted. The concrete for the invert was then put in, a space of 1 foot being left, between invert and arch. The concrete was now allowed to set for 48 hours or longer, when brick underpinning was put in the open space. The interval of time was allowed for possible shrinkage of the invert concrete.

After all the excavated sections of the invert had been thus concreted and the underpinning set, the unexcavated sections were dealt with, the same general procedure being followed. In this way the concrete arch was continually supported by the invert.

After all the concreting had been completed, the brick lining was put in place on the 13½-inch concrete invert. It is understood that the foregoing method of excavation had its first Canadian trial in this work at Toronto.

Cost of Brick Sewers.

Naturally, the cost of brickwork in sewers varies with numerous items, cost of labor, cost of material, special conditions, etc. In general, however, the brickwork may be expected to cost from $10 to $14 per cubic yard, or, say, $20 to $28 per thousand of bricks. This rough estimate includes labor, materials, tools, supervision. Other things in general being the same, a small diameter sewer will cost more than one of large diameter per thousand of bricks laid.

It has not unreasonably been suggested, in effect, that one mason will lay his thousand of bricks in 3.2 hours, that he will need labor help to the amount of 9.6 man-hours, that 2 barrels of cement will be consumed, that 0.56 cubic yards of sand will be used and that centering will cost 0.10. By means of these data one may calculate from local prices for labor and material the fundamental costs for labor and materials. Add to the total the cost of one thousand of bricks. We now have the total for labor and material. Finally add 15 per cent of this total to cover expense of supervision, lumber and tools. We will then have a pretty fair average estimate for the cost of 1,000 brick in place. To get the cost of one cubic yard in place, divide by 2.

The Public Service Commission for the First District, New York, has had important sewer construction in New York City under its supervision. Photographs of some of this work are shown in the present article.

WATER PROOF PAVEMENTS

Some papers before the Engineering Section of the American Association for the Advancement of Science show the necessity of water proofing pavements of modern design and thus get back to the first principles on which John Macadam based the design of the broken stone road which bears his name.

One of these papers is by Prof. Maurice B. Greenough, consulting engineer of the National Paving Brick Manufacturers' Association, on the real sources of troubles with brick pavements, and he finds that most of them are with water in one way or another.

Another is by C. J. Morrison, of Meyer, Morrison & Co., New York, and discusses directly the necessity for adequate methods of water proofing in road construction.

A third paper by A. T. Goldbeck, engineer of tests in the U. S. Office of Public Roads, considers, among many other things, the effect of water in expanding and cracking concrete, as well as its effect on foundations.

Still a fourth paper, by H. H. Schmidt, chief engineer of highways, Brooklyn, N. Y., while not discussing the dangers of water in pavements, develops a filler for granite block pavements which makes the pavement water-proof, thus meeting the second of his twelve requirements of the perfect filler.

And a fifth paper, by Philip P. Sharples, of New York, details the experiments that have been made in various cities with various materials and mixtures for making mastic (sand and bitumen) joints and the reasons for the successes and the failures observed.

From these papers this article has been prepared to show the methods used in the most modern pavements of meeting this ancient problem in road building, which has always been the most important one and will be as long as rain falls and water runs over or under or thru the roads or their foundations.

LONG ago the road pavement and the wheel were recognized as two parts of the same machine for the application of tractive power in the transmission of weight from one place to another. The two parts of the machine should be designed together and not each independently, as has heretofore been the tendency; tho this tendency is becoming less pronounced each year.

One prominent defect in the design and construction of the pavement half of the machine has been lack of consideration of the weight of the traffic to be borne and consequent lack of attention to the possibilities of deformation of the pavement on account of the weight being greater than the foundation could carry or the surface being too soft to carry the weight, on the kind of wheels used, without displacement or disintegration.

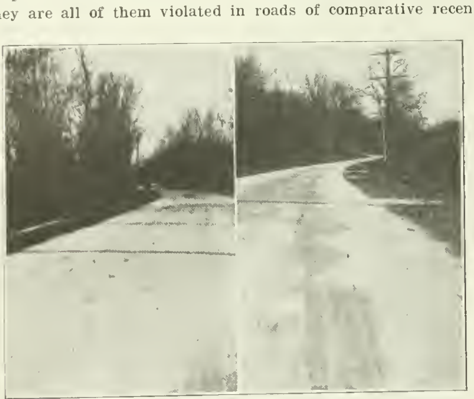
Neglecting the other important factors in the problem, this discussion covers only the effects of water on foundation and pavement and the methods of preventing or neutralizing these effects.

The first effect is that of undermining, the material below the pavement or in it being actually removed by the flow of water. Drainage, under or around the road or both, is so evidently the cure for this that it needs no further consideration except, in the design of the particular road, to select the best methods of removing or preventing the approach of water to the road on or under the surface.

The water falling on the road itself or draining from one part of it to another, thru ruts or otherwise, if it can soak into the road, will loosen up the soil, especially when it freezes, upheaves and disintegrates the road or sub-grade, making it more susceptible to displacement by water flowing thru or against the road. It also softens up many kinds of pavements, and practically all kinds of material commonly found in sub-grades, so that they are not so well able to carry the weights put upon them. Thus roads which are properly designed for use in good weather may go to pieces very promptly after a spell of bad weather or an exceptional storm and flood. This is perhaps the most common mistake in the design and construction of roads and is certainly responsible for more failures of roads during and after their first or second winters than any other factor.

On level ground, drains and ditches should be used to take the water out of the sub-soil and carry it to ditches, drains or sewers which will remove it entirely from the vicinity of the road. The road or pavement itself can then be built on top of the drained surface or on a fill above it. The surface drainage is thus taken care of, provided the slope of the cross section is sufficient and the surface material will not be displaced by the traffic, forming ruts or waves or hollows.

That these apparently fundamental principles of road building on level ground are often violated is shown by the photographs of roads in Little Falls and Bloomfield, N. J., where they are all of them violated in roads of comparative recent



CONCRETE ROAD NEAR PLAINFILD, N. J., WITH SOFT ASPHALT TOP. BADLY DRAINED ROAD BED. RUTTED SURFACE.

ABOVE: MAIN ROAD IN LITTLE FALLS, N. J., CLOSE TO A RIVER AND ABOVE IT SO THAT THORO DRAINAGE IS EASY AND CHEAP.

BELOW: BROAD STREET, BLOOMFIELD, N. J., NEAR THE BUSINESS CENTER WITHOUT DRAINAGE, TWENTY-FOUR HOURS AFTER RAIN.

construction in populous and well-to-do villages on important local main roads which are also thru lines of travel.

A pair of photographs of a concrete road with soft asphalt surface, near Plainfield, N. J., show a road which is not properly protected from flowing water, nor adequately drained. This road also illustrates the effect of the choice of too soft a material for the top surface. The ruts in the soft bituminous surface are clearly seen in the photographs. They will soon be cut down to the concrete and the water falling on the level surface will stand in these ruts and soak into the more or less porous concrete, where it will produce the same effects in some degree that water always produces in a pavement, especially in frosty weather. C. J. Morrison, the author of the paper from which these data are taken, predicts that this road, tho new, will not survive its second winter and points to sections of the concrete broken off along the edges.

The photograph of the Morristown-Mendham road shows how the road builder may go out of his way to ruin his road. In the foreground is the foot of the slope of a cut in a side hill, the water from which could have been drained to the foot of the slope, only a few feet away, but it had been standing on and alongside the improved road surface for nine days when the picture was taken.

The opposite side of the road is on a fill, but instead of grading so as to lead water off the road, an embankment actually keeps the water standing on the road.

The same fault can be found with the road in the fill farther back in the picture, and the whole road is ruined by the water which should have been kept off, but which seems to have been kept on by the exercise of considerable ingenuity and hard work.

The photograph of Pompton Pike shows a road which is in good condition because it is well drained naturally, has natural protection from water, and a land surface of sufficient width. In this case the natural drainage has not been interfered with as in the road just criticised so seriously.

The fourth of the drawings shows complete provision for drainage of roads in cuts, to remove water from sub-soil and to keep surface water off the road. Now that loads on roads are becoming so heavy, and the necessity for solidity of foundation is becoming so much more pronounced, such provision as this, modified according to the special circumstances in each individual cut, is becoming each day more economical, tho the cost is still heavy. The photograph of the road near Englewood, N. J., shows the effects of lack of drainage of sub-soil and surface water and lack of waterproofing of the road causing soft spots which develop the numerous hollows and holes seen in the picture. Ridges upheaved by frosts in February had not been repaired in December when the photograph was taken.

Ever since modern road building for wheel traffic began, say with John Macadam, the importance of drainage has been recognized. The value of the waterproof surface has also been seen, but motor truck traffic with its heavy loads and greater speeds has emphasized the waterproof surface as of prime importance to a road, not second event to the material of which the road is made.

In Prof. Greenough's discussion of the sources of troubles with brick pavements, he attributes at least part of the longitudinal cracks which occur in such pavements, particularly in county highways, to the presence of water in or under the pavements. These cracks are most commonly found in region of wet and heavy clay soil and extreme ranges or temperature, and they are a minimum in number in sandy or gravelly soils of easy natural drainage. The cracking of the pavement may be due to heaving by the freezing of the wet sub-soil. Again, water seeping downward about the curbs will naturally work under the outer edges of the pavement and soften a portion of the sub-grade. The loss in supporting power thus induced may be enough to allow the pavement to drop at the sides and open longitudinal cracks.

When brick pavements are opened the sand cushions are almost always found to be wet. If such a wet cushion should

MORRISTOWN.—MENDHAM ROAD, WEST OF MORRISTOWN, N. J. EFFORT SEEMS TO HAVE BEEN EXERTED HERE TO KEEP WATER ON THE ROAD RATHER THAN KEEP IT OFF, TO THE RUIN OF THE ROAD.

freeze, the expansion would doubtless act upward and might cause the cracks in the brick surface which are sometimes observed not accompanied by corresponding cracks in the concrete base.

This class of defects again emphasizes the necessity of thoro drainage of the sub-soil and thoro waterproofing of the surface in such way that it will continue to be water proof. It is further necessary to drain the gutters thoroly, so that water will not stand in them and thus have greater opportunity to find its way thru very small cracks or joints. The monolithic type of brick pavement does away with the sand cushion, but is still subject to disturbance of the sub-grade on account of the action of water and frost, unless the drainage is perfect, naturally or by construction.

A. T. Goldbeck, engineer of tests in the United States Office of Public Roads and Rural Engineering, in his paper on the causes of cracks in cement concrete pavements, goes into the theory of the action of water on concrete, checking up by reference to actual operations and draws some conclusions which are directly applicable to the question of making waterproof the wearing surfaces of roads.

In a completed concrete road or street, well cured and hardened, increase in temperature and absorption of moisture both produce expansion in the concrete, while decrease in temperature and drying out of the concrete induce contraction. This is demonstrated by data given in the paper which were derived from exact observations taken upon various sections of first-class concrete road. The two causes for expansion may act together or they may act in opposite directions so that it might even be possible that the expansion in a given length might be the sum of the two effects and at another time it might be zero. In figures, the shrinkage due to drying out the wet concrete may amount to 0.0004 inch per inch of length. A decrease in temperature of 100 deg. F., at the same time would give an additional shrinkage of 0.00055 inch, or a total shrinkage of very nearly 0.001 inch for each inch of length. If the change in temperature were an increase of 100 deg. rather than a decrease, than the contraction would be the difference between the two, or only 0.00015 inch per inch of length.

The larger amount of contraction may produce cracks, while the smaller amount probably will not in well cured concrete. In concrete which is in process of curing, cracks are almost sure to occur with even the smaller amount of contraction named.

Another fruitful cause of cracks in concrete pavements is unequal bearing of the concrete slabs on the sub-base. This

ROADWAY IN CUT NEAR ENGLEWOOD, N. J. WATER NOT KEPT OUT OR OFF. NOT WATERPROOFED. SOFTENED SPOTS WEAR INTO HOLES. RIDGES UPHEAVED BY FROST NOT REPAIRED.

POMPTON PIKE, ESSEX CO., N. J. WELL DRAINED, HARD SURFACE, GOOD CONDITION, MINIMUM MAINTENANCE COST.

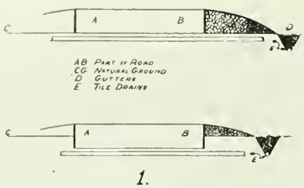
arises from inequalities in the surface of the sub-base. Neglecting other sources of inequalities, the softening of the sub-base in spots from the spots from the action of water, or the expansion of these spots thru freezing of the water, will transfer the weight of the slab and of the weight carried by the slab to these harder or upward projecting spots and the portions of the slab between are unsupported or but partially supported. Thus, freezing of the sub-base near the edges of the slab would make of it a beam, supported at the two ends; whereas, softening of the sub-base under the edges of the pavement, thru soaking it with water, or washing it out by the action of water, would make of the slab a beam supported in the middle and unsupported at the ends.

Mr. Goldbeck says that "the raising of the sub-base in spots need not be more than 0.2 inch to cause cracking, and the expansive effect of the frost and the swelling and shrinkage effect of moisture on the sub-base may be considerably more than this." He has some experiments in progress to show the effect of freezing and moisture on the vertical movement of the road.

Weight of traffic of course adds strains to those caused by these changes on the sub-base and their passage may be sufficient to cause cracks which would not form from either cause alone. This action of loads is exaggerated if the heavy weight travels rapidly on tires which are not continuous. They may cause longitudinal or transverse or diagonal cracks, according to the variations in location of the supporting spots. Corners and edges of slabs may be broken off by heavily loaded wheels running close to them.

Keeping the sub-base dry and making the concrete waterproof are the evident preventives of the actions of moisture described. Fearing that these things can not be done properly Mr. Goldbeck's final recommendation is to "design the slab as to thickness to carry the loads it is supposed to carry, irrespective of whether the sub-base offers uniform bearing, or not.

In the paper by H. H. Schmidt, Chief Engineer of the Brooklyn Bureau of Highways, on joint fillers for granite block pavements, he puts the water proof quality second in the list of twelve requirements of the perfect filler. He does not give the reasons for giving it this prominent place, but he shows what is the effect of modern heavy traffic on granite



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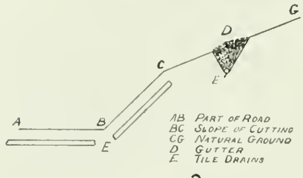

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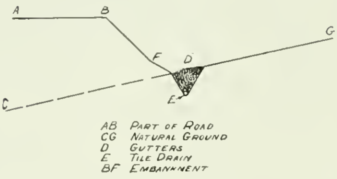

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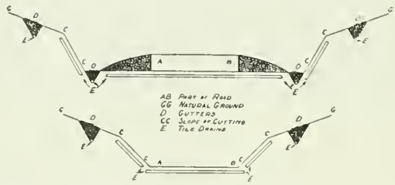

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1. CROSS-SECTION OF ROADS ON LEVEL GROUND, ONE ALTOGETHER ABOVE THE GENERAL SURFACE AND THE OTHER PARTLY BELOW IT.

2. CROSS-SECTION SHOWING PROVISIONS FOR DRAINAGE OF ROAD ON SIDE HILL, INTERCEPTING SURFACE WATER AND DRAWING OFF SUB-SOIL WATER.

3. CROSS-SECTION OF UPPER SIDE OF ROAD ON FILL SHOWING METHOD OF DRAINING AWAY WATER COMING DOWN HILL TO THE ROAD.

4. CROSS-SECTIONS OF ROADS IN CUTS SHOWING METHODS OF TAKING AND KEEPING WATER OUT. UPPER DRAWING SHOWS ROAD METAL IN PLACE; LOWER SHOWS EXCAVATION TO SUB-GRADE.

block streets and thus demonstrates the necessity for a smooth pavement with sufficient base and with sufficient strength of base and surface to withstand the traffic.

It may perhaps be assumed that granite blocks properly made and laid and of the best and most uniform stone, produce the most durable form of pavement under the heavy modern truck and trailer traffic. But granite streets have failed under a severe test by a large amount of the heaviest class of such traffic.

Applying the reasoning developed in the above abstracts from the other three papers, it may be shown that the reasons for the destruction of these pavements are in large part to be found in defective drainage of foundations and non-waterproof surfaces which let water into the sand cushion and caused inequalities in solidity of base and cushion respectively. These inequalities produced like inequalities in the surface of the granite block street, and the heavy traffic on hard tires moving rapidly, subjected to very heavy blows the corners of blocks caused to project by the unequal settlements of blocks. Again blocks driven down or softer than adjoining blocks, so that they wear down faster, produce low spots which again subject themselves and the corners of neighboring blocks to the heavy blows, which rapidly wear the small low spots into large deep holes. Proper waterproofing of pavement joints and proper protection from water of the sub-base will greatly improve the granite block pavement and give it longer life even under the grueling iron-tired trailer traffic.

The paper by Mr. Sharples presents the material for the application of the same reasoning to other block pavements, and definitely states the object of the bituminous fillers to be the waterproofing of street pavements of the block type.

Mr. Sharples's history shows that bituminous mortars for fillers in block pavements have been used in the United States since 1913. These fillers consist of mixtures of coal tar pitch and sand, or asphalt and sand. Specifications for both kinds were adopted at the 1916 meeting of the American Society of Municipal Improvements.

These bituminous mortars are particularly well adapted for use in filling the joints of stone block, brick, lug wood block, and Durax pavements. Observation shows that the asphalt-sand mastic does not fill the joints as well as the pitch-sand mortar, owing to the higher melting point of the former and its lower adhesive value.

Those bituminous mortar fillers that have given trouble to date have done so because not sufficient sand was originally mixed with the bitumen. A fine sand gives much better results than a coarse sand, and more of it can be introduced in the mastic. By properly heating and applying, a mastic with equal parts, by volume, of sand and bitumen can be forced into the joints of block pavements. For special conditions, special grades of bitumens must be used. Hand mixing is cheaper than machine mixing, and as good. The pouring method should be entirely dispensed with and the flushing and squeegeeing method substituted.

While but one of these papers takes up waterproofing as its principal theme, the discussions they give of this detail demonstrate its importance, especially under the traffic developments of the last four or five years.

Better materials than those we are now using for pavements will be hard to find. We must build our streets and roads to suit the traffic which develops, within reasonable limits of relative economy of hauling heavy loads. We admit defects in construction. Consequently we must improve our methods of construction. The unanimity of these papers by experts in pavements in emphasizing the value of waterproofing base and surface by removing water and keeping it out of base and of pavement proper, demonstrates its importance. Improvement of pavements in this regard will at this time produce better results than in any other one line of possible progress.

WORKERS IN THE FIELD

Repairing Pavement Cuts in Ottawa

The Editor of Municipal Engineering:

Sir—During the past three years considerable attention has been given to the method of making repairs to pavements in Ottawa, where cuts have been made.

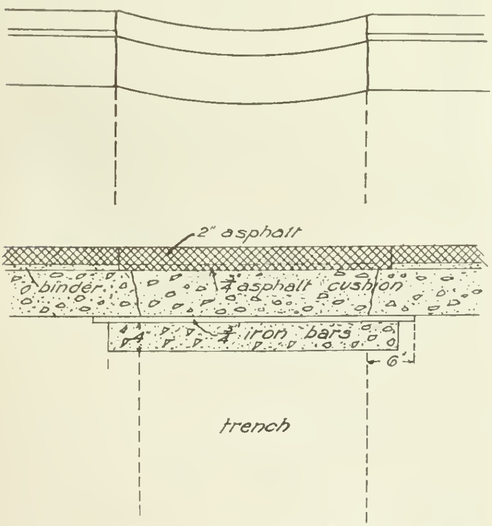
The repairs up to three years ago were done in a haphazard manner, the general result being the gradual settling of the packed-in earth, the concrete, of course, going with it, as shown in Fig. 1.

The present method of repairing cuts in pavements is shown by Fig 2. The trench is first of all well packed by means of a tamping machine. Then excavation is made to a depth of 4 inches below the old concrete, the sides of the old concrete being then slightly bevelled as shown. Square iron, three-quarter bars are then placed directly below the old concrete at 12-inch centers and the new concrete is afterwards placed and packed. The concrete is allowed to set for three days, then an asphalt cushion is pounded down and the asphalt wearing surface 2 inches thick is laid and compressed by an 8-ton roller. Great care is taken to secure a proper union between the old and new wearing surfaces. The edges are evenly cut away and cleaned up before the new top is put down. The practice of painting the edges with hot asphalt cement has been done away with as, if too much asphalt-cement be used, that portion of the pavement will be too rich in bitumen and will consequently be much softer than the rest. Smoothing irons are used to even up the joints, care being taken to see that they are not too hot, else they will burn the mixture.

In Ottawa a "Pavement Cut Book" is kept, where permits are given for the cutting of pavements. Thus, when a pavement is opened for the installing of gas, water or sewer, a record is available, and the cut is fixed up immediately the underground work is completed, thereby eliminating any fear of deterioration of the asphalt around the cut to any great extent.

The method of repairing the pavement cuts mentioned above costs a little more than formerly but this is more than offset by the good condition of the city streets.

L. McLaren Hunter,
City Engineer's Department, Ottawa, Can.



ABOVE: EFFECT OF ORDINARY METHOD OF FILLING TRENCH AND REPLACING PAVEMENT OVER IT.

BELOW: METHOD OF REINFORCING PAVEMENT OVER FILLED TRENCH TO PREVENT UNEQUAL SETTLEMENT OF PAVEMENT SURFACE.

An Opportunity for Efficiency in Public Work

The Editor of Municipal Engineering:

Sir—There is an endless number of needless inefficiencies in our public work, for which the taxpayer eventually pays in hard dollars and cents, in delays, inconveniences and unsightly features of design, due to an unnecessary neglect of details. The cause of this naturally brings up the relations and respective responsibilities of the contractor and the engineer, for therein lies the seat of many troubles. Take for example paving work. Surveys are made by men more or less proficient and plans are drawn up. With the ideals of good practice in view, specifications are written out, which say just what materials are to be used and in what quantity, and how and when they are to be placed. There are no loopholes left open for the contractor who is tied down as closely as possible and he made to do as he is told.

On the other hand, the contractor looks over the estimate and perhaps reads the specifications carefully and goes out to see the proposed location of the work. He knows what work has cost him before and makes a bid accordingly, keeping in mind the keen competition of other contractors. If the contract is awarded to him he has first to put up a certified check for from 10 per cent. to 100 per cent. of the amount of his bid. When he signs the contract a surety bond is required and the law makes it necessary for him to carry employer's liability insurance, public liability and contingent liability insurance. He must take the risk of bad weather, a rising market, delayed deliveries, accidents and labor shortage. Often he is paid by municipal bonds maturing in from one to five years in towns under 100,000 and one to ten years in towns over 100,000 population.. If he needs cash he must discount the bonds 5 or 6 per cent. and often they are hard to market at all. However, he is subject to the constant criticism of the unenlightened public. Only too often he is needlessly harassed by an unpractical inspector, steeped in book knowledge and newly acquired authority, who has passed the civil service examination. Finally, he is held responsible for the wearing quality of the work and must guarantee to fix it for a year or more. The average contractor takes these things lightly and makes the public pay, which is the only course he can honestly follow and win.

The engineering departments and the watch dogs of the treasuries of our states and municipalities have it within their power to balance up the responsibilities in our public works and to reduce the cost to the taxpayers.

In the first place, competent and experienced engineers should be employed and at salaries commensurate with their responsibilities, so that there is an inducement for them to work up in their particular line. If we must have civil service, let experience count 70 per cent, not 10 per cent. Under our present system a student can pass an examination for construction work of which he knows nothing practical at all. He gets a job and learns later at the expense of the contractor and the public.

The reason experience is so vital is that perfect specifications are impossible, local conditions cannot be foreseen and there should be an experienced engineer on the job with the knowledge and power to act immediately in an emergency, to share the responsibility and see that justice is done both the contractor and the suffering public. Moreover, the engineer in charge should be backed up by the department without delay and not hampered by ponderous wheels of authority or needless waits between weekly or monthly board meetings.

It often happens that contractors are hampered financially because estimates are not sent in promptly or their money is withheld because a telegram is answered by a letter a week or so later, or because some official is on a vacation. In such cases the contractor's money draws interest which he never gets and he must pay high rates for quick loans to meet a pay-roll or an impatient creditor.

Again, the contractor is often asked or required verbally to do things not covered in the contract, because the loss of time means poor work or added expense. He obeys without written orders so as to save time and trouble and to hurry up an estimate, trusting to the engineer and the board to give him fair play. For this he gets promises and relies on them, only to be made to wait months for his just due and he is told in the meantime that the powers that be are sorry for the delays but that things were not quite regular and they must go thru the proper channels. The result is that next time the prices for the same work are higher.

There is no panacea for many of our human failings, but it certainly behooves our officials and engineers to get together with the contractors on public work and work on a more efficient basis and with a great deal of team work.

J. T. C., Winnetka, Ill.

Records of Water Mains and Valves

THE EDITOR OF MUNICIPAL ENGINEERING:

About two years ago the water works of Aberdeen, South Dakota was placed in direct charge of the city engineer's department. On taking over the work, from the superintendent, it was found that no good records had been kept by him of the water system.

The plat which existed was found to be almost worthless for practical purposes. Many valves were shown on the wrong side of the street. Some existing valves were not shown at all and most serious of all, no record had been made showing if a certain valve was right or left. Whenever a break occurred in a main it was very difficult to locate the valves and to get the water shut off.

At one time during the winter, a break in a large main could not be shut off. The department spent two days trying to shut off the leak but was not successful. Finally all artesian wells were turned off and the entire city was without water until the break was repaired. The entire city was thus placed in great danger in case a fire had occurred at that time.

The city engineer's department, realizing the serious condition of affairs, started a survey early last spring of the entire water works system. The water was shut off in sections and a great deal of trouble was caused by not being able to close all valves completely. This was partly overcome by opening a fire hydrant in the section that was to be shut off and the valves were opened and closed until the deposit in the valve-seat had been washed out. As soon as a certain section was shut off, all valves were turned on again and all information in regard to these valves was put in a field book. Many valves were located with the aid of a magnetic needle. Some of them were from three to twelve inches beneath the surface of the ground. In all, 142 valves were found. Twenty-five of these valves were broken and twelve were found closed. Fifty valves were found of which there was no record and about one thousand feet of mains were found of which there was no record.

After all this information had been definitely obtained, a plat was made showing all mains, valves and hydrants. All valves were indicated on the plat as either right or left.

This information has proved very valuable. There have been several bad breaks in mains but with a complete record and plat no trouble was encountered in shutting off the water.

It should be the policy of the water works department to close the valves at least once a year. Some may be left closed by careless workmen and this will hinder the circulation in the mains.

A survey is now being made of all service connections.

The city has no record at present of the location of the services. All service boxes are being located and the distances from the lot lines taken. Many places have been found where there are several houses on one service with only one service box.

A plat is being prepared showing all services and their locations. When this is completed the city will have a complete record of the water works system.

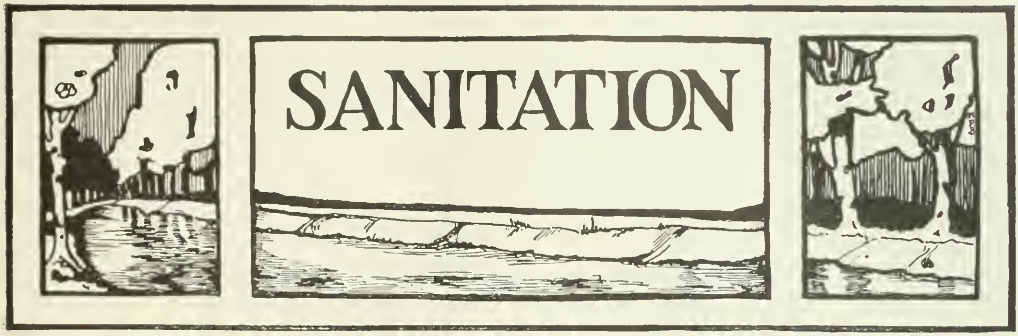
After all information has been obtained the records should be kept up to date by a competent engineer. No town or city can afford to neglect this matter for it is sure to bring disastrous results some day.

FRANK LECOCQ.
City Engineer, Aberdeen, S. D.

Pay of Civil Engineers

A committee of the American Society of Civil Engineers has made a study of the compensation of civil engineers and, while it finds that those who have demonstrated their ability receive reasonable compensation, there are men not so well treated. The older engineers are themselves the worst sinners in this respect as "engineers in private practice sometimes employ men of extensive experience and presumably of good ability at salaries which young graduates with little or no experience are able to command," salaries "less than those of ordinary mechanics who have a labor organization behind them."

State legislatures are equally derelict. In Indiana, for example, county engineering officials and employes are allowed for most public work \$2 to \$2.50 a day, and no increase in pay and competency can be secured from the state legislature.



Collection and Incineration of Garbage in Sewickley, Pa.

A paper by Edward E. Duff, City Engineer, before the American Society of Municipal Improvements.

The Boro of Sewickley, Pennsylvania, is a residential suburb of about 5,000 population, situated on the bank of the Ohio river, some 12 miles west of Pittsburg, Pa., having an area of about 1 square mile, with a taxable property valuation of $7,250,000. Prior to 1907 the garbage was hauled to the bank of a small run within the boro limits, where it was carefully washed and subsequently buried. This system, as can be readily seen, was far from satisfactory, and the boro council took steps to relieve the board of health of their duties in this connection. A 12-ton incinerator was purchased from the Dixon Garbage Crematory Co., and erected in a suitable two-story brick building on property purchased by the council at one corner of the boro on the Ohio river bank. Subsequent to this action, it was decided to purchase sufficient cans to accommodate all the residences and to arrange for a system of collecting and incinerating the contents of the same.

System of Cans.

To supply the borough, 1,357 cans are now in active use, 1,285 of which are at the residences, and 72 on one of the wagons as exchange cans. The cans are made of galvanized iron, weigh 17¼ pounds when empty, and have a capacity of about 11 gallons. They are ordered from the following specifications, which have been revised from year to year as weaknesses have developed in any feature: 12¾ inches diameter by 19½ inches high, 20-gage iron in body and bottom, 26-gage tight-fitting lid 1½ inches deep, wrought iron hoops ⅛ inch by 1½ inch shrunk around top and bottom, heavy drop handles 4½ inches from top. All cans and lids must be thoroly galvanized and be guaranteed against leakage. These cans are purchased in lots of 200 to 400 each year at prices varying from $1.00 to $1.80 each, depending on the current prices of the raw materials. The cans are subjected to hard usage and our records show their life to be from 3½ to 4 years. One of the main sources of damage is due to householders using the can as a convenient place to burn waste paper.

The cans are placed by the collectors in any location convenient for the householder, and while their use is primarily for garbage, all kinds of refuse are found in them, such as paper, bottles, cans and even occasionally a dead cat.

Method of Collection.

Two specially constructed wagons, carrying 72 cans each, were built by the boro for the collection of the garbage. The wagons consist of a flat bed or floor set above wheels, about 4 feet above the street level, and having a few uprights around the sides to which chains are fastened to prevent the cans from falling off. The cans are placed in six rows with twelve cans to a row and as the empty cans are taken from the wagon to replace the full cans, the driver or the collector shifts the remaining empty cans to the outside.

Collections are made once each week in the residence districts, except during the summer season when there is an unusual amount of vegetable refuse, such as corn husks, watermelon rinds, etc., when three collections are made in two weeks. The hotels, restaurants, hospital and other places where an unusual amount of garbage is found have two collections each week. From one to five cans are left at each residence and as many as eleven or twelve cans at the hospital and hotels, depending of course on the actual need and the garbage accumulating. We have found that two cans per week give ample accommodation for the average family, and where it is necessary to supply more than two cans, the additional cans must be purchased by the householder, and these, of course, are exchanged the same as those owned by the boro. In collecting, the lids are not removed from the cans from the time they leave the residence until they reach the furnace, and there is consequently no nuisance created emptying from one can to another or from the can to wagon. The lids fit tight, and the cans are kept so clean that there is little or no odor about the wagon. The usual unpleasantness generally associated with a garbage wagon, such as the rattling and banging of cans and the slamming of the doors on the familiar steel wagon, is conspicuous by its absence, and had you not been previously informed, I doubt if many of you would associate the wagon and equipment with the garbage work.

SEWICKLEY GARBAGE SYSTEM. SHOWING CANS ON WAGON JUST AS THEY ARRIVE FROM COLLECTION TRIP. WAGON ON RIGHT ABOUT TO START ON COLLECTION TRIP.

Our present needs require the use of only one team of horses and one wagon in the collection work, the second wagon being loaded at the furnace for the next trip. In charge of a driver and collector, both of whom, however, acting as collectors when necessary, each taking one side of a street, the wagon makes four trips per day, bringing 285 cans to the furnace, having a total average net weight of four tons. This is at the rate of 85,540 cans per year, having a weight of 1,200 tons. An additional ton of garbage is received each day in bulk from the grocery and fruit stores, making a daily incineration of five tons and a yearly incineration of about 1,500 tons.

The boro is 1 mile long and approximately 1 mile wide, so that in going from the garbage furnace to the diagonally opposite corner of the boro, the garbage wagon covers on the round trip about 3 1/3 miles, making collections, however, for only ¾ of a mile in this distance. The shortest route is 1¼ miles and collections are made for only ½ mile before the wagon is loaded. Due to more convenient location of the cans in the first mentioned district, the trip is completed in 2 hours, while it requires 1½ hours to do the work on the short trip. Eighteen routes are covered by the wagon in 4½ days, in which time one collection is made thruout the boro. The remaining day and one-half is used making the second collection for the week in the business district.

Disposal at Furnace.

Upon arriving at the furnace with a load, the wagon is left in front of the big door of the furnace building, and while the driver is hitching the horses to the extra wagon, which has previously been loaded with clean empty cans, the collector assists the furnace man in emptying the garbage into the incinerator until such time as the driver is ready to leave, which is usually about five minutes.

During the winter months when the wet garbage is frozen, we find it necessary to thaw the garbage before it can be emptied from the can. A short application of a jet of steam from the hot water heater will allow the garbage to be removed. The use of bars or hooks for this purpose is prohibited because of the damage likely to occur to the cans.

In the period of 1½ hours usually elapsing between loads, the furnace men allow fifteen minutes to empty garbage into the furnace, twenty minutes to wash the cans, and twenty-five minutes to load the 72 cans on the extra wagon and arrange it for the next trip. The remaining time is spent firing the furnace, hauling ashes, etc.

SEWICKLEY GARBAGE SYSTEM. SHOWING METHOD OF EMPTYING CANS FROM WAGON INTO CHARGING HOPPER OF INCINERATOR. TWO CHARGING HOPPERS IN FLOOR IN FOREGROUND. HOT WATER HEATER IN CORNER. FOUR OF THE FIVE CAN WASHERS AT LEFT OF PICTURE. TWO CANS ON THE WASHERS AND TWO WASHERS EXPOSED.

Coal is used in the furnace to burn the garbage, while coke is burned in the flue to complete combustion. Altho the garbage plant is located within 300 yards of some of the best residences there is no complaint at any time of objectionable odor.

All the cans are thoroly cleaned with scalding water before they are again placed in active use. Five cans are placed on a rack at one time, and after they are thoroly clean, they are placed on the wagon for service. It is very seldom that complaints are received regarding dirty cans, yet most householders do not realize the work required to clean a can that we have received probably half full of dough or some other equally adhesive "left overs" from the kitchen.

Cost Data.

The total investment, exclusive of real estate, might be distributed as follows:

Building, driveway, platform and incinerator	$ 8,500
Stable	2,000
Two horses and harness	700
Two wagons	400
1,357 Cans, at average price, $1.25	1,696
Total	$13,296

The average of the yearly charges for the past eight years and ten months to January 1, 1916, as taken from the annual report of the boro clerk, show:

Wages (driver, collector, 2 furnace men)	$2,699.22
Coal and coke (about 650 tons per year)	651.81
Freight on coal, coke, firebrick, etc	330.40
Repairs (relining furnace, grate bars, etc.)	257.40
Insurance (fire insurance on buildings and platform)	33.98
Horse feed	389.86
Blacksmithing	104.26
Cans	313.43
Extraordinary expenses (rebuild driveway and platform, etc.)	76.57
New horses	92.24
Credit (sale of cans and coal)	33.15
Total average cost per year	$4,997.98

Of this amount, one-half of the cost of wages (2 men), all of the coal and coke, 90 per cent. of freight charges, 90 per cent. of repairs, all insurance, 10 per cent. of blacksmithing and one-half of the miscellaneous, making a total of $2,616.81, are charged entirely to incineration, leaving a balance of $2,381.17 as the cost of collection. This amount is raised by about seven-tenths of a mill tax on the valuation of $7,250,000.

On the basis of the above figures, and exclusive of any interest on the investment or sinking fund charges, it has cost us $1.00 per inhabitant per year to collect and incinerate the garbage, of which amount 52 cents was spent for incineration and 48 cents for collection. On the basis of 1,500 tons per year, it has cost $3.33 to collect and incinerate each ton.

The incineration of the garbage is not new to any of you, but the question of collection has, no doubt, bothered many municipal officials. The best is none too good when one is planning an efficient sanitary garbage system, and the benefit derived from a successful incinerator may readily be counteracted by an inefficient, unsanitary system of collection. In Sewickley the residents are relieved of all responsibility regarding the purchase of cans and payments for collection. There are no unsanitary garbage wagons clattering over the streets, and there is no trail of garbage drippings from the back yard to the front street. Of course, any system will meet with objections from a few unreasonable people, but we feel that we are giving the best service in the best manner at a minimum cost, and while our system is small in proportion to the needs of many towns or cities, I feel sure that, with proper management, the principles applied in the Sewickley system would be applicable in places many times the size.

Alcohol from Garbage

A process for making industrial alcohol from garbage and other vegetable waste was patented December 26, 1916, by Dr. F. E. Young, of Canton, O., who has two more patents pending on apparatus used in the process. It is claimed that as much grease and fertilizer are recovered as with other reduction processes, at less expense, and in addition from 5 to 10 gallons of alcohol from a ton of garbage, so that the alcohol appears as clear gain over methods now in use. The apparatus can be installed and process used in reduction plants already established, without great expense.

In the usual process of reduction the fermentable content, the sugar and starch, is purposely destroyed or caramelized by prolonged steaming at high temperature, so that it will become brittle and not interfere with the milling and screening of the fertilizer and to prevent fermentation in the finished product. The caramel adds no value to the fertilizer, as that is sold according to its nitrogen content upon chemical analysis.

In Dr. Young's process the grease and fertilizer are separated without injury to the saccharines, which are left in solution. They are then fermented in an anaerobic manner—that is, without exposure to the air—and distilled in an improved simplified column still of his invention. The material being inclosed from start to finish, and the odors being condensed for utilization, there is nothing lost and no nuisance is created. It is said to be the cleanest and most sanitary method of garbage disposal as well as the most profitable.

Garbage, of course, varies according to the season, locality, weather and many other conditions, but it usually contains about 70 per cent water and 30 per cent solids. Of the solids, about 12 per cent are fermentable, and if properly fermented will yield 50 per cent of alcohol, equal to about 7 gallons per ton of garbage.

Dr. Young retired from practice a number of years ago to engage in chemical engineering as related to conservation. This brought him in contact with many canning, sugar and preserving factories, breweries and distilleries, packing houses and garbage disposal works. Finding such vast amount of waste of the carbo-hydrates led him to investigate the manufacture of alcohol. Here he found the cause for this great waste, as well as the complete failure of the Government's Industrial Alcohol Act, to be the lack of appropriate methods and apparatus to utilize this class of material. While it is true that there had been improvements made in apparatus for the manufacture of alcohol, as, for instance, the column still, these are adapted to large production only, and large production requires first-class grain to stand long transportation.

The patents on the improvements, as well as the large distilling plants, are controlled by the same interests that produce gasoline, which results in holding down the production of alcohol in order to hold the price of gasoline up. It was necessary, therefore, to invent process and apparatus adapted to the manufacture of alcohol from these waste materials, either in small or large quantity, at the point of their origin, and save the transportation charges on both the material and the product.

Fermentable wastes may be divided into four classes according to the preliminary treatment required to fit them properly for fermentation. The fermentation and distillation are the same for all, either separate or in mixture.

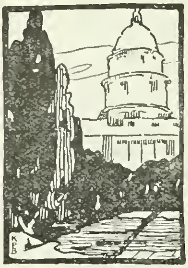
1. Sugars—Fruits, molasses, preserving, canning and sugar factory waste need only boiling and dilution.
2. Starch—Potatoes, cassava and grain of all kinds, should be ground, cooked and mashed to convert the starch into sugar.
3. Cellulose—Wood waste, kelp, straw and stable manure, must first be converted into glucose by a separate process.
4. Mixed—City garbage and market waste, being a mixture of all the above classes together with animal products, require altogether different treatment.

The mixed wastes are cooked in tall closed tanks, usually called digesters, at low pressure, by passing steam in at the bottom and up thru the garbage and out at the top thru a separator to the still to heat it. The steam carries with it the products of the fermentation that has taken place in the garbage. The enzymes of the ferment have changed the cooked starch into sugar and the raw starch is liquefied and will be converted into sugar during the fermenting process by the enzymes of the ferment without the use of malt. When the cooking is completed the water is pressed from the tankage and the grease is separated by mechanical means. The water is then cooled, yeasted and fermented without exposure to the air, which prevents decomposition of the animal products held in solution. When it is fermented it goes to the still, where it is heated by the steam from the cooker, the alcohol vapor passing over to be concentrated and condensed in the condenser. After the alcohol is distilled off, the water is called wash. It may be concentrated by evaporation and added to the tankage for fertilizer. The tankage is dried and separated, the animal portion having all of the fertilizing properties, and the vegetable portion, being principally cellulose, may be treated the same as wood waste and the glucose added to the tank water for fermentation.

The apparatus required for these preparatory operations is in common use and may be purchased in the open market. The process as outlined and the apparatus for the mechanical separation of grease, continuous and progressive fermentation and the improved still under Dr. Young's patents, in different sizes, will be placed upon the market soon. In order to obtain estimate of cost of plant and operating expense, statement of the class of material and the daily quantity to be worked should be given.

Buffalo's New Passenger Station

The union passenger station for the railroads now having stations in the neighborhood of Exchange street, Buffalo, N. Y., seems to be an impossibility and plans for a new New York Central station and terminal at Washington and Exchange streets have been presented to the terminal commission. This location requires a detour of the New York Central trains going west, and the Twentieth Century Limited, not making this detour, does not stop at Buffalo. According to the new plans, a sub-station for this class of trains will be built at Clinton and Bond streets. Other cities have moved their main railroad stations so far from the business section that Buffalo might be expected to move this station the comparatively short distance necessary to accommodate all trains in the New York Central system, but this does not seem to be possible, tho a number of people have advocated such a move.



ROADS AND PAVEMENTS

Concrete Bridges in Austin, Texas

One hundred thousand dollars, in round numbers, is the 1916 bill of Austin, Tex., for twelve concrete briges over Shoal, Waller and other creeks within the city limits. Taking the last census report as a basis, the City of Austin spent during the year $3 per capita for concrete bridges. It is doubtful whether any other city in the Southwest has indulged in so large a per capita expenditure for concrete bridges to accommodate street traffic in recent years, barring such notable exceptions as the Corpus Christi and Galveston causeways, and the like.

The brook which made the greater part of this expenditure necessary is Waller Creek, which meanders diagonally across the map of Austin. This stream has had the habit of sweeping its bridges clean about once in five years for the last seventy-five years. For the most part, it has been bridged with steel, wood and stone-arch structures which have proved entirely inadequate to the task of resisting the swollen freshets which occur infrequently. The city has been unpleasantly bisected half a dozen times, and the traffic from west to east Austin and vice versa has been under the necessity of detouring for several miles. It is therefore in self-defense, to maintain its unity, that the city has been compelled to concrete the passageways over this stream.

The old stone arch bridges, built for the most part in the early days, are gone. One exception is the arch across the old military highway from Austin to San Antonio, constructed shortly after the Civil war, a cut of which accompanies this article. It is such structures as this one, as well as many make-shift arrangements of wood, which are now being replaced by permanent structures of reinforced concrete. The following bridges were built during the year, all of reinforced concrete:

REINFORCED CONCRETE BRIDGE OVER WALLER CREEK AT EIGHTEENTH STREET, AUSTIN, TEXAS.

REINFORCED CONCRETE ARCH OVER WALLER CREEK AT SPEEDWAY UNDER CONSTRUCTION.

OLD STONE ARCH BUILT ABOUT 1865. ONE OF THE FEW NOT YET REPLACED BY REINFORCED CONCRETE.

REINFORCED CONCRETE ARCH OVER WALLER CREEK AT FIRST STREET, REPLACING STONE ARCH.

Over Waller creek; Speedway, $7,000; First st., $12,500; Eighteenth st., $8,200; Fourteenth st., $7,000; Nineteenth st., $8,000.

Over Red river; Eleventh st., $5,000.

Over Shoal creek; Camp Mabry road, $4,000; Twelfth st., $9,175.

Over Blum creek in South Austin, $3,500.

Over ravine in South Austin, $2,500.

Retaining wall 20 ft. high, 200 ft. long, Waller creek, 3rd st., and East ave., $3,000.

Besides these, bridges will be built over Waller creek, at

Asphalt Pavements Laid in 1916 and Proposed for 1917.

Descriptions of pavements as laid, cost per square yard and total cost. **Design, Cost and Quantity are shown.**

State and City	Laid in 1916 Sq. Yds.	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd. Pav. and Found.	Total Cost Inc. (1) (2) (3) (4)	Kind Asphalt Used	Estimate for 1917
Arizona—											
Phoenix	32,089	....	......	......	....	...	......	$1.24	$63,850	Tarvia	
Arkansas—											
Ft. Smith	26,000	....[8]	......	......	....	2	......	1.08	......	Texas[34]	9,453
Hot Springs	......	...	......	......	....	...	......	.....	......	....	25,000
California—											
Long Beach	11,972	4	1:3:6	1	....	1½	......	1.56(1)	.....		150,000
Los Angeles	519,559	3-6	1:3:6	0-1	....	1-2	......	0.81-1.35	634,477	....	....
Petaluma	35,000	5	1:2½:5	1½	....	...	......	0.81	4,550(1)	S. O. D.	95,245
San Diego	12,043	5	1:3:5	1	....	2	......	1.50	......	....	..
San Francisco	381,523	6	1:2½:7	1½	....	1-2½	......	.....	7,305,416	Union Standard	..
San Luis Obispo	......	....	......	......	....	...	......	.....	......	....	20,000
Santa Ana	20,950	4	1:8	......	....	...	......	.....	1.035	....	......
Santa Barbara	15,000	4-4½	1:3:6	......	....	1½-2	......	1.35	45,700	California	82,000
Santa Monica	34,910	5	1:3:6	1	....	2	......	1.215	62,097	California	..
Colorado—											
Ft. Collins	3,312	....	1:2:3	......	....	...	......	1.18	1.36	....	some
Connecticut—											
Hartford	32,195	6	1:2:3	1½	25:600	1½	......	1.58	56,804	Aztec	47,320
New Haven	92,742	6	1:3:6	1½	5-8%[11]	1½	10½-12½[11]	1.84	0.96[8]-1.96	U. S. Asphalt	30,000
Stamford	9,344	5	1:6	0	0	2	......	1.64	......	Aztec	......
District of Columbia—											
Washington	154,076	6	1:3:7	1½	....	2½	......	1.665	2.50	Aztec-Montezuma	150,000
Georgia—											
Atlanta	32,767	....[114]	......	0	....	2	......	.....	......	Natural	21,575
Illinois—											
Aurora	22,210	5	1:7G	1½	....	1½	......	.....	1.75(1)	Mexican-Trinidad	18,000
Berwyn	......	....	......	......	....	...	......	.....	......	....	132,800
Chicago	1,218,000	6	1:3:6	1½	....	2	......	1.893	2.849	Mexican-Trinidad	......
Cicero	78,135	6	......	......	....	2	......	2.35	160,412	....	72,342
Freeport	......	....	......	......	....	...	......	.....	......	....	20,000
Lincoln	......	....	......	......	....	...	......	.....	......	....	10-15,000
Moline	36,059	5	1:3:6	1½	........[10]	2	......[10]	1.81	93,857	Mexican	30,000
Oak Park	2,574	6	1:3:6	1½	....	2	......	1.82	7,085	Trinidad	....
Rock Island	6,254	5	1:3:6	1½	....	2	......	1.75	......	....	
Indiana—											
Elkhart	22,950	6	1:3:5	1	1:3.5:10.5	1½	1:1:5.5	1.80	57,950	Trinidad	10,000
Ft. Wayne	45,112	6	1:3:6	1[11]	........[108]	1½	......[103]	1.70	107,229	Trinidad	20,000
Goshen	24,046	6	1:3:5	1	....	1½	......	1.56	49,013	Trinidad	..
La Porte	38,325	6	1:3:6	1	1:26:103	1½	1:1.5:7	1.78	74,564	Trinidad	......
Logansport	44,618	5	1:3:5	1½	....	1	......	.....	1.95(1)	Trinidad	27,300
Michigan City	......	....	......	......	....	...	......	.....	......	....	15,125
Muncie	10,000	...[35]	1	......	2	...	......	1.50	......	Trinidad	......
New Castle	4,482	5	1:3:6	1½	....	1½	......	1.60	10,280	Trinidad	......
Richmond	23,791	6	1:2:5	1	....	1½	......	1.75	42,483	Trinidad	......
South Bend	18,702	6	1:7G	1½	4.6%[11]	2	11 %[11]	1.81	49,055	Trinidad	15,445
Vincennes	107,506	5	1:5	1	5.5%[11]	1½	10.5[11]	1.66	247,037	Trinidad	68,000
Wabash	16,941	5-6	1:3:5	1	....	1½	......	1.75	44,862	Trinidad	0
Iowa—											
Britt	35,796	5	1:3:5	1	....	1½	11%[12]	1.68	85,964	Texaco	- -
Forest City	19,523	4	1:3:5	1½	....	1½	......	1.66	45,325	Texaco	...
Mason City	131,489	5	1:3:6	1	6%[12]	1½	11%[12]	1.68	......	Trinidad	100,000
Sioux City	11,000	5	1:2½:4	1½	....	2	......	2.10	23,100	Trinidad	......
Waterloo	14,130	6	1:3:6	1	....	2	......	2.10	......	Trinidad	5,000
Kansas—											
Leavenworth	......	....	......	......	....	...	......	.....	......	... .	25,000
Newton	113,200	4	1:2:4	0	....	2	......	1.24-1.27	227,000	....	25,000[9]
Wichita	......	....	......	......	....	...	......	.....	......	....	30,000
Kentucky—											
Lexington	50,000	6	......	1	....	2	......	2.10	3.20	Trinidad	......
Louisville	47,747	6	1:3:6	1-1½	........[18]	2	......	1.74	......	Trin.-Cal.-Mex.	80,000
Owensboro	......	....	......	......	....	...	......	.....	......	....	75,000[9]
Maryland—											
Baltimore	9,257	4-6	1:3:6	1½	....	1½	......	1.37	18,484	....	.....

State and City	Laid in 1916 Sq. Yds.	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd. Pav. and Found.	Total Cost Inc. (1) (2) (3) (4)	Kind Asphalt Used	Estimate for 1917
Massachusetts—											
New Bedford	2,833	5	1:3:5	1	5:95	1½	10:11:79	...	...	Aztec	...
Michigan—											
Detroit	12,408	6	1:3:6	1½	...	2	...	2.04	2.98(1)(2)	Bermudez-Mex.-Std.	...
Flint	104,000	6	1:5	1	...	1½	...	1.31	234,000	Bermudez-Aztec	128,000
Grand Rapids	1,178	5	1:3½:7	1½	8%[12]	1½	10%[12]	1.90	2,900	Magnolia	...
Saginaw	6,780	6	1:3:6	1	...[79]	1½	...[79]	1.80	2.50	Trinidad	24,000
Minnesota—											
Duluth	21,300	6	1:3:6	1	6%[11]	2	...	2.14	68,637	Trinidad	5,000
Eveleth	...	...	...	...	...	...	...	...	...	...	25,000[9]
St. Paul	205	8	1:2½:5	1½	...	1½	...	3.00	900	Trinidad	2,138
Mississippi—											
Laurel	42,000	4	1:3:5	...[13]	...	1½	...	1.525	1.60(1)	Standard Oil	10,000
Vicksburg	2,996	4	1:3:5	...[13]	...	2	...	1.60	69,785	Stanacola	0
Missouri—											
St. Louis	130,475	5-7	1:3:6	1¼	...	1½	...	1.90	270,770(1)(2)	Several	85,000
Springfield	1,138	4	1:3:6	...	...	2	...	1.45	1.65(1)	Natural Rock	...
Nebraska—											
Hastings	84,989	4	1:5G	1½	5%	1½	10%	1.46-1.54	175,000	Trinidad-Texaco	129,000
Lincoln	26,837	5	1:3:6	1½	...	1½	...	...	1.84(1)	Trinidad-California	...
Omaha	23,130	5	1:3:6	1½	...	1½-2	...	1.90	68,864(1)	Mex.-Berm.	20,000
New Jersey—											
Bayonne	89,600	5	1:3:6	1½	...	1½	...	1.80	...	Bermudez & Oil	78,000
Bloomfield	3,758	6	1:3:5	2	...	...	...	1.45	11,272	Standard-Trinidad	3,000
Elizabeth	25,000	6	1:3:6	1½	...	1½	...	1.60	1.80	Mexican	...
Jersey City	2,323	5	1:3:5	1½	...	2	...	...	4,537(1)(2)	...	3,000
Passaic	24,368	6	1:3:6	1½	...	1½	...	...	1.65	1.92[1]	44,000
South Amboy	...	...	...	...	...	...	...	...	...	...	20,000
Trenton	37,650	5	1:3:6	1	...	1½-2	...	2.04-2.10	...	Bermudez	30,000
New Mexico—											
Roswell	7,337	6	1:6	...	...	2	...	1.55	14,179(1)(2)	Oil	1,160
New York—											
Albany	40,125	6	...	1	...	2	...	1.77	...	Trinidad-Standard	30,000
Buffalo	221,674	6-9	1:8-1:10	1½	...	2	...	...	772,467	Trinidad	225,000
Schenectady	16,036	6	1:3:6	...	...	2	...	1.39	43,071	Mexican	25,000
Syracuse	7,407	6	1:3:6	1	...	2	...	1.68	19,088	Montezuma	182,018[9]
North Carolina—											
Asheville	7,721	5	1:2½:5	...	...	...	...	1.81	16,126	...	...
Durham	8,000	4	1:3:6	1½	...	1½	...	1.73	20,000(1)(2)(3)	Montezuma	...
Fayetteville	22,361	...	...	...	...	...[14]	...	...	...	...	...
North Dakota—											
Bismarck	...	...	...	...	...	...	...	...	...	...	150,000
Ohio—											
Canton	16,040	5	1:3:5	1½	...	1½	...	1.79-1.86	52,236	Montezuma	57,051
Cincinnati	2,351	6	1:3:6	1.5	8%[11]	1.5	11%[11]	2.25	6,322[15]	Natural	...
Cleveland	24,149	...	...	1	...	2	...	2.08-2.25	...	Trinidad-Bermudez	...
Conneaut	14,921	6	1:3:6	1	...[16]	2	...[17]	1.40	31,320	Aztec	...
Findlay	...	...	...	...	...	...	...	...	...	...	11,931
Lakewood	13,790	6	1:3:6	1	...[18]	1½	...	1.99	26,837	Montezuma-Aztec	...
Lorain	7,500	6	1:3:6	1	...	1½	...	1.90	3.60	Trinidad-Mexican	50,000[9]
Toledo	43,357	6	1:3½:6	1½	...	1½	...	1.99	3.38	...	...
Van Wert	11,033	6	1:2:4	...	...	2	...[19]	1.68	33,686	Trinidad	0
Washington C. H.	15,519	6	1:5	1	...	1½	...	1.78	35,396	Trinidad	6,000
Xenia	25,000	6	1:3:6	1	...	1½	...	1.98	3.14	Trinidad	...
Oklahoma—											
Sapulpa	...	...	...	...	...	...	...	...	...	...	8,000
Oregon—											
Astoria	...	...	...	...	...	...	...	...	...	...	45,000[9]
Pennsylvania—											
Allentown	42,750	4-6	1:3:6	1	...	1½-2	...	1.89-2.03	86,050(1)	Trinidad	...
Erie	30,284	5	...	1½	...	1½	...	1.68(1)	56,753	Aztec	70,000
Hazleton	10,888	6	1:2:4	1	...	...	...	1.66	...	Mexican-Texaco	16,000
Johnstown	...	6	1:3:5	1	...	2	...	...	...	Natural Lake	14,088
Pittsburgh	74,131	6	1:3:6	1½	5-8%[11]	1½	10-13½[11]	2.16	2.38[20]	...	...
Wilkes-Barre	38,925	6	1:3:6	1½	...	2	...	2.00	...	Montezuma	...
York	14,888	6	1:3:5	1	...	2	...	...	1.85	Trinidad	10,000
South Carolina—											
Charleston	35,340	4-5	1:3:6	1½	...[21]	1½	...[22]	1.43[23]	...	Aztec	...
Greenville	10,000	4	1:3:6	1	...	2	...	1.55(1)	...	Trin.-Mex.-Oil	65,000[9]
Tennessee—											
Chattanooga	29,127	old base		2	...	2	...	0.96	1.23	Distillate	...

Texas—											
Amarillo	29,737	5	1:8	0	....	2	......	1.79	......	Natural Rock	10,000[9]
Beaumont	66,727	5	1:2½:5	......	....	2	......	1.90	146,303(1)(2)	Uvalde Rock	......
Cleburne	......	5	......	1½	....	2	......	2.00	(1)	Trinidad	30,000
Dallas	54,178	5	1:8	2	....	...	......	.....	132,517	Uvalde Rock	173,214
Denison	11,606	5	1:3:6	......	....	2	......	1.55	1.64	Texaco	......
Houston	2,288	6	1:3:6	......	....	2	......	1.90	4,900	Texaco	0
Port Arthur	......	....	......	......	....	...	......	.....	......	....	60,000
San Antonio	21,790	5	1:3:6	......	....	2-3	......	1.85	2.05	Uvalde Rock	60,000[9]
Taylor	22,000	5	1:2:4	......	....	2	......	1.84	80,000	Uvalde Rock	0
Utah—											
Ogden	10,585	6	......	1	....	1½	......	1.95	25,403(1)(3)(4)	Trinidad	......
Salt Lake City	100,300	5-6	1:3:6	1½	....	1½-2	......	1.80-2.24	315,726	Uvalde R.-Cal.	110,000
Virginia—											
Norfolk	42,421	4-5	1¼	......	1½	...	......	.....(1)	1.30-1.49	Mexican	30,820
Washington—											
Aberdeen	19,520	6	1:3:6	......	....	2	......	1.52	39,842	Standard Oil	......
Bellingham	104,402	6	1:3:5	¾	....	1½	12[12]	1.15-1.40	226,016	California	......
Olympia	4,205	5	1:3:6	0	....	2	......	1.16	11,500[15]	California	......
Seattle	146,173	5-6	1:3:6	1	....	2	......	1.40	......	California	100,000
Spokane	47,071	4-5	1:3:6	1	....	1½-2	......	1.05-1.25	89,522	California	10,000
Tacoma	1,888	5	1:3:6	1	5-8[11]	1½	11-13.5[11]	1.38	4,722	Pen. 70-80	......
Vancouver	1,250[24]	4	1:3:5	......	....	2	......	1.85	2,512	....	......
West Virginia—											
Charleston	6,450	5	1:2½:5	1	5-8[11]	1½	9½-13½[11]	1.863	2.679	Aztec	......
Wisconsin—											
Beloit	48,510	5	1:3:6	1	....	1½	......	1.25[25]	76,288	Trinidad-Aztec	0
Green Bay	......	....	......	......	...	...	......	.....	......	....	15,000
Madison	43,168	5	1:3:5	1	6:22:72	1½	12:10:78	1.60	93,765	Trinidad	50,000
Racine	20,851	5	1:3:5	1	....	2	......	1.99(1)	48,558	Trinidad	28,084
Wyoming—											
Cheyenne	......	....	......	......	....	...	......	.....	......	....	10,000

1 Per square yard.
2 Contract awarded.
3 Linear feet.
4 Miles.
5 Blocks of street.
6 Includes boros of Blakley, Dickson City, Jermyn, Jessup, Olyphant, Throop.
7 Will lay considerable in 1917.
8 Old brick or macadam foundation.
9 Kind not yet decided.
10 American Society of Municipal Improvements specification.
11 Bitumen.
12 Asphalt cement.
13 Paint coat.
14 Top coat.
15 Includes cost of water mains also.
16 A. C., 47; sand, 134; fine gravel, 134; 1-in. stone, 688.
17 A. C., 108; dust, 150; sand, 700.
18 Close binder.
19 3 parts stone, 2 parts sand, 7 to 10% bitumen.
20 Repaving including grading and removing old pavement.
21 A. C., 30; sand, 127; stone, 508.
22 A. C., 82; filler, 105; sand, 563.
23 4-in. concrete, $1.43; 5-in., $1.53.
24 1,250 sq. yds. on concrete base cost $1.85, or total of $2,512; 2,650 sq. yds. on crushed rock base cost $1.52, or total of $4,228.
25 34,957 sq. yds. using Aztec asphalt cost $1.25 a sq. yd.; 13,553 sq. yds. using Trinidad asphalt cost $1.37 a sq. yd.
26 Cost $2.12 a sq. yd. with concrete base; $1.50 with bituminous concrete base.
27 Crushed stone base.
28 ¼ gal. bit. cement per sq. yd.
29 $1.30 for 2½-in. top only, $1.32 for 2-in. top and 2-in. binder only; $1.48 for 1½-in. top on 4-in. crushed rock; $1.58 for 1½-in. top on 4-in. concrete, 1½-in. top on 4-in. bituminous base, 2-in. top on old macadam.
30 Oil and screenings ⅜ in. thick, 1 gal. of oil per sq. yd.
31 8% bitumen, 11% dust, 53% sand, 28% stone.
32 Cost of sidewalks also included.
33 4-in. base cost 57 cents and 2-in. top cost 70 cents.
34 Texaco asphalt 460 lb. per batch or 8.2%; stone dust 300 lb., cement 300 lb., together 10.7%; sand, 2,900 lb., or 52%; chats, 1,625 lb. or 29%. 30% of the sand must pass No. 10, 20 and 30 screens, 36%, No. 40 and 50 screens, and 34% No. 80, 100 and 200 screens.
35 Laid on old foundation.
36 2,540 sq. yds. Topeka mix with Montezuma asphalt; 11,570 standard bituminous concrete, averaging 7½% asphaltic cement, using Axtec asphalt.
37 2 cu. ft. of ½-in. stone; 3 cu. ft. of torpedo sand; 8 gals. of asphalt.
38 5 cents added to this price for maintenance.
39 National paving; asphalt, 18%, dust 82%.
40 Hot mix bituminous base, 1½ in. rock to dust with about 8% bitumen mixed hot, raked, and rolled with 10-ton roller.
41 Over old macadam base.
42 Open specifications.
43 With 4-in. concrete base, $1.42; 5-in., $1.50.
44 Bituminous base.
45 7,201 sq. yds. on 4-in. concrete foundation, at $1.58; 30,538 sq. yds. on 5-in. concrete foundation, at $1.75 a sq. yd.
46 $1.85 on concrete base; $1.35 on natural base.
47 Crushed stone 50 lbs.; sand 36; stone dust 7; asphaltic cement 7.
48 $1.55 on 6-in. concrete, $1.58 on 4-in. concrete, $1.05 on old macadam base.
49 Oiled.
50 982 sq. yds. laid 4 in. thick cost $0.585 a sq. yd.
51 2,000 sq. yds. of Amiesite on concrete base cost $1.75 a sq. yd.
52 6 in. Telford, 3 in. macadam.
53 2-in. top of 1½-in., ½-in. and stone chips.
54 Cost of 1,863 sq. yds.
55 Price includes wire fabric reinforcement.
56 Premolded expansion joint.
57 Bituminous wearing surface.
58 Total cost of all three varieties.
59 Hassam Bi-co-mac.
60 Bituminous.
61 Along curbs.
62 One thickness tar paper in transverse joints.
63 Granite in wearing course.
64 Baker protection plates.
65 Kahn bar joint protection.
66 Sandwich transverse joints.
67 Cost of pavement only.
68 Cross expansion joints every 25 ft. on alleys and 50 ft. on streets.
69 Trap rock in wearing course.
70 Creosoted wood blocks for joints.
71 Two contraction and one expansion joint per 100 ft.
72 Wearing surface is 2 coats of Tarvia A and screenings and is about ⅜ in. thick.
73 City furnishes coarse aggregate.
74 Transverse expansion joints are put in diagonal lines, 25 ft. apart. c. to c.
75 Transverse joints every 20 ft.; longitudinal joints are used where pavement is more than 24 ft. wide.
76 1,630 sq. yds., two-course, 1:2½:4 base, $1.65 sq. yd. 8,388 sq. yds., one-course, 1:2:3, $1.45.
77 Baker joints with Elastite filler 100 ft. apart, alternating with a specified contraction joint.
78 If not reinforced base is 7 in. thick, cost $1.37 sq. yd. If reinforced base averages 6½ in. thick, cost $1.49 to $1.53 per sq. yd., or $1.63 to $1.68 with integral curb.
79 Binder proportions are 56 lb. A. C., 275 lb. sand, 550 lb. stone. Surface coat proportions are 160 lb. A. C., 86 lb. filler, 768 lb. sand.
80 1½-in. first coat 1¼ gal. per sq. yd.; 1 in. surface coat, ¾ gal. per sq. yd. Bermudez asphalt.
81 26,165 sq. yds. on 4-in. water bound macadam base cost $1.17 a sq. yd.
82 Reinforced with triangular mesh if over 20 ft. wide.
83 1½ in. of crushed rock and 2 in. of bitulithic wearing surface.
84 Bituminous base.
85 Sand and cement.
86 Sand.
87 Sand filler with pitch for 3 ft. width crest to curb.
88 Surface coat 1 in. crushed stone with hot road oil applied.
89 1½ in. Barrett pitch filled joint along each curb, ½ in. ditto across streets at intersections.
90 1-in. expansion joints along curb; ½-in. joints every 50 ft.
91 12-lb. treatment of blocks.
92 Sandstone.
93 Elastite expansion joints.
94 Asphalt compound, premmolded, along curb, width proportioned to width of roadway.
95 Cement grout or bituminous filler, the latter 35% pitch, 15% asphalt.
96 Stone chips.
97 Filler is half sand and half paving pitch.
98 Eight-in. soft-coal-cinder base.
99 8,103 sq. yds. on natural soil base; 6,530 on 6-in. gravel base; 1,331 on 6-in. crushed rock.
100 Cost $1.92 with 3-in. vertical fiber blocks; $2.15 with 4-in. repressed blocks.
101 Cost $1.77 with 3-in. vertical fiber blocks; $1.97 with 4-in. repressed blocks.
102 Hillside brick.
103 Also 4,990 sq. yds. with filler one part sand and one part paving pitch.
104 Mortar bed.
105 Granulated slag.
106 6½ in. slag; 1¼ in. sand; 4-in. brick.
107 Filler is grout, bituminous or pitch mastic as specified. Latter proportions 85% pitch, 15% asphalt.
108 50 lb. A. C.; 800 lb. 3-in. stone.
109 170 lb. A. C.; 80 lb. dust; 800 lb. sand.
110 140 lb. A. C.; 575 lb. sand; 275 lb. stone; 95 lb. dust.
111 Telford base.
112 Warring-Underwood.

Fifteenth and Sixteenth streets, which will cost more than $10,000. The deepening of the channel under all the bridges on both Shoal and Waller creeks runs the bill up to nearly $100,000.

The new bridges are modern and up-to-date in every particular, most of them being artistic in design and pleasing in appearance. This is especially true of the Eighteenth street bridge, a cut of which accompanies this article. No two of these bridges follow the same pattern, giving a pleasing variety. All of the larger structures are wired for electric lights, and the First street bridge is now equipped with cluster street lights, while the Eighteenth street bridge is lighted with another variety of ornamental street light. Moreover, all of these bridges have a 6-ft. sidewalk on either side, and the width of the roadway is ample in each case to accommodate all the traffic. The width of the bridges from curb to curb varies from 26 to 40-ft., or, including walls and sidewalks, from 38 to 52 ft.

Altho this may seem a rather large concrete bill for a small city in one year, the municipality receives in return therefor the assurance that life and property on these two unruly streams will not be constantly menaced, and the inconvenience of having the city cut into two or three in flood-time is definitely and finally done away with.

Pneumatic Concreting of the Van Buren Street Tunnel

By H. B. Kirkland, President Concrete Mixing and Placing Company, Chicago

One of the more recent uses to which compressed air has been adapted is the mixing, conveying and placing of concrete. This process depends upon adiabatic expansion of the air, which is released thru an 8-inch pipe and carries a ½-yard batch of concrete at a time. This process has been used mostly for tunnel lining work and a recent example is that of the Van Buren street tunnel of the Chicago Surface Lines.

The Van Buren street tunnel carries a double-track street railway under the Chicago river and under the tracks of the Union Station. The proposed new Union Station required certain sub-passageways which would be interfered with by the location of the Van Buren street tunnel and for this reason it was necessary to change the grade so that the tunnel would pass under the proposed passageways of the new station. To make this change a new grade was established, lowering the tunnel under Canal street about 15 feet, and a new section, slightly less in width than the old tunnel, was designed. First the side walls and roof of the new tunnel were built, but instead of being carried down to their proposed depth in the first construction operation, these walls were built to the level of the old tunnel floor or invert and then the new roof was built upon them. Afterward the new side walls were extended down to the new level by underpinning—that is, alternate 10-foot sections of wall were excavated and filled with concrete down to the depth of the wall, and the remaining 10-foot sections were excavated, and the concrete invert constructed, thus completing the tunnel section.

Most of the concrete was mixed and placed by the pneumatic method. Inasmuch as the section of tunnel which was lowered was only 700 feet long, it was possible to locate the pneumatic mixer with bins above it at about half way between the ends of the work, thus making the maximum distance which it was necessary to convey concrete about 350 feet. This central point was at the tunnel portal. Bins were located here over the mixer, and the top of the bins came to the level of the street, so that materials brought in motor trucks were dumped directly into the bins and ran by gravity directly to the mixer.

The pneumatic mixer consists of a conical shaped hopper with a door at the top which is closed air tight after receiving each batch of unmixed ingredients for concrete. Air is admitted into the mixer at 80 to 100 pounds pressure above the batch and also below it, at the point of the conical shaped hopper. The lower air pipe is directed at the center of the 8-inch conveyor pipe which leads away from the machine to the point for depositing concrete. This stream of air mixes and conveys the concrete. The other air, admitted above the batch, merely forces the batch downward and into contact with the lower air stream. An air receiver of about 120 cubic feet capacity was located near the mixer and air was supplied by a Sullivan angle compound motor-driven air compressor, belt connected. The compressor has a rated capacity of 628 cubic feet of free air per minute, a size which is ample for placing one batch of concrete per minute at a distance of 300 feet. For shorter distances the number of batches could be increased and for a larger distance, the batches are less in number per minute.

PNEUMATIC CONCRETE EQUIPMENT IN THE VAN BUREN STREET TUNNEL.

The amount of air consumed in general in the mixing and placing of concrete by this method, is dependent on the specific gravity of the material conveyed, the size of pipe used, the size of storage reservoir, the horizontal and vertical distance of discharge, the number of bends in the discharge pipe, and, last but not least, upon the operator.

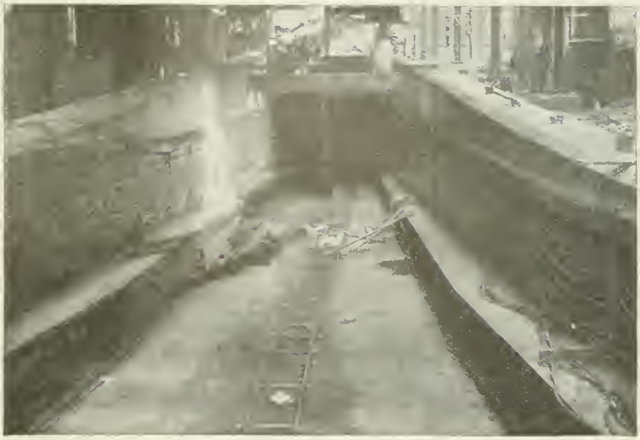
Accompanying are tables of theoretical capacities for continuous operation.

The figures in Table I are based on observation for the shorter distances of discharge and are computed for the longer distances. At the St. Louis water works tunnel the air consumption was from 1.2 to 1.7 cu. ft. per linear foot of discharge pipe. At the Richmond tunnel, San Francisco, the consumption was 1.3 cu. ft. per linear foot of pipe. Another tabulation given by H. A. Leeuw and stated to be based on three years' study and experience is shown in Table 2.

Time-Studies.—Tables 3 and 4 give two time-studies which were made during the course of a regular day's run on one job. The air supply was about 60 cu. ft. per minute and a ½-yard mixer was used. It was charged by hand from overhead bins operated by sliding gates immediately over the measuring hopper; two laborers controlled the sand and stone gates and one laborer operated the gate to the measuring hopper and also the air valves. Still another laborer operated the water valve and assisted the mixer operator, making five men at the mixer.

Note that a 600-foot compressor was used and that the average time of waiting for the air pressure to come up was 17.2 seconds in time-study No. 1, in which the distance was 350 feet. In study No. 2, in which the distance was only 102 feet, there was no wait for air pressure.

The Van Buren street tunnel work was done by the Chicago Surface Lines, under direction of Mr. John Z. Murphy, electrical engineer, and Mr. J. W. Harris, tunnel engineer.



GENERAL VIEW, VAN BUREN STREET TUNNEL ALTERATION.

TABLE III—TIME-STUDY NO. 1

Consec. No. of shot.	Charging mixer, sec.	Closing door, sec.	Discharging mixer, sec.	Wait for rise in air pressure, etc.
1	10	4	13	23
2	10	2	13	11
3	9	3	17	15
4	8	5	14	16
5	10	5	17	20
6	11	2	20	14
7	11	6	19	20
8	9	6	15	19
9	10	5	18	..
Average	9.8	4.2	16.2	17.2

Average time per shot, 47.4 seconds. Length of conveyor pipe line, 315 feet. Vertical rise of pipe, 15 feet. Bends in pipe, 270 degrees.

TABLE IV—TIME-STUDY NO. 2

Consec. No. of shots	Charging mixer, sec.	Closing door, sec.	Discharging mixer, sec.
1	8	3	7
2	5	3	11
3	9	1	9
4	7	4	8
5	6	4	9
6	7	5	9
7	5	5	12
8	7	9	11
9	6	3	10
10	5	5	11
11	7	5	10
12	5	4	13
Average	8.7	4.4	10.0

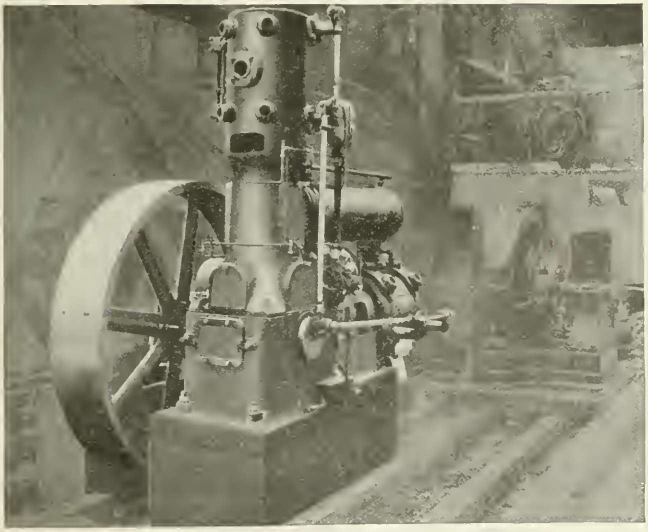
Average time per shot, 23.1 seconds. Length of conveyor pipe, 102 feet. Vertical rise of pipe, 37 feet. Bends in pipe line, 205 degrees.

TABLE I.

Distance, feet	100	200	500	800	1,000	1,200	1,500	2,000	2,500
Time of shooting, minutes	10	15	25	40	50	60	75	100	125
Time of loading, sec.	20	20	20	20	20	20	20	20	20
Time per batch, sec.	30	35	45	60	70	80	100	130	145
Batches per minute	2.0	1.8	1.3	1.0	.85	.75	.6	.46	.41
Batches per hour	120	108	78	60	51	45	36	27	24
Yards per hour	40	36	26	20	17	15	12	9	8
Actual free air required, cu. ft. min.	400	720	1,300	1,600	1,700	1,800	1,840	1,840	2,000
Size of air reservoir, cubic feet	50	100	150	240	300	360	450	500	750

TABLE II—CUBIC YARDS OF CONCRETE PER HOUR, MIXER CAPACITY ½ CUBIC YARD

Actual amount air required	Length of horizontal discharge					
	100	300	400	600	800	1,000
Cu. ft. of free air per minute.	Lin. ft.	Lin. ft.	Lin. ft.	Lin. ft.	Lin. ft.	Lin. ft.
600	20	15	10	..	..	..
800	30	20	18	12	6	..
1,200	40	30	25	20	12	8



SULLIVAN WJ3 ANGLE-COMPOUND COMPRESSOR THAT SUPPLIED AIR FOR CONCRETING THE VAN BUREN STREET TUNNEL.

Toll Gates on Country Roads

Virginia cities, like those in Indiana, are not taxed for country roads, but, unlike Indiana cities, they may contribute to the construction of roads to a distance of ten miles. Fredericksburg did not contribute to the cost of the roads in Spotsylvania county and its automobile traffic is wearing the roads. The county has established toll gates on these principal roads so that the traffic wearing the roads pays for their repair. This reversion to an ancient system seems to be a backward step, but if it results in a change in the law so that the cities originating the traffic can contribute their share toward the construction and maintenance of the roads carrying it, it will be thoroly justified. The Virginia legislature seems to be as difficult to lead into the march of progress as that of Indiana, which is one of the very few states not yet provided with a state highway commission and a method of building roads which will insure that they are of the same design and quality of construction in any two townships, or will even make the improved roads of adjoining townships join.

MISCELLANEOUS

Meetings of Organizations

February 5-9, in Mechanics Hall, Boston, Mass. American Road Builders' Association. E. L. Powers, secretary, 150 Nassau street, Boston, Mass.

February 6, 7, at New York. National Lime Manufacturers' Association. F. K. Irvine, secretary, 537 South Dearborn street, Chicago, Ill.

February 7-9, in Engineers' Building, New York City. American Institute of Electrical Engineers. F. J. Hutchinson, secretary, 33 West 39th street, New York.

February 7-9, at Hotel Radisson, Minneapolis, Minn. Minnesota Surveyors' and Engineers' Society. W. F. Rosenwald, secretary, Germania Building, St. Paul, Minn.

February 7-15, at the Coliseum, Chicago, Ill. Tenth Chicago Cement Show. Cement Products Exhibition Co., 210 South LaSalle street, Chicago, Ill.

February, dates as follows: At Providence, R. I., Engineering Society. February 7, structural engineering section on mixing and pouring concrete; February 9, industrial and technical education section; February 13, designing and drafting section; February 28, general meeting, addressed by Dr. M. R. Hutchinson, engineering adviser to T. A. Edison.

February 8-10, at Hotel LaSalle, Chicago, Ill. American Association of Engineers. Secretary, 29 South LaSalle street, Chicago, Ill.

February 8-10, at Hotel LaSalle, Chicago, Ill. American Concrete Institute. H. D. Hynds, secretary, 1418 Walnut street, Philadelphia, Pa.

February 9, at Sherman, Tex. Texas Town and City Planning Association. J. E. Suratt, secretary, Sherman, Tex.

February 12, 13, at Sherman Hotel, Chicago, Ill. National Builders' Supply Association. L. F. Desmond, secretary, 1211 Chamber of Commerce Building, Chicago, Ill.

February 12-14, at Chicago, Ill. American Concrete Pipe Association. E. S. Hanson, secretary, 538 South Clark street, Chicago, Ill.

February 14, 15, at Claypool Hotel, Indianapolis, Ind. Indiana Sanitary and Water Supply Association. W. F. King, secretary, State House, Indianapolis, Ind.

February 14-16, at Hotel Sherman, Chicago, Ill. Illinois Lumber and Builders' Supply Dealers.

February 15, 16, at Madison, Wis. Wisconsin Engineering Society. L. S. Smith, secretary, 939 University avenue, Madison, Wis.

February 19-22, at Engineering Building, New York City. American Institute of Mining Engineers. Bradley Stoughton, secretary, 29 West 39th street, New York City.

February 19-24, at the Convention Hall, Kansas City, Mo. Southwestern Concrete Association. Chas. A. Stevenson, 1413 West 10th street, Kansas City, Mo.

February 21-23, at Ames, Iowa. Iowa Engineering Society. J. H. Dunlap, secretary, Iowa City.

March 5, 6, at Hotel McAlpin, New York. National Paving Brick Manufacturers' Association. W. P. Blair, secretary, Cleveland, O.

March 5-7, at Hotel Astor, New York. American Ceramic Society. Edward Orton, secretary, Columbus, O.

March 5-11, at Grand Central Palace, New York. National Complete Building Exposition.

March 6-10, at Auditorium, Omaha, Neb. Mid-West Cement Show.

March 7-10, at Hotel Rome, Omaha, Neb. Mid-West Cement Users' Association.

May 8-10, at Washington, D. C. National Fire Protection Association. Franklin H. Wentworth, secretary, 87 Milk street, Boston, Mass.

May —, at Cincinnati, O. Dixie Highway Exposition and Convention.

June —, at St. Paul, Minn. International Jefferson Highway Association.

November 12-16, at Hotel Gruenewald, New Orleans, La. American Society of Municipal Improvements. Charles C. Brown, secretary, 608 South Dearborn street, Chicago, Ill.

How New York City Now Controls the Development of Private Property

By George B. Ford, Consultant to the Commission on Building Districts and Restrictions.

The city government of New York has just put into effect by a virtually unanimous vote of the Board of Estimate and Apportionment the radical and much-talked of Zoning Law. All future buildings will be restricted as to their height, size and use, and the restrictions will be different in different parts of the 327 square miles of the city.

Hon. George McAneny, the father of the law, said: "It is the greatest thing the city has ever done, not even excepting the building of the great rapid transit system." Mayor Mitchel said that he believed that it would prevent in the future the enormous decline in property values, such as had occurred below Thirty-fourth street in Manhattan. He believed that residence sections thruout the city would be protected against the sporadic store, factory or garage.

In general, the law will limit the height of buildings in proportion to the widths of the streets on which they face all the way from two and a half times the width of the street in the financial district, thru two times the width of the street in central Manhattan, with one and one-half times in the balance of Manhattan and in small portions of the other boros, down to once the width of the street thruout all the rest of the city. A future Equitable building could only be a third as high, because it faces on narrow streets, but a tower in the center of it, half as large again as the Woolworth tower, might rise to any height. The Woolworth building on the other hand, if facing on a park, might be very nearly duplicated. The shopping district of Fifth avenue will consist of buildings not much higher than Tiffany's, but along Forty-second street buildings may rise about as high as the Hotel Manhattan or Knickerbocker. Twelve and 14-story apartments will continue to go up on the main avenues and eight and nine-story apartments on the side streets, but no building of any kind can go any higher except by setting back from the street. Thruout most of the city, however, four or five stories will be the limit. Towers may be built to any height, but they cannot cover more than a quarter of the lot. Mansards, dormers and terraces are encouraged; anything that will open the streets and bring light down into them by making the upper part of the buildings set back from the street above a reasonable height.

The size of buildings will be controlled by the fact that the law requires just so much open space on each lot. This again ranges all the way from the warehouse districts along the commercial water front and along the freight railways, where a building may cover the whole of its lot, thru the B, C and D districts, so-called, in each of which in succession a building has to provide for larger and larger yards and courts, down to the villa districts, where a house can cover only 30 per cent of its lot and must be widely separated from its neighbor on at least one side. Thruout Manhattan and the densely built-up portions of the other boros, yards and courts in office buildings, factories, lofts, hotels, apartments, in fact, all buildings, would have to be as large as those that have been required for the last 14 years in tenement and apartment houses. Everywhere the yards and courts have to be increasingly larger at the top as a building goes up in height, so much so that these requirements tend to limit the practicable economic height of buildings even more effectively than do those directly affecting height. This is particularly true in the outlying boros. One important feature of the law is the encouragement it gives to playgrounds, for material concessions are allowed to any one who will provide adequate recreational space in connection with his buildings.

Right here it is desirable to sound a note of warning. It would be most unfortunate if the law were applied as it stands to other cities, for it is full of unduly liberal provisions in the way of height and size that tend strongly to defeat the object of the law, but which were necessitated by the exceptional economic conditions of New York.

As to the use of buildings, there are only two general restrictions; first, the districts which are restricted against business and industry of all sorts, the so-called "residence" districts, and, second, the tracts which are restricted only against manufacturing and public stables and garages, the so-called "business" districts. In the former almost any kind of building that people live in is allowed, also churches, schools, hospitals and various institutional buildings. In the business districts any residence use is allowed, and even a certain small proportion of the unobjectionable types of manufacturing. The use districts have been laid down street by street, and, in fact, block by block, depending on existing conditions and tendencies. The result has been that about two-fifths of Manhattan and about two-thirds of the whole city has been set aside for all time for strictly residential use, while the main thorofares, the transit streets and all other streets that are or might be appropriately used for stores or show rooms are set aside as business streets. Many streets which are now seriously invaded by factories or garages are restricted against them from now on because it was felt that they were a distinct harm to the street. On this ground all of the central part of Manhattan above Twenty-third street was made a business district, despite the fact that there were already hundreds of factories, employing in all upward of 30,000 operatives, within the district. This law will not touch the existing factory lofts, as it is in no sense retroactive, but the "Saving New York" movement, in which most of the merchants along Fifth avenue combined to oust the factories in the neighborhood, has already succeeded in persuading almost all of the manufacturers to move away. It was a remarkable and timely vindication of the economic need of this law.

It is interesting to see how the unbroken residence districts have been becoming larger and larger at the insistence of the property owners themselves, so that in some cases of their own volition they must walk at least a mile to the nearest store of any sort. These restrictions do not interfere in any way with existing or future private restrictions placed on any property except that if this law happens to be more drastic than the latter in any particular this law would govern. All of the balance of the city which is not in one or the other of these two kinds of districts is left unrestricted. It includes all of the land appropriate for industry along the navigable water front and along the freight railways, as well as most of the territory which is now given over to manufacturing. It includes also scattered thruout the city a number of blocks which are already invaded by public garages or which are appropriate for that use. Certain other areas, especially around Jamaica Bay and along the shores of Staten Island, are left entirely undetermined in their use pending the working out of the plans for the port and terminal facilities of New York.

In the various reports of the Commission nothing whatever has been said about the effect of the new law on the appearance of the city, and yet within the next 25 or 50 years it is bound to make the city far more orderly and even more beautiful. It has been said that it would spoil the glorious sky line of New York and rob the city of its "crowning glories." But so far from doing that, I am convinced that the sky line of New York some 25 or 50 years from now will be far more wonderful than anything we have yet dreamed of, for the law is full of special provisions which are bound to encourage the erection of towers, mansards, dormers, terracing roofs of a variety and interest far different from anything which this country has yet seen. More immediately, it will put order and harmony into the streets of the city, particularly the residential streets. It will tend to prevent the streets from being broken up, as they are now.

High Prices Delay Chicago Bridge Plans

An increase in prices bid, amounting in some cases to 100 per cent. over estimates, has resulted in holding up the awarding of the contracts for the Twelfth street bridge in Chicago, so great an increase being termed extortionate. The city still has nine bridges to build with the $6,500,000 remaining of its bond issue for this purpose. Of the others, two are ready to advertise for bids, two have plans completed, one under way and the other four will follow other improvements which are not yet ready for the bridges.

Prizes for Engineering Papers

The prizes for engineering papers by undergraduates and recent graduates of technical colleges, offered by the Engineers' Subdivision of the Chicago Association of Commerce, have been awarded. The first of $50 to Harvey T. Hill, Field Museum, Jackson Park, Chicago, subject, "Engineering and Civic Progress"; the second of $30 to Leo Shippy, 2903 West street, Ames, Iowa, and the third of $20 to H. M. Kistler, 6737 Penn avenue, Pittsburg, Pa., subject of each, "The Engineer of the Future." Honorable mention was given to R. D. Stitt, 72 West Adams street, Chicago, subject, "The Business Relations of the Engineer to the Commercial World," and to Gordon D. Cooke, 160 Dexter boulevard, Detroit, Mich., subject, "Charting Rocks and Reefs on the Great Lakes."

Technical Schools

A recent publication of the Engineering Experimental Station, University of Illinois, Urbana, Ill., is entitled "Subsidence Resulting from Mining." Bulletin 91, 200 pp., paper, free.

Bulletin No. 10 of the research division of the electrical engineering department of the Massachusetts Institute of Technology is by A. E. Kennelly and O. R. Schurig and gives a discussion of a series of experiments on traction resistances to a motor delivery wagon on different roads and at different speeds.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

At any time papers are presented: For mechanical draftsman, office of chief of ordnance, War Department, Washington, D. C., at $1,000 to $1,200.

February 6: Electrical draftsman in bureau of yards and docks, Navy Department, at $3.52 to $6 a day; mechanical draftsman, same office and pay.

February 7: Laboratorian qualified in electrical science in machinery division of Mare Island navy yard, Cal., at $3.60 a day; sanitary engineer in Philippine health service, at $1,600 a year; second-class steam engineer, State, War and Navy Department Building, Washington, D. C., at $1,000 a year; junior physicist in bureau of mines, Pittsburg, Pa., at $1,500 a year; electrical assistant in signal service at large, War Department, at $1,200 a year.

February 7-8: Laboratory assistant in bureau of standards, Department of Commerce, at $900 to $1,200; mechanical laboratorian in naval engineering experimental station, Annapolis, Md., at $4.24 a day; aid and deck officer in Coast and Geodetic Survey, at $1,000 and field allowances.

February 13: Marine draftsman, Panama Canal service, at $125 to $150 a month.

February 27: Sub-inspector of ordnance in any navy yard or establishment, at $4.48 a day.

February 27-28: Assistant engineer in forest products, at Madison, Wis., at $900 to $1,200 a year.

A Correction

Through error in make-up department our January issue reproduced a comparative cost record tabulation on page 63 of the Motor Truck Section. The statistics from which these records were compiled were obtained by our editorial department some time ago, and while the statistics were accurate at that time they are now out of date, inasmuch as the price of the 3-wheel type Martin tractor was $3,750, whereas the price of the 4-wheel Knox tractor at this time is $4,500. Consequently this change in prices seriously affects the data. The present type of Knox 4-wheel tractor is equipped with electric lighting and starting systems whereas the old 3-wheel model possessed none of these modern improvements and conveniences. Since the hauling tabulation was compiled, the cost of operating horse-drawn vehicles has materially increased and the comparisons recorded in the table therefore are not accurate under present conditions.

Personal Notes

Robert H. McCormick, for thirty-four years in the city engineer's office at Detroit, Mich., for the last sixteen years as chief, has resigned and is succeeded by Clarence W. Hubbell, formerly civil engineer for the Detroit Board of Water Commissioners and more recently in responsible positions in the public works department of Manila and the Philippine Islands.

Harry F. Harris, recently assistant engineer in charge of Trenton, N. J., street construction, has been appointed engineer of the county in which Trenton is situated.

E. S. Shuler is city manager of Sumter, S. C.

Henry Welles Durham has resigned as county engineer of Bergen county, N. J., to devote himself to his consulting engineering practice in connection with Percival Robert Moses, at 366 Fifth avenue, New York. Ross McClave is his successor as Bergen county engineer.

Francis J. Brennan has been appointed street commissioner for Boston, Mass.

Fuller and McClintock is now the style of the firm of George W. Fuller, consulting engineer, 170 Broadway, New York, and Jesse K. Giesey has been admitted as a partner.

George P. Bemis, who was quite as spectacular in his way as his cousin, George Francis Train, and was associated with him in the construction of the first tramways in London, England, recently died at the age of 78 years, in Omaha, Neb., of which city he was twice mayor. The two were active promoters of the Union Pacific railway; of a French republic in 1870, for which effort they barely escaped execution; of woman suffrage in its early and most strenuous days, and of other movements, progressive, spectacular, or both. Mr. Bemis celebrated his seventy-fifth birthday by a fifteen-day fast.

J. L. Stephens, for some years assistant city engineer, has been promoted to city engineer of Mishawaka, Ind.

Capt. J. H. Burnham, a well-known bridge contractor of central Illinois, died at Bloomington, Ill., January 21, at the age of 83. Beginning in 1867, he supplied half the counties of Illinois with iron bridges, following them with concrete bridges, many of which he has built during the last ten years.

Publications Received

The Institute for Public Service, W. H. Allen, director, 51 Chambers street, New York, issues a weekly bulletin, entitled "Public Service," under its public service exchange, the subscription price being 50 cents for 40 issues to 3 persons. Its mission is co-operative (1) with mayors and other municipal officers in keeping in touch with what other communities are doing; (2) with newspapers by means of short weekly articles on advances in city government; (3) sheets of short public service notes; (4) aid in answering questions asked by local readers or editors.

The Elgin Commercial Club, of Elgin, Ill., thru the liberality of certain citizens and printers, has issued a report on an Elgin city plan which demonstrates the progressive spirit of this small city. It will certainly make the city a beauty spot and set a pace which will ultimately surround Chicago with beautiful suburban cities and towns. It takes advantage of the possibilities in the surroundings and utilizes them at very reasonable cost.

C. E. Grunsky, of San Francisco, has written a valuable book on valuation of public utilities and other engineering structures, which is published by John Wiley & Sons at $4 net. It is a notable contribution to a subject on which many books have been written in the last five years or so.

A Handbook on Wood Preservation has been issued by the American Wood-Preservers' Association, F. J. Angier, secretary, Mt. Royal Station, Baltimore, Md., which gives very full information about processes, the history of the industry and the plants now in operation in the United States and Canada. It gives also the constitution and the list of members of the association in 1916.

Bulletin 388 from the U. S. Office of Public Roads gives public road mileage and revenues in the New England states in 1914.

Recent bulletins of the Portland Cement Association are on concreting in cold weather and concrete houses.

MACHINERY AND SUPPLIES

Williston Construction Co.'s Asphalt Plant

The steadily increasing popularity of the portable asphalt plant is most recently shown by the De Pere, Wis., installation of a Cummer type by the Williston Construction Company.

This well-known Chicago firm of paving and sewer contractors received a new Cummer 3-unit plant the latter part of September and commenced operations with it in De Pere on October 3, finally completing the work on November 11. The plant was not operated continuously during this period, delays being principally caused by failure of the street railway company to get their portion of the work ready in time. The contractor also had considerable wet weather with which to contend and only completed the job an hour or so before a snowfall that was 10 inches deep by next morning.

C. H. Draney, superintendent for the Williston Construction Company in De Pere, reports a total of 22,213 sq. yd. of 2-inch asphalt concrete laid on 5-inch concrete foundation, on the following streets: Charles street from Broadway to Huron, 4,395 sq. yd.: Michigan street from Fulton to Merrill, 8,710 sq. yd.; Third street from Lande to Main, 9,108 sq. yd.

"The Cummer plant we used," states Mr. Draney, "is rated at 1,800 square yards of 2-inch surface daily, and under favorable conditions we found it easily capable of turning out 2,000 square yards in a 10-hour day.

"It may be interesting to know this Cummer 1,800-yard road plant consists of three units, all mounted on wheels and easily portable from place to place as convenience may suggest. The main and largest unit is that containing the dryer and mixer. Also there are two portable fire-melting kettles, each equipped with an asphalt pipe line which comprises the second unit. The third unit consists of a portable boiler and engine.

"The mixer and dryer unit—weighing about 22 tons—was shipped on a flat-car and was unloaded by jacking it up off the car, and supported by a cribbing of railroad ties and 12 by

CUMMER ROAD ASPHALT PLANT IN SERVICE OF WILLISTON CONSTRUCTION CO., DEPERE, WIS.

LAYING ASPHALTIC CONCRETE ON THIRD STREET, DEPERE, WIS. WILLISTON CONSTRUCTION CO.

12 timbers. When sufficiently clear, the car was pushed out from under the plant, which was itself then lowered to the ground and towed by a steam roller to the location where it was set up. The other two units were unloaded by means of block and fall in conjunction with a steam roller. The plant was set up alongside the railroad tracks. All paving materials received were thus easily unloaded from the cars to the ground and then shipped up to the cold link-belt elevator by team.

"This cold link-belt elevator is beside the Cummer type dryer which it feeds. The sand and stone, after being heated, are passed into the hot elevator and on up into the storage bin, over which is placed a revolving screen, divided into three different sizes. Thence the screened material drops into the storage bin, which is itself divided into three compartments, the contents of each of which are drawn off separately and weighed before being introduced into the mixer located directly beneath. The foregoing applies to our manufacture of asphalt concrete, but the only alteration requisite for making sheet asphalt is in connection with the revolving screen.

"The mixer is of the twin pug type of 9 cubic feet capacity. It sits directly under the box in which the hot sand and stone is weighed. The latter is thence passed on into the mixer by merely lifting a lever which opens a gate. Limestone, dust, or other powdered material is then introduced into the mixer, after which asphalt cement—same having previously been pumped from the kettle to a bucket supported on a scale—is poured into the mixer. Then after having been thoroly mixed, the whole mass is emptied into the motor truck or wagon beneath. This is accomplished by simply moving a lever which opens a gate in the bottom of the mixer.

"The asphalt is melted in the kettles by direct fire and is transported to the mixer thru a steam-jacketed pipe line by means of a Kinney pump. Change can be made from one kettle to another by merely turning two stop cocks. The pump works continuously during mixing, and the asphalt is kept in steady circulation.

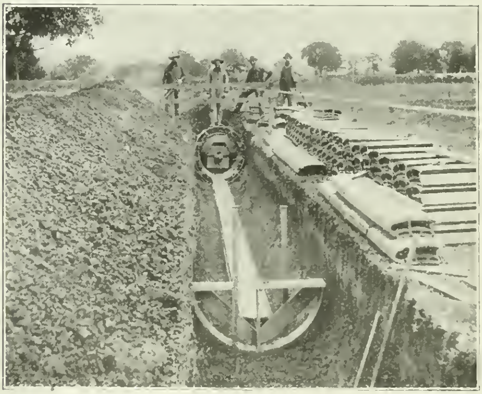
"We used Aztec asphalt, a portion of which was shipped in tank cars, and the remainder in iron drums. The tank cars were unloaded by means of a Kinney pump and the steam was afforded by the plant boiler. When finally mixed, the material was delivered in dump wagons to the streets where paving was in progress.

"Our plant crew consisted of a foreman, an engineer, a night-man, a drum fireman, a kettle man and a box-man. In addition to those we also employed two men feeding the elevator and about four other men for general work such as charging the kettles, etc.

"Our street paving crew included a foreman, a roller-man, three rakers, two tampers and six shovelers, beside the four men whose business it was to put on the flush coat and chips. Our roller is a Kelly-Springfield and weighs eight tons."

Vitrified Block Sewer

The accompanying photograph shows the end of a 30-inch single ring vitrified block sewer under construction in Fond du Lac, Wis., in a part of the line where the depth of trench is hardly greater than the diameter of the sewer. It is apparent that the street in which the sewer is laid will be filled to the elevation of the streets and tracks seen in the background and at the left, so that the sewer will have an ordinary amount of earth between it and the passing traffic. This really makes but little difference, however, as tests show that the block sewer will carry without side support above its horizontal diameter a weight far greater than would come on it from any road traffic.



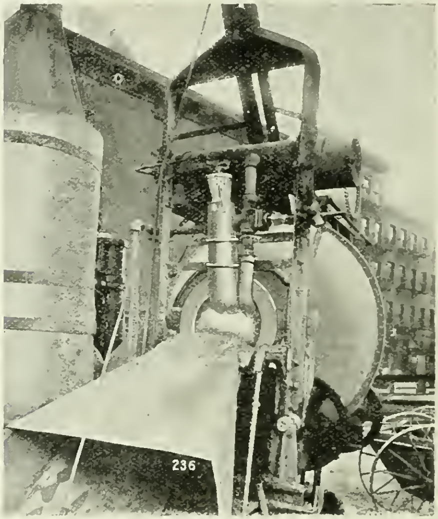
SHOWING ALL STEPS IN PROCESS OF LAYING SEGMENTAL BLOCK SEWER FROM TRENCH FORMATION TO BACK FILLING.

The photograph, for which we are indebted to the National Fireproofing Co., shows the shaping of the bottom of the trench to the shape of the sewer, the placing of the templet to whose form the blocks are laid, the invert block in place, with string stretched between form and completed sewer to give line and grade. The corrugated joint surface will be plastered with cement and the successive sections laid so as to break joint.

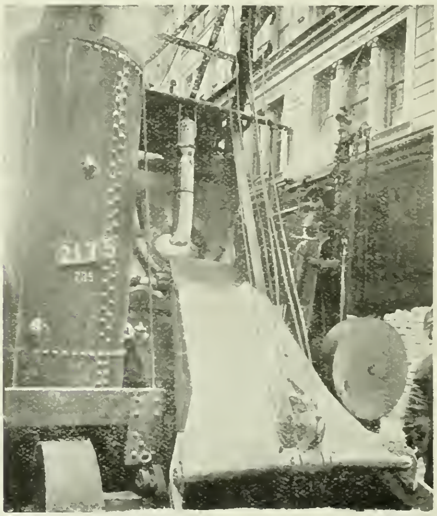
The end of the collapsible center on which the arch sections are laid is quite clearly shown, so that all the steps in the process of laying the blocks from trench digging to backfilling can be worked out from the one picture.

An Oil Burning Heater for Concrete Mixer

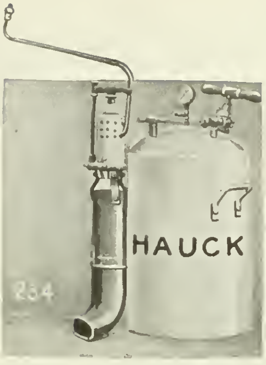
The accompanying photographs almost tell the story of the Hauck compressed-air oil burner for heating concrete mixers in cold weather. The small cut shows the elements of the apparatus, the tank, the hand pump for putting on the operating air-pressure of 20 to 60 pounds per square inch, the vaporizer, burner and heating pipe. A few minutes' operation of the hand air pump will keep the pressure within the limits named for three hours of operation. The burner is of the vap-



HALF YARD FOOTE CONCRETE MIXER EQUIPPED WITH HAUCK COMPRESSED AIR OIL BURNER. RAPID TRANSIT SUBWAY CONSTRUCTION CO., NEW YORK SUBWAY.



HALF YARD MILWAUKEE CONCRETE MIXER OPERATING WITH HAUCK HAND PUMP KEROSENE HEATER. NEW YORK SUBWAY CONSTRUCTION.



HAUCK KEROSENE HEATER HAND PUMP BUILT INSIDE TANK FOR FORCING OIL TO BURNER.

orizing type, burning kerosene or coal oil and is subject to a special patent.

One of the larger photographs shows a Foote mixer equipped with the heater and another shows it on a Milwaukee mixer. The connections, locations of oil tanks and burners show for themselves as conveniently out-of-the-way of the concrete-mixing operations but readily reached for what little attention they may need. Further information can be obtained from the Hauck Manufacturing Co., 140 Livingston street, Brooklyn, N. Y.

Forms in Sidewalk Construction

By J. S. Murray, Contractor, New Kensington, Pa.

The one-course concrete sidewalk, as compared with the two-course type, is rapidly gaining in favor as the entire mass is wearing surface. One layer naturally can be placed more cheaply than two, and the additional strength is such that the equivalent of a 5-inch two-course walk can probably be obtained by 4½ inches of the richer mix, placed in one operation.

Then, too, the actual amount of materials is nearly identical for each type. Below is shown the comparison of the two constructions based on 100 square feet of surface:

Type	Mixture	Bbls. Cement	Cu. Yds. Sand	Cu. Yds. Gravel	Total Cost Materials
5-inch 2-course....	1:2½:5 base				
	1:1½ top	2.52	.80	1.21	$6.79
4½-inch 1-course..	1:2:3	2.42	.73	1.08	6.16

The cost of cement walk, of course, will vary with the cost of materials and labor and with the experience of the men doing the work; also with the location of the walk, the amount of walk to be placed at one time and its width, as well as the types of forms used.

Our experience has been that the proper use of steel forms is a most important factor in the reduction of construction cost, as less manual labor is required and the work progresses in more speedy and uniform fashion. In our work, we use 200 feet of Heltzel sidewalk forms as well as 325 feet of curb and gutter forms.

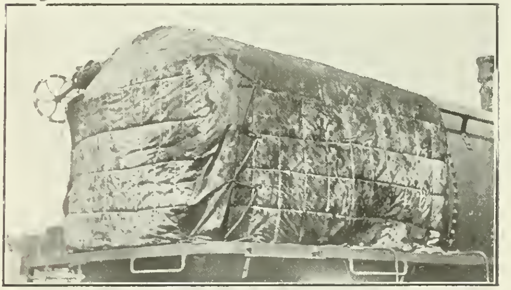
The recommended method of constructing sidewalks with these forms is about as follows: At least 50 feet of forms are connected up in place and the concrete placed in the first block. The grader starts at work leveling the concrete so that after it is tamped it will come within 1 or 1½ inches of the top of the forms. Behind the grader follows the tamper, tamping the whole concrete surface firmly, taking pains to tamp next to the side rails and the division plates. The concrete should have been mixed middling stiff. While this work is being done another part of the gang should have been mixing the top. This, too, should be mixed middling stiff, with just enough water so that when it is tamped firmly into the concrete base there will be enough moisture come to the top to finish nicely. There is another tamper at work on the top. Following him are two men striking off, and close on the strike-off is the finisher floating and edging, which is also done immediately without any waiting for the puddled surface to dry out.

The sidewalk forms are composed of rigid, adjustable, flexible and curved side rails; also division plates or templates. The rigid side rails are made of annealed steel, pressed to shape in sections of 6, 9 and 12-foot lengths, with curvilinear openings in the top flange to receive the division plates at intervals of one foot. These rails are 4 inches deep with a 1½-inch flange on the bottom and a 2-inch flange on top, from which is a depending flange of 1 inch, and are connected end to end by sleeves. Rigid adjustable side rails, 5 feet long are arranged to telescope a part of their full length with the regular side rails. By their use, forms can be set in any odd space without using any wood to fill in. Flexible side rails made in 6, 8, 10 and 12-foot lengths, slotted at intervals of 1 foot for division plates are used in curved sections.

Reduces Time in Unloading

The application of heat is necessary in unloading a tank car of asphalt. It takes a few hours to raise a full head of steam in the coils and to begin to affect the solidity of the asphaltic material. In fact, approximately 24 hours generally has been found necessary to unload the average tank car in severe weather. Any reduction of this time tends to greater efficiency, as it might save demurrage, and would certainly reduce the expense of fuel and attendants.

A portable cover has been invented for the purpose of reducing the amount of heat lost by radiation while heating the tank. By the use of this cover it has been found that the time of unloading a car in severe weather is reduced about one-half. The cover, furnished by the H. W. Johns-Manville Co., is in blanket form and is equipped with lashing ropes and grommets for the purpose of making it fast to the running board, and also with grommets and lacing rope so that the sections may be laced together, avoiding the possibility of the cover being blown away by the wind.



INSULATING COVER PARTLY IN PLACE ON ASPHALT TANK CAR.

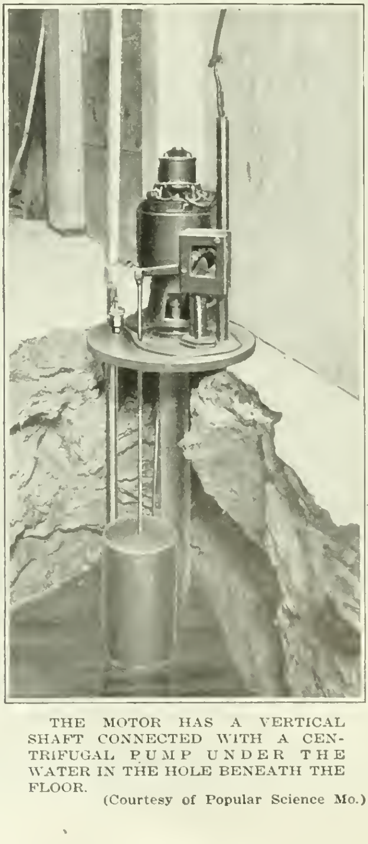
The stitching in both directions makes it impossible for the asbestos insulating material to wad in the canvas. The manufacturers use 8-oz. canvas next to the shell of the tank, and 7-oz. canvas, paraffin treated, on the outside. The covers are being manufactured for 6,500, 8,000 and 10,000-gallon tank cars. The present price of the 6,500-gallon cover is about $260, and of the 8,000-gallon cover, about $300, f. o. b. New York. The accompanying illustration (shown through the courtesy of the *Canadian Engineer*) shows one section of the cover in place on a tank car.

Midget Electric Pump for Draining Cellar Seepage

Residences located on low ground are perpetually subject to the seepage of water in their cellars and the condition is not easily remedied for the reason that not even concrete floors and walls are successful in preventing the gradual entrance of water.

To eliminate this condition a new electric seepage pump has been invented which, according to all reports, is proving remarkably efficient. For the best use of this pump a hole for use as a small reservoir should be made in some corner of the cellar. The water will then naturally seep into that instead of working its insidious way up thru the concrete of the floor. This tank hole, being at a lower level than surrounding floor, insures the dry, sanitary condition of the rest of the basement.

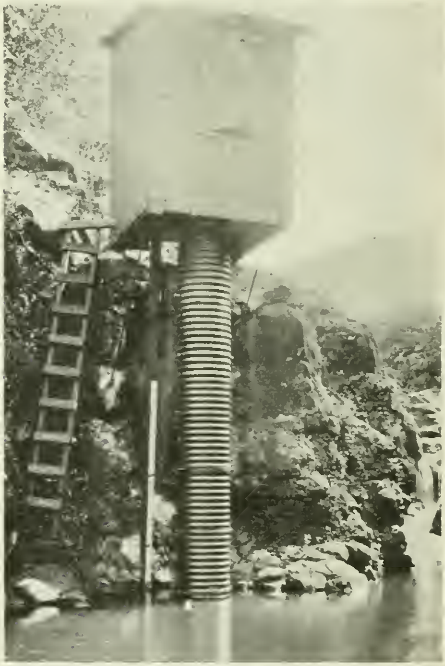
The pump device is equipped with a vertical-shaft motor which is located on the cellar floor at the edge of the tank hole. The shaft is connected with a small centrifugal pump submerged in the water in the hole. Operation is entirely automatic. A float sets the motor going immediately the water has attained a fixed height and shuts off the current as soon as a sufficient amount has been pumped out.



THE MOTOR HAS A VERTICAL SHAFT CONNECTED WITH A CENTRIFUGAL PUMP UNDER THE WATER IN THE HOLE BENEATH THE FLOOR.
(Courtesy of Popular Science Mo.)

Stream Gaging Station

The accompanying photograph shows a novel stream gaging ing station constructed and maintained by the U. S. Geological Survey, under C. T. Bailey. The float, counter-weight and driving weight of the recording mechanism operate in the well, which is made up of sections of Armco iron corrugated culvert. The recording drum is in the house built around its top.



Dangers of Narrow Roads

Not long ago the photographer who was taking the moving pictures for the new Du Pont road-building film had set up his camera with a view of showing a short section of a narrow, rocky road. At that moment along came a boy pushing a bicycle followed by two men in a buggy. The horse became frightened and in endeavoring to turn out for the boy ran over a large boulder, tipping both men out and breaking the buggy.

The photographer, being a true movie man, seized the opportunity to run the film on a "scene." Fortunately, no one was hurt, and the film was such a good illustration of the results of bad roads that it was incorporated into the body of the road-building film.

The Du Pont Company has made this film with a view of loaning it to responsible parties for showing at meetings of all kinds having for their object the aiding of good roads.

Direct Placing of Mix in Pavement Cut

We are illustrating a type of concrete mixer as used by the city of Cincinnati which deposits the concrete mix directly into the pavement cut.

Considerable shoveling and cleaning of concrete was done away with thru this method of discharging directly into the trench. This method considerably facilitated the work and the mixer was moved along over a trench about ten feet deep.

CONCRETE MIXER DISCHARGING DIRECT INTO PAVEMENT CUT.

Above method was adopted in filling in about five miles of pavement cut, which cut was necessitated on account of installing as many miles of pressure water mains in the business district.

An Anti-Skidding Device

We are illustrating an attachment that is designed especially for use with trucks having dual tire equipment. This consists primarily of a chain that encircles the wheel circumferentially between the shoes of the dual tire, which at intervals carries a series of cross pieces that are mounted at right angles to the chain.

These cross pieces are constructed of woven steel wire of finest quality, so that they are practically unbreakable, save thru wear, and have comparatively large areas in contact with snow or ice. The ends of these cross pieces cross the treads of the shoes and are of such width that they cannot damage the tires. The chains are fitted with turnbuckles to adjust them in the event of tires wearing. The chains can be put on without jacking the wheels and are easily attached with special tools. They are made for different sizes and makes of tires.

Safety Trench Braces

The Bond safety trench braces are made with double-thread steel screws so that they can be opened quickly to fit the width of trench. The steel nut, or handle, is drop-forged. Each head has a lug which can be placed on top of horizontal braces and prevents dropping into the trench so that one man can place any brace not too heavy for him to lift, as he can rest one end on a ranger while he is adjusting the length of the brace to the width of the trench.

Motor Truck Service at Reasonable Cost.

R. E. Taylor, president of the R. E. Taylor Corporation, 1457 Broadway, New York, announces his new plan of co-operation in truck service, whereby owners of the trucks he sells will receive a dividend at the end of the year if they have been charged during the year more than the cost of the service, repairs, renewals, supplies, etc.

This requires that he operate both the selling and the service departments in his territory, and the Gramm-Bernstein Motor Truck Company, of Lima, O., have agreed to co-operate with Mr. Taylor fully in his effort to give truck purchasers the kind and amount of service which they should have at actual cost. Mr. Taylor's organization guarantees this under his new plan of assuming responsibility for the service in his field.

Trade Publications

Under the title, "The Thames-Victoria Embankment Pavement," The Barber Asphalt Paving Company (Philadelphia) has just issued an illustrated pamphlet covering the history and evolution of the paving of London's famous thorofare. In 1906 the London county council undertook to replace the old water-bound macadam of the embankment with a more permanent wearing surface. Some ten or twelve types of pavement were laid. Starting with an initial area of only 800 square yards, Trinidad sheet asphalt has replaced all the other types of pavement and now covers the embankment from Blackfriars to Westminster bridge. A striking feature of the embankment pavement is the thickness of the binder course, namely 3 in. with a 1½-in. wearing surface. These proportions of course reverse the proportioning usually followed in this country. The first Trinidad pavement laid in 1906 was put down under the supervision and according to the ideas of Mr. Clifford Richardson, whose specification has not been changed in the pavement subsequently laid.

Dependable Concrete: Hydrated lime and its effect on workability, segregation, uniformity, strength, permeability, is published by the Hydrated Lime Bureau of the National Lime Manufacturers' Association, Arrott Bldg., Pittsburg, Pa., in Bulletin A-2.

A booklet on "Concrete Swimming and Wading Pools and How to Build Them" has been published and will be sent on request by the Portland Cement Association, 111 West Washington street, Chicago, Ill. Other booklets obtainable in like manner are "Concrete Linings for Irrigation Canals," "Concrete Sewers," and "Concreting in Winter."

The specifications for creosoted wood paving blocks adopted by the Asso. for Standardizing Paving Specifications are issued in pamphlet form by Robert W. Hunt & Co., engineers, Chicago, Ill.

The E. I. du Pont de Nemours & Company, of Wilmington, Del., have just had printed a Clay Blasting Booklet. As it is the first booklet ever issued on this subject, it contains valuable and interesting information. Some of the phases covered are "Digging Clay," "Stripping," "Blasting Down Shale," "Digging Plastic Clays," "Mining Flint Clays," "Draining Clay Pits," as well as full information on the use of explosives. The booklet will be sent to any address upon request.

FIRE DEPARTMENT

Advantages of Combination Pumper

EFFICIENT MOTORIZATION FOR THE SMALL TOWN AT A PRICE IT CAN AFFORD TO PAY.

By Chief Henry Smith, Lapeer, Mich.

The city of Lapeer, Mich., has in service its new South Bend Double Duty Hoosier pumper.

This pumping outfit, which was delivered in 30 days from date of sale, is rated at 350 gallons per minute, but shows a grand average of 500 gallons per minute. This type of motor-driven pumper is exceptionally light for its rated capacity, enabling the fire department of the small city to make greater speed over bad roads. The great majority of small pumps, now on the market, deliver small streams, but this outfit, moderate in size and weight, delivers a real fire stream. The pump, which is of improved geared rotary type, as perfected by A. C. Mecklenburg, of the South Bend Motor Car Works, is confined to a small area, yet sufficiently large and powerful to easily handle two 2½-inch fire streams at one time. This outfit, pumper and all, is confined in construction to the size of an ordinary, first-class combination chemical and hose wagon.

Results of Tests.

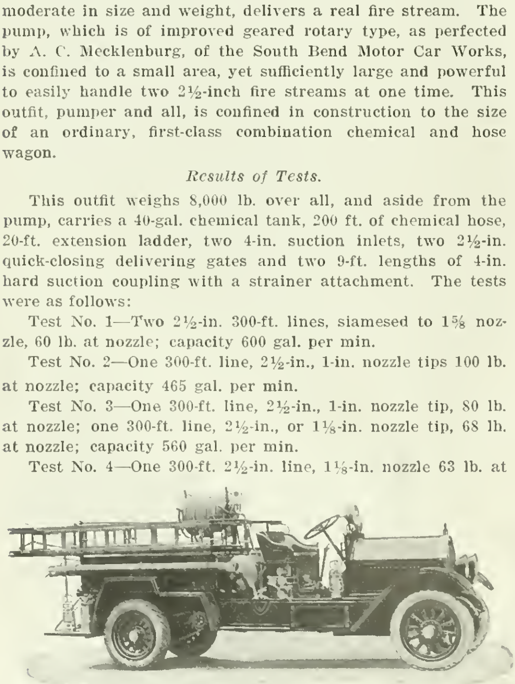
This outfit weighs 8,000 lb. over all, and aside from the pump, carries a 40-gal. chemical tank, 200 ft. of chemical hose, 20-ft. extension ladder, two 4-in. suction inlets, two 2½-in. quick-closing delivering gates and two 9-ft. lengths of 4-in. hard suction coupling with a strainer attachment. The tests were as follows:

Test No. 1—Two 2½-in. 300-ft. lines, siamesed to 1⅝ nozzle, 60 lb. at nozzle; capacity 600 gal. per min.

Test No. 2—One 300-ft. line, 2½-in., 1-in. nozzle tips 100 lb. at nozzle; capacity 465 gal. per min.

Test No. 3—One 300-ft. line, 2½-in., 1-in. nozzle tip, 80 lb. at nozzle; one 300-ft. line, 2½-in., or 1⅛-in. nozzle tip, 68 lb. at nozzle; capacity 560 gal. per min.

Test No. 4—One 300-ft. 2½-in. line, 1⅛-in. nozzle 63 lb. at nozzle; one 300-ft. 2½-in. line, 1⅛-in. nozzle 65 lbs. at nozzle; capacity 500 gal. per min. All above tests were made on a basis of one hour each, and the company states that the Hoosier pump has a rated capacity of 350 gal. per min.



SOUTH BEND "DOUBLE DUTY" HOOSIER PUMPER, AS OPERATED BY LAPEER, MICH.

Fire Department on Four Wheels.

The Hoosier pump, from which the entire outfit with a carrying capacity of 8 men derives its name, is operated by a 95-h.p. 4-cyl. motor. It is equipped with a Leece-Neville electric starter and generator and a 24-volt Willard storage battery.

This outfit, in spite of its limited size, is an entire fire department on four wheels. It is a pumper and at the same time it is a combination hose and chemical. It carries the men as well as the fundamental tools requisite to successful fire fighting.

Being a motor unit, it gets us to the fire in speedy fashion and while some of the men are busy in an endeavor to knock the fire with the chemical, thus preventing a head, others of the crew are making necessary pumper connections. No unit would get us to the fire quicker than this outfit, and successful fire-fighting depends on getting to the fire in time to strike it before it obtains a heavy start. If, however, the fire is a big one, we are there with our pumper and our entire department arrives at one and the same time. There are no delays, because we are there on four wheels.

Within Means of Small City.

But aside from the concentrated efficiency advantages of such a combination unit, we secure same at a price the small town can afford to pay. Our money is not invested in an overly large and heavy unit with a pumper of capacity exceeding our requirements, neither have we an unwieldly, bulky unit which would with difficulty navigate the muddy, rutty or hilly roads of the average town. The road conditions of country towns differ from the paved streets and boulevards of the large cities.

Many towns and small cities have unwisely spent their appropriations for units of greater than the necessary capacity. Yet these expenditures are but indications of the rapidly increasing desire to motorize. Some towns with populations as low as 2,500 have been hit with the motor bug to such an extent that they have plunged to the extent of $10,500 for a large motor pumping unit, overly large and a mighty poor investment, a white elephant all around when you consider that the man who must pay the bill could have obtained as efficient protection for considerably less money thru the purchase of such a pumping combination as I have described.

Why should any city pay more than necessary to secure maximum fire-fighting efficiency? Our combination gives the required efficiency for the smallest city at the right price and it is also in line with the tendency toward a large number of moderate-sized units for use in the larger cities. The tendency in the purchase of motor apparatus in the larger cities is along these lines.

Small motor-driven units in every fire house and more fire houses—increased efficiency at lower cost. Fire stations should be more closely placed. It is good business to purchase two units where these units are to be had at the same cost as one large unit—two-fold efficiency at no increase in cost.

The outlying districts and the suburban tracts are demanding more protection. Vast districts in factory sections which now must rely on center or downtown motor apparatus, are demanding motor fire apparatus. A big fire in an outlying district means that the heavy apparatus located in the downtown district must make a long and expensive run. In such cases the apparatus in each zone must make a move toward the central zone; thus not only leaving the central, or downtown district under the protection of the second and third zones, but causing a tremendous expense in the moving of the apparatus from zone to zone. Fully 85 per cent. of our largest fires would never have happened if the fire could have been killed in its incipiency. In other words, real fire-fighting efficiency depends on getting to the fire quickly and knocking it before it gets a head. The greater the number of units properly distributed over a given area the more efficient does the fire-fighting become.

Horses are becoming more and more costly, but even tho they could be obtained at half their present price, they would still be costly as compared with the annual operating and maintenance of a moderate-sized pumping combination.

Massachusetts Municipal Electric Plants Show Important Gains

The Concord plant, about which a recent agitation for the abandonment of the local generating station in favor of purchased power resulted in the decision to continue to operate the plant, made a good showing, especially in the lighting load which includes small domestic appliances and electric ranges, of which there is a comparatively large number in that town. Two new industrial plants, which will take a considerable amount of power, will help the "curve" and improve the day load, of which there has been comparatively little heretofore. Improvements in the plant now going forward, which include a new feed water supply to the generating station, will help the plant's efficiency. The profit balance of nearly $7,000, obtained under the management of A. W. Lee, is a creditable feature of the year's operation.

Peabody's gain, under the successful management of Warren D. King, is not less noteworthy, a profit of $15,000 on $71,000 of business being the record for the year. The town's plant generated 45 per cent more energy than the year before, the power load increasing more than 50 per cent, or 644 horsepower.

One of the most conspicuous increases in output and income is in the case of the Chicopee plant, which increased its kilowatt-hour output more than 75 per cent, and its gross income in the same ratio. This is a record hardly exceeded by any plant in the state in any year. Tho the return is incomplete in the item of connected loads, it is probable that the great increase in volume of electricity generated found use, in large part, in the power end of the business, the phenomenal increases in industrial activity, especially in Connecticut valley cities, accounting for great demands for this class of service.

Especially noteworthy, too, is the rise in figures representing the business of the Holyoke city electricity department. Here the gain in kilowatt-hour output was more than four million units, or nearly 35 per cent. Gross income increased more than $100,000 over the previous year, or 36 per cent, while operating expenses show an increase of only 12 per cent. A net profit from operation of $190,576 is shown as a result of the business of the year. The power business of the Holyoke plant gained 24 per cent in connected load, and when it is considered that the large power units, above 300 horsepower, are supplied by the Holyoke Water Power Company thru its generating department, the gain of 1,537 horsepower in the city is very commendable.

Hurlburt In Police Service

Herewith is shown a Hurlburt motor truck equipped with wireless outfit and used for transportation of supplies, strike work, riots and like emergencies by the New York city police department. It recently completed a trip to the Syracuse State Fair accompanied by forty of the mounted police flying squadron. These men were constantly in touch with their headquarters thru their wireless truck.

In the recent police parade, this truck led the parade and sent messages and orders to and from headquarters.

The New York police department selected this Hurlburt chassis after competitive tests of various machines. It is equipped with solid tires in the rear and pneumatic tires in the front and makes the second Hurlburt now in the service of the local police department.

Motor Apparatus in Fire Departments

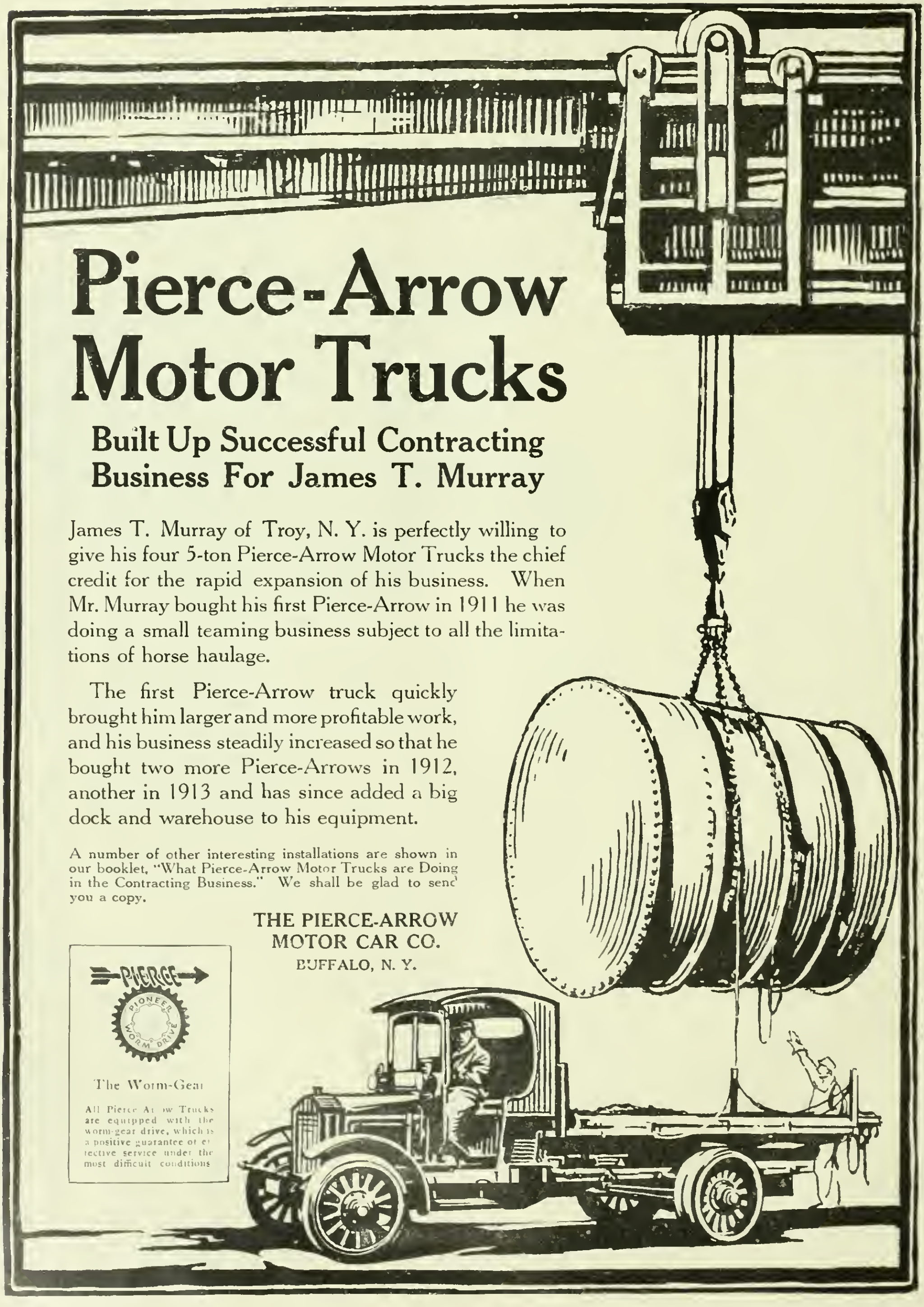
(Continued from January number, page 25.)

In the second column of this table, in describing combinations, *ae* stands for aerial ladder equipment; *ch*, chemical; *chf*, chief's car; *ho*, hose; *h.p.*, high pressure; *L*, electric; *l*, ladders carried on combination trucks; *ladd*, city service hook and ladder equipment; *mot*, motorcycle; *pp*, gasoline pumping engine truck; *sal*, salvage corps truck; *sq*, squad wagon; *st*, steam pumping engine; *sup*, supply wagon; *tow*, water tower; *tr*, tractor; *tr. ae*, aerial ladder truck hauled by tractor; *tr. la*, hook and ladder truck hauled by tractor; *tr. st*, steamer hauled by tractor; *tur*, turret. o in column of "Years service" means that apparatus is new or not yet in service. *p*, pyrene cylinders.

1—Cost of gasoline and repairs. 2—Cost of gasoline, oil and tires. 3—55 gallons gasoline, 3 gallons oil. 4—180 gallons gasoline, 10 gallons oil. 5—40 gallons gasoline, 2 gallons oil. 6—105 gallons gasoline, 4 gallons oil. 7—Difference in cost of repairs in the two machines due to pneumatic tires on one and Dayton airless on the other. Both cars now equipped with Dayton airless. 8—Cost of repairs and gasoline and oil. 9—Materials only; repair work done by drivers or mechanicians in fire department. 10—Cost of repairs for all 28 machines in the department. 11—Cost per horse employed in the department. 12—6 gallons. 13—Sum for four American-La France pumping and combination. 14—These cost figures include all three pieces of apparatus and the cost of gasoline and oil includes also some police apparatus. 15—10 miles of streets in good condition, 5 fair, 15 bad. 16—gallons of gasoline. 17—542 gallons gasoline. 30 gallons oil. 18—121 gallons gasoline, 20 quarts oil. 19—214 gallons gasoline, 75 quarts oil; 20—25 per cent good, 40 per cent. fair, 35 per cent. bad. 21—40 per cent. good, 40 per cent. fair, 20 per cent. bad. 22—Two-thirds good, one-third fair.

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Minnesota—													
Minneapolis........	chf	Buick (3)	½	..	...	....	...	...	....	....	....	....	....
	chf	Ford	2	4	22	....	...	...	8,814	....	123.55	110.46	....
	chf	Winton	2	6	49	....	...	...	8,336	....	63.17	214.90	....
	chf	Cole	4	4	32	....	...	...	7,143	....	563.12	122.58	....
	chf	Cole	4	4	32	....	...	...	3,083	....	680.87	73.21	....
	chf	Cole	4	4	32	....	...	...	4,474	....	213.88	98.22	....
	chf	Rambler	5	4	40	....	...	...	4,261	....	665.58	115.26	....
	chf	Stod.-Dayton	5	4	40	....	...	...	3,566	....	674.36	113.61	....
	ch ho	Four wh. drive	1	6	66	1,000	...	32	368	....	450.21	83.98	....
	ch ho	Wilcox-local	4	4	29	1,000	50	32	569	....	127.92	32.72	....
	sq ch	Am.-La France	4	4	48	....	50	32	1,419	....	107.24	88.63	....
	ch ho	Am.-La France	5	4	48	1,200	50	32	494	....	146.53	53.85	....
	ch ho	Am.-La F. (2)	o	6	100	1,200	6	32	....	....	....	....	....
	sq	Am.-La France	o	..	...	....	...	...	....	....	....	....	....
	tr	Am.-La France	o	6	75	....	...	...	....	....	....	....	....
	sq	Am.-La France	½	6	100	....	...	...	....	....	....	....	....
	tr	Nott	2	6	80	....	...	...	411	....	278.88	73.35	....
	tr	Nott	3	4	44	....	...	...	680	....	140.22	59.37	....
	ae	Seagrave	1	6	80	....	...	85	305	....	107.81	32.88	....
	ch ho	Seagrave	4	6	80	1,000	50	32	423	....	845.29	57.34	....
	ch ho	Seagrave	4	6	80	1,000	50	32	452	....	37.89	44.83	....
	ch ho	Seagrave	4	6	80	1,000	50	32	285	....	429.93	45.51	....
	pp ch ho	Seagrave	1	6	80	1,000	30	42	400	....	292.22	55.81	....
	pp ch ho	Seagrave	1	6	80	1,000	30	42	217	....	103.80	22.45	....
	pp ch ho	Nott	2	6	104	1,000	...	32	508	....	284.07	136.21	....
	pp ch ho	Nott	4	4	53	1,000	50	32	418	....	149.93	58.57	....
St. Paul........	chf	Pierce-A. (2)	6	6	36	....	...	...	....	....	....	....	....
	sq	Pierce-A. (2)	4	6	66	....	40	...	2,834a	1,077a	....	....	....
	ho	White	1-12	6	66	1,200	...	...	....	....	....	....	....
	chf	Pierce-Arrow	8	4	45	....	...	...	....	....	....	....	....
	chf	Cadillac	4	4	40	....	...	...	....	....	....	....	....
	ch ho	Am.-La France	4	4	48	1,000	40	...	345	231	....	....	....
	tr la	Am.-La F. (2)	1	6	80	....	...	308	161	212	....	....	....
	tr st	Am.-La France	½	4	48	....	...	...	....	....	....	....	....
	pp ch ho	Waterous (2)	4	4	90	....	...	...	430	157	....	....	....
	tr la	Seagrave (2)	1	6	80	....	...	240	160	391	....	....	....
	chf	Oakland (3)	2½	4	35	....	...	...	....	....	....	....	....
	chf	Ford (2)	3	..	22	....	...	...	....	....	....	....	....
	chf	Maxwell	6	..	30	....	...	...	....	....	....	....	....
Winona........	chf	Mitchell	1	6	48	200	31	...	2,500	100	5.00	60.00	225.00
	ch ho l	Seagrave	4	6	80	1,700	40	36	100	65	15.00	30.00	400.00
	ch ho l	G. M. C.	1	4	40	1,300	60	40	80	50	o	15.00	400.00
Mississippi—													
Aberdeen..........	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
Brookhaven........	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Canton............	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
Clarksdale........	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Greenville..........	pp ch ho	Am.-La France	1	4	75	1,200	45	40	239	80	33.68	34.45	240.00
	chf	Oakland	1	4	40	....	2½	...	2,956	141	0	45.85	120.00
Greenwood.........	ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Granada...........	ch ho	Am.-La France	½	4	75	1,000	40	36	....	....	....	....	....
Hattiesburg........	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Jackson............	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Laurel.............	ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	....	....	....
McComb...........	ch ho	Am.-La France	2	6	55	1,400	40	32	....	....	....	....	....
Vicksburg..........	ch ho	Am.-La F.	2-3	4	75	1,000	40	36	220	157	0	59.77	241.90
	ladd	Am.-La F.	2-3	6	105	....	...	210	292	181	0	100.16	241.90
	chf	Overland	2	4	35	....	...	...	600	254	199.27	53.95	170.95
Missouri—													
Carthage...........	ch ho	Hale, Velie	3	4	65	1,200	40	48	200	64	28.00	32.00	350.00
Excelsior Springs..	ch ho	Hale, Velie	..	..	...	....	...	...	....	....	....	....	....
Hannibal...........		No motor apparatus. Present equipment all new horse-drawn.											
Joplin..............	pp ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Kansas City........	chf	Pope-Hartford	6½	4	40	....	...	...	10,950	380	369.45	182.65	288.41
	ch ho	Hale (12)	o	6	90	1,200	40	32	....	....	....	....	....
	ho tur	Hale (2)	o	6	90	1,200	35	32	....	....	....	....	....
	ladd	Hale (6)	o	..	...	....	...	...	....	....	....	....	....
	ch ho l	Webb	5	6	90	800	40	32	2,150	449	884.11	197.80	830.69
	ch ho l	Hale	2	4	60	1,100	35	32	1,105	221	108.25	155.20	567.80
	pp ho	Webb	5	6	90	800	6	32	1,796	432	1,416.18	180.12	838.74
	tr	Knox	1	4	50	o	6	305	338	201	280.33	114.26	712.80
	tr	(3)	o	..	...	....	...	...	....	....	....	....	....
Moberly............	ch ho	Hale	1	..	...	1,300	42	273	273	81	0	23.28	....
Monett.............	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
Poplar Bluff........		No motor apparatus at present.											
St. Charles.........		No motor apparatus.											
St. Joseph..........	chf	Velie	5	4	40	....	6	...	....	....	....	....	....
	chf	Cadillac	5	4	35	....	...	...	....	....	....	....	....
	ch ho	Seagrave	2	4	60	1,000	46	72	....	....	....	....	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
St. Louis	pp	Am.-La F. (2)	½										
	pp ho	Robinson (5)	1			1,000	12	16					
	tr	Robinson (2)	1		80								
	chf	Marmon	1										
	chf	Hudson	1										
	chf	Oakland (13)	1										
	pp ch ho	Robinson (3)	3			800							
	pp ch ho	Wagner	1			1,000	12						
	pp ch ho	Webb (2)	5			1,000	12						
	sup	(2)											
Sedalia	ch ho	Am.-La France	3	4	70	1,400	35	32					
Springfield	pp ho	Am.-La France	3	6	110	1,200	6	36					
	ch	Am.-La France	4	4	70	200	120	32					
	ho	Am.-La F. (2)	3	4	70	1,600	126	36					
	chf	Rambler	4	4	37								
	ch ho l	Anderson	3	6	70	1,500	35	36					
Trenton	pp ho ch	Buckeye	1-6	4	40	1,000	50	36					
Webb City	ch ho	Paige	2	4	36	500	10		100	60	60.00	15.00	
	ch ho l	Am.-La France	5	4	48	1,100	75	35	250	125	100.00	25.00	
Webster Groves	chf	Ford (2)	1-6									7.00	
	ch ho	Am.-La France	1-6		70	1,200	35	30	150	7	0	8.00	
	pp ho ch	Howe Buckeye	1		80	1,000	35	30	600	72	176.00	42.60	
Montana—													
Anaconda	ch ho l	Webb	4½	6	70	1,200	90	40					
	ch ho l	Seagrave	1½	6	110	1,500	60	40		109	75.00	150.00	600.00
	pp	Am.-La France	½										
Billings	ch ho	Am.-La France	4	4	70	1,400	35	32					
Bozeman	chf	Ford	2	4	22	150	30	15	294	39	63.00	37.55	
	ch ho	Thomas	5	6	90	1,200	40	30	78	39	32.35	34.30	
Butte	ae	Couple Gear	4	4	60			85					
	pp ch ho	Am.-La France	½	6	100	1,400	40	32					
Forsyth	ch ho	Brockway	1										
Great Falls	ch ho	Am.-La France	2	6	100	1,400	40	32					
Kalispell	ch ho l	Nott	2	6	72	1,000	70	36	300	70	29.60	40.00	650.00
	pp ho l	Hale	2	6	78	1,000	6	36	200	10	22.80	41.78	
Lewiston	ch ho	Am.-La France	3	6	100	1,400	40	32					
Missoula	chf	Buick	3	4	4								
	ch ho	Seagrave	5	6	80	1,400	70	36		89	0	32.00	
	tr	Stevens-Duryea	2	6	70	800	10			18	0	22.00	
Red Lodge	ch ho	Am.-La France	1										
Nebraska—													
Columbus	ch ho l	Seagrave	5	4	63	1,260	70	50	35	22	25.00		
Dundee	pp	Am.-La France	3										
Freemont	chf	Apperson	1	45									
	ch ho	White	2	45	900	60			40				
	ch ho	Nott	3	60	900	55			40				
Grand Island	ch ho l	Anderson	3	6	70	1,200	46	40	122	78		64.46*	
Lincoln	ch ho	Am.-La F. (3)	5	4	70	1,400	35	32					
Nebraska City	ch ho l	Kissel	1	4	50	950	40	28	150	25	0	4.00	300.00
Norfolk		No motor apparatus as yet.											
Omaha	ho ch	Am.-La France	5-12	4	72	1,200	46	32	117	97	5.66	90.00	
	ho ch	Knox	4½	6	60	1,200	41	55	479	357	464.05	66.04	169.04
	ho ch	Am.-La France	1-3	4	72	1,000	46	32	123	93	4.51	42.68	
	ho ch	Am.-La France	¼	4	75	1,100	46	32	138	76		29.68	
	ho ch pp	Am.-La France	¼	4	72	1,000	46	36	205	59	1.60	56.65	
	ho ch pp	Am.-La France	¼	4	72	1,000	46	32	307	20	152.03	46.81	
	ho ch pp	Am.-La France	¼	4	72	1,000	46	32	298	51	0.10	35.81	
	ho ch	Am.-La France	¼	4	72	1,200	46	32	227	56	1.96	46.74	
	ho ch	Am.-La France	1-3	4	72	1,000	50	33	120	66		48.94	
	ho ch	Am.-La France	1-3	4	72	1,200	41	36	239	92	1.73	38.11	
	ho ch	Am.-La France	1-3	4	72	1,200	46	32	399	59	4.26	38.86	
	ho ch	Am.-La France	1-5	4	72	1,000	41	34	301	35	0	45.00	
	ho ch	Am.-La France	3	4	72	1,000	45	46	318	80	59.49	38.58	203.70
Superior	ch ho	Am.-La France	½										
Nevada—													
Reno	ch ho	(2)	o										
Sparks	pp ch ho	Am.-La France	½										
New Hampshire—													
Claremont	pp ch ho	Am.-La France	1	6	100	1,400	40	32					
Concord	ch ho	Robinson	3		80	1,000	80	50					
	ch ho	White (2)	2		30	1,000	40	50					
	ch ho	Winton	1		50	1,000	40	50					
	pp ho	Ahrens-Fox	o	6	100	1,000	6	32					
Derby	pp ho	Am.-La France	1	6	100	1,000	6	32					
Leconia		Has no motor apparatus at present.											
Manchester	chf	Cadillac	3		32								
	chf	Rambler			32								
	chf	Chalmers	½		25								
	ladd	Am.-La France	4	4	70		35	249		60			
	ch ho	Netco-Fcd. (2)	2										
	ladd	Robinson	3				40	382		64			
Nashua	chf	Cadillac	1	8	80				700	190	32.00	33.00	
	sq	Maxwell	2	4	40		25	40	1,100	163	34.00	43.00	
	ch ho l	Seagrave	2	6	90	1,200	100	48	876	324	87.00	95.00	
Peterboro	ch ho	Am.-La France	2	4	70	1,400	35	32					
Plymouth	pp ch ho	Am.-La France	½										
Portsmouth	ch ho	Pope	4	4	60	1,000	70	40	300	92	64.00	20.00	
Rochester	ch ho	Am.-La France	½										
New Jersey—													
Atlantic City	tr	Am.-La F. (11)	3	6	100		6	177					
	ae	Am.-La France	3	4	75		6	177					
	ch ho	Am.-La France	3	4	70	1,400	35	32					
	ch ho	Am.-La F. (4)	1										
	tr st	Am.-La F. (4)	1										
Belleville	pp ho	Am.-La France	3	4	75	1,200	6	32					
Bernardsville	pp	Am.-La France	1										
Beverley	pp ch ho	Am.-La France	½										
Bloomfield	pp	Am.-La France	½										
Bogota	ch ho	Brockway	1	4	42	1,400	40	32					
Bound Brook	ch ho	Brockway	1	4	42	1,400	40	32					
Burlington	tr	Am.-La France	½	4	70								
Camden	tr	Am.-La France	3	6	100		6	177					
	ae	Am.-La France	3	4	75		6	177					
	pp ho	Am.-La France	3	6	100	1,200	6	32					


Pierce-Arrow
Motor Trucks
Built Up Successful Contracting
Business For James T. Murray
James T. Murray of Troy, N. Y. is perfectly willing to give his four 5-ton Pierce-Arrow Motor Trucks the chief credit for the rapid expansion of his business. When Mr. Murray bought his first Pierce-Arrow in 1911 he was doing a small teaming business subject to all the limitations of horse haulage.
The first Pierce-Arrow truck quickly brought him larger and more profitable work, and his business steadily increased so that he bought two more Pierce-Arrows in 1912, another in 1913 and has since added a big dock and warehouse to his equipment.
A number of other interesting installations are shown in our booklet, "What Pierce-Arrow Motor Trucks are Doing in the Contracting Business." We shall be glad to send you a copy.
THE PIERCE-ARROW
MOTOR CAR CO.
BUFFALO, N. Y.
PIERCE
PIONEER WORM DRIVE
The Worm-Gear
All Pierce Arrow Trucks are equipped with the worm-gear drive, which is a positive guarantee of effective service under the most difficult conditions

MOTOR TRUCK OPERATION AND ACCOUNTING XVIII.

By Charles A. Dickens.

One of the very best reasons why more pleasure car salesmen and regulation truck agency salesmen do not sell more trucks to the contractor is because they are not only minus on what motor trucks must do under given conditions in the contracting business but because they bemuddle their contractor prospect with the needless talk on worm, double-chain, internal gear, double reduction axle and four-wheel drive twaddle! They try to make up for their ignorance of operating conditions on contracting work by befogging the mind of their prospect with unessential drivel regarding governors and differentials and brakes and clutches and transmissions.

REQUIRES SPECIALTY EFFORT.

Many of these salesmen know how to surround a pleasure car order and many of them can sell trucks for the delivery of department store parcels, but that is not saying that they can register an equally successful record in truck sales to contractors. Until such time as they have the desire and patience to become as thoroly conversant with the contractor's problems (and the conditions under which he must operate), as they are conversant with the mechanical "makings" of their truck, they had better not attempt it.

MUST WIN HIS CONFIDENCE.

The contractor knows his two-horse teams can haul from 3½ to 5 tons, from 15 to 25 miles per day, on smooth, hard roads and he has not forgotten that under certain conditions he has been compelled to use six to eight 2-horse teams to haul but two tons the same distance. That's why it pays to know what you're talking about (especially when you're talking to a man who does know), if you would merit his confidence. And until you win the contractor's confidence, you are further away from an order than before you started. That's why it would have been far better for your manufacturer if you had not started at all.

MUST FIT PERFORMANCE REQUIREMENTS.

There are scores of truck makes to choose from, and still more scores of sizes and types to still further confuse. That's why I'd keep out of mechanical arguments until he wanted my truck. I'd first instill a desire to operate my truck by conclusively proving that it would save money over present methods and I would refer to the engineering features involved only in so far as it was necessary to prove that my truck was best suited to fit the performance requirements of my prospect's problems. In other words actual developed horse-power per pound of total weight carried at given speed would help me in proving a certain point as would chassis weight and construction (including body weight allowance), required to carry a given load under his conditions. I would only talk quality of materials and perfection of parts as considered in regard to the work in question.

TALK IN CONTRACTING TERMS.

There is a truck language but I would talk trucks in plain, everyday contracting terms—the only language the contractor understands. I would not befuddle and confuse him with technical jargon (a matter which concerns him little and concerning which he cares less).

I would, however, prove that my make of truck fitted the special requirements of the contractor I was talking to. But I would first make sure of that contractor's requirements.

I would not compare truck and horse costs on a 'per day" basis because truck performance is so far ahead of horse performance that I'd be killing my strongest talking point. I'd not forget that the "cost per mile" method is almost as

GARFORD TRACTOR AND SPECIALLY DESIGNED TRAILER AS OPERATED BY THE STANDARD BUILDING SUPPLY CO., BROOKLYN, N. Y., IN TRANSPORTATION AND UNLOADING OF BRICK.

MOTOR TRUCKS AS USED IN BUILDING AND BRIDGE CONSTRUCTION.

SIGNAL MOTOR TRUCK, AS OPERATED BY JAMES A. MOYNES & CO., OSWEGO, N. Y.

STERLING MOTOR TRUCK, AS OPERATED BY THE WISCONSIN BRIDGE & IRON CO., MILWAUKEE, WIS.

UNITED MOTOR TRUCK, AS OPERATED BY A WELL-KNOWN CHICAGO, ILL., BUILDING CONTRACTOR.

PIERCE - ARROW DUMP TRUCK, AS OPERATED BY HOLBROOK, CABOT & ROLLINS, NEW YORK, N. Y.

UNITED DUMP TRUCK, AS OPERATED BY THE CHICAGO FIRE BRICK CO., CHICAGO, ILL.

ATLANTIC ELECTRIC TRUCK, AS OPERATED BY BATCHELDER BROTHERS, NEW YORK, N. Y.

STEGEMAN MOTOR TRUCK, AS OPERATED BY J. & W. KRAUSE, MILWAUKEE, WIS.

MACK MOTOR TRUCK, AS OPERATED ON TEST ON 20° GRADE UP MT. WILSON, CAL.

FEDERAL DUMP TRUCK, AS OPERATED BY M. J. WALSH & SONS, HOLYOKE, MASS.

FEDERAL DUMP TRUCK, AS OPERATED BY W. T. HARDISON & CO., NASHVILLE, TENN.

PIERCE - ARROW DUMP TRUCK, AS OPERATED BY THE PERRY-VICTORIA SAND CO., BUFFALO, N. Y.

G M C TRUCK, AS OPERATED BY A BIG NEW YORK STATE BUILDING CONTRACTOR.

unfair to the truck for the reason that actual tonnage moved is not credited. I'd put my best foot forward at ALL times and talk in "Costs Per Ton-Mile."

And that's why you must talk trucks to the contractor in a language he can understand. He has sweat blood in his fight to wring out a profit thruout his gradual transition from the human muscle to the machine way of grading and crushing and mixing. He now realizes that to bid low at a profit to himself he must substitute steel muscle for mule and horse sinew.

DEPENDS ON THE CONDITIONS.

The motor truck can not be considered a transportation "cure-all" for all haulage problems encountered in the contracting business—it all hinges on conditions.

No two jobs are exactly alike—simply because the conditions encountered on no two contracting jobs are identically the same.

From the standpoint of draw-bar pull performance, you may say that the horse-motor is not more than 2 per cent. efficient as far as heat units are concerned, whereas the gas motor transforms fully 75 per cent of its "meals" into performance. 'Tis true as far as the operation of hay-motor by most contractors is concerned, yet it all depends on the job you're talking about or the conditions under which the comparisons are made.

STUDY HIS HAULAGE PROBLEMS.

There is no doubt but that the vagaries encountered in contracting exceed those encountered in any other line of business and hauling costs have become one of the most important items entering into the total costs of a contracting job! That is why I would make a study of the contractors' hauling problem. I would understand (for myself) just why teams, or tractors, or trucks, or gasoline locomotives, or railway equipment, were most economical for certain kinds of contracting haulage, and under just what specific conditions. I would know the real reasons why (in each instance). I would ferret this information out for myself right "on the job."

GET OUT ON THE JOB.

I would become as thoroly conversant with the contractor's hauling problem as is the contractor himself. I would get out on the job with Mr. Contractor and stay alongside of him from morning until night. I would ride on the trucks and watch them perform. I would stick with the contractor in his office after hours and I would keep at it until I could figure costs intelligently from standpoints of length of haul, capacity of outfit per trip, rate of speed, amount of time lost in loading and unloading, amount of time lost due to bad roads, breakdowns and varying operating conditions. I would do all of these things and more, realizing that until such time as I knew enough about the contracting business to make up a contractor's estimate, which would "get over" that I was not in a position to talk trucks to the contractor from "his side of the fence."

MAKE SURE OF YOUR REASONS.

Before advising the purchase of a specific capacity or type of truck to my contractor prospect, I would first make sure of the particular work it would be called upon to perform and I would know all about the conditions under which it would be operated. I would then make my suggestions and would

MOTOR TRUCKS AS USED IN BUILDING AND BRIDGE CONSTRUCTION.

LEWIS-HALL DUMP TRUCK, AS OPERATED BY HENRY MINCEL, DETROIT, MICH.

FEDERAL MOTOR TRUCK, AS OPERATED BY THE BUFFALO GENERAL ELECTRIC CO., BUFFALO, N. Y.

4-WHEEL DRIVE DUMP TRUCK, AS OPERATED BY THE GARLAND BLOCK & SAND CO., YOUNGSTOWN, O.

PACKARD MOTOR TRUCK, AS OPERATED BY ROEHM & DAVISON, NEW YORK, N. Y.

KISSELKAR MOTOR TRUCK, AS OPERATED BY THE HOWARDS CO., NEW HAVEN, CONN.

KISSELKAR MOTOR TRUCK, AS OPERATED BY THE SCHAEFER BROTHERS, BUFFALO, N. Y.

STEGEMAN MOTOR TRUCK, AS OPERATED BY THE E. E. GILLEN CO., MILWAUKEE, WIS.

HURLBURT DUMP TRUCK, AS OPERATED BY THE LITCHFIELD CONSTRUCTION CO., NEW YORK, N. Y.

LEWIS-HALL DUMP TRUCK, AS OPERATED BY JAMES WALLS, INC., NEW YORK, N. Y.

KNOX TRACTOR WITH SEMI TRAILER, OPERATED BY THE GOODMAN CONTRACTING CO., NEW YORK.

GRAMM-BERNSTEIN DUMP TRUCK, AS OPERATED BY THE TIMROTH TEAMING CO., CHICAGO, ILL.

LEWIS-HALL DUMP TRUCK, AS OPERATED BY JAMES WALLS, INC., NEW YORK, N. Y.

give my reasons—all of them. And not until then would I be in a position to practically advise as to required capacity, proper weight and power of truck, needed road clearance, efficient body equipment, etc. The more practical my suggestions the nearer I would come to solving my prospect's individual problems, the closer I would be to his order. It takes more than "just talk" to sell trucks to contractors.

I would never "make a town" without spending some of my time on a construction job on which trucks were used, and it would make no difference to me whether these trucks were the product of my manufacturer or not. I would "cram" myself with actual "Short Cuts in Contracting" until helpfully practical truck information fairly oozed out of me at every pore!

WHY "IT ALL DEPENDS."

Motor trucks can be put into successful operation on any road and under almost any conditions under which teams and wagons can be used. Motor trucks will carry their greater loads up steeper grades on which teams cannot secure traction—and then some!

But, remember, that the word "road" in the contracting business is a misnomer—many times it is not even a trail—rather it is a nightmare, a rock-ribbed ditch or undulating stretch of boulders, jagged crags, chuckholes, sand pits, sudden drops and trenches—one wheel in a three-foot rut and the other somewhere on the crest of another!

A five-ton truck operating continuously on a new asphaltic concrete boulevard "may" safely carry more than its rated capacity, but the same truck operating on worn-out pavements and discouraging roads and chuck-hole trails, as encountered in contracting service, "may" not safely carry more than two-thirds of its rated capacity. That's why a five-ton truck is not always a five-ton carrier—it all depends.

LOT DEPENDS ON DRIVER.

Contractors feel that their past experience has qualified them to select the proper team or wagon best suited to their needs, but as regards trucks they are not quite so sure. That's why I would first merit their confidence by proving (via my selling talk) that I know what I am talking about. All of which is the same as saying that they will be more apt to take my word for it when I have convinced them that I know more about the operation of trucks on contracting work than they do.

The cost of operating a motor truck (like that of any other piece of machinery) depends a great deal upon the operator. That is why I would do all in my power to see to it that my new contractor customer hesitated before placing an ordinary team driver on his truck. A skilled truck driver not only knows how to increase truck performance per diem, but how to hold operating costs down to the minimum.

TRUCKS AT WORK ARE TRUCKS THAT PAY.

There is no longer any good reason why human muscle should be paid good money to shovel material direct from the gondola car to the truck. Such slipshod methods are not only wastefully expensive from the shovel standpoint alone, but result in costly truck delays and stalling at the car.

Time is money in the contracting business! A truck cannot wait like a team without excessive cost for loading and unloading! Quick loading and unloading are essential requisites to the economical operation of motor trucks!

Economical truck operation requires hauling conditions which make the ratio of running to standing time large, and high average speeds possible. The more instantaneous the loading or unloading device the more efficient the work of the truck.

KNOX TRACTOR ON COTTONWOOD CANYON HAUL.

DROPPING UNDER BINS AT FORKS IN BIG COTTONWOOD. (18 PER CENT. PITCH IN 20 FEET.)

A 'FAIR' SAMPLE OF THE 'GOING.'

TRACTOR AND TWO TRAILERS AT THE LOADING BINS.

LOOSE GRAVEL HILL 12 PER CENT. GRADE. TRACTOR PULLING 4,300 LBS. OF COAL.

TRACTOR AND TRAILERS HELD BY HYDRAULIC BRAKES ON 15 PER CENT. GRADE. MAXFIELD HILL.

SHOWING DOCKS WHERE COAL IS DUMPED INTO CARS BELOW.

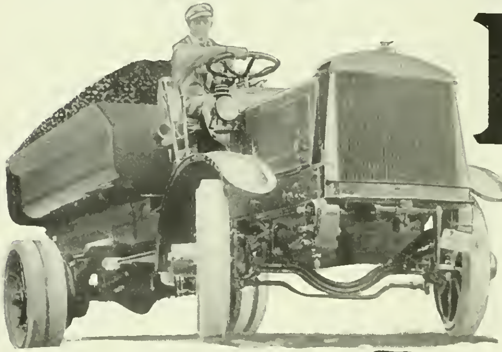
The busy truck is the truck that pays the biggest dividends. That's why I would not only make it a point to recommend the use of loading and unloading devices, but I would know exactly why I was so advising. Instead of "airing" my own opinions, I would talk specifications as to why and how Pat McNulty or Frank Casey or Mike Ponderelli did this or did that. I would state their problems tersely and explain just why they did this or did that. And I'd show the Dollars and Cents Savings they made. I would state their problems tersely and explain their solution minutely. I would show my prospect actual action photographs of the ways and means employed by these progressive contractors in keeping their trucks constantly on the move.

ADVOCATE THE SHORT CUTS.

Certain old-fashioned contractors hold that quick loading methods are impossible in handling spoil from excavation except in cases where steam shovels and trains are operated—but they are wrong, and every day the most successful contractors operating motor trucks are proving that they are wrong—that's why I would talk from the standpoint of the man who makes good in a tight pinch. You cannot get around the record which can be verified. I have yet to find the contractor who will not listen to the experience of the other fellow—he always wants to find out if the other fellow has anything on him, and he is always ready to consider a method which is practical enough to increase the profits of his competitor.

JEFFERY QUAD HAULING 22,410 POUNDS FOR THE MOTOR TRUCK AND TERMINAL COMPANY FROM LOS ANGELES TO SAN PEDRO HARBOR, CAL.

Cut Down Your Hauling Expense



Features of Known Value

Worm Drive.
Wisconsin and Continental Motors.
Brown-Lipe Transmission.
Sheldon Axles.
Timken Bearings.
Perfection Springs.
Eisemann Magneto.
Stromberg Carburetor.

The Whole Truck is OK

In municipal work, *one* big item of expense is the hauling. Yet is the *one place* where a big saving is possible.

It may not be possible to cut down the general expenses very materially—but by getting the materials transported in less time and with less help, you can make a big saving every trip and greatly increase your profits.

Actual use has proven that **United Trucks** cut down the hauling expenses to a very appreciable extent. They have the power to move the heaviest loads in quick time—the strength to stand the unusually severe strain encountered on *extra* rush jobs—the endurance and stability to insure years of hard service.

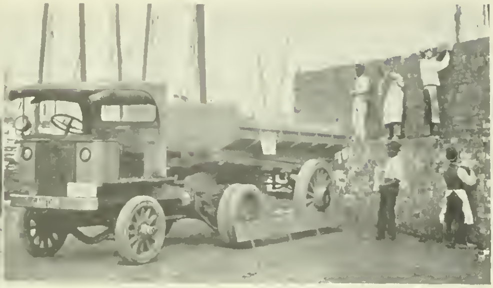
And with our special dumping bodies and hydraulic hoist, unloading takes but a few seconds. This feature alone means a big saving in time and labor.

Start in right now to cut down hauling expenses with the **United Truck**—the product of America's foremost engineers. We are prepared to make prompt delivery. Write us for full details.

UNITED MOTORS CO.

690 North Street. GRAND RAPIDS, MICH.

United Trucks



GARFORD 10-TON TRACTOR, AS OPERATED BY THE STANDARD BUILDING SUPPLY CO., NEW YORK CITY, IN HAULING AND DEPOSITING OF BRICK. THIS SPECIALLY DESIGNED OUTFIT ELIMINATES MUCH OF THE DELAYING DRUDGERY OF BRICK HANDLING.

The Average Contractor suffers no special pang to see his team standing idle, but you must change all this. You must systematize his transportation. You must advocate short cuts in loading and unloading. You must in many cases talk traveling belts, gravity chutes, slides, grab buckets or detachable bodies. It all depends on conditions, but you must show your contractor prospect how to load his trucks in a fractional part of the time in which he used to load his old horse wagon. Prove that your plan means more performance at less cost—(profits for him)—and he'll motorize! He'll buy your trucks!

OVERLOADING MEANS TRUCK SUICIDE.

Overloading not only results in excessive strains and a greatly accelerated rate of depreciation, but in unnecessary high maintenance cost.

Overloading affects frame, springs, wheels, axles, tires, power plant and even the driving mechanism—and while the truck is designed with a certain factor of safety, this factor was intended merely for emergencies, and not for continuous and continual abuse.

I would never miss an opportunity to prove via actual incidents that overloading means motor truck suicide! While it is true that the fatigue of steel is much slower than that of flesh tissues, the fatigue is there just the same. Remember it was the one extra straw that broke the camel's back.

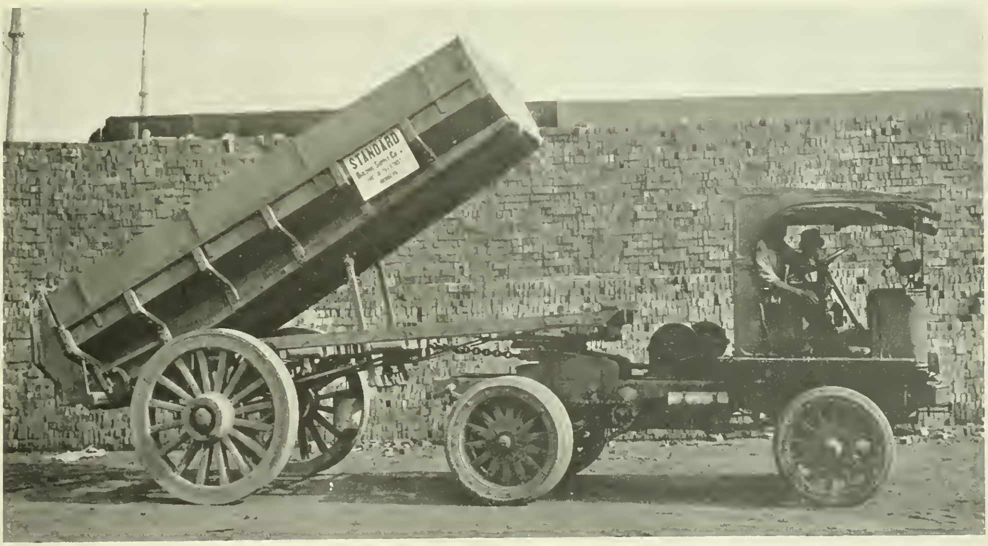
OVER-SPEEDING HASTENS CRYSTALIZATION.

Truck over-speeding results in excessive strains and a greatly accelerated rate of depreciation. I would make it plain that the advantages of motor truck haulage over horses was not only a matter of speed, but rather the gain accruing from constant operation in all sorts of weather at any time of the day or night.

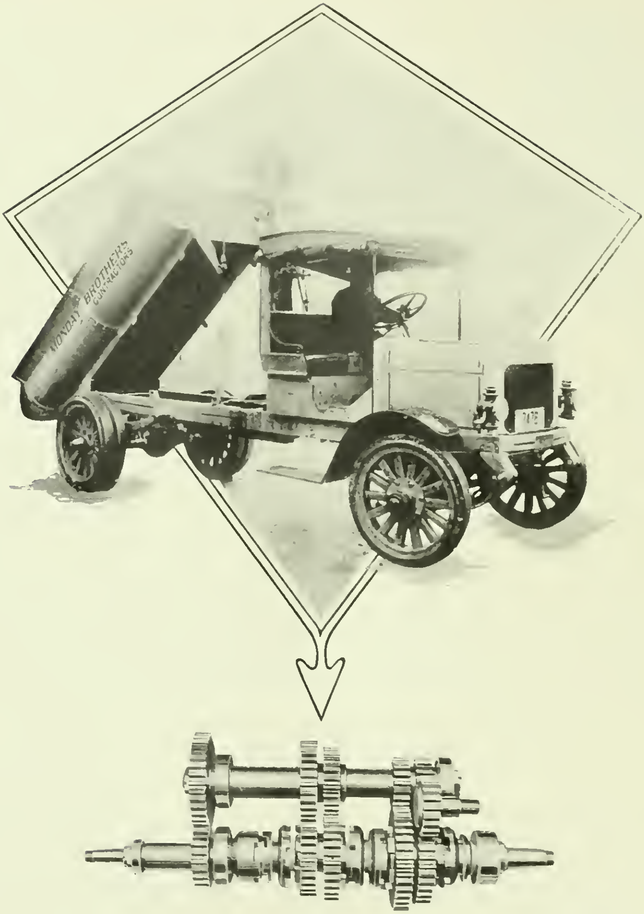
I would study the speed and load situation from the angle of my contractor owners—and I would arrive at an approximately average speed at which it would be safe to drive a loaded truck over certain types of roads without a serious increase of repairs.

TRUCK JOY-RIDING IS COSTLY.

Upkeep and depreciation are serious items to the contrac-



CLOSE VIEW OF GARFORD TRACTOR AS SHOWN AT TOP OF PAGE. SPECIALLY DESIGNED 10-TON TRAILER, WHICH IS POWER OPERATED FROM THE TRACTOR ENGINE AFTER THE MANNER OF AUTOMATIC DUMP BODY. THE AUTOMATIC WINCH ENABLES THE DRIVER WITHOUT LEAVING HIS SEAT TO CAREFULLY DEPOSIT HIS LOAD OF BRICK AT ANY GIVEN POINT OR POINTS BY THE TOUCH OF A LEVER.



A truck is no stronger than its transmission. The G-B transmission is the strongest transmission in the World! That's why G-B trucks are strong trucks!

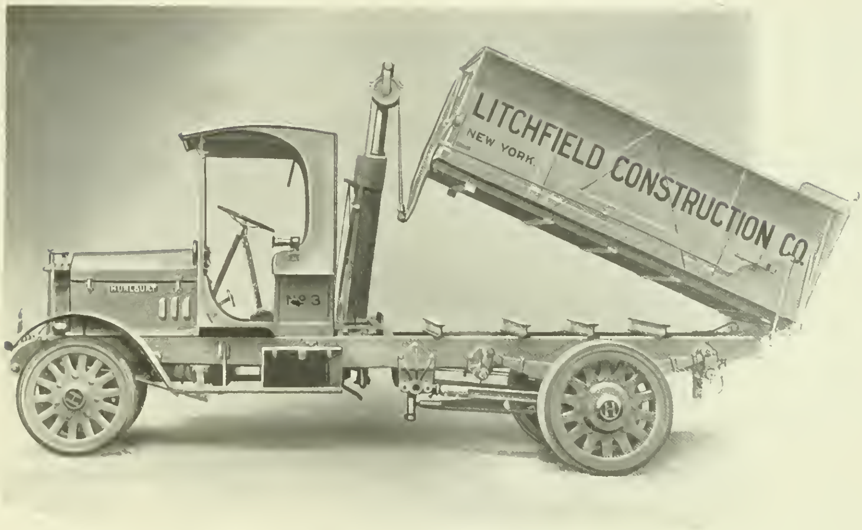
All gears in a G-B transmission are always in mesh—they cannot strip, chip or crack. Shifting is done with rugged dog clutches. That's one reason why G-B Trucks give continually good service over bad roads as well as the good!

When the G-B Transmission is at low speed the leverage is so great that the truck easily climbs hills and goes through sand and mud the ordinary truck would be afraid to attempt!

No jerks and jars. And a considerable amount of wear on tires and all parts is prevented! Verily we say the G-B Transmission approaches 100% efficiency under all conditions encountered in the contracting business! Send for its Autobiography.

Gramm-Bernstein Motor Truck Company

LIMA, OHIO, U.S.A.



HURLBURT 7-TON SIX-CYLINDER WORM TRUCK, AS OPERATED BY THE LITCHFIELD CONSTRUCTION CO., NEW YORK CITY.

tor operating heavy machinery and the relation between efficiency and speed is of equally vital importance. That's why the over-speeding of heavily loaded trucks in rough-and-tumble fashion is every bit as dangerous as truck over-loading. That's why I'd take pains to vividly picture the disastrous results of sending a heavy load jogging over rough pavements and railroad crossings at break-neck speed. The effect of constant shock encountered in forced output runs up the upkeep. While it is true that too slow a speed means a less number of tons and constantly increased cost per ton-mile, it is equally true that over-speeding means a greater tonnage at even greater cost per ton-mile. Motor truck joy-riding is a costly habit!

BIG TRUCKS FOR BIG WORK.

Highway contractors, in a number of states, have found, thru experience, that the large capacity truck is most profitable; materially cheaper than a lesser capacity truck as far as maintenance and operation are concerned! They are thru with the cheap, makeshift contraption that looks like a gasoline apple-cart!

How much should a truck weigh? I do not know. It should weigh enough, however, to enable it to successfully perform its work—day in and day out and year in and year out and at the minimum outlay for operation and maintenance (performance and satisfaction considered) and with a minimum depreciation in value after years of service.

CONTRACTING SHOWS UP CONSTRUCTION.

When accidents happen to contracting machinery it is too late to find out what broke first! War may test a truck, but the contracting business proves it!

Strength plays an important part in the usable life of a truck, but accuracy of workmanship is as important! True alinement of all parts to reduce friction and a good oiling and cooling system have much to do with it.

I would convince my prospect that in purchasing my trucks he was not buying so many pounds of iron and steel. I would make him realize that I was selling him Service—and I would see to it that he got it.

I would know just why trucks of moderate size are most economical and convenient for handling men, small machinery, tools and supplies, as well as small odd hauling jobs. Many truck salesmen think they know. But they don't! They're guessing!

THE BEST IS NONE TOO GOOD.

Don't think that any kind of a truck is good enough for the contracting business! Long, continuous (day-in, day-out), dependable service is what counts. A truck "on the job" is worth any number of trucks in the repair shop. The con-

PIERCE-ARROW 5-TON TRUCK, AS OPERATED BY THE McKELVY-HINE CONSTRUCTION CO., YOUNGSTOWN, O. WORKING AGAINST A TIME FORFEIT OF $250 TO $350 A DAY, THIS TRUCK DELIVERED AN AVERAGE OF 225 TONS DAILY FOR 125 WORKING DAYS. THIS TRUCK DELIVER9D 290 TONS OF SAND IN 10 HOURS ON A ROUND TRIP HAUL OF 1 1-3 MILES.

Quality Construction Plus Quality Performance Equals *"On the Job."*

The claim of the SIGNAL MOTOR TRUCK for your business is not based upon any sensational exploit or any sensational feature. It is based upon two things only (*a*) quality construction all through (*b*) quality performance in daily service.

The quality construction is evidenced by the use of exclusively quality units such as Continental Motors, Timken-David Brown Worm Drive Rear Axles, Ross Steering Gear, Brown-Lipe Transmission, Eisemann Magneto, Detroit Self-Lubricating Springs, Stromberg Carburetor.

Equally important with the quality of the units is the careful engineering and the practical skill with which the various units are harmonized into one complete unit of remarkable strength, endurance and reliability, so that the uniform experience of users everywhere is quality performance in daily service—and the uniform report to those who inquire of users concerning **Signal Motor Trucks** may be boiled down into five words, "They are on the Job."

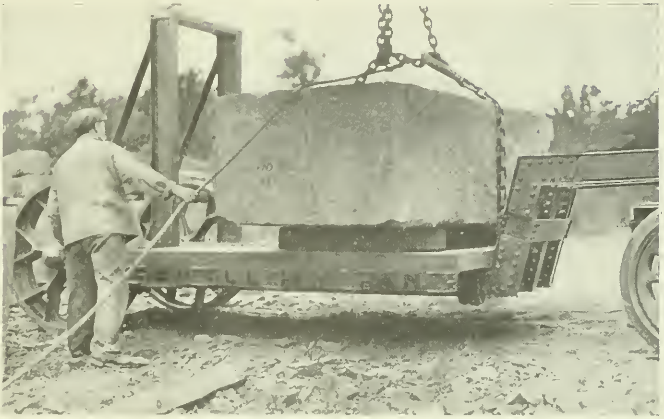
No matter what business you are in, no matter for what service you require a motor truck, the most important element you can buy in a truck is the ability to be "on the job."

Signal Motor Trucks are made in all sizes from 1 ton to 5 tons. Write for catalog and full information concerning the Signal line.

SIGNAL

MOTOR TRUCK COMPANY

DETROIT, MICH.



KNOX LOW-HUNG SEMI-TRAILER AND TRACTOR, AS USED IN THE HANDLING OF CUT STONE. LOADING PLATFORM IS BUT 26⅞ INCHES ABOVE THE GROUND. THE WEIGHT OF THE STONE BLOCK, AS SHOWN, IS 12 TONS.

tractor's truck must be "Johnny-on-the-spot" 365 days in the year!

The best truck is none too good for the hardest work on which a truck can be used—contracting haulage. My truck might cost more, but so does a sound, willing horse cost more than a spavined, wind-broken wreck.

Many trucks may be alike in appearance when viewed from a distance. Perhaps that is the reason so many contractors formerly selected inferior makes. They could not see the difference between a truck of doubtful merit as applied to contracting and one of superior qualities simply because the salesman did not understand the contracting business thoroly enough to make him see the truck after it had been working under his conditions. Consequently many contractors accepted the claims made by the price salesman representing the light, or cheaper truck, under the belief that he was saving money and getting the truck that would give the same kind of service that could be obtained from the higher priced truck.

Truck economy depends not upon what you pay for the truck, but upon what you get for what you do pay. Rightly considered, the purchase of the best truck for the construction business is the truest economy. Such a truck will last much more than twice as long as many trucks costing half as much. And what is more to the point, they will be worth more than twice as much in satisfactory service all the time.

THE "FIRST COST" FALLACY.

The best built truck (best suited to the working requirements) is the only truck the contractor can operate at less than team and wagon rates. It is "the cost to keep" that counts. The gruelling work of contracting hauling shows up a poorly designed truck, and the experience of most contractors who have tried to save on first cost has been most painful and decidedly expensive!

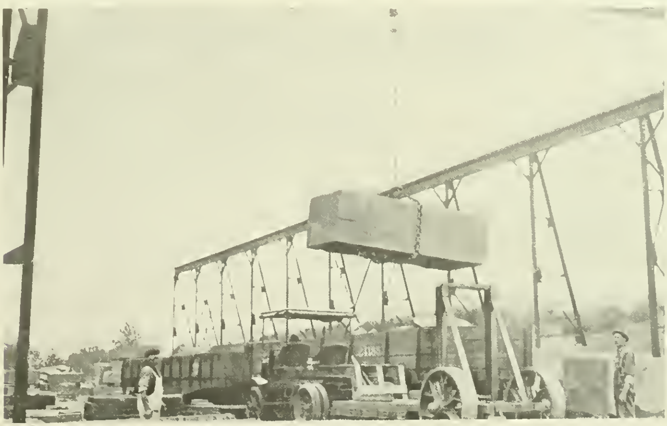
The truck made to meet the requirements of the contracting business need not be sold in price competition with the light or cheap truck made for the delivery of small store parcels.

The "first cost" saving is the ostrich way of figuring real truck economy. The only true way is to figure the ultimate cost of truck service—the cost per ton-mile. Bargain price "first cost" talk contains a joker! Veteran contractors know that. Serious minded contractors know it. Contractors who have operated trucks know it.

The "first cost" is the biggest cost of a good truck and that's the smallest cost of any other truck because of the after expense. The contractors' truck must stand up and deliver mileage enough to justify its first cost or its first cost at any price is a joke.

MEASURE VALUE IN TERMS OF USE.

It is no longer considered good contracting practice to burn



KNOX TRAILER AND TRACTOR (AS SHOWN ABOVE). TRACTOR CAN BE "JACK-KNIFED" AT A SHARP ANGLE UNDER THE SEMI-TRAILER. THIS OUTFIT CARRIED ITS 12-TON LOAD A DISTANCE OF THREE MILES IN EXACTLY TWELVE MINUTES.

GRAMM 5-TON TRUCK, AS OPERATED BY ARMY DEPARTMENTS OF SEVERAL GOVERNMENTS.

up money nor is there a craze for mere cheapness among the great majority of contractors who really do good work. They are beginning to learn that it pays to measure value in terms of use.

Now the contractor has found out what the truck really is, he is beginning to buy real value- that is why price is no longer the prime consideration! The contractor who really does big things in a big way at a big profit to himself knows that real value depends on the cost of service rendered, not on the first cost. Final cost is more important than first cost. Upkeep charges are governed largely by the prices paid for parts.

You can buy a truck at almost any price you want to pay. My truck may be a little higher in price than some others so also is a gold watch higher in price than a silver one. Still, all who can buy gold, buy it.

Tractor Hauls Ore From Mine to Smelter.

The United States Transportation Co., Murray, Utah, are operating Knox tractors in the hauling of ore from the bins of the Cardiff mines in the Big Cottonwood Canyon to the smelters in Salt Lake Valley. This decision was reached after eleven demonstrations by the Utah-Idaho Motor Company.

Following is a brief synopsis of results of these eleven demonstrations. The equipment consisted of one Model 36 Knox tractor with 5-ton ore body, and two 5-ton Troy trailers equipped with regular steering apparatus, roller bearings and 36 by 7-inch tires.

On the down trips from the mine the trailers were practically always held back by the brakes on the tractor, this being a remarkable performance, owing to the fact that in many places the grades are as steep as 16 per cent.

Traffic was never interfered with in any manner, on account of the fact that the tractor could pass as easily as the ordinary automobile. The tractor was equipped with steel wheels 14 inches wide, which were fitted with diagonal cleats. After the 11 trips up and down the canyon, no appreciable wear was noticeable on the tires. Some of the demonstrations were made during heavy rainstorms and no difficulty in negotiating the trip was encountered at any time.

BIG TONNAGE HAULED.

The total tonnage of ore hauled during these eleven demonstrations was 272,660 pounds and altho coal was not taken back on every return trip, a total of 27,080 pounds of coal was hauled back from the valley up to the mines. The amount of coal hauled per trip ranged from 3,600 to 4,300 pounds. An average gas consumption of 21 gallons per round trip was registered and the round trip consumption of oil averaged 2 quarts.

Two trips were made every 24 hours, the average time coming down being 3½ hours and returning 4½ hours, which, with allowing 1 hour for loading and unloading, gave 3 hours for oiling, taking on gas and inspecting the machine. No repairs of any nature were necessary during the 11 trips. The distance covered on each trip down included 9 miles in the

PIERCE-ARROW 5-TON TRUCK AS OPERATED BY THE AMES TRANSFER CO., NEW YORK CITY, IN THE HAULAGE OF CEMENT, SAND, GRAVEL AND VARIOUS BUILDING MATERIALS.

GARFORD TRACTOR, AS OPERATED BY FRANK J. CLANCY (CONTRACTOR), ASTORIA, LONG ISLAND CITY, N. Y. THIS VIEW SHOWS TRACTOR TOWING LOADED SCOWS TO DESIRED LOCATION FOR UNLOADING, THUS SAVING TUG HIRE AND DEMURRAGE CHARGES AMOUNTING TO $90 PER DAY.

canyon proper and 7 miles across the valley, which included one very steep hill.

One of the most remarkable features of the demonstration was the fact that at no time during the demonstrations was it necessary to add water to the radiator on account of heating. The radiator showed signs of boiling at no stage of the demonstration.

Considering that a rise of 3,050 feet is negotiated in this trip of 16 miles, seven of which are across the valley, the fact that the radiator did not overheat is even more remarkable. The difference in altitude seemed to make no difference whatever in the power of the Knox tractor engine.

COSTS OF OPERATION.

Following is a record of cost and maintenance covering operation for the first 30 days, as submitted by Mr. L. D. Stone:

Equipment—	
Two Knox towing-winch tractors	$10,800.00
Four Troy trailers (5-ton)	5,280.00
Bodies for trailers	200.00
Total equipment	$16,280.00
Fixed Charges, per 24 hours—	
Two drivers per car, at $5.00	$20.00
Two helpers per car, at $3.00	12.00
Depreciation, at 25 per cent	11.30
Interest, at 8 per cent	3.68
Insurance	1.00
	$47.98
Current Charges, per 24 hours—	
Gasoline, 84 gallons, at $0.25	$21.00

GARFORD TRACTOR (SAME AS ABOVE) PULLING SEMI-TRAILER LOADED WITH SAND (OR GRAVEL). MR. CLANCY STATES THAT THIS TRACTOR EASILY DOES THE WORK OF SEVEN HORSES. IT IS ALSO A "MOTOR MULE," AS SHOWN IN ILLUSTRATION AT TOP OF THIS PAGE.

PACKARD 5-TON, AS OPERATED BY THE BOSTON BRIDGE WORKS. THIS TRUCK, 21 FEET IN LENGTH OVER ALL, HAULS MAMMOTH STRUCTURAL BRIDGE TRUSSES MEASURING 37 FEET IN LENGTH

Oil, 2 gallons, at $0.50	1.00
Tires, at $0.08	10.24
Maintenance, at $0.05	6.40
	$38.64
Total cost per day	$86.62
On basis of 30 tons per machine per day (24 hours), cost per ton-mile	$1.45

"These figures," states Mr. Stone, "are based on the exact equipment used while I was there and there is nothing estimated. This does not include dock men or garage men or the transfer of the ore from the sleds on which it has to be brought part way out, but is the cost of actual operation while demonstrating.

"Some of the worst grades will scale 16 per cent. The 8 miles of canyon proper is all hill and runs from 8 and 10 per cent. to the above mentioned. The rest of the road (8 miles) is an average of about 4 per cent. with one or two hills, the worst about 14 per cent., and stretches of sand.

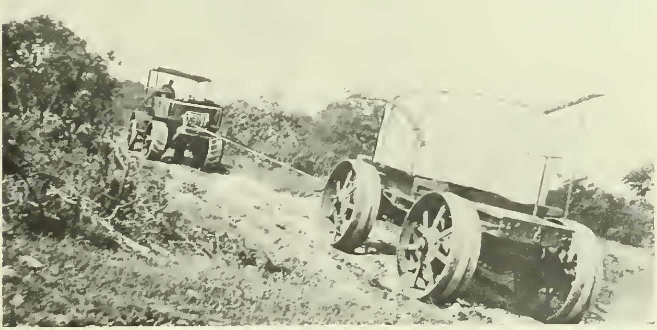
"Levendale is about 10 miles south of Salt Lake City, and the Transportation Co. now have their garage and station at that place. The ore is loaded from the tractors at this place into coal cars and taken to the sampler. This unloading is done over a tipple. I can safely say that this is the worst haul I have ever seen and I have placed trucks and tractors on some of the biggest contracts in the country."

Small Truck Pulls Sixteen Tons.

B. A. Dockery, contractor, Trenton, Mo., recently used his G. M. C. $1\frac{1}{2}$-ton truck in pulling a trailer loaded with a 16-ton granite monument. "Two teams," states Mr. Dockery, "failed to budge the load. The truck, however, hauled the 32,000 pounds, mounted on a trio of house trucks, five blocks of the distance, unassisted. The horses helped up grades, however.

Resume of Itinerary Statistics.

Total time of trips	10 hours, 20 minutes
Total miles traveled	32.7
Total tonnage hauled	23.85
Total number of cans hauled	554
Total commercial ton-miles	157
Total time consumed in loading	5 hours, 39 minutes
Total time consumed in dumping	24 minutes
Net running time	2 hours, 17 minutes
Net average speed	3.2 miles per hour
Net average running speed	14 miles per hour
Average tonnage per load	4.77 tons
Ratio of running time to total time	22 per cent.
Average loading time	1 hour, 8 minutes
Average dumping time	5 minutes.



KNOX TRACTOR, AS OPERATED BY THE VERMONT MARBLE CO., SAN SABA, TEXAS. THIS VIEW SHOWS WINCH POWER OF TRACTOR BEING USED TO PULL 12-TON BLOCK OVER A STEEP PITCH ON A POOR ROAD.

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The World's Leading Municipal Publication

THE ENGINEER OF THE FUTURE

Professor Newell has made a definition of "profession," which requires that the practitioner shall be the dictator to the man who pays his fee and not be subject to dictation, nor does he perform certain operations within certain hours. He is said to cease to be a professional man the moment he takes orders from an employer. The matter of wages, salary or fee is declared to be an index of the consensus of opinion as to what is or is not a profession, not as to method of payment, but as to the theory of subordination or independence of action which underlies the method. Wage earning engineers are not as yet professional men, but are on the way to becoming so, he thinks.

Professor Newell evidently is so taken up with the methods heretofore most prevalent in the medical and legal professions that he overlooks the fact that the clerical profession, which he mentions, and the teaching profession, which he does not mention, tho a member of it, are made up, if not of wage earners, at least of salaried men and women, the difference between wages and salaries being often difficult to demonstrate. Many engineers who are equally professional in their attainments and influence with men answering the professor's definition are on salary and largely under orders of their superiors. Then there is the new profession of business, which gets more recognition each year and, with the characteristic capability for organization of business, will soon be in the forefront of professions.

The fact is that the definition presented is too dependent upon outward recognition and tries to fit itself to what other people think or do rather than to what the real relations of the profession are or may be.

The first profession was that of priest, and it included a treatment of all the disagreements of man with his maker, his fellow man and himself.

In the differentiation coming from development the first function of binding back man to his Creator fell to what has come to be the clerical profession. If one may judge from history, its practitioners have always been more or less subject to superior authority and even in these modern days of religious independence must conform to the ideas of their people or they cannot retain their positions. None are paid by fees.

The settlement of man's differences with his fellow men fell to the legal profession, to which the professor's definition applies almost exactly, tho in recent years business has obtained such a hold upon it that few attorneys can now be classed as purely professional and many of the most competent are high-salaried employes of large corporations.

His differences with himself came to the medical profession, to which the definition applies most nearly, tho here again the modern development of hospitals and sanitariums and public institutions of similar nature gathers in many of the best men in the profession and puts them on salaries. Indeed many physicians classed by every test as professional believe that if all physicians were put on public salaries many of the temptations to misuse of their positions would be removed and the world the better for it.

With the modern development of general education men are each year becoming better able to settle their own differences of all three classes and there is great complaint of the decline in the importance of the clerical profession; there has been an enormous change in the status of the individuals of the legal profession and a man must now be a good business man as well as a good lawyer as a pre-requisite to success in the practice of his profession, whether in general practice or on salary. The term "annual retainer" is only another name for wages, tho it may pay for a rather indefinite part of the year's total of hours of work.

The teaching profession is the oldest of the constructive professions, dating back to the priest, and its practitioners have always been paid salaries and probably always will be, tho some of them act in advisory and consulting capacities which make them really professional men or women under every part of the professor's definition but the method of payment for services.

The constructive engineering profession, including architecture, is hardly a century old, if one leaves out of consideration the occasional engineers and architects of earlier times, and is a development from the builders of earlier centuries. It has always had a large admixture of business influences, quite as large as the modern legal profession, and a common definition of the real engineer is "the man who can do for a dollar what any one could do for two." While inaccurate and inexact, this definition expresses the general idea that the money available is one of the most important factors in the problem, which the truly professional engineer must consider in his solution of it.

And now comes the business engineer, whose title is a compliment to his predecessor in the professions, whose problems are not less professional in their nature but are strictly business. This profession is also constructive, and some of its practitioners answer all the requirements of the professor's definition.

It is not the intention to develop a definition of the term "profession" here, but merely to show that the definition must be based on the real relations of the members of the professions to their work and their employers, whether called clients or not, and not upon what outsiders may think of these relations without definite or even any knowledge of the same; or what they may think of the methods of paying professional men for their work and whether this payment is termed wages, salary, fee, retainer, honorarium or what not. Only in this way can a definition be formed which will apply to all professions. Certainly Professor Newell's does not.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

The Design of Asphaltic Concrete and Bituminous Macadam Pavements

By Lester Kirschbraun, Philip P. Sharples and the Editor.

This article carries the design of bituminous pavements thru the asphaltic concrete and bituminous macadam classes. These classes of pavements have been as irregularly named as they have been described and specified. They seem to fill a place for road surfaces which is intermediate in quality and in price between soft and hard surfaces, between "roads" and "pavements" so that they require more attention just at this time than they perhaps deserve.

Several experts have been drawn from in securing the basis for the theory advanced, two in particular, and it is probable that there are others who do not agree with what is here developed. The regular invitation to present criticisms or additions is extended with the hope that a discussion of the subject will bring about a more thoro agreement regarding classification and specifications.

TWO requirements are fulfilled by each of the two bituminous pavements described in the last article in this series; each particle of the aggregate is completely coated with the bitumen and the voids are completely filled with it. In the asphalt pavement, surface wearing coat, the aggregate itself does not have inherent stability, tho there is some approach to a minimum of voids, if the stone dust is considered as mixed with the sand; in the bitulithic pavement the aggregate makes as near an approach to inherent stability as the practical limitations of economical construction permit the constructor to approach the theory of the pavement. In each case there is an attempt to coat with bitumen each particle of the aggregate, from stone or cement dust to the largest particle of sand or stone. Each pavement is intended to be water-proof, in the sense that no water can find its way thru the compacted mass to the foundation beneath.

The bitulithic pavement is an asphaltic concrete, composed of stone of carefully selected sizes to produce a minimum of voids, the voids being filled by the cementing bitumen and the surface sealed by the film of bitumen on it. The pavements described in this article range from an attempt to produce an equally good bituminous concrete by less efficient methods, to an attempt to hold loose dust together by spraying it with oil, passing on the way by almost inappreciable gradations from an asphaltic concrete approaching the theoretical perfection of bitulithic, thru the bituminous macadams and bitumen-treated macadam, to the laying of dust by oil.

Some study of the bituminous cement may give an indication or two of the reasons for expecting it to be able to do all the various kinds of work demanded of it in these greatly differing road surfaces. We know comparatively little as yet of the full action of the bitumen in a pavement, but this statement may serve as a basis of discussion by the experts and for addition of the special knowledge which is the result of their individual studies.

It is generally assumed that the adhesion of the bituminous cement to the particles of aggregate and the cohesion of the same cement are the forces which hold the aggregate together in the completed pavement, but the researches of Clifford Richardson have called attention to the enormous increase in holding power of liquids in intimate contact with solid surfaces, called surface energy, and the importance of this physical property in the combination of bitumens with aggregates to form pavements.

The greater the surfaces to be covered, the greater the total amount of energy developed in a mass of a given volume. It follows that the smaller the particles of the aggregate, the greater is this total amount of surface energy, and when the aggregate is in the colloidal form or condition this surface energy is so great that it is impossible to separate aggregate from bitumen by physical means. Perhaps this explains why the sand of the asphalt pavement mixture, which, alone, has no inherent stability, is welded into a stable, solid, durable wearing surface, comparable in these qualities with a mass of aggregate of the same mineral matter of selected sizes, from large to small, having inherent stability and with which bitumen is used primarily to water-proof the aggregate, and to a certain extent secondarily to prevent motion and consequent wear of loose stones in the mass, but only incidentally and partially as the source of the energy which holds the mass together and makes it a successful pavement. It is evident that to develop this surface energy it is necessary to coat every particle of the aggregate completely. It may not be so evident, but is not the less true, that the finer the particles of the aggregate the more difficult it is to coat them completely, so that practically there is a point beyond which it is not possible to go in increasing this surface energy by comminuting the aggregate. Again, the proportion of voids in a mass of aggregate depends not on the size of the particles, but on their variations in size, so that the proportion of voids in the aggregate will increase as the particles are reduced in size to a uniform minimum, and then the less strength of cohesion of the bitumen must be depended upon to hold the mass together, so that below a certain point reduction in size of particles may cause diminution of strength.

An illustration of this may be seen in the action of water on sand. The dry sand on a beach, back from the water's edge, is loose and unstable and to haul a wagon over it is difficult. The sand near the water's edge, saturated with water, but not in excess, on account of the surface energy of the film of water on the sand grains is hard and will carry almost any wheel load. The sand under the water is again unstable, and under a wheel load will give way so that the load will sink into it, indefinitely if there is any motion to aid in continuing the displacement of the sand. The action of the bitumen seems to be quite similar, except that the cohesive strength of the bitumen, being more appreciable than that of water, permits more variation in the proportion of bitumen to sand.

The ordinary crusher run of stone used in macadam highway construction has a proportion of voids less than that in a mass of spherical particles of uniform size, but greater than

BITUMINOUS CONCRETE PAVEMENT ON CONCRETE BASE, NORTHEAST BOULEVARD, PHILADELPHIA, PA.

the practical minimum obtainable in the attempt at inherent stability. Even when compacted in the road, there is plenty of opportunity for motion of the particles on each other. It will be found that the stones in the inner parts of the layer of macadam are worn as well as those on the surface in direct contact with the traffic. This is especially true if the traffic is on rubber tires, because their action adds motions in both horizontal directions, along and across the direction of traffic, to those produced by the weight of the load itself, tho they do obviate the cutting action of wheels loaded too heavily for the width of a solid tire. Anything which will separate these surfaces of the stone particles and prevent their rubbing on each other will reduce the wear, even if it does not prevent the motion entirely. If bitumen is used for the purpose, it also holds the dust in place and thus conserves the material of the pavement. Other materials than bitumen can serve this purpose.

The bitumen in the pavement then serves the following purposes, among others, in a pavement:

By the development of its surface energy it holds fine aggregates together and produces a stable pavement as in the ordinary asphalt pavement. Other mixtures with fine materials have not yet proven equally successful, perhaps because their scientific combination with the asphalt has not been studied in sufficient detail.

It holds particles of larger size together rather by adhension than by the development of surface energy, the surfaces in a given volume being so much less extensive.

It fill the voids in some varieties of pavement thus making the pavement waterproof.

It covers the surfaces of particles and prevents wear when motion occurs under traffic in a pavement whose inherent stability is not perfect.

It serves in its lighter grades and cheaper applications simply to hold the abraded particles of stone together and so prevents the dust nuisance at the same time that it retains this dust to cover the surface stones of the road and thus reduce the wear on them.

One or more of these services are rendered in each of the varieties of pavement and road surface here described. No attempt has been made even to mention all the varieties in existence, that would be almost impossible. Typical cases have been selected of typical varieties. Data about special forms devised for special purposes or using special materials will be given later. Information about them is solicited from their inventors, designers or promoters.

Asphaltic Concrete.

One of the earliest of the asphaltic concrete pavements, for the promotion of which on the market any particular effort was made, was that devised by F. O. Blake, which after various contests over infringement of patents become known as the Topeka specification pavement, the specification being one established by the court as not an infringement of the bitulithic patents. This specification, modified in some respects after scientific study, appeared in the specifications adopted by the Society for Standardizing Paving Specifications and in the standard specifications of the American Society of Municipal Improvements, where it was further modified by changing the grading of the stone, so that it is no longer the Topeka specification, though often known as such.

The desire has been to approach as nearly as possible to the minimum of voids in the stone aggregate without infringing on the patent whose basic principle is inherent stability, carried out by a specification for graded sizes and proportions of voids. As this cannot be attained by the use of ordinary crusher run of stone, even with the additions provided for in the specifications, the resulting pavement is only approximately a perfect asphaltic concrete, but is ordinarily known by that name. As usually constructed it lacks to some extent inherent stability and so must depend upon the strength of the bitumen for a portion of its stability; it has enough large particles to reduce the area to be covered by the bitumen, and is not thoroly enough mixed to insure the complete coating of all particles, especially the smallest in size, so that there is not the opportunity for development of surface energy which exists in the sand-asphalt mixture of sheet asphalt pavement; it is not always certain that all the voids are filled, so that it may be necessary to keep the surface skim coat intact by frequent renewal in order to insure that the pavement will be water-proof; but it probably contains enough bitumen to prevent wear of the stones by friction on each other under any slight motions which may take place in the interior of the pavement under the action of moving traffic.

The better the specification and the closer the inspection of materials and methods of construction and the nearer the mixture of aggregates approaches the minimum of voids, the more nearly the pavement approaches the perfect asphaltic concrete and, as experience demonstrates, the better is the pavement. Defects in the specifications or inspection which emphasize any of the defects mentioned above reduce the value of the pavement and, especially if two or more of these defects occur together, cause it to approach or really become bituminous macadam as that pavement is described later in this article.

The standard specification of the American Society of Municipal Improvements, after prescribing sub-drainage; subgrade; new and old macadam and concrete foundations as alternatives; curb and gutter; provides for the asphaltic concrete wearing surface of 1½ to 2 inches thickness according to amount, kind and weight of traffic, as follows:

The mineral aggregate is to be of (1) sound, durable macadam stone, cubical, without distinct cleavage planes, tough enough not to crush or split readily under the roller, with a certain percentage of absorption such as the better grades of limestone have; (2) hard-grained, moderately sharp sand, free from foreign matter, varying in size from 200-mesh to ¼-inch screen with not over 20 per cent. passing a 10-mesh screen; (3) ground limestone or Portland cement if desired, provided that the screenings of the total aggregate in the mixture do not contain more than 11 per cent. passing 200-mesh screen.

The bitumen must be an asphaltic cement of the same specification provided for sheet asphalt pavement as given in the standard specifications of the same society. The minimum of bitumen allowed in the following table of allowable variations in composition can be used only in mixtures containing the minimum total passing the 80-mesh screen. As the proportion of such fine material increases the amount of surface area of particles of aggregate increases and the amount of bitumen must be increased to correspond. Since the area of the particles increases much more rapidly than the increase in percentage of fines, the percentage of bitumen increases more rapidly than the percentage of fines. For this reason the cost of a mixture with a large percentage of fines is increased and there is a tendency to use as small a percentage of such fines as possible.

The proportions of asphaltic cement including any mineral dust contained in it; sand, including any fine sand passing a 200-mesh screen, of which there should not be in the sand used more than 5 per cent. of the total mixture; broken stone; and fine stone dust or Portland cement in case any is added, must be within the following limits:

	Per Cent.
Bitumen	7 to 9
Passing 200-mesh screen	7 to 10
Between 200 and 80-mesh	10 to 20
Between 80 and 40-mesh	10 to 25
Between 40 and 20-mesh	10 to 25
Between 20 and 8-mesh	10 to 20
Between 8 and 4-mesh	15 to 20
Between 4 and 2-mesh	5 to 10

It will be noted that the largest size used must pass a ½-inch screen.

The lack of inherent stability in the aggregate can be demonstrated readily by spreading a layer of it ½ to 2 inches thick, compacting it and then drawing a loaded wagon wheel across it.

Methods of mixing and laying will be taken up in a later article when further differences in asphaltic concretes will be shown.

The main advantage of pavements of this type is their relatively low cost. Asphaltic concrete is not likely to rival sheet asphalt in durability, altho all we know about it up to the present time warrants the conclusion that it is worth what it costs. The principal saving effected in the use of asphaltic concrete arises out of the fact that the binder course of the sheet asphalt pavement is eliminated, the wearing surface being laid in one course or layer, 2 or 2½ inches thick; there is also a saving in the amount of asphalt required, amounting to from one to three per cent., depending upon the amount of very fine material that is incorporated in the mixture.

It is a mistake to suppose that the making and laying of asphaltic concrete requires less care and skill than the laying of sheet asphalt, altho it is true, of course, that a mixing plant will turn out and a street force will lay a larger yardage of asphaltic concrete than of sheet asphalt, owing to the fact that the latter pavement is composed of two different courses, the binder course and the wearing surface. A smaller and cheaper plant may be used for asphaltic concrete than is required for sheet asphalt. Prices vary greatly, owing to local requirements, costs and conditions, but the rough estimate may be made that 2-inch asphaltic concrete pavement will average 35 cents per yard less than sheet asphalt.

It is approximately true that good asphaltic concrete consists of a high-grade sheet asphalt mixture to which there has been added about 8 per cent. of ½-inch and about 20 per cent. of ¼-inch stone. It will throw considerable light on this subject to present a number of examples of good and bad formulas and to compare them with the general formula given above. One of the best asphaltic concrete pavements is that laid on Riverside Drive, New York, in 1913, from 72nd street to 114th street. This pavement is 3 inches thick, rolled in two layers, on a 6-inch concrete base, the wearing surface having the following composition:

Composition.	Pounds.		A	B
Asphalt cement	110	Bitumen	8.9	11.1
Portland cement dust	110	200 mesh	11.9	16.5
Sand	312	80 mesh	14.5	20.1
Stone screenings	564	40 mesh	18.6	25.9
	——	10 mesh	18.9	26.4
	1,096	4 mesh	19.1	....
		2 mesh	8.1	....
			100.0	100.0

Column A gives the average composition of the surface mixture as laid on the street; column B that of the finer portion, excluding the ¼ and ½-inch stone and the 4 per cent. of bitumen which is estimated as being sufficient to cover this portion of the aggregate.

Closely approximating this formula is one under which a large yardage of very successful asphaltic concrete pavement has been laid in Rochester, N. Y., some of it ten years old:

Composition.	Original mixture.	Finer portion.
Bitumen	8.9	11.1
200 mesh	12.3	17.1
100 and 80 mesh	10.8	15.0
50 and 40 mesh	24.2	33.7
30, 20 and 10 mesh	16.3	22.7
4 mesh	21.5	....

A third mixture differing somewhat from the two just given was used in Trenton, N. J., four years ago and has so far proved satisfactory:

Composition.	Pounds.		Original mixture.	Finer portion.
Asphalt cement	105	Bitumen	8.1	10.6
Dust	80	200 mesh	8.9	13.1
Sand	560	80 mesh	10.7	15.8
Stone screenings	370	40 mesh	25.3	37.3

WATER-BOUND MACADAM ROAD WITH BITUMINOUS SURFACE TREATMENT, PHILADELPHIA, PA.

	——	10 mesh...	15.7	23.2
	1,115	4 mesh...	13.0	....
		2 mesh...	17.3	....
Retained by		2 mesh...	1.0	....
			100.0	100.0

As an example of asphaltic concrete from which good results have not been obtained and cannot be expected, may be instanced the following from a Georgia city:

Composition.			Original mixture.	Finer portion.
Asphalt cement ...	160 pounds	Bitumen...	7.7	9.6
Dust	60 pounds	200 mesh..	6.8	10.1
Sand	9 cu. ft.	80 mesh..	15.0	22.4
Stone screenings ..	9 cu. ft.	40 mesh..	17.0	25.4
		10 mesh..	21.8	32.5
		4 mesh..	19.5	....
		2 mesh..	12.2	....
			100.0	100.0

This mixture is evidently deficient in bitumen, while the following is deficient in filler and fine sand:

Composition.	Pounds.		Original mixture.	Finer portion.
Asphalt cement	140	Bitumen....	8.4	13.5
Stone screenings	400	200 mesh...	3.4	5.5
Sand	600	80 mesh...	2.5	4.0
	——	40 mesh...	26.0	41.7
	1,140	10 mesh...	22.0	34.3
		4 mesh...	20.0	....
		2 mesh...	17.7	....
			100.0	100.0

Bituminous Macadam.

The American Society of Municipal Improvements has also a specification for "Bituminous Concrete with One Product of Stone Crushing Plant" which is produced by the mixing method and may be styled bituminous concrete if all bituminous stone pavements so produced are called bituminous concrete, but which departs sufficiently from the requirements of the definition of bituminous concrete given in the preceding article of this series to warrant placing it high in the class of bituminous macadams rather than low in the class of bituminous concretes.

The broken stone used for the mineral aggregate must pass a 1¼-inch screen; not more than 10 or less than 1 per cent. shall be retained on a 1-inch screen and not more than 10 nor less than 3 per cent. shall pass a ¼-inch screen. The mixture as laid in the street must contain from 5 to 8 per cent. by weight of bitumen, according to the kinds of bituminous cement and mineral aggregate used.

This combination has in its mineral aggregate less inherent stability than water-bound macadam as constructed under the best specifications and the bitumen is not sufficient to fill the voids completely. There is doubtless enough of the bitumen in the absence of much fine material to coat all the pieces of stone, so that the quality of preventing wear by keeping stone surfaces apart is present in full; by means of its cohesive and adhesive strengths the bitumen reduces the motion in the particles of stone under the weight of traffic to a minimum, but cannot prevent it entirely; it is not water-proof.

The water-proofing of the pavement is attained by putting on a seal coat of hot asphalt cement spread on the surface at the rate of ½ to 1 gallon per square yard into which are rolled dry, clean broken stone chips between ⅛ or ¼ and ⅜ or ½-inch screen sizes, in two applications.

Numerous specifications for asphalt cements and refined tars are given, the object apparently being to give a specification for each kind of asphalt and each kind of tar which would be acceptable on the job, instead of one specification each for asphalt and tar. It will be noted that these asphalts, and the tars, are softer than those prescribed for sheet asphalt and true asphaltic concrete.

The following extracts from a letter written by Lester Kirschbraun, consulting asphalt chemist and engineer, of Chicago, give the reasons for the differences in specifications for asphalt in sheet asphalt, bitulithic, other varieties of asphaltic concrete and bituminous macadam:

The penetration of bituminous cement used is determined among other things by type of construction in which it is employed. The binding power of asphalt cement increases with increased hardness. The stickiness, however, or adhesiveness increases with its softness. Where a type of construction is employed in which the mineral aggregate possesses a great degree of stability, less binding properties are demanded of the asphaltic cement and a softer cement is employed. By employing a soft cement in such construction, an increased degree of stickiness or adhesiveness is secured, making it possible to use the cement more advantageously as in bituminous macadam. In bitulithic construction it is likewise possible, on account of the stability of the aggregate, to employ a softer cement than would be employed under similar conditions in sheet asphalt work. As a matter of practice, however, in many instances of bitulithic construction, it is customary, instead of using a softer cement, to use a larger percentage of a harder cement, the amount of cement and the softness being interchangeable to a considerable extent so far as the effect upon plasticity of the resulting pavement is concerned. As a general rule, the greater the degree of stability characteristic of the type of construction and aggregate used, the softer may be the cement which is employed. For example, if a sheet asphalt mixture were to be laid without a binder course, a much harder cement should be employed on account of the lack of stability of such construction in comparison with the standard construction of sheet asphalt on a binder course. Any other factor which affects the stability of the pavement, such as the character of the filler, sand, the use of gravel or stone, will be a consideration in determining the consistency of asphaltic cement. In a similar manner, the thickness of the pavement is a factor in its stability, for the reason that the cement in a thick pavement is less affected by changes of temperature than is the cement in a thin pavement. Asphalt mixture is a good non-conductor of heat. It follows therefore that in a thick pavement or in heavy construction, a softer cement may be used than in the case of a comparatively thin construction where the effect of the climatic temperature is to influence the cement more quickly thruout the body of the surface mixture.

The penetration of bituminous cement is to a certain extent a function of the nature of the cement. Certain cements carry mineral matter, which disguises the consistency of the bituminous materials therein. It is therefore necessary to interpret the consistency of such cements in connection with the effect of their contained mineral matter. Again, cements prepared from various crude materials and by various processes of refining possess variable cementing qualities, making it necessary to compensate by increased hardness of such cements their lessened cementing qualities, or by increased softness of these cements their greater cementing powers. In other words cements of great binding properties may be laid at softer penetration than in the case of bitumens of comparatively low cementing value.

ABOVE: APPLYING BITUMINOUS MATERIAL WITH AUTO PRESSURE DISTRIBUTER.
BELOW: SPREADING GRAVEL AFTER APPLICATION, 65TH, NORTH OF CHELTEN AVENUE, PHILADELPHIA, PA.

The ductility of asphaltic cement is one of its most important characteristics. It is taken to indicate and does in a very general way show the cementing qualities of the bituminous binder. It must not be mistakenly interpreted as a direct and mathematical expression of binding properties.

Successful pavements have been laid with cements possessing little ductility, and with cements of comparatively high ductility. The general experience, in a practical way, has been that cements of low ductility and of comparatively low cementing qualities produce pavements having a tendency to crack, displace, and to be less resistent to traffic conditions of any great severity. In types of construction, however, in which less cementing ability is required of the binder, cements of less ductility may be more successfully used. Constructions such as bituminous macadam and others in which the aggregate possesses a great stability, permit the use of cements of low ductility with, in many cases very satisfactory results. As a general rule, it may be stated, the less the traffic and the greater the stability characteristic of the type of construction, the less ductility is required in the asphalt cement.

The proportion of asphaltic cement used in the various types of pavement is a factor which is dependent directly upon the surface of the aggregate which must be covered. It is necessary to use an amount of asphaltic cement in all cases to cover the mineral aggregate with a film of sufficient thickness to firmly bind the particles together, and yet not of so great thickness as to result in too easy movement between the surfaces of the mineral particles. The proportioning of a bituminous mixture therefore requires considerable skill and careful judgment in order to arrive at this happy medium. The increase of surface area with reduction of size of particles of a given weight is well known, and is the determining factor in regulating the proportion of the bituminous material in a pavement mixture, whereby the finer aggregates, with their larger surface area, require more bitumen than do the coarser aggregates. There is an exception to this in the case of penetration macadam, where the amount of bituminous material used is much larger than required to coat the aggregate, and acts to a certain extent as a filler of the coarse interstices of this construction.

Bituminous materials are affected during the laying of pavements by the temperature at which the laying operation is carried out. Too great a degree of heat in contact with oxygen of the air results in hardening of the bituminous cement and lessening of its cementing qualities. It is therefore essential in the production of paving compositions that the temperature be regulated in such a manner as to minimize this condition.

On the other hand, it is necessary to produce paving mixtures at temperatures at which they may be easily worked, raked and compacted. In mechanically mixed work, such temperatures range between 225 deg. and 375 deg. F., depending upon the type of construction and the character of mixture and asphalt used. The very dense mixtures necessitate higher working temperatures. A loose mixture, such as an open binder, can be laid at a comparatively low temperature. The character of asphalt is also a consideration. Those asphalts which become easily liquid or liquid at comparatively low temperatures, or contain substantial amounts of volatile ingredients, can and should be handled with lower heat than the more sluggish and more viscous cements. In bituminous macadam, the temperature of the asphaltic cement may be higher than in mixed work, as the cement is not exposed in thin films upon hot aggregate, but cools quickly to the temperature of the cold road metal. In general, it is desirable to regulate the temperature of mechanically mixed compositions to the minimum at which mineral aggregate may be thoroly coated and the mixture handled to the best advantage.

Penetration Method.

The standard specifications for macadam roads contain specifications for bituminous macadam, penetration method, and for surface treatment of water-bound macadam roads, which will be taken up more in detail in a subsequent article on construction. It is sufficient here to point to the fact that both asphalts and tars are lighter and softer than those specified for bituminous concrete above, that there are several specifications, each applicable to a certain class of asphalts or tars and that both hot and cold applications are covered. The principles of the application of the asphalt are briefly but clearly stated in the quotation from Mr. Kirschbraun above.

The following extracts from a paper by Philip P. Sharples, technical expert of the Barrett Company, before the American Association of State Highway officials gives a good idea of the principles and general practice of the surface treatment of roads. His paper has more direct reference to the use of refined tars, but the same principles, modified by the differences in physical manipulation of the bitumens are adaptable to the use of asphalts. Both natural and artificial asphalts are available in considerable numbers for such surface treatments both hot and cold. The standard specifications, as stated above give specifications for the acceptable kinds of asphalts and tars and should be used to insure the best results.

The success of simply surface treatments over water-bound macadam in resisting modern state highway traffic has led in the last few years to a reversion to the macadam type to meet the needs of the lesser traffic roads. Its ease of construction and its adaptability to repairs, widening and reconstruction, commend themselves to the thinking engineer.

The choice of bituminous materials for protecting the surface lies between those which form distinct mats and those which are thin enough to enter into the surface of the roadway and form an integral part of it. Both asphalts and tars are available, refined to suitable consistencies. They must, however, be handled with extreme care to avoid the formation of a movable mat which ruts and rolls under traffic. It is necessary, in order to keep the snrface smooth and free from waves, to use as large a stone chip as practical and to avoid re-treatments until repair work is no longer effective.

Excellent examples of this form of mat surface long in use are to be seen in the vicinity of Boston. A section of the Newton Boulevard opposite the Brae Burn Club has never been re-treated since the original three-quarters of a gallon of refined tar to the square yard was given in 1906. As the road receives heavy auto traffic, several thousand per day, it probably represents as low an upkeep cost for a road kept in perfect condition as any in the United States. The traffic is, however, wholly automobile and the road and its surface as perfect as could be presented for this form of treatment.

The employment of bituminous material applied cold to the macadam surface has to a large extent taken the place of the hot applications. The ease and cheapness of application and the less skill required in their use have been responsible for the wider extension of cold applications.

A sharp distinction must be drawn between merely dust-laying oils and the asphalts and refined tars which have binding power. For state highway work on a good macadam, the light dust-laying oils should be used with extreme caution. They may act as lubricants and cause the entire disintegration of the macadam.

The refined tars used for cold application have great penetrating power which makes them particularly valuable

STONE-FILLED ASPHALT PAVEMENT ON MANSFIELD STREET, MONTREAL, QUE.

where it is important to avoid the formation of a distinct mat, owing to traffic conditions which would disrupt a mat if formed. The refined tar finds its way into the surface and has a healing effect even on a distinctly disintegrating road.

The amount of bituminous material required will usually vary from ¼ gallon per square yard for re-treatments to ¾ of a gallon per square yard for new absorptive roads. The most favorable results on a first treatment can be obtained by supplying sufficient bituminous material to cause a slight excess to remain on the surface after it has been allowed to dry in for an hour or so. Usually better results are obtained on new work by applying in two treatments at an interval of two to six hours.

The kind of cover to be used depends largely on the local material available. With the refined tars, success may be obtained with a large variety of materials from ¾-inch stone chips, thru the gravels to a fine tho sharp sand. Materials containing clay are barred as its presence tends to cause disruption of the surface thru the emulsifying properties of clay and water on bitumens.

On roads of over 4 or 5 per cent. grade, coarse hard covers should be chosen, in order to prevent slipperiness. The marked success of large-sized hard stone in the cover is nowhere better shown than in Maryland where grades up to 10 per cent. have been successfully treated. The stone used has been a ¾-inch clean chip.

The point where it becomes desirable from an economic and engineering standpoint to build a bituminous macadam instead of a plain macadam with a surface treatment is not easy of determination. Theoretically, the decision should rest on the ability of the road to resist internal wear. The surface coatings, if kept intact, preserve the road from wear from the top, but they do not prevent wear within the road itself. This internal wear has long been understood in England, but has been given little study in this country. If the loads on a macadam road increase beyond the ability of the structural strength of the road to bear them, the stones move on each other and internal disintegration takes place. With soft stone and heavy loads, a road will quickly wear out from within even tho the surface is protected by treatment. Any approach to the point where this wear becomes a serious menace to the life of the road would indicate the advisability of introducing a bitumen into the structure of the road to prevent interstitial wear.

The bitumen may be introduced either by the mixing method or by the penetration method. The less expense of the penetration method, the ease of handling the bitumen, the less skilled workmen required, and its peculiar adaptability to state highway conditions would warrant its wider adoption. Theoretically, the method is not perfect; practically, under ordinary conditions, it meets every requirement.

The stone for the bituminous course, which is usually 2½-inch rolled, must be carefully selected to get clean stone, in fact much of the success of the pavement depends on the cleanliness of the stone, its proper sizing, and its proper rolling.

The size of the stone and the method of putting the top together depend much on the softness of the stone, its form of fracture, and its action under the roller. As a general rule, a soft stone should be of larger size, even up to 3 inches, than hard trap rocks. With the hard rocks, it is often necessary to add smaller sizes of clean stone in order to form a proper surface for the reception of the bitumen.

The course must be rolled enough to key the stone together and obtain structural strength, but extreme care must be exercised, especially with soft stone, not to roll it so much that the surface is closed against the entrance of bitumen. Work with asphalts and work in cold weather require a more open top than work in hot weather. In fact, care must be taken in extremely hot weather not to let the bitumen run thru to the top of the base course, leaving the top course deficient in bitumen at the surface.

The amount of bitumen is, roughly, one gallon for each inch in depth of rolled stone, but this quantity should include the seal coat. Usually, 1½ to 1¾ gallons are used in the first coat and ½ to ¾ of a gallon in the seal coat, for a 2½-inch top.

The bitumen is applied best by pressure apparatus of some kind. A very simple one adaptable to refined tars delivered in tank cars has been devised using steam pressure from a road roller on the refined tar in a tank wagon and forcing it out under pressure thru a single spraying nozzle. The success of the method depends on the man at the nozzle, but it is not difficult to train a man to do good work and a little extra bonus usually keeps him on the job.

After the first coat of bitumen, clean ¾-inch stone is cast over the surface to chink the voids. The road is then thoroly rolled and any excess of chinking stone removed by sweeping with push brooms.

The seal coat is applied in the same way and then clean peastone cast over the surface and rolled in.

If the stone is soft, the road is finished with clean peastone. If it is hard stone, especially on light traffic roads, it is best to follow the clean peastone with stone dust. The surface voids are in this way more completely filled.

For penetration road work, refined tar has been standdardized and may be obtained at many different points of the standard quality, subject to laboratory control in manufacture. The material may be shipped in tank cars and easily handled with steam heat with any form of spraying apparatus.

The property of refined coal tar of sticking to cold stone makes it especially valuable in penetration work. The hot spray striking a cold surface sticks and even a slight amount of moisture does not prevent adhesion. Coupled with this, the coal tar bitumen has strong cohesion so that, even tho coated surfaces be disturbed, the pieces upon being brought together reunite. These rather striking properties allow considerable latitude in penetration work and it is not impossible, if due care is used, to build good pavements even in freezing weather.

The possibility of building macadam roads with stone not previously considered available should also be kept in mind. The cementitious qualities of a rock so necessary in water-bound macadam may be neglected, and really successful roads may be built out of flint, quartzite and granite of very low cementing value. Some soft rocks are also made available, especially where not subject to much rainfall. Roads built of the soft adobe rock in the vicinity of San Antonio, Tex., and protected with refined tar have been markedly successful. Experiments at Phoenix, Ariz., with caliche gravel show equal promise.

Classification of Asphaltic Mixtures.

As this article goes to press, the following is received from Lester Kirschbraun, giving his ideas regarding the proper basis of classification of asphaltic concrete and bituminous macadam. It agrees with the preceding in principle. The editor suggests that his own nomenclature, "asphaltic concrete" and "bituminous macadam," is the simplest and fits the conditions most closely. If necessary to differentiate still more, "bituminous macadam" may be termed "asphaltic macadam" if it is made with asphalt, and the words "mixing method" or "penetration method" may be added. If the concrete or macadam is made with tar, of course "tar" should be in the title instead of "asphalt."

There appear to be serious inconsistencies in classification of bituminous concrete and nomenclature of constructional types of bituminous surfaces containing stone aggregates. Present classifications of bituminous concretes cover preparation by mixing methods of all sorts of combinations of aggregates, many of which, in a true sense, do not appear to be concretes at all.

The writer's understanding of a true concrete involves the idea and the definition that such a structure is a composition containing large aggregates, the voids of which are filled with a mortar composed of fine aggregate and binder. The definition of true concrete embraces the idea that the voids of large aggregates must be substantially filled, but not greatly overfilled, and that the amount of large aggregate should be the preponderating constituent of the mixture.

With this idea as a guide, the writer would not classify as true concretes, in a strictly accurate sense, such compositions as Topeka mixture or such pavements as that described in the standard specifications of the A. S. M. I., 1916, as "bituminous concrete with one product of a stone crushing plant."

An example of a true bituminous concrete is the bitulithic pavement, which is a true concrete, with refinements as to grading of aggregate. The Topeka mixture, on the other hand, contains a comparatively small amount of what is commonly considered large aggregate, and a preponderating amount of what is ordinarily a mortar constituent similar to sheet asphalt mixture. The Topeka mixture, in fact, should be correctly classified as *a stone-filled sheet asphalt mixture.*

On the other hand, such mixtures as are devoid of fine aggregate or contain insufficient fine aggregate to fill the voids of the large aggregate, such as the A. S. M. I. mixture just referred to, really correspond to the old open binder mixture. Compositions of this character are not concretes in a true sense any more than such compositions as the Topeka mixture above referred to. It would seem to the writer that open mixture of this kind, which is really a binder mixture, could be more appropriately named as either "bituminated rock" or "asphalt macadam by mixing method."

There is a fairly consistent and uniform application of the term "macadam" to those road compositions which are prepared by application of binder thru penetration processes. Such types of construction are very properly termed macadam. The open mixture referred to above is, in fact, a bituminous macadam prepared by mixing method, and should be so classified.

ROTARY TRAFFIC REGULATION

AT STREET INTERSECTIONS

By William P. Eno, Washington, D. C.

The system of alternating traffic at busy street intersections has always caused delays, and the greater the congestion of traffic the greater the delays. A demonstration of its inefficiency is seen in the vacant street space ahead of the block and the crowd of vehicles behind it.

The author of this paper, which was presented before the American Association for the Advancement of Science, gives the brief history of the rotary system of handling traffic on intersecting lines and shows some of its advantages. Not the least, even on narrow streets, is the possibility of continuity of travel of street cars with a minimum of delay to other traffic.

Difficulties occur when car lines cross at a busy intersection, but usually cars can be routed to minimize them.

Foot passengers must have their full measure of attention, not given in the paper except as the diagrams show the location of isles of safety outside the limits of the rotary travel. An exceptional case is that of Michigan Avenue, Chicago, at Van Buren Street, where the crowds crossing the boulevard sometimes hold the automobiles back for two or three blocks, quite as much as tho Van Buren were a busy thru street rather than practically a dead end.

IN 1903 when Gen. Francis V. Greene was police commissioner, at the request of Capt. A. R. Piper, U. S. A., retired, then police deputy in charge of street traffic in New York city, a remedy was suggested to solve the difficulties of Columbus Circle where accidents were of almost daily occurrence. At that time vehicles were going around the circle in both directions. The remedy suggested was that they should go in but one direction. The official regulation now in force reads: "A vehicle passing around a circle shall keep to the right from entrance to exit."

On January 7, 1905, the *Rider and Driver* published an article on this subject. The plan had already been carefully explained to Police Commissioner McAdoo shortly after he took office in January, 1904, but not followed accurately, and vehicles were being forced not only to go around the circle but to go around the block to the north and the block to the south of it, or six blocks further than there was the slightest necessity for. This was corrected later and adopted in its present rather crude but fairly effective form. Iron stanchions with lamps surround a large space in the center, and at the same time reduce the width of the roadway to necessary vehicular requirements. Plate I.

It is not postively known who first suggested rotary traffic. Mr. Inigo Triggs of London and Mr. Eugene Hennard of Paris have both written about it, calling it gyratory traffic, and have published beautiful diagrams illustrating it. Their publications, however, post-date its suggestion for Columbus Circle. I am told that Mr. Camillo Sitte and Dr. Van Steuben also have written on the subject, but I have been unable to find their works. However, the only wonder is that many more people did not think of it, as it is so simple and practical. Its introduction at Columbus Circle is believed to be the first instance of its adoption.

The second example of rotary traffic is at the Place de l'Etoile around the Arc de Triomphe in Paris, where it was put in effect in 1907 and has solved the greatest difficulties of one of the worst traffic centers of the world. Plate II.

The rotary system has now been adopted at all circles in all cities where there is any intelligent attempt at traffic regulation.

There are still, however, many places where streets converge which have no central pivotal zone and where one could easily be created, either by a curbed platform or by lines in or on the pavement, and by traffic stanchions. One of the most important of these places is the Rond Point on the Champs Elysees in Paris. A plan for this was submitted in July, 1912, and was about to be adopted in 1914, when the caving in of the Avenue d'Antin over the catacombs caused its postponement, and then the war came and stopped all constructive traffic work. Plate III.

In the case of the Rond Point the form of the central pivotal zone was to be an ellipse showing that it need not necessarily be a circle, but should be the form best adapted to the particular local conditions.

Up to the present time the traffic plan generally adopted

PLATE I. Temporary lay-out of street car tracks, curb lines, traffic posts and ropes, confining vehicle traffic to the outside 52 feet of the circle. Isles of safety for foot passengers are not shown. The entire inner circle is open for them to pass and to board cars.

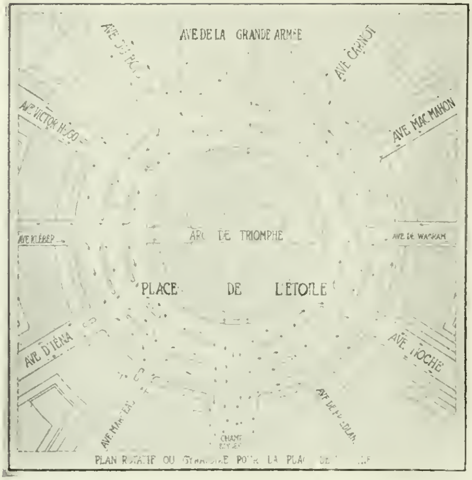


PLATE II. Treatment of the circular Place de l'Etoile, with a dozen entering streets and three stub-end car lines. Traffic is divided into three lines, all traveling in the same direction, to the right. This gives two lines of spaces extending between street intersections which may serve as isles of safety for foot passengers crossing to the center of the circle. Note, also, isles of safety in the wider entering streets, opposite the sidewalks, which serve to separate the two lines of traffic in those streets at their points of entrance into the circle.

at important intersections is the English block system, consisting in stopping and starting vehicles alternately at the intersection of streets in order that traffic may proceed thru each in turn. It was first employed in New York in 1902.

The objection to the block system is that it delays traffic unnecessarily. Vehicles accumulate behind the block and are passed thru in a mass when the block is raised, instead of filtering thru continuously and distributing themselves more evenly over the surface of the street. If you will watch the operation of the block system you will see that just before the block is raised there is often a space ahead of three or more squares which is practically unoccupied by vehicles. In other words this space is wasted so far as traffic is concerned. Plate IV.

The present system of gogo semaphores on Fifth Avenue to enforce the block system for a number of squares at a time is delaying traffic unreasonably. The main feature of it already has had to be abandoned as it did not work, and now each semaphore is being operated independently. Semaphores for individual work are not nearly so good as the hand because they direct all drivers in sight, bringing about a full stop of all vehicles going in one direction, while the hand can direct them individually.

A gogo semaphore is a poor assistant for an incompetent "cop," but none at all for an efficient traffic officer. One of the objections to the gogo semaphore is that the "cop" often forgets to turn it and traffic stops entirely on one of the streets until he finds himself and gets on the job again. If the semaphore had a neutral position it would not be so bad, as when turned to neutral it would cease its detrimental work. However, the gogo semaphore should go anyhow, and when a competent traffic officer cannot be provided for an intersection, one of those posts now known as dummy policemen should be placed at the center of intersection. These posts were suggested in an article published in the *Rider and Driver* on December 24, 1904, but not used until two or three years ago, and now their number thruout the country is legion and their use is general.

It is evident then that the block system, since it is wasteful of space, should not be used except possibly at the most important intersections at congested hours as a temporary expedient to force traffic over those intersections.

A Substitute for the Block System.

The rotary system will work equally as well at an intersection of streets where there is enough room, and with little or no police supervision, as it will at a focus of streets. It is a no-stop system and would very greatly increase the traffic capacity of many streets.

At an intersection of streets the principle to follow is exactly the same as at a focus of streets. In one case the pivotal zone to go around is large, in the other it is small, and that is the only difference. At a simple intersection of streets vehicles will do exactly what they do now where there is no traffic officer in charge—*i. e.*, the drivers will follow the general traffic regulation of going around the point of intersection before turning, only with a pivotal zone in the center they will be still further constrained to follow this rule.

The corners of streets are not now usually cut back on a large enough radius, especially for the rotary system, six feet being about the average. The scientific radius where streets intersect at right angles is one equal to the width of the narrower sidewalk of the two streets. For acute angles it is greater and for obtuse angles less, the exact radius suited for any case being easily determined mathematically.

Where this scientific radius for rounding corners is adopted, the turning space at an intersection will often become sufficiently great for the installation of a pivotal zone around which traffic may rotate just as it now does around a large circle. Plate V.

For all intersections where there is sufficient room rotary traffic is strongly recommended, altho it may possibly be advisable to use the block system with it during congested

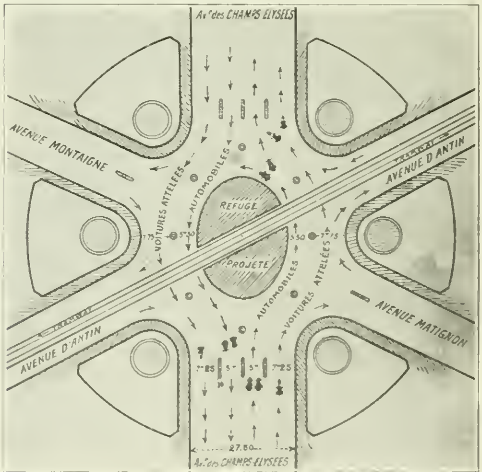


PLATE III. Proposed system for the Rond Point on the avenue des Champs Elysees. The heavily traveled boulevard has its traffic in each direction divided into two streams, horse-drawn and automobile. It is crossed by a street railway line and two other streets enter. Posts around the ellipse serve to keep the two kinds of traffic separate. Isles of safety or traffic separators are shown on all streets except along the street railway tracks.

PLATE IV. Illustration of block system, showing congestion behind block and vacant street space before it, thus using but half the street at a time and increasing rather than distributing the density of traffic along the street.

hours where there are car tracks on one or both streets, but only local conditions will determine this in each case.

In 1914 the police department of New York was prevailed upon to try rotary traffic at the intersection of Fifth Avenue and 57th street, but the lines on the pavement were painted only once, the signs promised by the department were not provided, and it was soon discontinued. Even in its crude form, however, it worked surprisingly well. But rotary traffic cannot be given a really fair trial on such a street as Fifth Avenue unless the trial system extends over quite a distance, as the operation of the block system at points that feed the spot selected for the trial, interferes with the normally even flow of traffic. It seemed as tho perhaps no traffic officers would be needed, as it worked automatically, and this groundless fear may have influenced its discontinuance.

About a year ago, at the suggestion of S. W. Taylor, rotary traffic was adopted in Detroit at the intersection of Grand River and Farmer Streets where the room for the inscribed circle is somewhat less than it would be anywhere on Fifth Avenue. Last October I had occasion to go to Detroit to read a paper on Uniform Traffic Regulations for the National Safety Council, and while there I spent the best part of three days going around with Inspector Rutledge to see what had been accomplished, and especially to observe the working of rotary traffic at the point where they had installed it last year. I was told that the traffic officer stationed at this point before the rotary system was installed had requested to be removed as his nerves could no longer stand the strain. Now they have no traffic officer at this point. The scheme works automatically and satisfactorily. Plate VI.

I should, however, recommend that on Fifth Avenue there be one traffic officer at each intersection during the con-

PLATE V. Effect of large radii at curb corners.

ABOVE: At the left, the curb corner has a radius of 6 feet and the outer circle for rotary traffic can have a radius of only 36 feet. At the right, with 22.5 feet radius for curb corner, the rotary traffic circle has an outer radius of 45 feet, and the inner circle one of 17.55 feet, large enough to make turning easy. The larger the circle, however, the farther back from the corner the isle of safety is forced and on the narrower street it is moved entirely out of the line of the sidewalk.

BELOW: Method of laying out curb corner when the radius is made equal to the width of the narrower sidewalk.

gested hours as his supervision would add considerably to the comfort and safety of both pedestrains and drivers and facilitate the rapid passage of traffic.

I received a letter lately from Inspector Rutledge of Detroit which says:

"I wish to inform you that we have installed the rotary system at Madison and Randolph Streets, that is, at the Detroit Club. Also at Second and Third Streets at the intersections of these two streets with the Boston Boulevard. These are some of the places that we agreed upon where it would be well to try out the system.'

PLATE VI. A small rotary traffic circle at Grand River avenue and Farmer street, Detroit, Michigan, which has eliminated the traffic officer formerly stationed there. While this circle may always be busy, foot pasengers have little trouble in crossing any of the four streets, especially if a traffic separator or isle of safety is placed in the middle of each, just outside the rotary traffic circle.

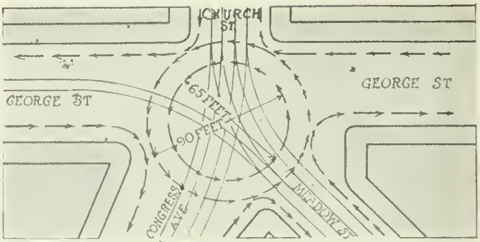


PLATE VII. Rotary traffic circle in New Haven, Conn. Traffic moves to the right in a circular band 25 feet wide with outside circle 57.5 feet in diameter. The street railway crossing is rather complicated, but the traffic circle crosses the tracks where they are reduced to the minimum number. Foot passengers on one side of George street must make quite a detour to keep out of the rotary traffic circle. This is reported to operate successfully, tho it is rather exceptionally difficult. If the wear or disturbance of switches and frogs is excessive the circle could be given a larger radius or distorted somewhat by giving curb corners larger radius, especially at the corner of George and Meadow streets.

More than a year ago the New York city mayor's street traffic committee recommended to the police department that they try rotary traffic on Fifth Avenue from 34th Street to 42d Street or from 42d Street to 58th Street inclusive, and that they expend not exceeding $2,000, in the experiment. The police department said they had not the money for this purpose, altho they bought gogo semaphores.

Now if there is any plan that will increase the traffic capacity of our streets it ought to be given a fair and exhaustive trial. If it proves of as much value at intersections as it has at foci of streets it will pay for the temporary trial in one day and in one month for all necessary construction for permanent installation.

As already said, it took over two years to get rotary traffic even tried at a focus. Now it is the general rule thruout the world.

With the crying necessity for street traffic betterment the authorities should welcome any suggestion and especially the extension of one which has already proven so valuable in saving life and facilitating traffic that a trifle of what it has saved New York alone would pay for all the permanent constructions and changes where it can be applied thruout the whole city.

PROPOSED SOLUTION OF CHICAGO'S STREET TRANSPORTATION PROBLEMS

A commission appointed by the Chicago city council to study the problem of transfer of passengers to and from the center of the city and to work out plans for reducing the present congestion has made its report. The commission is composed of W. B. Parsons, Robert Ridgway and B. J. Arnold and it has made a very comprehensive report covering all phases of the questions involved. The summary of conclusions and recommendations is reproduced here to show how thoroly the commission has done its work and how comprehensive is the plant it has devised.

The experts recommend:

1. That a single corporation be organized to take over the surface and elevated lines.

2. That legislation be sought.

(a) To permit the formation of such a corporation.

(b) To permit the grant of a terminable franchise in return for which the existing companies shall surrender all their definite franchises;

(c) That the city of Chicago be empowered to purchase the property of the new corporation;

(d) That the city of Chicago be empowered to procure the consents of abutting property owners.

3. That the construction of a combined system of subways and elevated railroads be begun at once and co-ordinated with the present and future elevated railroads so developed as to furnish the highest grade of rapid transit service.

4. To give to the city full control over the extensions to the system and additions to equipment and the furnishing of service limited only in that the net return to the corporation will not be reduced below 6 per cent.

Would Extend Partnership.

5. That a financial plan be developed so as:

(a) To extend the partnership management now existing between the city and the surface lines to include the elevated lines so that the city shall have a share in the divisible net receipts of all the lines.

(b) To allow to the corporation, so far as affected by any act or orders of the city, a net return on the combined valuation of the existing properties of 6 per cent.

(c) To invest in the construction of subways or other producing additions the present traction fund and increases thereto on the same terms as new capital furnished by the corporation. That is to say, the corporation shall receive only the actual interest that it has to pay on the new capital furnished and the city shall receive on its revenue producing investment the same rate of return.

(d) To provide for two amortization funds whereby the outstanding valuation or purchase price shall be progressively reduced, these amortization funds to be increased by all remainders of the traction fund, over requirements, for new construction.

(e) To confine the return to the corporation between the limits of 6 and 8 per cent on its then investment in road and equipment by requiring that after its total return exceeds 7 per cent a portion of such excess over 7 per cent and all of the excess over 8 per cent shall be paid into the special amortization fund.

(f) To provide for such use of the traction fund and amortization funds as to establish a practicable and feasible method of acquisition by the city of the entire local traction system.

PLACING AND LINING NEW ARCH IN RECONSTRUCTING NORTH BROADWAY TUNNEL, LOS ANGELES, CALIFORNIA.

RECONSTRUCTION OF THE BROADWAY TUNNEL

LOS ANGELES, CALIFORNIA

The reconstruction of the North Broadway tunnel, Los Angeles, Cal., is interesting as an instance of ingenuity in securing the desired results at a minimum of expense for material and labor, a minimum of disturbance of the old structure, and with a material improvement of the appearance of the street and the tunnel.

The photograph on the front cover shows the end at which the most change was made, while it was still in process of construction and before the space in the portal between the old and the new arches was walled up. The other pictures show various stages in the process of construction.

THE old tunnel on North Broadway, Los Angeles, extending from California street on the south to Sunset boulevard on the north, about 760 feet, gave an outlet from the business section of the city to residence and suburban sections on the north and northeast.

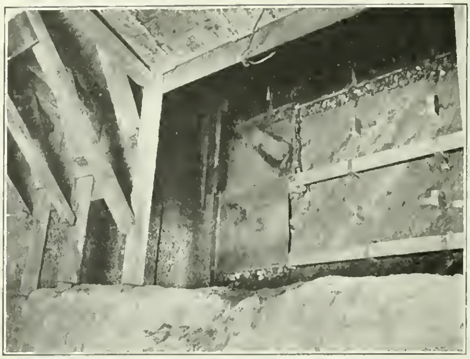
The grade in the street from Temple street, one block south, and extending thru the tunnel was one of 6 per cent., and the street was unpaved. This made traffic difficult. Moreover the appearance of the tunnel was objectionable, since the inner surface was of plaster, continually damp and mildewed in appearance.

It was proposed to improve the situation by reducing the grade from 6 per cent. to 3.8 per cent. from Temple street thru the tunnel, changing California street grades to meet the new Broadway grade, and to pave the roadway with wood blocks.

This required a lowering of the tunnel floor of 3 feet at the north entrance and of 20 feet at the south portal. The tunnel had a span of 40 feet, and its original height was 22 feet at the center.

The excavation was made 36 feet wide with a Thew steam shovel, leaving 2 feet on each side to be removed as the new side walls of the tunnel were put in. The shovel was put to work at the north end, where the cut was least, and the first time thru a maximum depth of 7 feet of earth was removed. All the remainder of the depth was taken out on the second trip of the shovel.

Immediately following the steam shovel on its first trip the excavation for the underpinning of the old tunnel was made. The second photograph on the following page shows one wall near the north end under which the underpinning is completed. These underpinning walls are 5 ft. 5 in. thick and were constructed in sections 10 feet long, a separate excavation being made for each of the 160 sections required under the two walls together. The photograph gives an idea of the rapidity of increase in height of this new underpinning wall as it extends from the north end of the tunnel toward the south end. To insure that no settlement would occur on account of the methods of construction of this wall,



EXCAVATION FOR 10-FOOT SECTION OF UNDERPINNING WALL, SHOWING METHOD OF INSERTING BROKEN STONE DRAINAGE LAYER AND OF JOINING NEW AND OLD SECTIONS.

each excavation for a new section was at least 70 feet distant from any preceding section which had not been finished long enough for the concrete to be thoroly set. At least 10 days was allowed for the setting. All the materials for the concrete walls were handled and mixed on the floor of the tunnel, as the work proceeded, a Foote mixer being used.

The photograph shows also the bearing for the new arch at its springing line.

Before placing the concrete in these walls, proper drainage was provided for by placing 3 inches of broken stone next to the earth in the excavation. The photograph above shows the excavation for a section of the underpinning wall with planks attached to other timbers embedded in the earth, the horizontal planks serving to carry sheet iron plates which hold the broken stone in place and serve at the same time for the back form for the wall. Two of these plates are seen in position with gravel behind them. The method of holding the gravel behind a plate until the next plate and its gravel are put in place is seen at the left edge of the lower plate, a light strip of wood of any sort held in place by spikes driven into the earth.

At the right the end of a completed section of the wall shows the groove formed in it by a beveled plank set in the end of the form, so as to make a recess. The concrete of the new section of the wall fills this recess, and thus the two sections of wall are made to act together in the desired manner.

The new arch, 8 inches thick, is composed of two rings of hard common brick masonry with an inner facing of 3 by 6-inch white glazed tile set in an inch of cement plaster. The construction of this arch and tile facing is shown in the picture at the head of this article. The open space between the upper side of the new arch and the inner surface of the old arch is also indicated.

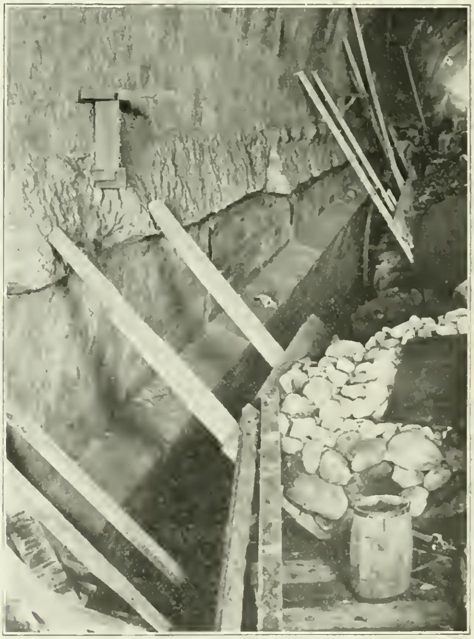
The brick arch was built in 20-foot sections on a large arch form of five trussed sections carried on heavy timber bents. It was moved from one bent to the next by means of rollers running on cross timbers, being lowered a few inches to clear the finished brick work and then jacked up to proper elevation for laying the brick for the new section. A section of the arch would be finished and keyed up one evening, would be allowed to stand for about 36 hours, when the form would be moved forward and set and a new section laid. In this way a section was completed in 48 hours. To give the bricklayers continuous employment and thus halve the time of construction two of the large forms were used and the arch was constructed in two divisions, one beginning at the north portal and the other at the center of the tunnel. By working each alternate day on a section one gang working continuously kept the two sections going.

The tile lining was also placed on the two sections in the same way, two 50-foot movable scaffolds being used. One of these is seen in the background of the picture at the head of this article.

The 8-inch brick arch, about 40 feet span, is self-supporting, but has nothing else to carry, as the space between the old arch and the new one is left vacant. It ranges from 3 feet in height at the north end to 20 feet at the south end, the latter being seen in the last photograph. Cables, conduits and pipes may be laid in this space on occasion. The two ends were walled up before the contract was finished, tho the photograph shows the south end open. This chamber has 8-inch vents leading to the street above with 3 by 5-foot manholes. Drains collect any water which may seep in thru the old arch.

The tunnel itself is paved with 2,555 sq. yds. of creosoted Oregon cedar block paving. One of the approaches is paved with 2,778 sq. yds. of asphalt paving and the other with 1,222 sq. yds. of granite block paving.

The excavation in the tunnel floor amounted to 36,000 cu. yds. About 5,000 cu. yds. of concrete were placed, keeping a ½-yard mixer employed constantly. The construction work cost $190,000, and the damages on account of the changes in grade of the streets affected were about $110,000. Contractor Lynn S. Atkinson, Los Angeles, completed the work in about nine months without accident of any kind to work or workmen. We are indebted to him for data and photographs.



COMPLETED CONCRETE UNDERPINNING WALL NEAR NORTH END READY TO RECEIVE THE NEW BRICK ARCH.

CONCRETE SEWER FAILURE

DUE TO POOR AGGREGATE AND DEFECTIVE METHODS

By M. T. Cantell, C. E., Winnipeg, Man.

This article is abstracted from a report of the author to the rural municipality of St. Vital, and demonstrates the necessity of proper construction of concrete sewers and at the same time the value of concrete sewers when properly constructed. The article is made up of selections from two reports by Mr. Cantell, to whom we are indebted also for the photographs from which the cuts are made.

THE trunk sewer of the rural municipality of St. Vital on St. Mary's Road was built of concrete in 1914, being finished in the fall. Decomposition in the concrete was first noticed in the fall of 1915. Detailed examinations of the condition of the sewer were made in February, May, June and October, 1916, and the results of the investigations are taken from the reports upon them as follows:

The sewer is egg shape in section and is constructed of concrete, as shown in the accompanying drawing, the dimensions of this portion being 42 inches wide and 63 inches high, with the concrete six inches thick.

On February 12 the report was that in the portion between the Municipal Hall and Nichol Avenue disintegration of the concrete is rapidly taking place, and to such an extent that if it is not immediately arrested destruction of the whole of this length of sewer would be inevitable at an early date. North of Nichol Avenue, it was under the process of disintegration; altho not so far advanced as in the more southerly portion.

In May the disintegration had greatly increased; a considerable length between Hull Avenue and Nichol Avenue had entirely collapsed, and large patches had fallen out in many places.

It was necessary to entirely reconstruct about 430 feet between Hull Avenue and Nichol Avenue, and some 400 feet further south of this point and about 400 feet north of Nichol Avenue. The remainder in St. Mary's Road, from the south end of Harrowby Avenue, must be lined. About 20 feet of the sewer in St. Anne's Road must be reconstructed. Some of the Mager Drive sewer must be patched, and it must be lined thruout to avert disintegration. The same was true of the sewer in Rosewarne Avenue and Kingston Row, but promptness of action was not quite so necessary.

The coarse aggregate used for the concrete consists of from 60 to 65 per cent. of limestone in various degrees of crystallization, some of which is silicious and some of a metamorphic nature; about 20 per cent. consists of hard stone of igneous formation, chiefly granite and trap rock; the remaining 15 to 20 per cent. consists of soft granular limestone, i. e.: limestone devoid of crystallization. The sand is similar in nature to the coarse aggregate but does not contain such a large percentage of non-crystalline limestone.

The proportion and quality of cement used thruout is satisfactory and appears to agree fairly closely with the 1 to 6 mixture and the other conditions called for in the specifications.

There is evidence of the concrete being mixed with an excess of water and of being deposited with insufficient or no tamping, resulting in a porous concrete of insufficient density to resist the penetration of moisture and deleterious gases. The density of the concrete is very irregular. In places it is of average density but it is generally porous and in places exceptionally so, the cavities varying in size up to that of the stones,

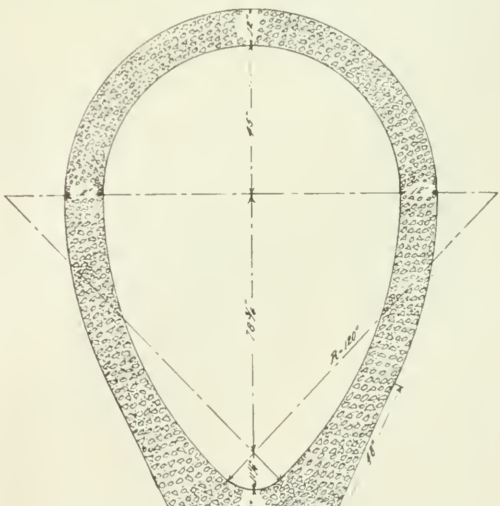
The air in the sewer contains a large proportion of carbonic acid and ammonia, a small proportion of sulphureted hydrogen and a trace of marsh gas.

The soil in which the sewer is built consists of a plastic calcareous clay containing a small trace of alkaline matter, underlying about 18 inches of peaty vegetable earth in which there is a trace of carbonic acid, probably generated by decaying vegetation and carried in by surface water. The alkaline matter is insufficient to give rise to the formation of soluble salts likely to cause efflorescence and consequent disintegration.

The disintegration is brought about primarily by a breakdown of the limestone aggregate of the concrete, thru being attacked, chiefly by the carbonic acid and the ammonia and to a smaller degree by the other deleterious gases contained in the sewer air. These chemicals have great affinity for carbonate of lime and carbonate of magnesia. The limestone consists almost entirely of the former, with, in some cases, a small percentage of the latter. The acids in the air are dissolved by moisture and thus rendered capable of attacking the carbonates and setting up chemical action, which results in decomposition of the stone. The acids then attack the lime in the cement, which results in the complete disintegration of the concrete.

The chemical action and process of disintegration are observable in the following:

90"x135"



SECTION OF SEWER SHOWING FORM AND DIMENSIONS.

STALACTITES AND DISINTEGRATION IN THE CROWN OF THE SEWER.

(1) The formation of sulphates and carbonates, which are extensive and in various forms. Sulphate of magnesia is shown as a white salt-like efflorescence, and the sulphate and carbonates of lime as a creamy white substance running down the wall like a thick paint, and in numerous places hanging like icicles in the form of stalactites, each of which can be seen in the accompanying photographs. These sulphates and carbonates exert an irresistible force during formation, and when forming within the pores of the concrete they fracture, burst, or render friable, the surrounding material.

(2) By the gases attacking the limestone in parts more free from moisture and liberating the carbonic acid gas contained in the stone. This converts it into quicklime, which hydrates in the presence of moisture, and in so doing it expands, fractures the concrete, powders and is subsequently converted into a paste of putty-like consistency, which is dissolved and washed away by water.

The action of the gases is intensified by the presence of moisture due to percolation thru the concrete from the soil and from the water within the sewer; this water dissolves the acids in the sewer air thus enabling them to easily attack the carbonate of lime and magnesia, forming sulphates which are very soluble in water. Owing to porosity the concrete offers very little or no resistance to the penetration of the gases.

The disintegration invariably commences at the inside and varies in depth from superficial roughness to complete disintegration thru the whole thickness of the concrete. At any one particular point it is greater at the inside than toward the outside, and is invariably greatest where the moisture most easily penetrates and the non-crystalline limestone is present.

My detailed examination fully indicates the following:

(1) That the disintegration is chiefly due to the use in the concrete of a large proportion of soft non-crystalline limestone, containing 90 to 96 per cent. carbonate of lime (lime, carbonic acid and water).

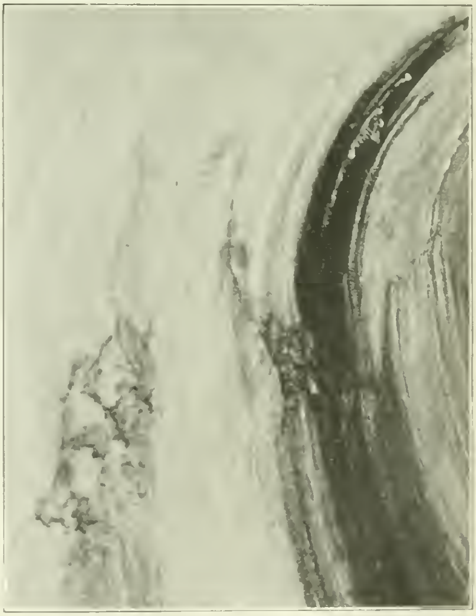
(2) That the disintegration would have been much less rapid and probably only superficial if the concrete had been of sufficient density to resist the penetration of air and water, and had the sewer been better ventilated.

(3) That the disintegration would not have taken place if the interior of the sewer had been finished with an impervious lining. The existing lining consists of a coating of cement grout.

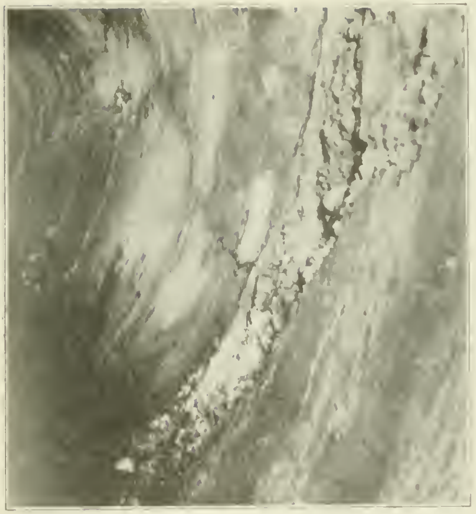
When an extension of the sewer is made I recommend the municipality to refuse permission to use limestone of the class herein described as bringing about the disintegration, and to enforce means to secure a dense impervious concrete with a water-proofing lining.

To restore the sewer to a satisfactory condition I recommend the following:

(1) That about 400 feet between the Municipal Hall and Nicholl Avenue be entirely removed and reconstructed, for which it will be necessary to open up the trench to facilitate construction. A further portion of this length to have a part



TWO DISINTEGRATED SPOTS. WHITE SURFACE SHOWS DISSOLVED LIME. BLACK STRIP IS ORIGINAL UNAFFECTED CONCRETE.



DISINTEGRATION ON SIDE WALL OF SEWER. SURFACE COVERED WITH DISSOLVED LIME.

only removed and reconstructed; this can be done from inside the sewer and will not necessitate opening the trench above. The remainder of this portion to have small defective patches cut out and made good.

(2) That to preserve this portion from further disintegration and ultimate destruction, the whole of the inside, except the portion entirely reconstructed, be cleaned and lined with an impervious lining in accordance with the appended specifications.

The cost of the reconstruction recommended above is estimated at $7,500 and of the lining $8,500, making a total of $16,000.

The accompanying photographs show the decomposition and disintegration in various stages. The white streaks and coating represent the sulphates and carbonates of lime which in places cover almost the entire surface and can be seen hanging in the form of stalactites. The dark streaks show the cement surface not yet covered with lime. The uneven broken patches are of putty-like consistency and can be easily removed without the use of tools. Fractures are seen along the side.

SURFACE COMPLETELY COVERED WITH DISSOLVED LIME. CRACKS IN SIDES AND DISINTEGRATION.

CRITICISMS OF CHICAGO PAVING

Last summer Prof. I. O. Baker made a report on paving methods and results in Chicago, which cast some very serious reflections on the work, the honesty of the contractors and the competency if not the honesty of the city's engineers and inspectors. It developed that the report was made on the basis of a very brief personal examination and some data furnished by others, and on that account it was not published in MUNICIPAL ENGINEERING.

After time for careful study of the facts in the case, C. D. Hill, engineer in charge of sewers for the Chicago board of local improvements, has written a letter to *Engineering News* in which he demonstrates the inaccuracy of many statements in the report and does much to repair the damaged reputations of his colleagues in Chicago's engineering force.

It would seem from Mr. Hill's statements and figures that the contractors were unusually expert in doing their work. In many investigations of the same sort as Prof. Baker's, the writer has found that when the contractor was expert he followed the limitations of the specifications exactly, and that when a contractor failed to meet the specifications it was because he was not sufficiently expert and instances of work better than required offset those which were not as good as required, showing that he had the same intentions as the expert contractor, but could not carry them out uniformly. Of course, there is the occasional contractor who is trying to skin his job, but he is not numerous even in the jobs which are subject to special investigation, where he might be expected.

Every contractor is expected to make all the money he can legitimately and he would be foolish to exceed the specifications any more than would be necesary to insure that he would be always within them. The most successful contractor, really the best contractor on any job all things considered, is the one who meets his specifications with the greatest exactness and with the least to spare. At least that is the writer's experience.

WORKERS IN THE FIELD

The Schenectady Recut Granite Block Pavements

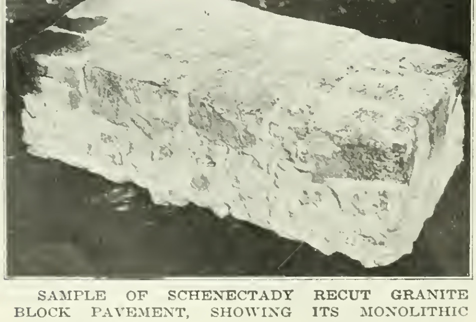
The Editor of MUNICIPAL ENGINEERING:

Sir—During 1913, when the writer was Commissioner of Public Works of that city, Schenectady, N. Y., repaved State street part way around Crescent Park, in front of the court house, central fire station and armory, with small granite blocks laid in a mortar bed upon a new and still wet concrete foundation, and grouted the joints with cement grout, accomplishing a monolithic construction such as is now so strongly recommended for all block pavement.

These small new granite blocks were cut from the large old blocks already on the street, the work of recutting being done on the job. A detailed description of this work was published in MUNICIPAL ENGINEERING of May, 1914. Four new blocks were cut out of each large old one, the new blocks averaging about 6 inches long, 4 inches wide and 4 inches deep. The blocks so cut covering just about twice the surface area of the old, it was possible to relay about 10,000 square yards of pavement with the blocks from about 5,000 square yards of old work.

Some cities seem still to think that modern, small-sized, highly dressed granite blocks cut from old blocks are different from and inferior to new blocks from the quarries. There is a difference—but in price only. For from 50 to 80 cents per square yard, and about twelve old blocks, new ones can be produced, equal in every way for paving purposes to those costing from $2 to $2.50 per square yard delivered on the job from the quarries.

If any city official who has old granite block pavements to deal with doubts this at all, let him go to Schenectady today and look at this work in front of the court house and the armory, in the center of that city. There are other small sections at street intersections that will be worth seeing, but this one section will probably be enough. Then let him get MUNICIPAL ENGINEERING for May, 1914, and see just how the work was done.



SAMPLE OF SCHENECTADY RECUT GRANITE BLOCK PAVEMENT, SHOWING ITS MONOLITHIC CHARACTER.

The writer examined this pavement in January, 1917, after it had been under rather heavy traffic for three years and more, and could see little sign of wear. It is still perfectly smooth and in line, and, as it is traversed on pneumatic tires, is quite as smooth-riding as sheet asphalt. It is neither very noisy nor hard on the vehicles that pass over it by the thousands each day. The other stretches of this work in the city are in equally good condition, except where street openings and track repairs have been made.

At the time the above work was done, some claimed that the concrete foundation was not thick enough to hold the traffic, others that it was unwise to dispense with the sand cushion, and still others declared the blocks too small. The results seem to indicate that these critics were wrong. There is very little settlement any where, in spite of the fact that the street is directly over an old waterway and the former pavement on a sand bed had sunk badly out of shape. New York and other cities are now adopting mortar bed for granite blocks, and the modern brick roadway is of like construction. The small granite block is getting even smaller, and today we have the 3-inch cubes or Durax, which the writer believes will be quite successful wherever it is properly laid.

Tho the work at Schenectady was done by inexperienced foremen, the man in charge, Mr. Robert K. Wilson, was of high intelligence, and the writer gave the job considerable personal attention. The results in smoothness of surface and detail are very gratifying. Where so much money is being spent in material, especially with new granite block work, it would seem very poor economy to stint on supervision and care in the paving and surfacing. A young assistant engineer should, the writer thinks, be on the work at all times and right with the pavers, watching the laying of each yard and detecting the slightest departure from the proposed surface lines. It is quite difficult and expensive to correct errors after they are made, and no possibility of error that can be avoided should be allowed to exist.

The Milton Hersey Company has recently recommended to the City of Montreal the recutting and relaying of all granite block streets that need repaving, and as soon as any of this type of work is done by them, will draw careful specifications therefor following out the Schenectady method, with any slight modifications that the local situation may require.

The photograph herewith is of a model section of the pavement made at Schenectady while the work was in progress, and shows the monolithic construction as it was practiced in the work and now exists on the streets.

CHARLES A. MULLEN, Director of Paving Dept.,
Milton Hersey Co., Montreal, Que.

LEFT: GRATING OVER CATCHBASIN AND ENTRANCE TO DRAIN UNDER STREET INTERSECTION. RIGHT: GRATING REMOVED, SHOWING BASIN AND END OF PART-CIRCLE CULVERT.

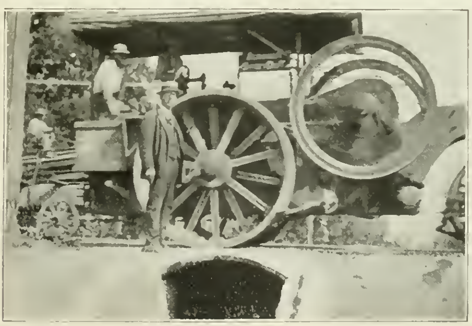
Surface Drainage at Street Intersections

One of the difficult problems of the street superintendent and the city engineer is to carry surface water across street intersections when there are no sewers or storm water drains to take the water. Usually the depth below the crown of the street is limited, and if the amount of water to be carried in a sudden hard storm is large the cross section of the opening must be large, and since it cannot be deep it must be wide. Circular culverts are therefore ruled out in many cases. If the span is large the roof of the culvert, which must be at or very close to the surface must be flat or nearly so and must be strong enough to carry the weight of the traffic.

One excellent solution of the problem, applicable in many cases, is the part-circle corrugated iron culvert set in cement with ample bearings at the sides. This plan has been used in Alhambra, Cal., under City Engineer R. H. Blacklidge and the accompanying photographs show how the details have been worked out.

In the left hand photograph above is shown the surface of the gutter with the curb on the right and a grating in place to screen out large floating matter which might lodge in the culvert. Under the grating is a chamber, seen in part in the right hand photograph, which catches sand and other heavy matter, the water running off across the street thru the culvert, the end of which is seen in the picture.

To show closer views of the construction of other varieties and its strength the third photograph is shown with



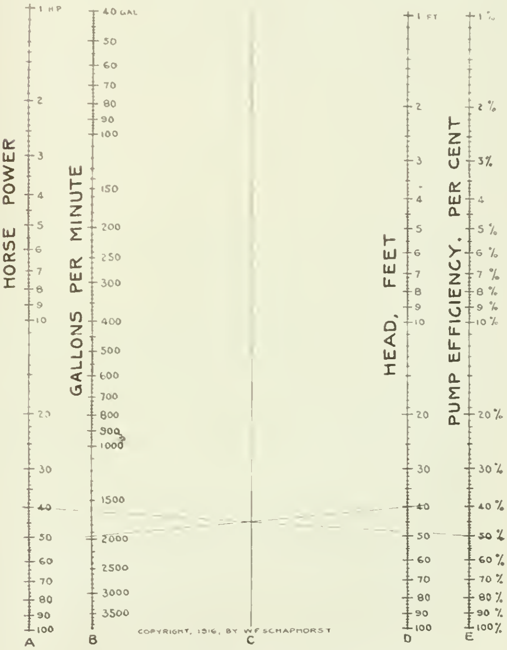
a 12-ton roller over the arch of the top. The span of the ingot iron arch set in concrete is 26 inches, and the rise is 4 inches. Ledges on which to rest sloping grating or cover are seen on each side of the opening.

A Handy Chart for Figuring Pumping Capacity, Etc.

The Editor of MUNICIPAL ENGINEERING:

Sir—This chart will be found useful for finding the horsepower necessary to do almost any pumping job up to 100 h.p.; for finding the gallons of water a given pump will lift per minute; for finding the head; or for finding the efficiency of a given installation.

For example, how many gallons per minute will be pumped by a 40-h.p. motor thru a 40-foot head, the efficiency of the pump being 50 per cent? Join the 40 (column A) with the 50 per cent (column E) and locate the intersection with column C. Then run a straight line thru that intersection (column C) and the 40 (column D) and the answer (1,950 gallons per minute) is found in column B.



The principal point to remember is—always connect A and E; B and D. The two outside columns must be used together, and B and D must be used together.

It is plain, now, that knowing three of the values in A, B, D and E, the fourth one is easily and quickly found without any computing.

When figuring efficiencies usually allow about 80 per cent. for duplex, triplex, and reciprocating pumps in general; a good modern centrifugal pump, about 60 per cent.; and for air lift pumps 40 per cent is considered pretty good. Higher efficiencies than these have been attained with all the above pumps, to be sure. If you know the exact efficiency of your pump or the pump you have in mind, that is the efficiency to use in the chart, of course.

W. F. SCHAPHORST, M. E.,
New York.

WATER

How Cleveland Accounts for 94 Per Cent. of its Water Supply

An item has been going the rounds of the press to the effect that Cleveland, O., was accounting for 94 per cent. of the water pumped, knowing within 6 per cent. where all the water goes, whether for public or private use, or wasted. This is a larger percentage than any other reported at the meeting of the American Water Works Association at which the statement was made, and requires explanation either as to the delinquency of water works officials in other cities or as to the manner in which the percentage of efficiency of the measuring system is computed.

Mr. C. T. Schulz of the Cleveland water department gave some details of the method of obtaining the percentage referred to.

At the beginning he states that he begins to measure the efficiency after the water has passed the venturi meters in the discharge mains, and he obtains the quantity to be accounted for, not from the readings of the meters, but by deducting 3 per cent. for slippage from the pump plunger displacement. He states that the venturi meters show that the pump slippage does not average more than 1 per cent., so that he would start his computation with 2 per cent. more water than he actually has, but for the fact that he believes that his venturi meters are less accurate than his pump displacement measurement and his 3 per cent. slippage estimate. Moreover, he assumes the difference to be always in the same direction.

About 99 per cent. of all services are metered and the meters account for 88 per cent .of the water.

Accurate record of water used for fire extinguishing is kept, showing 74,566,000 gallons in 1915. The gangs settling trenches, flushing services and water mains, etc., keep accurate record of the amount of water they use.

A few connections are not metered, and public utility corporations use unmetered water for construction purposes. These unmetered quantities are assumed to amount to less than 3 per cent. of the supply. Overflow of the reservoir is assumed to account for a considerable portion of the remainder.

From the detailed table showing the items of the account for several years the following data are taken for 1915:

	Per Cent.
The percentage of water metered and sold was..	82.03
That metered but free was	6.74
A total of	88.77
The slippage in the meters is estimated at 3 per cent., or computed on the 88.77 per cent., is	2.66
The use of water paid for on the flat rate basis, hydrant rentals building purposes, sprinkling streets, miscellaneous purposes, was estimated by computing the number of gallons at meter rates which would call for the flat payments made. These all amount to	0.72
Unmetered free water for testing meters, building sewers, paving streets, puddling trenches, flushing water mains, flushing sewers, watering troughs, parks and fountains, fire extinguishment, etc., some of which is measured more or less accurately by means of size of nozzle and time water is running, amounts to	2.07
The leakage from the pipe system based on reports of leaks discovered, with no data as to duration, and otherwise unreliable, is estimated at	1.20
Making a total accounted for the year 1915 of	95.37

This detail indicates unusual care in studying the sources of error, but also shows where there are some opportunities for inaccuracy in estimates. But the accounting for nearly 89 per cent. of the water thru meters, even when corrected by the difference between displacement and meter measurements at the pumps, cannot be seriously questioned and goes well beyond the results in other cities.

Indeed, in the discussion of which this report by Mr. Schulz is a part, the statement was made that accounting for 80 per cent. of the water indicated a very efficient water department, and 85 per cent. was a warning to investigate the methods of securing the result that sources of possible error might be discovered.

Co-operation Secures Water for Two Towns

The towns of Pecos and Barstow, 10 miles apart, and located in different West Texas counties, have solved by cooperation the vexed problem of securing an adequate and satisfactory water supply and a sewer system. These two towns are located in a region of alkali water, and neither of them has felt able singly to go to the expense of bringing pure water from a distance. The two towns have now joined forces and by jointly offering a favorable franchise, a company capitalized at $300,000 and upon the physical properties of which $200,000 in bonds will be issued, has undertaken to put in joint waterworks and sewer systems for the two places. Two hundred consumers have been secured in Barstow and 500 in Pecos, as well as a number along the line of the watermain which will be laid between the two places.

The water is to be secured from wells located 10 miles northeast of Barstow, where the amount of the water available has been thoroly tested as well as its quality approved. A site for a concrete reservoir has been selected which is 350 feet higher than either Pecos or Barstow, and a short distance from the location of the wells. Here a reservoir of sufficient capacity to supply a maximum demand for 20 days is to be constructed, and the natural fall from the reservoir site to the two cities will furnish adequate pressure for any emergency. H. LaSalle, of El Paso, who is in charge of the enterprise, has secured contracts from laundries, cotton gins, railroads and all other large consumers of water in the two towns, to furnish water at specified rates.

Practical Method of Using Waterproofing

One of the secrets of success in water-proofing concrete is uniform distribution of the waterproofing so that no voids are left unfilled. If all voids are properly filled with an active collodial substance there can be no passage of water thru the structure. It is very important that a certain measured amount of waterproofing should be used in every yard of concrete to insure maximum density and non-porosity.

The consistency of concrete varies widely on different operations and under different conditions. A few contractors prefer to use 25 or 30 gallons of water per cubic yard, which gives a rather dry mix. The majority are using from 30 to 40 gallons per yard, yielding a wet mix which is eatsily spaded and more easily handled than the drier mix.

Under some conditons it is necessary to use two different mixes. Perhaps some of the concret has to be poured on a slope, necessitating a dry mixture, while that on the level is poured wet.

A striking example of this is seen in the large reservoir at Omaha. The sides were poured on about a 30 degree slope, requiring only 26 gallons of water per yard of concrete. The floor was poured sufficiently wet, so that the concrete could be placed thru chutes.

By this it is seen that there can be no standard set for the amount of water that shall be used for mixing a cubic yard of concrete.

The usual specification for using a paste waterproofing states that a certain amount by volume shall be mixed with a certain number of parts of water. This mixture is then to be used in place of clear water for tempering the cement and aggregate.

Since the amount of water used for each yard varies from 25 gallons to 40 gallons, so also will the amount of waterproofing per cubic yard vary. For example, we will take a waterproofing that is used in the proportion of one part by volume to 36 parts by volume of water. If 1 gallon of waterproofing was mixed with 36 gallons of water there would be a total of 37 gallons of waterproofing mixture to be used the same as clear water for tempering the cement and aggregate. Assuming that the waterproofing weighs 8 pounds per gallon, then every gallon of mixture would contain 1/37 of 8 pounds, i. e. .216 pounds of waterproofing. The contractor using 25 gallons of water per cubic yard will use 25 times .216, or 5.4 pounds of waterproofing, in every yard, while the contractor using 35 gallons of water will use 35 times .216, or 7.5 pounds of waterproofing, in every yard. This would mean that one man is using too little or the other too much. It demonstrates that uniform results cannot be obtained by mixing the waterproofing as specified above. It is necessary, instead, to specify that a certain number of pounds of waterproofing shall be used per cubic yard and then introduce that number of pounds regardless of variable factors.

In one case it was decided that 6 pounds of paste per cubic yard was sufficient for the job, and it was introduced as follows:

The head was knocked out of a barrel of paste and half of it removed to an empty barrel. About five gallons of water was added to the half barrel of paste and the mixture was

stirred thoroly. The object of this stirring with a small amount of water is to prevent the formation of lumps, which are liable to occur if all the water is added at first.

When this has been thoroly stirred to a smooth consistency, more water is gradually added while stirring until the barrel is full. This gives a thick, creamy mixture containing one part of paste and one part of water. The paste weighs 8 pounds per gallon. So every gallon of one-to-one mixture contains four pounds of waterproofing paste. Since 6 pounds of paste was to be used in every yard, 1½ gallons of the one-to-one mixture was necessary. The mixers used were of ¾ yard capacity, and so in every batch there was used ¾ of 1½ gallons, or 9/8 gallons, of the one-to-one mix. A measure was made which held just the correct amount for one batch, and the workman filled this and dumped it into each batch as the cement and aggregate were added. This insured that 6 pounds of paste would be introduced into every yard of concrete, regardless of the number of gallons of water used. Each night the number of yards of concrete and the number of pounds of paste used were accounted, giving a check on amount.

The European War Changes the Water Supply of an American City

The city of McKeesport, Pa., has for many years taken its water supply from the Youghiogheny river. This water is seriously polluted by drainage from coal mines, which makes the water acidulous and very hard. McKeesport was the first city to put in a large water-softening plant for the purpose of treating the entire water supply as a city and it has had some very interesting experiences, as the conditions of the water from day to day, and even from hour to hour, from a condition of alkalinity to one of considerable acidity and hardness, the latter being the ordinary condition. The maximum acidity in six years was 390 and the maximum alkalinity was 60, the average of every year being pronouncedly acid. The hardness varied from 39 to 802, averaging each year from 128 to 243.

In the softening of the water from 100 to 3,800 pounds of lime have been required per million gallons, and from 0 to 7,000 pounds of soda ash, the average for the six years being 1,866 pounds of lime and 1,450 pounds of soda ash per million gallons. The cost of lime has been $3.03 and of soda ash $11.72, making a total of $14.75 for chemicals per million gallons treated.

The large amount of chemicals required for the treatment of the water from the Youghiogheny river has caused the water department to consider the Monongahela river as a source of supply. The question of future pollution in the two watersheds, particularly from mine drainage, prevented the change from the one to the other until the European war made a material change in the cost of soda ash.

When the report on the use of the Monongahela river water was made it was estimated that its use would save the city $15,000 a year because of the smaller quantities of chemicals which would be required, while the works required to make the change would cost only $75,000, being simply an installation of turbine pumps and about 2 miles of supply mains, but the doubt regarding the continuance of the relative difference between the two waters prevented a decision in favor of the change. But when the war lifted the price of soda ash from $14 a ton to $50, with a possibility of still a higher figure when the present short-time contract expires, the saving from the use of Monongahela river water jumped and will be from $25,000 to $75,000 a year, according to the relative conditions of the waters of the two rivers. At the latter figure the cost of the necessary works to make the change would be saved in a year. As a consequence the works are under construction and the Monongahela river water will be available in July.

The works consist of an intake and a low-service pumping station on the east shore of the Monongahela river about a mile above its juncture with the Youghiogheny, the pumping station containing three electrically driven centrifugal pumps of 4, 5 and 6 million gallons capacity, and 10,000 feet of 24-inch cast iron supply main to the present purification plant.

The old plant can be kept in use as long as may be desired.

Patented Paving Materials on National Aid Roads

Considerable discussion occurred at the recent Boston Good Roads Congress of a regulation by the Secretary of Agriculture among those governing the application of National Aid to good roads, which regulation provides that no part of the money apportioned under the act shall be used directly or indirectly to pay or to reimburse a state, county or local subdivision for the payment of any premium or royalty on any patented or proprietary material, specification, process, or type of construction, unless purchased or obtained on open actual competitive bidding at the same or a less cost than unpatented articles or methods equally suitable for the same purpose.

Not all the bearings of such a regulation were touched in the discussion, tho it was shown that in at least one state, New York, it would eliminate all patented materials and methods from the competitions, because there cannot be in that state competition between different kinds of material for street or road in the same letting. The choice of specification must be made first and the competition must be under that specification. A patented pavement could be laid under the New York system, but under this regulation no part of the National appropriation could be applied toward payment for it, because the competition of bidders did not demonstrate that the patented pavement cost no more than another equally good.

It was suggested that the royalty might be deducted from the gross cost of the pavement and paid by the local authority and the portion to be paid from the National appropriation be figured in this net cost, but there was no indication that this could be done.

One difficulty with the regulation arises from the fact that many patents on paving materials and methods are obtained because the inventor thinks he has something better than any one else in the same field, and occasionally he is correct. When this is the case, the question of actual cost is one which should not enter. The pavement costs more and is worth more without reference to any royalty. There is no pavement of equal quality admissible to the competition, so there is nothing with which to compare it under the terms of the regulation. There is thus an actual loss to the highway system on account of the exclusion of this patented pavement from the competition.

Again, a strict reading of the regulation would restrict the comparison with a payment equally suitable to the bid prices. This might be unjust because the real value of a pavement is not measured by its first cost, but by its continuous cost including annual maintenance and amount set aside for renewal at the end of its economical life.

Of course all these comparisons include the item of personal judgment of some one or some board. Are not the chances for error and for graft under the regulation not fully equal, or a little greater than they would be with no regulation? Would not a less drastic regulation work less injustice to good pavements at the same time that it enables the Government's experts to refuse approval of poor pavements, patented in ignorance or as a basis for improper promotion?

ROADS AND PAVEMENTS

Cost Accounting for Municipal Work

The value of cost accounting is now so thoroly recognized that no argument for its principles is necessary. The principal causes of delay in the application of systems of cost accounting are perhaps three: (1) The fear, in departments run for the benefit of the party, that the system will demonstrate too clearly the fact that work is done at too great expense and the reason why, thus making radical changes necessary; (2) lack of knowledge of how to establish a system and of sufficient tenure of office to make it worth while, in the official's opinion to do the study and work necessary; (3) as a corollary, inefficiency in such attempt at establishing of cost records as may have been made, so that the results are not commensurate with the labor and expense involved, such failures being cited as reasons for refusing to go further with the matter.

It would seem that cities doing work by day labor would be specially desirous of keeping full data regarding cost of doing work, but this is seldom the case and foremen are permitted to go indefinitely with no check upon their efficiency as managers, resulting in excessive cost of work. If amount of work done is not measured or is incorrectly measured or estimated even total costs are not checked and waste is certain.

Any information regarding success in installing cost accounting methods will aid in overcoming the difficulties in the way. This report of a few details of such a system is given for that purpose.

Victoria, B. C., is a city which grew rapidly for several years, and consequently did a large amount of public improvement work. Much of this work was done by the city departments, materials being purchased by the city and labor employed, and work done under the supervision of the city's engineers, superintendents and foremen. Cost keeping systems were adopted and have been improved from time to time until they are now very efficient.

Daily and weekly reports are made on blanks for the purpose and these are summarized in monthly and annual reports.

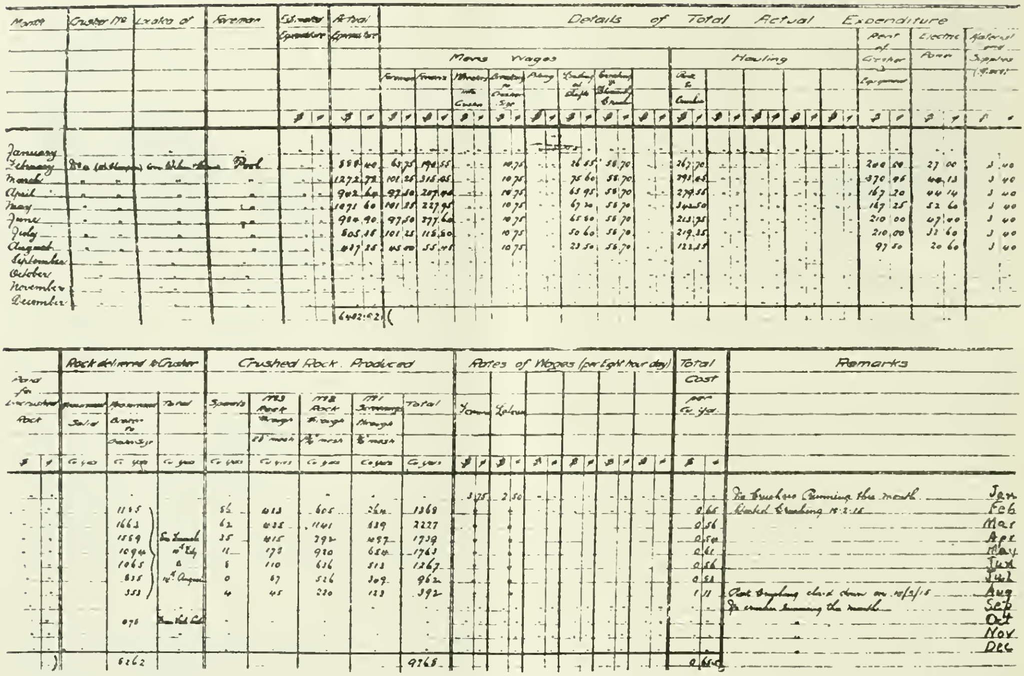
The tables reproduced herewith give samples of the completeness of detail in the reports and one or two jobs are given with more detailed explanation to show the value of the data obtained. Each class of work done by the city has its own forms of report, but space forbids giving more than an example of one or two.

The table showing operation of rock crusher will repay study. It shows the comparative efficiency of the machinery in turning out its product, and of the men. Sufficient detail

By Law No.	Street	From	To	Started	Completed	Foreman	Estimated Cost $ c	Actual Cost: Total $ c	Material $ c	Labor $ c	Plant Rent $ c	Misc. Bills $ c	Cost per sq. yd.: Material $ c	Labor $ c	Plant Rent $ c	Misc. Bills $ c	Total $ c	Concrete Base Laid: Area sq. yds	Thickness inches	Estimated Mix: Cement bbls	Sand cu. yds	Gravel cu. yds	Material Used: Cement bbls	Sand cu. yds	Gravel cu. yds	Cement per $ c
350	Sylvia	Boyd	End	10.2.15	12.2.15	Mitchell		562.70	428.95	116.15	17.60	-	0.505	0.127	0.02	-	0.666	842	5	116	40	95	114	42	94	1.06
302	St. James	Rendall	Oswego	12.2.15	15.2.15	"		1075.05	830.45	212.85	26.35	-	0.574	0.147	0.018		0.739	1448	5	206	90	178	205½	89	179	1.10
434	Bank	Oak Bay Ave.	Cowan Ave.	29.2.15	7.4.15	"		1589.50	1170.50	348.20	70.50	-	0.538	0.156	0.032	-	0.731	2174	5	301½	133	265	325	146	259½	1.29
361	Market	Douglas	Rose	16.3.15	21.4.15	"		1815.32	1404.57	296.66	114.60	-	0.57	0.12	0.046	-	0.704	2059	5	370	142	254	370½	138	266	0.97
429	Regent Place	St. Charles	End	21.4.15	24.4.15	"		632.62	483.72	106.25	43.66	-	0.043	0.128	0.051	-	0.702	553	5	134	52	104	128½	49	105	0.59
444	Cormorant	Blanchard	Quadra	27.4.15	29.4.15	"		2092.67	1716.57	315.75	60.35	-	0.707	0.13	0.025	-	0.864	2425	6	437	175	340	445½	171½	359	0.70
392	St. Andrews	Simcoe	End	7.5.15	10.5.15	"		813.70	649.30	135.55	25.55	-	0.564	0.12	0.022	-	0.707	1151	5	162	70	140	167½	67	132½	0.69
501	Richmond	Oak Bay Ave.	Cowan	22.6.15	26.6.15	"		1497.62	1130.27	327.10	40.25	-	0.454	0.128	0.015	-	0.728	2563	5	406	155	315	353½	169	324	[illegible]
500	Ash	Fort	Bagbie	20.7.15	23.7.15	"		1270.43	1062.53	191.90	24.00	-	0.614	0.11	0.011	-	0.734	1727	5	273	106	212	251½	105	216	[illegible]
462	Empress	Cook	Chambers	19.8.15	21.8.15	"		1230.76	[illegible]	191.25	45.10	-	0.578	0.104	0.024	-	0.711	1732	5	272	106	212	232½	106	199	[illegible]
S.B.S.	Robertson	Hollywood	Fairfield	13.9.15	13.9.15	"		188.66	143.90	40.75	4.00	-	0.094	0.207	0.02	-	0.774	203	5	36	14	26	36	14	26	0.91
347	Commercial	Hollywood	Fairfield	17.9.15	17.9.15	"		165.35	145.15	19.20	4.00	-	0.64	0.085	0.02	-	0.708	225	5	33¼	14	30	32¼	14	30	0.92
S.B.S.	St. Charles	Rockland	Fairfield	13.9.15	13.9.15	"		61.15	40.90	16.25	4.00	-	0.67	0.27	0.06	-	1.00	61	5	11	4	8	11	4	8	0.8

Labor Cost per 100 sq. ft.: Sand Men $ c	Gravel Men $ c	Cement Graders $ c	Foreman $ c	Mixer Engineer $ c	Teamsters $ c	Concrete Handlers $ c	Misc. $ c	Mixing $ c	$ c	Rates of Wages: Foreman $ c	Mixer Engineer $ c	Laborers $ c	$ c	$ c	$ c	$ c	Cost of Material: Cement per bbl. $ c	Sand per cu. yd. $ c	Gravel per cu. yd. $ c	$ c	$ c	$ c	By Law No.
1.16	1.99	2.20	0.29	0.62	0.53	1.95	0.62	0.37	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	350
1.10	2.73	2.65	0.52	0.65	0.32	2.60	0.33	0.33	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	302
1.65	2.53	2.60	0.62	0.60	0.62	2.30	1.06	1.36	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	434
0.50	2.15	2.33	0.44	0.52	0.46	2.36	0.36	1.17	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	361
0.52	1.87	1.70	0.52	0.90	0.47	2.30	1.11	1.54	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	429
0.70	2.19	2.03	0.70	0.52	0.50	2.21	1.75	1.26	-	4.00	2.75	2.00	-	-	-	-	2.00	1.35	1.50	-	-	-	444
0.67	1.73	1.81	0.95	0.56	0.35	1.43	1.95	1.79	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	392
0.92	2.00	2.22	0.50	0.62	0.46	2.55	0.97	1.01	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	501
0.70	2.0	1.91	0.75	0.65	0.35	1.67	1.19	0.50	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	500
0.73	2.33	2.42	0.57	0.73	0.32	1.90	1.10	0.26	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	462
0.92	2.19	2.03	0.83	0.96	0.47	2.14	1.11	1.54	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	S.B.S.
0.90	2.10	2.00	0.52	0.90	0.45	2.30	1.10	1.50	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	347
0.45	2.25	2.10	0.55	0.95	0.50	2.30	1.10	1.60	-	4.00	2.75	2.00	-	-	-	-	2.00	1.60	1.75	-	-	-	S.B.S.

COST ACCOUNTING IN VICTORIA, B. C. DETAILED COST OF CONCRETE BASE CONSTRUCTION IN 1915.



Month	Actual Expenditure	Foreman	Firemen	Breaking to Crusher Size	Loading at Quarry	Crushing	Haul Rock to Crusher	Rent of Crusher and Equipment	Electric Power	Material and Supplies
January										
February	880.40	65.75	190.55	10.75	26.65	56.70	267.70	200.00	27.00	3.40
March	1272.72	101.25	315.05	10.75	75.60	56.70	391.65	370.96	44.13	3.40
April	902.60	97.50	207.90	10.75	63.95	56.70	279.56	167.20	44.14	3.40
May	1071.60	101.25	227.95	10.75	67.20	56.70	342.50	167.25	52.60	3.40
June	980.90	97.50	277.60	10.75	65.60	56.70	213.75	210.00	67.00	3.40
July	805.18	101.25	115.50	10.75	50.60	56.70	219.35	210.00	32.60	3.40
August	417.25	45.00	55.40	10.75	23.50	56.70	122.25	97.50	20.60	3.40
September										
October										
November										
December										
	6402.92									

Month	Rock Delivered to Crusher, cu. yds.	Screenings	Rock through 1½" mesh	Rock through ¾" mesh	Screenings through ¼" mesh	Total, cu. yds.	Rates of Wages: Foreman	Labor	Total Cost per cu. yd.	Remarks
Jan							3.75	2.50		No crusher running this month
Feb	1185	56	613	605	24	1368			0.65	Started crushing
Mar	1663	62	435	1141	589	2227			0.56	
Apr	1559	35	415	792	497	1739			0.50	
May	1094	11	173	910	654	1763			0.61	
Jun	1065	8	110	636	513	1267			0.56	
Jul	835	0	67	526	309	962			0.51	
Aug	353	4	45	220	123	392			1.11	Rock crushing closed down
Sep	078									No crusher running this month
Oct										
Nov										
Dec										
	6262					9765			0.66	

COST ACCOUNTING IN VICTORIA, B. C., DETAILED COST OF ROCK CRUSHING IN 1915.

of costs and of unit costs is given to make possible not only comparisons of the plant with its own performance but with that of plants in other cities.

Concrete Base Construction.

A table has been made showing the detailed cost of each job of concrete base construction done during 1915, which is very illuminating as to differences in cost and the reasons for them. Two typical streets are selected for comparison in the following table to show the possibilities of comparison of details in order to find out the reasons for differences as a pointer to places where improvements can be made:

Item.	St. James St. from Rendall to Oswego.	St. Andrews St. from Simcoe to end.
Started	March 12, 1915	May 7, 1915
Completed	March 15, 1915	May 10, 1915
Foreman	Mitchell	Mitchell
Miscellaneous	$0.38	$1.95
Traveling	.58	1.79
Rates of wages per 8-hour day—		
Foreman	4.00	4.00
Mixer engineer	2.75	2.75
Laborers	2.00	2.00
Cost of material—		
Cement per bbl	2.00	2.00
Sand per cu. yd	1.35	1.60
Gravel per cu. yd	1.50	1.75
Actual cost—		
Total	$1,070.15	$813.74
Material	830.95	649.34
Labor	212.85	138.55
Plant rent	26.35	25.85
Cost per sq. yd., cts.—		
Total	73.9	70.07
Material	57.3	56.04
Labor	14.7	12.00
Plant rent	1.9	2.2
Concrete base laid—		
Thickness inch	5.00	5.00
Area sq. yd	1,448.00	1,151.00
Estimated materials—		
Cement, bbls.	206.00	182.00
Sand cu. yd	90.00	70.00
Gravel, cu. yd	178.00	140.00
Materials used—		
Cement, bbl.	205.25	167.75
Sand, cu. yd	89.00	67.00
Gravel, cu. yd	179.00	133.25
Labor cost per 100 sq. ft.—		
Cement men	1.10	.69
Sand men	1.10	.69
Gravel men	2.73	1.73
Concrete graders	2.65	1.81
Foremen	.52	.95
Mixer engineer	.65	.56
Tampers	.52	.35
Concrete wheelers	2.60	1.48

All concrete base construction in 1915 was carried on as relief work with special prices for material and reduced wages for labor. Laborers were taken from the Labor Bureau and were not entirely satisfactory. A barrel of cement was assumed as 3½ cu. ft. Plant rentals are based on length of time plant is on the job.

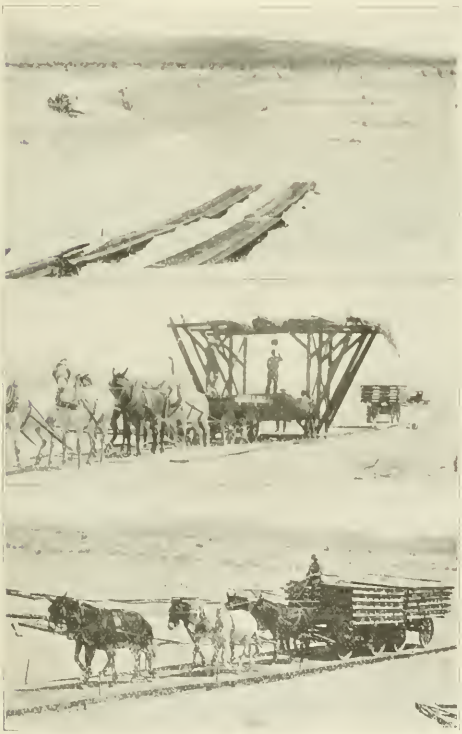
The table as a whole is reproduced in two sections.

We are indebted to Alvah E. Foreman, Assistant City Engineer, for the data herewith.

Plank Road on California Highway

The great variety in the conditions met in building highways in California means many varieties of construction to meet the difficulties. The California State Highway Commission is equal to the demands made upon it and is responsible for many departures from customary methods, most of which have proved successful for the situations in which they are used. Several of these novel constructions have been described in MUNICIPAL ENGINEERING. Another is the sectional wood pavement shown in the accompanying illustrations.

A road across the desert in the higher area on the eastern edge of the Imperial Valley from Holtville, Cal., 50 miles to Yuma, Ariz., on the Colorado River was needed. Most of the distance could be covered by ordinary methods of road construction, but for about 6 miles the road runs thru a shifting sand region where a permanent structure would soon be covered up and put entirely out of use. Something movable was demanded which could be taken out before it was buried too deeply and moved to the next best location. The character of this country is clearly shown in the photographs. The action of the wind is indicated by the condition of the old plank wheelway seen in the first photograph, much of which is more or less completely covered by the shifting sand.



TOP: OLD PLANK RUNWAYS BEING COVERED BY SHIFTING SAND.

MIDDLE: TRAVELING CRANE LAYING ROAD SECTIONS. WAGON LOADED WITH FIVE SECTIONS IN REAR.

BOTTOM: LOAD OF SECTIONS ON ITS WAY TO END OF ROAD. NOTE STEEL CONNECTING STRIPS TURNED UP AND NOT YET CONNECTED.

In this dry country the deterioration of the wood is measured by the wear and deformation from heat, and for this 6 miles of the new road a series of movable platforms was devised, built of wood and treated after laying with heavy road oil and stone screenings to form a protecting wearing coat.

The platforms were built at the railroad station, Ogilby, on the Southern Pacific Railroad at the point nearest the eastern end of the plank road. A yard was fitted up with overhead plank railway and car to lift the timbers and the completed sections and transfer them to storage or to the wagons for carrying to the road. The general design of these platforms can be seen in the photographs. They consist of three 4 by 6-inch stringers to which are spiked 4-inch planks for the wearing surface. The sections are 8 feet wide, the width of the roadway, and 12 feet long, and each one weighs about 1,500 pounds.

About five of these sections were loaded on a wagon and, as seen in one of the photographs, a six-horse team can haul two of these wagons on the plank road.

Arriving at the end of the road as laid, a traveling crane is seen which spans the width of the road and is mounted on small wheels or rollers which run on planks laid for the purpose. The frame supports a block and tackle, which lifts a section from the wagon and, when the wagon has pulled out, drops it into its place on the roadway. It will be noted that it takes a six-horse team to haul one wagon in the sand beyond the end of the completed surface.

After the sections of the roadway are laid strips of steel 1½ inches wide and ¼-inch thick are laid over the three rows of spikes in the floor and are bolted down thru planks and stringers. These strips extend over from one section to the next and serve to hold the planks together and to the stringers and to hold the sections together. These strips are located one near each end of the planks and one down the center.

After the sections are laid and bolted together in the manner described the surface is treated with a heavy road oil and a coat of stone screenings to form a ¼-inch wearing and protecting coat.

The width of the road is increased at intervals of 1,000 feet to allow cars to pass each other.

The lumber required for this six-mile section measured 1,200,000 feet, there being some 250,000 linear feet of 4 by 12-inch planks and 100,000 linear feet of 4 by 6-inch stringers. About 100,000 linear feet of the steel strips were used.

The last of the three photographs shows the road with sections laid and in the foreground the steel strips are bolted to the sections, but the ends of the strips are turned up that the sections may be adjusted before spiking the strips across to hold the sections together.

About 80 men and teams worked about four months on this section of the road. The cost complete was $8,500 a mile.

The traveling crane will be kept on the job for use in shifting sections of the roadway when the advancing hillocks of shifting sand require that the road be moved.

We are indebted to the California State Highway Commissioner's office for data and photographs.

Good Roads Notes

The State Highway Department has adopted provisionally the following relations of amount of traffic to kind of roadway surface: For 9-foot gravel roads up to 200 vehicles daily; 16-foot gravel and macadam, 200 to 500; 16-foot macadam with bituminous surfacing, 500 to 1,000; 16-foot concrete roads, 500 to 2,000 vehicles daily.

Brick Pavements Laid in 1916 and Proposed for 1917.

Descriptions of pavements as laid, cost per square yard and total cost. **Design, Cost and Quantity are shown.**

		Base		Cushion				Expansion Joint					
	Sq. Yds. Laid in 1916	Thick	Propor.	Thick	Kind	Thickness of Brick	Filler	Kind	Distance Apart	Name	Cost per Sq. Yd. Pave. and Foundation	Total cost of Pav., inc. (1) (2) (3) (4)	Proposed Yardage 1917
California—													
Berkeley													13,200
Los Angeles	1,800	4	1:3:6	1½-2	[86]	4					2.52	3,160	
San Francisco	18,828	4-6	1:2½:7	1½	[86]	4	1:1½ grout		1½[61]	asphalt		63,084	
Colorado—													
Ft. Collins	2,146		1:2:3	2	[86]		1:1 grout[56]	tar	30			2.75 (1)	
Connecticut—													
New London	20,000												6,300
Florida—													
Gainesville													20,000
Georgia—													
Atlanta	9,716	6	1:3:6	½-1	[86]	3½	grout		[61]	asphalt		14,574	
Columbus	637	6	1:3:5	2	[86]	4	1:1 grout	tar	1[61]		1.925		10,000
Waycross													7,550
Illinois—													
Alton	51,510	4	1:3:6	1	[85]		grout	[56] [61]		asphalt	1.65	1.90	100,000
Aurora	3,780	5	1:7G	2	[86]							1.80	7,000
Champaign	30,000	6	1:3:5	1½	[86]		asphalt[86]				1.81	111,520	90,000
Chicago	448,000			2	[86]		pitch		[61]		2,443	3,686	
Chicago Heights	75,000	6		2	[86]		grout	[61]	100	elastite	2.15	171,000	25,000
Cicero	15,462	6		2	[86]	4	asphalt				2.60	198,184	
Danville	42,000	5	1:3:5	1	1:4	4	1:1 grout	[61]		elastite	1.72	2.35	40,000
Decatur	85,561	5	1:1:4	1	[86]				[61] [63]	asphalt	1.78	230,000	100,000
DeKalb	14,475	5	G	1	[86]	4	asphalt				1.64	32,114	
E. St. Louis	7,800	6-7	1:3:6	⅝	1:4	4	1:1 grout	1[61]		Carey	2.00		160,000
Evanston	85,315	5	1:3:6	2	[86]		[86]		[61]	bitum.	1.86	200,152	
Evanston	6,008	5	1:3:6	2	[86]		1:1 grout		[61]	bitum.	2.09	17,323	106,574
Flora											1.75		32,464
Freeport	19,144												20,000[9]
Galesburg	17,760	4	1:3:6	1	[86]		asphalt	0			1.76	47,645	75,000
Joliet	23,250	5		1½	[86]	4	asphalt				1.90	62,527	28,130
Lincoln													20,000
Mattoon	32,269	5	1:4½:8	1	[86]		1:1 grout	¼[56]	100	elastite	1.63	77,000	32,000
Moline	12,850	5	1:3:6	2	[86]	4	asphalt, Std.				1.80-1.96	31,964	20,000
Morrison	44,000	4	1:7G	2	[86]		asphalt					100,000	
Oak Park													6,900
Ottawa	14,100		1-6G	1½	[86]			1	50		1.54	35,082	85,000
Peoria	36,536	4-5	1:3:5	1-2	[86]		1:1 grout	[56]	25		1.60	71,373	40,000
Peru	31,078		[68]		[86]						1.75	77,911 (1) (2) (3)	
Rockford	68,987	5	1:3:6	1½	[86]	4	asphalt 99½%[11]				1.838	167,932	
Rock Island	64,736	5	1:3:6	1½	[86]			tar				1.98-2.01	
Springfield	17,027	5	1:6	1	[86]	4	grout			elastite	1.73	36,467	69,600
Sterling	11,640	4	1:2:4	2	[86]		pitch					28,788	
Streator	15,964	[90]		1	[86]	4	[86]	¾[56]		elastite	0.74-0.87	25,828	17,000
Indiana—													
Brazil		8		2		4	[56]					9,825 (1)	7,470
Crawfordsville	4,108	4	1:3:5	1½	[86]		1:1 grout	[11]		asphalt	1.30	5,210	13,500
Elkhart													15,500
Ft. Wayne	21,005	6	1:3:6	2	[86]		grout	[61]		Genasco	1.79	52,520	15,000
Frankfort	14,975	4		½	grout	4	cement			elastite	1.76	36,522	
Goshen	14,668	6	G	2	[86]	4	1:1 grout		[61]	elastite	1.60	29,598	
Huntington	5,300	6	1:2½:5	1½			Barrett	[56]	[61]	Carey	2.35	14,051	10,000
Madison	12,800	5	1:2½:5	1½	[86]	4	1:1 grout	¼ 75	1½[61]	elastite	1.95 (1) (4)	25,868	17,000
Marion	1,822	10	G		[86]							6,603	20,000
Muncie	12,000	6	1:3:5	2	[86]	4	1:1 grout		[61]	elastite	2.03	24,360	
New Castle	19,408	5	1:3:6		1:1 grout	4	2:1 grout		[61]	elastite	1.60	43,611	
South Bend	7,291	6	1:7G	1	1:4						2.30	18,373	25,164
Terre Haute	2,286		resurface			4	1:1 grout		[61]	elastite	1.53	47,830	
Vincennes													38,000
Wabash	2,575	6	1:3:5	1½	[86]	4	1:1 grout	0			2.25	7,338	
Iowa—													
Burlington	5,854	6	1:3:6	1	[86]		[56]					1,272	
Cedar Rapids	6,166	5	1:3:5	1½	[86]	4	Sarco	0			211	14,004	
Clinton	22,608	6	1:3:6	1½	[86]		Texaco				220	58,465	

Davenport	45,034	5	1:3:6	2	....[86]	4	pitch	0	...	...	1.75-2.10	98,764	100,000[8]
Dubuque	22,876	...	...	2	....[86]	...	...	...	...	...	...	64,721	100,000
Ft. Madison	35,685	4	1:3:5	2	....[86]	4	Barr. P. & asph.	Standard	...	...	1.75-1.86	98,916	...
Keokuk	1,936	4	1:2:4	2	....[86]	...	Bit., Sarco	...	...	...	1.83	2.23	80,000
Marshalltown	2,227	5	1:3:6	1½	....[86]	...	...	...	...	...	2.28	5,802	60,000[9]
Muscatine	...	4	1:6G	1	....[86]	...	asphalt	...	...	...	1.86	19,036	...
Kansas—													
Arkansas City	26,132	4	1:2:5	1½	....[86]	3	asphalt	asphalt	50	...	1.81	......(1)(3)(4)	...
Atchison	10,000	6	1:2½:5	1½	....[86]	...	asphalt, standard	...	...	...	1.95	...	5,000
Chanute	3,500	4	1:1:5	1½.	....[86]	...	...	...	...	...	1.70	5,161	2,509
Coffeyville	...	...	...	...	...	...	...	...	...	...	...	...	1,200
Erie	7,833	6	......[27]	1	....[86]	...	asphalt	...	...	...	...	16,137	...
Hutchinson	77,000	...	1:4:6	1	...	2½-3	asphalt	...	....[86]	...	1.25-1.85	...	75,000
Independence	...	...	...	...	...	...	...	...	...	...	...	...	15,000
Leavenworth	4,717	5	1:3:5	2	....[86]	4	1:1 grout	½	50	elastite	1.80	12,493	...
Ottawa	14,000	4	1:3:5	2	....[86]	3	asphalt, Texaco	...	...	...	1.57	33,772	6,600
Ottawa	1,500	4	1:2:5	...	....[86]	3	Texaco	...	...	...	1.66	1.78(1)	20,000
Parsons	6,208	4	1:3:5	1½	....[86]	3	asphalt	...	...	...	1.63	13,074	7,000
Pittsburg	28,258	4	1:2:5	1½	....[86]	...	...[86]	...	...	...	1.50-1.61	61,284	...
Salina	27,461	5	...	1½	....[86]	3	asphalt	...	...	...	1.92[100]	63,997	30,000[9]
Topeka	46,000	5	1:2½:5	1½	....[86]	3-4	asph., Std., Mag.	...	...	...	1.77[101]	2.33	30,000
Wichita	34,311	5	1:3:6	1	....[86]	3-4	asphalt	...	...	...	1.85-1.95	92,997	...
Kentucky—													
Louisville	59,758	6	1:3:6	1½	....[86]	4	1:1 grout	......[61]	...	...	1.81	...	90,000
Owensboro	...	...	...	...	...	...	...	...	...	...	...	...	75,000[9]
Louisiana—													
Lake Charles	4,500	...	...	...	...	...	...	...	...	...	...	...	10,000
Maryland—													
Baltimore	7,616	4-6	1:3:6	1	grout	4	1:1 grout	...	1[61]	asphalt	2.22	5,212	...
Massachusetts—													
Fitchburg	13,844[102]	5	1:2:4	1	....[86]	...	grout	...	16	pitch	277	4,465	30,000[9]
Michigan—													
Albion	5,900	...	...	2	....[86]	...	...[56]	...	...	...	...	...	6,000
Ann Arbor	12,000	5-6	1:2½:5	1	....[86]	...	grout	......[61]	...	pioneer	1.90	2.40	...
Battle Creek	8,403	6	1:7	1	....[86]	4	1:2 grout	...	...	...	...	14,789	...
Bay City	807	5	...	1½	....[86]	4	1:1 grout	...	...	...	1.70	1,817	...
Benton Harbor	...	...	...	...	...	...	...	...	...	...	...	...	30,000
Cadillac	2,600	5	1:7G	1	....[86]	4	1:1 grout	......[61]	...	pioneer	1.61	5,553	21,603
Coldwater	5,357	4½	1:6 & 7	¾	...	4	2:1 grout, tar	...	....[61]	...	1.85	17,311	0
Detroit	71,800	6	1:3:6	1	....[86]	4	grout, tar	...	1[61]	...	2.145	2.98	...
Flint	4,000	6	1:5	1½	....[86]	...	1:2 grout	...	....[61]	Carey	1.90	11,400	22,000
Grand Rapids	34,512[103]	5	1:3½:7	1½	....[86]	...	1:1 grout	1[61]	50	elastite	1.90	82,100	...
Hillsdale	...	...	...	...	...	...	...	...	...	...	...	...	4,000
Kalamazoo	26,360	6	1:8	1½	....[86]	...	asphalt	...	...	standard	1.74	2.00(1)	15,000
Owosso	5,720	6	1:3:6	1½	....[86]	4	2:1 grout	S. O. ¾[61]	30	elastite	...	12,592	7,000
Port Huron	2,572	5	1:2:5	1	...	...	1:2 grout	...	....[61]	asphalt	1.91	5,577	...
Sault Ste Marie	1,038	...	1:2½:5	...	1:2 grout	...	...	...	30	bit.	3.45	3,581	...
Minnesota—													
Duluth	71,000	6	1:3:6	2	....[86]	...	1:1 grout	...	33	...	2.35	215,000	5,000
Minneapolis	22,395	5	1:3½:7½	1	....[86]	4	pitch	...	...	...	2.30	...	...
St. Paul	10,049	5	1:2½:5	1½	....[86]	...	asphalt	...	...	...	2.40	23,114	8,000
Mississippi—													
Vicksburg	18,946	...	1:3:5	1	....[86]	½	1:1 grout	......[56]	....[61]	...	2.05	45,889	0
Missouri—													
Fulton	2,448	5	1:3:5	1½	....[86]	...	Barrett	0	...	...	2.24	...	0
Jefferson City	11,500	old foundation		2	....[86]	...	grout	...	...	Carey	1.14	13,110	...
Kirksville	680	4	1:3:5	1½	....[86]	4	1:1 grout	......[56]	....[61]	...	2.00	......(1)	15,000
Moberly	1,040	...	...	4	....[86]	...	...	...	...	...	1.55	...	8,000
St. Louis	262,600	5-7	1:3:6	...	1:4	4	1:1 grout	Creo.	wood	...	1.85	577,000	360,000
Sedalia	12,345	4	1:3:6	1½	....[86]	3	Standard	0	...	...	1.66	20,425	4,000
Montana—													
Helena	1,550	5	...	2	....[86]	4	grout	...	...	Pioneer	2.65	5,200(1)(3)(4)	1,700
Nebraska—													
Fremont	20,809	4	1:3:5	1½	....[86]	3	Texaco	...	...	Texaco	...	2.04	30,000[9]
Lincoln	46,457	5	1:3:6	2	....[86]	3-4	asphalt	...	...	Magnolia	...(1)(3)(4)	1.955-2.23	...
Omaha	101,080	5	1:3:6	1½	....[86]	...	grout	...	...	bit.	...	229,080	100,000
New Jersey—													
Elizabeth	400	6	1:3:6	1½	...	4	grout	...	....[61]	...[56]	2.30	2.50	...
Jersey City	7,620	6	1:3:5	1½	....[86]	...	...	Bit.	....[61]	...	...	19,117	8,000
New Brunswick	8,440	5	1:3:6	1½	...	4	1:1 grout	...	....[61]	...[56]	2.60	2.75	...
Ridgewood	18,000	4-6	1:3:6	2	....[86]	...	1:1 grout	tar	....[61]	...	1.90-2.10	36,600	...
Trenton	14,766	5	1:3:6	1	1:4	...	grout	...	....[61]	ideal	2.36-2.42	...	14,000
New York—													
Albany	7,110	6	...	1½	....[86]	4	1:1 grout	...	...	...	1.50	...	1,500
Albion	...	...	...	...	...	...	...	...	...	...	...	...	21,000
Amsterdam	4,310	6	1:3:6	1	....[104]	...	grout	Bit.	....[61]	...	2.50	16,100	...
Auburn	...	...	...	...	...	...	...	...	...	...	...	...	7,000
Batavia	16,400	6	1:2½:5	1½	....[86]	...	1:1 grout	...	...	elastite	2.12	56,800	5,000
Binghamton	665	6	1:3:6	...	...	...	1:1 grout	...	...	...	2.30	...	...

	Sq. Yds. Laid in 1916	Base: Thick	Base: Propor.	Cushion: Thick	Cushion: Kind	Thickness of Brick	Filler	Expansion Joint: Kind	Expansion Joint: Distance Apart	Expansion Joint: Name	Cost per Sq. Yd. Pave. and Foundation	Total cost of Pav., Inc. (1) (2) (3) (4)	Proposed Yardage 1917
Buffalo	39,956	6	......	1½	....	...	grout	Bit.	....	....	....	120,652	40,000
Cohoes	4,934	6	1:2½:5	1½	....[86]	4	1:1 grout	......[56]	....[61]	....	2.31	16,472	4,000
Elmira	28,372	5	1:2½:5	1½	....[86]	...	grout and Bit.	......	....	War. chem.	2.34-2.68	79,650	20,000
Fulton	2,000	....	......	1½	....[86]	...	1:1 grout	......	....	....	....	......	1,200
Geneva	5,750	5	1:2½:5	1	....[104]	3-4	....	......	....[61]	Ideal	2.20	3.50	21,000
Hudson	1,035	5	1:3:6	1	....[104]	...	1:1 grout	......[56]	1[61]	Pioneer	....	2.60	......
Ithaca	2,431	5	1:2½:5	1	....[86]	4	1:2 grout	......	30[61]	elastite	2.18	6,198	4,400
Jamestown	19,947	5	1:6	1½	....[86]	...	1:1 grout	......[61]	40	elastite	2.08	48,418	......
Little Falls	684	5	1:2½:5	2	....[88]	...	1:1 grout	......	....	....	2.54	3.04	......
Lockport	4,300	6	1:4:6	2	....	...	1:3	......	....[61]	pitch	2.05	......	4,500
Mamaroneck	4,154	6	1:3:5	2	....[86]	...	....	......	....	....	2.70	......	......
New Rochelle	2,510	6	1:3:5	1	....[88]	4	....	1[61]	½ 50	Carey	2.57	6,451	......
Niagara Falls	11,502	6	......	1	....[86]	4	1:1 grout	Bit.	1[61]	Trinidad	2.80	43,765	......
Olean	1,770	5	1:2½:5	1½	....[86]	4	1:1½ grout	......	....[61]	elastite	2.16	4,424	23,600
Oswego	5,834	5	1:3:6	1	1:4	3½	1:2 grout	....[illegible]	...[56 61]	Ideal	2.05	27,573	7,000
Plattsburg	......	....	......	....	....	...	....	......	....	....	....	......	1,300
Port Jervis	5,586	5	1:3:6	1½	....[88]	...	1:1 grout	1[61]	1[61]	....	2.40	13,500(1)	......
Poughkeepsie	25,000	5	1:3:6	1	....[104]	3½	1:1 grout	asphalt	...[56 61]	Barber	2.16	70,000	......
Salamanca	22,560	5	1:3:6	1½	....[86]	...	....	......	40	elastite	1.84	2.26	......
Syracuse	14,014	6	1:3:6	1½	....[86]	...	1:1 grout	......	...	....	2.15	46,315	182,018[9]
Ohio—													
Ashtabula	11,616	6	1:3:6	1½	G	...	1:1½ grout	......	....[61]	Carey	1.73	33,828	......
Barberton	7,400	6	......	3-16	....[104]	...	grout	0	....	....	2.14	16,050	......
Bellefontaine	1,800	6	1:4:8	1½	....	...	....	......	....	....	1.95	6,490	......
Bucyrus	47,840	5	1:2½:5	1½	....[86]	...	1:1 grout	......	....[61]	.........[56]	....	2.79	52,000
Cambridge	7,960	4	1:2:4	1½	....[86]	...	grout	½[61]	¾ 30	Carey	1.85	18,652	23,225
Canton	50,120	5	1:3:5	1	....[86]	...	..............[107]	......	....[61]	....	1.60	155,497	48,800
Cincinnati	8,207	6	1:3:6	1.5	....[86]	...	pitch or grout	......[56]	....[61]	asphalt	2.33	39,586	......
Circleville	10,952	6	1:2:4	2	....[86]	...	Barr., mastic	......	....	....	1.78	20,062(1) (3) (4)	......
Cleveland	251,996	6	1:3:6	1	....[85]	4-5	1:1 grout	......	....	B. & B.	2.25-2.50	......	......
Coshocton	10,787	8	G	2	....	4	Barrett pitch	......	....	....	1.32	1.58	......
Dayton	39,597	6	......	1	....[86]	...	1:1 grout	......	¾[56]	trans.	1.82	81,583	152,092
Delaware	10,700	6	1:3:6	2	....[88]	4	1:1 grout	1[61]	½ 50	elastite	1.80	......	3,000
E. Cleveland	37,400	4	1:3:6	1½	....[86]	4	grout	....		.........[56]	1.98	99,242	......
East Liverpool	4,378	6	1:2:5	2	....[88]	...	grout[86]	......	....	....	2.30	4.65	43,380
Findlay	34,637	6	1:3:5	1½	....[80]	...	1:1½ grout	......[61]	....	....	1.74	72,756	......
Fostoria	......	....	......	....	....	...	....	......	....	....	....	......	4,600
Galion	8,264	5	1:3:5	1	....[104]	4	1:1 grout	......[56]	....[61]	Barrett	1.99	23,434	13,000
Ironton	16,641	2	......[86]	1-1	....[85]	...	....	......[61]	30	elastite	.......[113]	18,724	......
Lakewood	22,223	6	1:3:6	1½	....[105]	4	1:1 grout	1[56]	....[61]	B. & B.	1.82	54,612	......
Lancaster	20,936	....	......	....	....	...	..............[86]	......	....	....	0.93	26,110	17,499
Marion	25,262	6	1:3:5	....	....	...	....	......	....	....	1.98	84,272	......
Massillon	2,373	5	1:6	1	....[80]	...	Barrett pitch	......	....	....	1.74	......	......
Norwalk	6,000	5	......	....	....[88]	4	1:1 grout	......[61]	....	elastite	1.83	14,522	......
Norwalk	5,000	3½-5	......	....	....	4	1:1 grout	......	100	asphalt	1.87	10,293	9,000
Piqua	6,000	6	......	1	....[104]	...	grout	......	....	elastite	1.79-1.88	47,400	19,000
Ravenna	5,400	6	......[105]	....	...[105 86]	...	1:1 grout	......	....[61]	elastite	1.33	15,000	12,000
Tiffin	16,800	4	1:2:4	....	...[105 86]	...	1:2 grout	¾	....[61]	Carey	1.70	2.76	15,000[9]
Toledo	63,121	6	1:3½:6	1	grout	4	asphalt	......	....[61]	asphalt	2.04	2.64	......
Urbana	28,700	6	1:3:6	1½	....[86]	4	mastic	......	....[61]	Pioneer	....	66,340	......
Van Wert	408	5	......	1½	....	...	....	......	....	....	2.55	11,831	......
Warren	42,000	5	1:3:6	2	....[105]	4	1:1 grout, tar	......	30	asphalt	1.80	2.78	70,230
Washington C. H.	31,066	6	1:5	1½	....[86]	...	1:1 grout	......	....[61]	elastite	1.84	68,850	20,000
Wooster	7,184	4	1:1½:4	1½	....[105]	4	1:2 grout	......[61]	50	....	....	14,994	20,000
Youngstown	42,333	6	1:3:6	2	....[86]	...	1:1 grout	......	....[61]	.........[56]	2.10	75,613	......
Zanesville	22,389	6	1:2½:5	1½	....[88]	...	1:1 grout	¾	40-50	....	1.70	......	47,438
Oregon—													
Astoria	3,418	5	1:3:5	....	....[104]	2¾	1:3 grout	......	....	....	2.70	......	2,000
Portland	10,730	6	1:3:6	1	1:4 grout	...	1:1 grout	......	....	....	2.33	32,510	5,163
Pennsylvania—													
Bradford	4,799	6	1:3:6	1	....[86]	4	1:1 grout	......	½ 25[61]	pitch	2.30	22,962	23,700
Butler	2,918	6	1:3:6	1½-2	....[88]	...	1:1 grout	½[61]	½ 25	elastite	1.74-2.00	......	......
Carbondale	34,000	4-8	1:2½:5	1½	....[88]	...	1:2 grout	pitch	....	....	1.86-1.94	2.24	38,500
Connellsville	21,815	....	......	....	....	...	....	......	....	....	1.41-1.56	51,580	29,230
DuBois	4,154	6	......	1	....[86]	...	1:1 grout	......	....[61]	Carey	1.45	1.65	15,000
DuQuesne	2,475	....	......	2[86]	8[106]	...	....	......	....	....	1.54	7,526	......
Erie	2,645	4	......	0	....	...	1:2 grout	asphalt	....	....	1.65(1)	8,022	5,000
Farrell	14,700	....	......[103]	....	....	...	pitch	......	....	....	1.59	......	15,000
Greensburg	10,218	6	......[106]	1	....[80]	...	....	......	....	....	1.53	22,505	11,300
Homestead	1,100	6	1:2½:5	1¼	....[80]	...	cement	....[56 61]	35	2.00	2,560(1) (2)	......	......
Johnstown	7,373	5	1:3:5[103]	1½	....[86]	4	1:1 grout	......	24[61]	.........[86]	1.73-1.88	1.86-2.03	......
Juniata	2,975	6	1:2:6	....	....	...	1:1 grout	......	....[61]	elastite	....	7,331	5,000
Lewistown	1,497	5	......	2	....[86]	...	....	......	½ 30	universal	2.19	3,367	0
Monogahela	2,370	....	......	1½	....[86]	...[100]	....	......	....	....	1.95	5,375	4,700
Norristown	3,400	4½	......	1½	....[86]	...	grout	......	....[61]	elastite	2.25	2.50	......

North Braddock	6,665	5	......	1	....[86]	...	1:2 grout	......	....[61]	Pittsburg	1.[illegible]	10,8[illegible]	10,[illegible]
Oil City	728	5	1:8G	1½	....[105]	4	1:1 grout	......	....[61]	elastite	2.32	3,168	
Pittsburgh	26,672	6	1:3:6	1½	....[86]	...	Standard[107]	......	....[61]	......	2.15	......	
Pittston	3,440	6	1:3:5	1-2	...[86 104]	...	....	......	....	....	2.29-2.66	.....	...
Rankin	5,800	6	1:3:6	1½	....[86]	4	1:1 grout	Bit.	....[61]	......	2.05-2.20	1,700	12,000
Reading	7,363	6	1:3:6	1	....[86]	4	1:1 grout	1½	....[61]	....	2.63	......	......
Wilkes-Barre	3,811	6	1:3:6	2	....[86]	...	tar	......	....	....	2.26	......	.....
South Carolina—													
Florence	12,936	0	......	2	....[86]	4	1:1 grout	......	....[61]	asphalt	....	18,561	......
Greenville	19,000	4	1:3:6	1½	....[86]	4	tar	......	35	....	1.99(1)	......	......
Greenwood	15,000	4	1:3:6	1½	....[86]	...	1:1 grout	......	60	tarvia	1.96	30,000	......
Tennessee—													
Jackson	22,791	1	1:6	1	1:4	..	Bit.	......	....	Carey	2.05	......(1)	28,000
Texas—													
Corsicana	32,872	4-5	......	1½	....[61]	2½-3	asphalt	......	....	....	1.81	14,338	......
Houston	17,600	6	1:3:6	¾	grout	3	Texaco	......	1[61]	....	2.45	46,800	16,000
San Antonio	41,571	5	1:3:6	1½	....[86]	3	asphalt	......	....	....	2.50	2.70	60,000[9]
Texarkana	2,270	5	......	1½	....[86]	3	asphalt	⅝	30	asphalt	2.17	......	......
Vermont—													
Montpelier	308	....	......	1	....[86]	...	pitch	......	....	....	2.00	......	4,000
Rutland	2,029	6	1:3:5	1	....[86]	...	1:3 grout	......	....[61]	asphalt	....	8,300	......
Washington—													
Bellingham	420	6	1:3:6	1½	....[86]	...	1:1 grout	......	....	....	2.70-2.90	.....	......
Seattle	112,581	5-6	1:3:6	....	1:5	...	1:1½ grout	......	....	....	2.65	......	120,000
Spokane	3,050	....	......	1½	....[86]	...	asphalt	......	....	....	....	11,082	......
West Virginia—													
Charleston	14,002	....	1:2½:5	1	....[86]	...	1:1 grout	.	....[61]	Carey	2.281	3.05	......
Fairmont	9,138	....	......	4	....[86]	...	2:1 grout	......	....	....	1.40	9,227	......
Moundsville	3,146	1	......	2	....[86]	...	1:1 grout	......[61]	25	Carey	1.05-1.64	7,787	14,000
Parkersburg	40,857	1-6	1:2½:5	1-2	....[86]	...	1:1 grout	asphalt	....[61]	...	1.60-1.73	......	24,471
Wisconsin—													
Appleton	11,096	5	1:3:6	1	....[86]	4	2:1 grout	......[61]	35	elastite	....	27,962	......
Baraboo	1,500	....[41]	......	....	....	...	....	......	....	....	......	2,600	3,000
Beloit	14,488	5	1:3:6	1½	....[86]	...	asphalt	......	....	....	1.99	33,357	......
La Crosse	35,215	5	1:2½:5	2	....[86]	...	Asph. S. O.	0	....	....	....	6,838	......
Oshkosh	5,100	6	1:3:6	1½	....[86]	...	1:1 grout	..	100	elastite	2.46	14,715	......
Racine	39,326	6	1:3:5	2	....[86]	4	grout	Sarco	....	....	2.16(1)	96,449	48,167
Wausau	10,012	5	1:2:3	1½	....[86]	...	asphalt	....	...	...	2.02-2.34	21,893	10,000

For foot-note references see page 65 of February number.

Paving Done in 1916 and Proposed for 1917.

Additions to Table in January Number. Vol. LII, P. 31

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Tot. Cost	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
California—							
Eureka	15,000	10,000	7,500	7,500	50,000	30,000	....
Long Beach	40,000	33,467	39,705	....	150,000	172,500	....
Los Angeles	530,000	623,534	855,791	....	....	....	....
Georgia—							
Macon	60,000	137,125	182,341	....	75,000	112,000	....
Illinois—							
Evanston	30,000	118,959	269,687	....	143,250	....	....
Iowa—							
Knoxville	3,500	13,660	36,191	36,191	0	....	....
Mt. Pleasant	4,500	27,600	....	....	....	....	....
Kansas—							
Newton	9,000	113,200	184,360	30,000	25,000	37,500	6,000
Maine—							
S. Portland	7,500	17,936	20,050	....	....	....	....
Massachusetts—							
Cambridge	108,822	75,863	....	....	....	....	....
Haverhill	50,000	51,360	59,960	all	50,000	60,000	all
Minnesota—							
Hibbing	12,000	4,686	....	....	30,000	....	....
St. Paul	275,000	236,197	554,930	469,971	300,000	750,000	....
Missouri—							
Lexington	5,000	0	0	0	5,600	2.20	0
Nebraska—							
Omaha	166,000	267,685	517,426	74,798	250,000	475,000	70,000
New York—							
Herkimer	10,595	9,990	20,888	6,963	10,000	21,000	7,000

City	Population	Done in 1916 Sq. Yds.	Done in 1916 Sq. Yds.	Done in 1916 City's Share	Proposed for 1917 Sq. Yds.	Proposed for 1917 Tot. Cost	Proposed for 1917 City's Share
Schenectady	90,000	16,026	43,071	1,940	25,000	70,000	3,000
Syracuse	23,259	70,929	12,371	182,018	600,000	50,000	..
Ohio—							
Bucyrus	12,000	47,840	133,000	10%	62,000	....	....
Dayton	140,000	81,419	245,263	2 & A	227,774	685,000	2 & A
Gallipolis	6,000	0	....	....	7,400	10,400	A
Middletown	20,000	45,230	1.36	....	.......[9]	....	....
Oklahoma—							
McAlester	15,000	6,026	9,739	1,000	....	....	....
Oregon—							
Albany	7,000	6,843	9,800	1,998	....	....	....
Pennsylvania—							
Lewistown	10,388	1,479	3,367	1,119	0	....	....
Texas—							
Beaumont	30,000	66,727	124,882	56,033	46,000	87,400	29,133
Cleburne	16,000	0	....	....	60,000	108,000	0
Taylor	8,500	152,000	380,000	152,000	60,000	140,000	48,000
Corsicana	10,000	134,796	250,362	75,108	31,100	65,000	16,250
Ft. Worth	104,000	77,067	173,199	....	....	....	....
Utah—							
Salt Lake City	125,000	184,000	616,100	95,000	233,000	660,000	120,000
Virginia—							
Phoebus	4,000	......	....	....	8,000	....	....
West Virginia—							
Elkins	7,500	834	2,216	976	1,000	....	....
Wyoming—							
Sheridan	12,000	4,941	18,000	....	5,820	....	....

MISCELLANEOUS

Meetings of Organizations

March 5, 6, at Hotel McAlpin, New York, National Paving Brick Manufacturers' Association. W. P. Blair, secretary, 830 Engineers Bldg., Cleveland, Ohio.

March 13, 14, at University of Illinois, Urbana-Champaign, Ill. Illinois Section of American Water Works Association. Edward Bartow, secretary, Urbana, Ill.

March 13-15, at University of Illinois, Urbana, Ill. Second Annual Drainage Conference. Department of Civil Engineering, University of Illinois.

April 10-15, at Ottawa, Ont. Dominion Good Roads Association.

April 17-19, at Macon, Ga. Tri-State Water and Light Association of the Carolinas and Georgia. W. F. Stieglitz, secretary, Columbia, S. C.

April 18-22, at Chicago, Ill. National Conference of Community Centers. John Collier, secretary, 10 Fifth avenue, New York.

May 8-10, at Washington, D. C. National Fire Protection Association. F. H. Wentworth, secretary, 87 Milk street, Boston, Mass.

June 6-13, at Pittsburg, Pa. National Conference of Charities and Correction. Wm. T. Cross, secretary, 315 Plymouth Court, Chicago, Ill.

June 11, at Buffalo, N. Y. New York State Conference of Mayors and Other City Officials. W. P. Capes, secretary, 25 Washington avenue, Albany, N. Y.

November 12-16, at Hotel Gruenewald, New Orleans, La. American Society of Municipal Improvements. Charles Carroll Brown, secretary, 1648 Transportation Bldg., Chicago, Ill.

Technical Schools

A recent bulletin of the University of Missouri contains No. 18 of the Engineering Experiment Station series on "Heat Transmission Thru Boiler Tubes," by Prof. E. A. Fessenden and J. W. Haney, research assistant.

Bulletin No. 7 of the University of Kansas is on "The Removal of Iron from Municipal Water Supplies."

Municipal Reports

Report of the operations of the Engineer Department of the District of Columbia, 1916. Lieut. Col. Charles W. Kutz, engineer commissioner.

On February 5 Commissioner William Williams, of the New York city department of Water Supply, Gas and Electricity, presented to the Board of Estimate and Apportionment the report of deputy commissioner Delos F. Wilcox on the Citizens Water Supply Co., of Newton, Boro of Queens. The relations of this company to the city, its territory, its customers and the city water supply system are so complicated that almost every question arising in reference to private water companies, their operation and management, is treated in the 378 page book containing the report. It is really a compendium of methods of handling all these questions and as such will be valuable in the study of almost any other case of inquiry into the conditions of contracts or franchises, fixing of rates or of purchase prices.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows:

March 6: Designing mechanical engineer, Board of Engineers, U. S. Army, New York, at $2,100 a year; metallurgist in Bureau of Mines, in field, at $2,400 to $3,300 a year; aeronautical engineering draftsman, technical assistant to National Advisory Committee for aeronautics, at $2,000 a year.

March 7: Assistant physicist qualified in spectro-photometry in Bureau of Standards, Department of Commerce, Washington, D. C., at $1,400 to $1,800 a year.

March 13: Mechanical draftsman, Panama Canal service, at $125 for second class and $150 for first class per month.

March 14: Aids and computers on Coast and Geodetic Survey; assistant in Philippine service; assistant examiner in Patent Office; assistant inspectors of boilers and of hulls, steamboat inspection service; draftsman, copyist and topographic in departmental service and junior architectural in Supervising Architect's office; electricians, junior chemists, junior civil engineers and draftsmen in departmental service; junior mechanical or electrical engineer in Engineer Department at Large; laboratory apprentice in bureau of standards.

March 20: Engineer of tests for experimental work in aero motor engineering in Department of Steam Engineering, Navy Yard, Washington, D. C., at $4,000 a year. Inspector of gages at Frankfort Arsenal, Philadelphia, Pa., at $2,000 to $2,400 a year.

March 21: Junior mechanical engineer in Ordnance Department at Large, Springfield Armory, Mass., at $1,000 a year.

March 21, 22: Civil engineer and superintendent of construction in Quartermaster Corp, Schofeld Barracks, Hawaii, at $1,500 a year.

April 11: Aid in bureau of standards; aid in lighthouse service; assistant observer in weather bureau; assistant photographers, bookkeepers, first-class steam engineers, library assistants, statistical clerks in departmental service; computer in Nautical Almanac office and Naval Observatory; draftsmen, architectural, in Supervising Architect's office; copyist in Navy Department; mechanical and topographic in Panama Canal service; engineer in Indian service; junior engineer in bureau of mines; laboratory assistant in bureau of standards; scientific assistant in Department of Agriculture.

The Garbage Destructor Suits

Some months since, as briefly reported in MUNICIPAL ENGINEERING, decision was rendered in favor of the Destructor Co. in litigation with the city of Atlanta, Ga., in which the city made the claim that the plant did not fulfill the guaranties given by the company. It was shown that the contention was not well founded and judgment was rendered requiring the city to pay for the plant.

On January 17 decision was rendered in the U. S. District Court against the city of San Francisco, Cal., in a similar suit. The suit occupied 23 days' time in the court, the jury was out 45 minutes and returned a verdict for the full amount of the company's claim, $160,077 with interest.

This verdict sustains the company's claims that the plant was built as contracted for and that it was not a nuisance. It was originally selected by the city as the highest development in the destruction of city waste and garbage, and was built under rigid specifications and inspection.

The witnesses in the case included a large number of experts in garbage and refuse destruction, city officials and citizens. For the Destructor Co. appeared Marsden Manson, former city engineer; Dr. Rudolph Hering, Prof. Charles Gilman Hyde, J. J. Jessup, city engineer of Berkeley, four of the engineers on the staff of the company and 22 residents in the neighborhood of the plant. For the city appeared Fred P. Smith, H. A. Campbell, John J. Corcoran, T. W. Ransom, Ralph H. Gould, Milton Kraemer, seven witnesses from the city engineer's office, including City Engineer M. M. O'Shaughnessy and City Chemist C. L. Cook, and 31 citizens.

The real point at issue in each case was the question of the ability of city officials and others, largely for political reasons, to refuse payment for a structure practically meeting all requirements of the specifications, differing slightly in a relatively unimportant point or two on tests, but actually performing in a satisfactory manner all the work required of it under the specifications in practical operation. This question arises frequently, in one form or another, but United States Courts do not look with favor on such suits and, as was stated by the judge in one paving case with which the writer was connected, his court could not be used to save the political lives of city officials afraid to do their duty.

The Cement Show

The Chicago Cement Show sustained its reputation for showing in full the new things in machinery and methods for handling cement and concrete in construction and had the usual number of satisfied exhibitors and interested and curious spectators. Placing exhibits in the gallery and reducing areas of spaces slightly made it possible to put all the exhibits in the Coliseum, a great convenience. And the exhibitors in the gallery apparently had more attention than they would have had if located in the Armory, as in recent years.

The combined exhibits of the association of concrete mixer manufacturers made the biggest show, and the exposition of concrete mixing machinery was the most satisfactory that has been made. The progress in the art and the increase in size, convenience, and efficiency of mixers and their motors since the first show is comparable with that of the automobile and the motor truck. Prominent among these machines for excellence on all points was the Koehring mixer from Milwaukee.

The R. D. Baker Co. of Detroit and the Heltzel Steel Form and Iron Co. of Warren, O., exhibited street paving machines; the former the well-known Baker concrete pavement layer and finisher, and the latter the Parrish machine for laying foundation and mortar bed for wire-cut lug brick pavements.

Steel forms for concrete work, curbs, gutters, sewers, conduits, walls, etc., were shown by the Blaw Steel Construction Co., Pittsburg, Pa., and for curb and gutter, with reinforcement for the same by the Trussed Concrete Steel Co., Youngstown, O. The display of forms for silos, blocks, ornamental concrete work, posts, etc., etc., was immense.

The John F. Byers Co., Ravenna, O., was among those exhibiting portable cranes for loading trucks and cars, excavating and transferring earth, sand, gravel, stone, etc.

Elastite waterproofing and expansion joints were put in evidence by the Philip Carey Co., Cincinnati, O. The Pioneer paving joint was shown by the Pioneer Asphalt Co., Lawrenceville, Ill., together with waterproofing construction for bridges, buildings, etc.

The modern development of the motor truck for contractor's work was shown fully by such firms as the Federal Motor Truck Co., Detroit, Mich.; the Garford Motor Truck Co., Chicago, Ill.; Indiana Truck Co., Marion, Ind.; Sterling Motor Truck Co., Milwaukee, Wis.

Personal Notes

Dr. W. F. M. Goss, dean of the college of engineering of the University of Illinois, was elected president of the Railway Car Manufacturers' Association beginning March 1, having been released by the university authorities. Dr. Goss made his early reputation in the school of engineering of Purdue University, Lafayette, Ind., and has added to it greatly by his very efficient work since 1907 in the position which he is leaving. His work on smoke prevention and electrification of railway lines in Chicago done during a recent leave of absence was also notable. His work for the newly formed association will be in establishing co-operative relations with car purchasers especially in standardizing designs and specifications, and studying the problems of the industry to develop the utmost efficiency.

Publications Received

Directory of Cement, Gypsum and Lime Manufacturers, 1917 edition. Small leather pocketbook size, 244 pp. $2. The Cement Era, 538 S. Clark St., Chicago, Ill.

Technologic papers of the Bureau of Standards of the Department of Commerce, No. 58, on the Strength and other Properties of Concretes as Affected by Materials and Methods of Preparation.

Hand Book for Highway Engineers, containing information ordinarily used in the design and construction of roads warranting an expenditure of $5,000 to $30,000 per mile. Part I. Principles of Design. Part II. Practice of Design and Construction. By Wilson G. Harger, C. E., and Edmund A. Bonney. Second edition, revised and enlarged, 609 pages. Price $3.00 net. McGraw-Hill Book Co., 239 W. 39th St., New York City.

Waterworks Handbook, compiled by Alfred Douglas Flinn, M. Am. Soc. C. E., Am. Water Works Assoc., etc., Deputy Chief Engineer, Board of Water Supply, New York, and Robert Spurr Weston, M. Am. Inst. Consulting Engineers, Am. Soc. C. E., etc., Professor of Public Health Engineering, Mass. Inst. of Technology, Consulting Sanitary Engineer, Boston, Mass., and Clinton Lathrop Bogert, Asst. Engineer, Board of Water Supply, New York. 824 pp. Price $6.00 net. McGraw-Hill Book Co., New York City.

City Planning, by Frank G. Bates, associate professor of political science, Indiana Univ., being bulletin No. 8 of the Indiana Bureau of Legislative Information, State House, Indianapolis, Ind.

MACHINERY AND SUPPLIES

Three Years' Experience with Portable Asphalt Plants

Portable road asphalt plants have received still another emphatic endorsement—this time from W. B. Spencer, president of the Continental Public Works Co., with main offices at 2 Rector street, New York city.

"During the past three years," he states, "this company has purchased three portable Cummer road asphalt plants for paving work in various parts of the country. The first plant was bought in 1913 for use in connection with our contract with the Board of Water Supply of the City of New York, for the laying of approximately 300,000 yds. of bituminous highways around the Ashokan Reservoir. The operation of the first plant was so successful that a repeat order was given in the summer of the same year, with the result that a large proportion of the Ashokan work was laid with the Cummer plants. The specifications called for the laying of a bituminous macadam pavement 2 inches thick after compression. This pavement consisted of a dense mineral aggregate ranging in size from stone passing 1¼-inch ring to stone retained on ¼-inch ring. This material was dried to a temperature of 250 deg. F., mixed with asphalt cement, and laid on the road while still hot, by an 8-ton roller. A squeegee coat of approximately ¾ gallon of asphalt cement to the square yard was then placed upon the roadway, after which the heated stone chips were spread over the asphalt and the roadway was again rolled.

"These two plants were sent to Florida in 1915 where they have been ever since employed for the laying of approximately 100 miles of sand asphalt roadways.

"The third plant was purchased by us during the spring of 1916 and has recently completed the laying of approximately 40,000 sq. yds. of sheet asphalt pavement in the City of Elizabeth, N. J.

"The last plant was what is known as a 1,250-yd. Cummer portable road asphalt plant; the first two were the Cummer 750-yd. type of portable road asphalt plant.

"We find," continued Mr. Spencer, "that the average daily yardage of the smaller size Cummer plant is approximately 1,000 sq. yds. of 2-inch wearing surface per day, and in the larger size plant we find that it has an average yardage of approximately 1,400 sq. yds. per day. We do not believe in pushing our plants too much, and therefore have no extra high records of output, as we believe that a consistent daily average is better than attempting to create records which undoubtedly shorten the life of the plant by imposing excessive strain upon it.

"The asphalt used in connection with the operation of all our asphalt plants is generally delivered to us in tank cars, where it is first heated in the cars by means of steam coils and then pumped by means of the Kinney rotary pump into asphalt kettles adjacent to the plant. These kettles are heated by means of coal fires, the asphalt being delivered into the measuring boxes by means of pumps or by the use of ladles.

"The average plant crew consists of approximately 20 men, and their work consists of unloading materials from the cars, feeding materials into the dryer, and attending to the asphalt kettles, supplying coal and dust when needed. We, of course, also have men on the platform attending to the operation of the mixer, the weighing of the mineral aggregate and the placing of the asphalt in the weigh boxes. Also an engineer, a plant foreman and a fireman.

"It is almost impossible to give the exact number of trucks or wagons used in delivering asphalt mixtures to the street, as that depends entirely upon the length of the haul from the plant, and upon the capacity of the plant itself. Where teams are employed it generally requires at least five teams if haul does not exceed one mile from the plant to street. We find that the use of auto trucks on our particular work is largely limited to jobs where the average haul is more than three miles.

"The street-laying apparatus used by this company consists of a tandem steam roller of the weight required by the specifications, the minimum requirements generally being at least 200 lb. to the linear inch, and the maximum 300 lb. to the linear inch of compression.

"'The street crew generally consists of from seven to ten shovellers, two rakers and two tampers and a foreman. A standard fire wagon is kept as part of the street equipment and is generally employed in keeping asphalt tools hot in order that the asphalt material may be more quickly handled. This company uses Kelly-Springfield rollers exclusively, as we have found them best suited to our needs.

"Where we have employed motor trucks we have found that we have secured excellent satisfaction from Packards, Pierce-Arrow and Saurers.

"It is almost impossible to give the cost of plant transportation and street gang operation as each job is a history in itself. In 1916 the cost of all items where labor was employed was exceedingly high, due to the high cost of labor and exceedingly low efficiency of such help as we could get."

Illinois and Indiana Road Construction

Practically every road-building contractor knows of the mixing difficulties to be experienced with Rocmac binder, and it is therefore noteworthy that the initial use of Rocmac in the state of Indiana was made with the assistance of a Koehring mixer.

The Miller Sales Co., of Indianapolis, Ind.—state sales-agents for Rocmac—last summer promoted the first 11½ miles of such highways in that section. A stretch of Rocmac was built at New Castle, Henry county, where," says Mr. Brooks E. Miller, president of the Miller Sales Co., "a Koehring mixer proved wholly satisfactory for the severe work. A job at Anderson, Ind., is now nearing completion and a Koehring mixer is also being successfully used by the contractor there. This is the second Rocmac job in the vicinity of Anderson, the first being handled by the local contracting firm of Daniels & Lyst. Each set of contractors in various parts of the state have their individual outfits for Rocmac work and, after a little preliminary instruction from the supervision we furnish, have no trouble with the work."

Mr. E. E. Lyst, of Daniels & Lyst, who handled the first Anderson, Ind., job, was new to Rocmac work. The pavement was on an 8 per cent. grade, but it was quickly demonstrated that his Koehring mixer would handle the Rocmac with the same facility as it does concrete.

"Our firm," says Mr. Lyst, "at the present time operates three Koehring mixers. We bought the first one nine or ten years ago, and it is in as efficient working order today as when we first installed it. Of course, we have not used this mixer continuously, but the only reason we haven't has been insufficient work to keep all of our three mixers busy at the same time.

"Our first (old type) Koehring was not equipped for the distribution of the mixed material, and we have since added a chute distributer for use on paving work. Lately, however, we have employed this outfit mainly for concreting on bridge construction jobs and foundation work.

"Our other two machines are of the later, improved Koehring models, No. 16 and No. 11, with reversible traction and boom-and-bucket distributer. We have given them hard usage on street paving work in the laying of foundations for brick pavements and concrete road construction. We also have used the No. 11 machine for mixing and placing of Rocmac concrete. Rather to our surprise, we found that the mixer was very well adapted for this material, and gave us no trouble whatever in the mixing of this difficult solution."

Mr. Lyst goes on to say that he found the cost of his labor with the chute was practically the same as with the boom-and-bucket machine.

Further corroboration of Koehring mixer economy features is advanced by Mr. Cy. J. Rudolph, of Reeb Brothers, big paving and sewer contractors, with headquarters at Belleville, Ill. His firm is using a 1914 model No. 11 and 1916 models No. 11 and No. 6 mixers on the West Main street improvement job in Belleville. Their two No. 11 machines are operated with the roadway between them for the reason that there are double car tracks running along the middle of the road. Their No. 6 machine is employed exclusively for putting down curbing.

KOEHRING PAVER, AS OPERATED BY REEB BROTHERS, BELLEVILLE, ILL.

"With our two No. 11 machines," states Mr. Rudolph, "we are laying a two-course paving bottom of 6½-inch thickness, mixed 1 part cement, 2½ parts sand and 4 parts crushed limestone rock. The top, or wearing course, is composed of 1 part cement mixed with 2¼ parts of aggregate. The aggregate comprises ¼ part of crushed granite and 1 part of sand. This implies approximately 95 cubic yards of concrete in the base, and 7½ cubic yards of top, making a total of 102½ cubic yards. We are doing this on an 8-hour run, which we consider very creditable to the mixer.

"The West Main street improvement contract upon which we are working occasioned a great deal of attention at the time specifications were first drawn. Up to four years ago, this work was greatly retarded for one reason or another, but the last two years have seen it strongly pushed by Belleville city officials.

"Main street is the main thorofare between this city and St. Louis and originally was the right-of-way of the East St. Louis & Belleville Trolley Company, their tracks running along the side of the road. These tracks are now being transferred to the center of the road. With the company's right-of-way 21 feet in center, and 19½ feet on each side, this gives the paved roadway a total width of 60 feet.

"Prior to the letting of the contract, vigorous protests against the improvement were made by big property owners all along the thorofare. They refused to pay the required assessments, and went so far as to carry the fight to the Supreme Court of Illinois, where decision was still pending when the contract was finally let. The validity of the contract was shortly afterwards sustained in the courts and work was begun about four months later. The estimate on the work was $290,000, and bids were as follows:

Reeb Brothers, Belleville, Ill.	$228,468.00
Hoeffken Bros., Belleville, Ill.	242,274.50
Chas. Dekenhardt, Alton, Ill.	250,377.00
J. A. Sturdyvin, Rantoul, Ill.	255,305.00
Dunlap-Dippeld, Edwardsville, Ill.	262,628.40
Granite City Lime & Cement Co., Granite City, Ill.	264,011.40
Birdsall Griffits Const. Co., Racine, Wis.	295,184.00

"Work consisted of:	Unit Reeb's Bid.
124,000 square yards paving	$1.62
32,000 transverse joint	.13½
55,500 lin. feet longitudinal joint	.05
55,500 lin. feet curbing	.25

"With the No. 6 machine we had a run of 1,039 feet (linear) 7 by 16-inch curbing in 8 hours. We consider this a very good run, inasmuch as the mix is 1 part of cement, 2½ parts of sand and 4 parts crushed rock. The No. 6 machine cannot be beat as a mixer for curbing.

"There are approximately 50,000 square yards of this work complete at present time and 24,000 linear feet of curbing. The total length of the roadway being paved is 27,800 linear feet, or about 5 miles and 1,400 linear feet. Also, we have 11,000 linear feet finished on the one side and 10,000 feet on the other.

"Considering the difficulties encountered, this progress of the work has been quite rapid. For instance, it was understood that we were to be given clear roadway by the street car company for the removal of their tracks from the side to the center of the roadway, but a serious strike of their employes held up all work for five weeks right in the middle of the season. To cap that, the steel shortage, which developed just a week or so after the settlement of the strike, held us up for practically a month or more. And we would undoubtedly have lost much more time if it hadn't been for the extra efficiency of the mixers, which certainly did economize on all the time we had left in which to work."

Green's Experience with Gravity Brick Conveyors

C. F. Green, head of the Green Paving Co., with headquarters in Marion, Ind., has for a long time past been using Mathews gravity brick carriers in his street work and, when questioned as to several recent jobs upon which these were used, he answers:

"I have been using eight 8-foot and two 18-foot sections of the conveyors and I'm willing to go on record right here as saying that I couldn't be successful in my brick paving operations without them.

"I use 4 men to put brick on the carriers and 6 men to set the brick as the carriers automatically bring them to hand. These 10 men are thus enabled to average 65,000 brick per day. Two other men are also kept busy making the sand cushion, but they have nothing whatever to do with the brick laying.

"Now, if I were to go back to the old, conventional wheelbarrow method and have to carry brick to the board, it would be necessary for me to increase my present gang by at least 8 more men, at a daily wage of $2.50. Even with an additional cost of $20.00 per day, it is certain that I could get no more brick laid than is now done by my 10-man gang with the Mathews carriers.

"These carriers also eliminate all the old disadvantages of wheel-barrow carriage. Brick are hard on the wheelbarrows to begin with; many brick are unavoidably broken, or at least chipped, in placing in and dumping from the barrows. The wheelbarrows gouge holes in the new pavement and tend to force a crooked alinement of laid brick, necessitating extra work in re-straightening. With the carriers, on the other hand, we cull and lay the brick at one and the same time. Mere inexperienced boys from sixteen to twenty years old (i. e., cheaper labor) can handle and put brick on the carriers well enough for all purposes. There is nothing about the carriers to get out of order; they'll stand a lifetime of hard service, cost little and certainly do speed up the work.

"I also have had a new type of grouting machine made es-

pecially for me for putting grout on brick pavement. With it, I find that a 6-man gang using no brooms at all can spread two coats of approximately 5,000 square yards per day. That, I believe, is quite a record."

Mathews gravity carriers of the type used by Mr. Green are made entirely of steel, the rollers being of cold-drawn seamless steel tubing with patented ball-bearings. Caster supports are provided, allowing the sections to be rolled along over the new-laid brick pavement in the rear of the droppers. The support at the upper (loading) end is set at a distance of 4 feet, which permits the conveyor to extend out over the curb within easy reach of the brick piles. A detachable apron on the lower (discharge) end keeps the brick from falling off and checks the moving line of brick when the conveyor happens to be full.

Sixteen-foot sections are customarily used on all streets from 24 to 32 feet wide, but the sections are made up in any lengths desired. They are built on a grade of 4 per cent., which implies a fall of ¼ inch to the foot. On this incline brick travel gently by their own weight without danger of breakage or falling off.

All sections are made 8 inches wide and each roller is provided with flanges at ends, rising ¼ inch above surface of roller. These flanges act as a guard rail, but do not produce friction, because they are a part of the roller and revolve with it. Axles are full length, extending clear thru the rollers, the ends terminating in the side rails and securely fastened by means of a full-length lock bar. This method of handling brick is endorsed and recommended by the National Association of Paving Brick Manufacturers.

New Automatic Unloader

One of the newest outfits to appear on the contracting market is the Quick shovel, which is especially adapted for labor-saving in the unloading of car and storage bins and the loading of motor trucks or other heavy haulage vehicles. It is estimated by the manufacturers that the transferring of a carload of material can be accomplished in 1 hour and, if 3 cars are handled per day, the machine will pay for itself within a year's time.

The Quick shovel is 8 feet wide by 16 feet long, weighs from 6 to 7 tons and is a 1-man machine, self-propelled by a 15-h.p. gasoline engine, which engine likewise operates the hoist. The operator stands on a platform about 5 feet above the ground—this position giving him a clear view of the inside of the car and perfect supervision of all moving parts of the outfit.

The equipment includes all standard parts, such as a clamshell bucket, hoist, etc., and a 3½-yard loading hopper located on the top portion of the machine. This hopper dumps automatically at the will of the operator.

One of the notable features is provision for the swinging of the bucket in a perfectly straight line, which assures accurate spotting. The rocking arm upon which the bucket is suspended can be folded down on the side of the machine, thus bringing the highest point 16 feet above ground level. This rocking arm is raised into proper position by the connecting link. It requires only about 20 minutes to get the machine ready for operation. The whole is mounted on wide-face wheels suitable for traction over bad roads at a speed of 2½ miles per hour.

The Quick shovel is also made in a low "B" type, employing the same principle for operating on top of material bins.

New Ditch Digging Machine

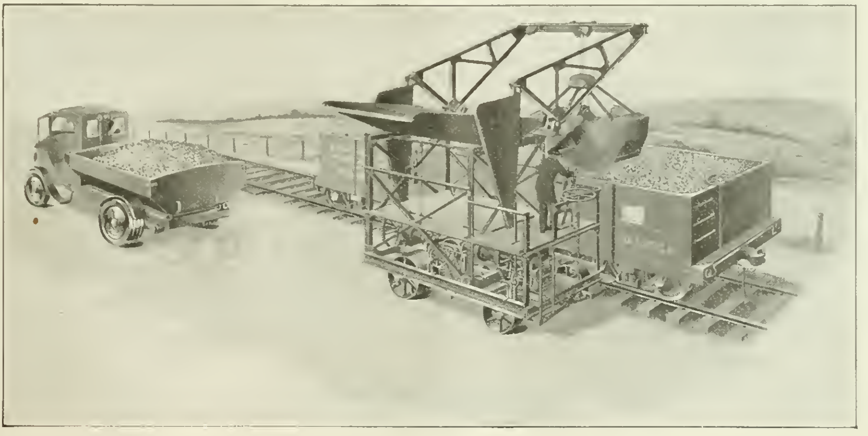
A new ditch-digging and back-filling machine has now been put on the market and, it is claimed, will considerably reduce the cost of all work, except on cuts of such size or depth as require a much larger outfit.

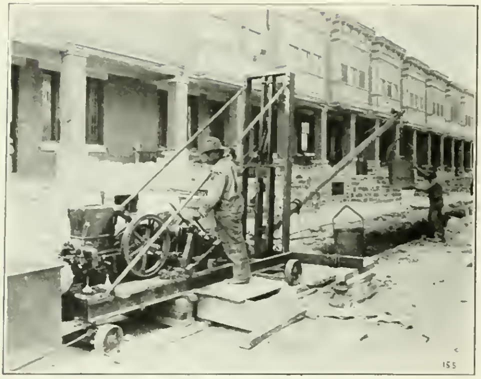
It consists of a suitable-sized gasoline engine chain-driving a back-geared double-drum hoist. In hoisting work one drum is used to hoist the bucket and the other drum to work the boom. The frame is made of heavy channel irons and very rigidly built.

The boom works on a foot-block allowing it to swing on either side. The first few feet of the trench can be scooped with a drag scoop hung between the two lines. As the trench gets deeper the bucket may be used as shown in the illustration on next page. The dirt is shoveled into the bucket by the men below and thence hoisted to the truck at the top of the trench.

For shallow trench work up to 8 ft. deep, the outfit is equipped with a digger arm. A short steel boom is tied, and each line is used to work the scoop-bucket, one scooping the bucket and the other hoisting it. The digger arm works on a swivel, allowing the bucket to be pulled to the side of the ditch where materials are to be dumped. To dump the bucket it is only necessary to release the line that does the scooping. This throws all weight on the other line, which automatically turns the bucket upside down.

The machine is always set ahead of the ditch and is pulled forward and locked as the digging proceeds. By this arrangement it is obvious that the machine is nothing more than a small shovel, differing only from the heavy steam





shovel in that here the pull is toward the machine instead of away from it.

This 8-ft. trench type excavates an average of from 125 to 250 yds. per day, depending, of course, upon the toughness of the soil upon which it is working. Only 6 gal. of gasoline is required for a full day's operation of the outfit.

The engine is 5 h.p., and is taken care of by the man operating the drums. The height over all is 10 ft.; weight 2,500 lbs., wheelbase 12 ft., tread 5 ft. 6 in. The boom is 25 ft. in length. The cost of the outfit is surprisingly low and should be defrayed by the machine itself after a short time in operation.

Vitrified Block Sewer at Louisville

The accompanying photograph shows one of the sewers put in by County Engineer S. F. Crecelius, Louisville, Ky., in suburban towns. The sewer is 36 inches in diameter.

The level character of the district is well shown in the photograph, requiring very low grades. Consequently it was desirable to have the inner surface of the sewer as smooth as possible to give a minimum of obstruction to the flow of sewage.

The sewer as shown is very near the surface of the ground. This means that when the district is developed and the alleys are in use any heavy loads will be carried in large part by the sewer arch and it must therefore be stronger than if at greater depth in good ground.

The soil is apparently badly drained, and for much of the time before the construction of the sewer must have been rather difficult to cross with heavy loads.

All these special conditions were met successfully by the use of vitrified lock-joint sewer tile as reported by Mr. Crecelius. The size and weight of blocks is such that they can be handled with very little equipment and there is less perishable material on the job during construction. It is possible to work and lay sewer in several places at once without an increase of equipment, according to Mr. Crecelius. This is a saving to the contractor and hastens the completion of the work, both important features under the conditions of the job.

Two sharp curves, of 50 feet radius, are seen in the sewer line, made necessary by the position of the sewer in the alleys. They are easily made with the block construction and give no obstruction to the flow of the sewage other than the small amount due to a curve of the given radius in any material.

Owing to the unusual conditions some of the work in this job required under draining during construction, but much of it did not, and under usual conditions the hollows in the blocks carry off the sub-soil water without backing up on the work under construction if there is an outlet below, either to a stream or to a sump where a pump lifts the water out, so that underdrains are not necessary. The sub-soil is drained by the hollow tile sewer so that after it is in place the soil is dry, except for a short time after a heavy rain fall.

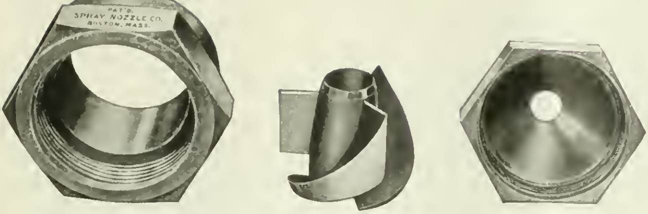
In the photograph an opening is seen in the sewer over which a manhole will be constructed. This shows the flexibility of the construction methods as either sewer or manhole can be constructed first and the other later or both can be built together.

The exposed end of the sewer shows that two rings or courses of the hollow tiles are used. Recesses in the outer faces of the ring of inner tiles receive projections on the tiles of the outer ring, making three interlocking points of each tile with widths of 1¼ to 1¾ inches. The joints being filled

with mortar, there is an irregular continuous mortar joint between the inner and outer courses for the entire length of the sewer. The blocks also interlap 6 to 9 inches lengthwise of the sewer and 3 to 4 inches radially, so that there are nowhere any thru mortar joints. With the joints filled with mortar the sewer is therefore practically waterproof. This interlocking and cementing of the interlocked block together also causes them to work as tho the sewer were monolithic and thus enhance the strength of the structure, an effect to be desired under the conditions of this case, where heavy loads on the surface of the ground will be transmitted thru a rather thin layer of earth almost directly to the sewer ring.

Trussed Concrete Steel Convention

Nearly 200 men were present at the recent convention of representatives of the Trussed Concrete Steel Co., at Youngstown, O., Jan. 23-26, from all parts of the country. Besides the addresses by President Julius Kahn on the work of the company for 1916 and the program for 1917, and one by T. H. Kane on the progress made in the shops, two very valuable papers on credits and contracts were presented and others on pressed steel and Kahn steel buildings, reinforced concrete, steel sash, floretyle construction, hy-rib, metal lath and highway products. Banquets and entertainments lent their aid in making the week highly enjoyable.



MACHINE NOZZLE TAKEN APART. NOTE LARGE ORIFICES.

Spray Nozzle for Highway Maintenance

One of the most approved ways of applying bituminous binder to roads in the course of construction or maintenance is the so-called penetration method, in which the binding material is heated and sprayed over the roads under pressure by a spraying machine.

Naturally one of the most important features of any good spraying machine is the spray nozzle. This must be of such design that it will distribute the material evenly, and, above all, must not clog. A spraying machine which continually clogs after the distributer starts applying material to the road quickly becomes a nuisance, interrupts the progress of the work and converts an otherwise profitable contract into loss.

The use of light oil is now practically confined to surface applications only, but for construction work, the heavier asphalt binders are being specified. These binders, which are practically solid at ordinary temperatures, must be heated to 350 deg. F. and then sprayed upon the roads by means of a pressure sprayer.

It has been found that as a general rule the same type of spraying machine nozzle will work effectively in use with both the lighter and heavier oils. The heavy binders have a tendency to clog the nozzles. This is one reason why many engineers still permit the distribution of materials by the pouring-pot method.

HAND SPRAYING NOZZLE.

The advantages of applying this heavy material under pressure, are, however, so great that numerous endeavors were made to perfect a new type of spraying nozzle which would handle the heavier spraying binders, and one of the most noteworthy of these is illustrated herewith. This nozzle has been put to the most severe tests in various parts of the country by state highway commissions and big private concerns, and demonstrated its economy and practicability.

The nozzles are so constructed that they can easily be taken apart and reassembled without delaying the work. They will spray at the rate of $\frac{1}{4}$ to $1\frac{1}{2}$ gal. per sq. yd., and will coat the stone evenly on all sides as well as on the upper surface. This is said to be quite exceptional.

It is estimated that the cost of constructing a bituminous-bound, macadamized road can be cut 20 per cent. by the way in which this nozzle expedites the work.

For hand-spraying with single nozzles, such as are frequently employed with Tarvias and for patching, a special nozzle, having an orifice 9/16 in. in diameter, is recommended.

Trade Publications

From time immemorial mastic has been prepared from cakes consisting of bitumen and dust. This cake mastic is combined on the work with sand, gravel and flux, the mixture being cooked in kettles. Under this practice it has been necessary to ship the mastic cake long distances from the point of manufacture and the pot mixing has been a slow and laborious undertaking. The Iroquois Works of The Barber Asphalt Paving Company have now designed and put on the market a mastic mixing machine which is described in a bulletin just issued. This machine has two heating drums in which the bitumen, dust and other mineral aggregate is combined in the mixer located at the site of the work. As all the ingredients but the asphalt are usually to be obtained locally, the machine makes it possible to handle mastic jobs much more economically than has ever been done in the past. It is also claimed that the machine-made mixture is more uniform than that obtained from pots.

An appendix to 1913 edition of National Pipe Standards has been isued for attachment to that publication, issued by the National Tube Co., Pittsburg, Pa.

An unique service by an unique organization advertises the work of Esterline & Angus in industrial research and development, Indianapolis, Ind.

Modern steam disinfection methods and apparatus are shown in detail in a well illustrated booklet of the Grampian Engineering Co., Ltd., Sterling, Scotland and London, Eng.

A 2-page circular on how to maintain concrete roads and streets has been issued by the Portland Cement Association.

The Dandie concrete mixer is the subject of an attractive folder of the Koehring Machine Co., Milwaukee, Wis.

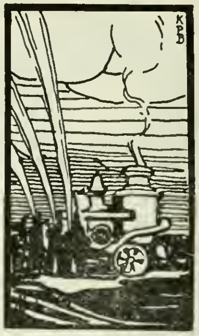
The Blaw Steel Construction Co. has a folder comparing steel forms with wooden forms for road, sidewalk, curb and gutter work which has the striking title, "Stop That Waste."

Bulletin 34Q of the Chicago Pneumatic Tool Co., purports to give a few applications of Grant gas and fuel oil engines.

The Harris Municipal Garbage Incinerator and Steam Generator Co., Nashville, Tenn., have printed full plans and specifications for their incinerator in a booklet, showing the details of design and construction of what promises to be a successful sanitary and economical method of garbage and refuse disposal.

Solvay hydraulic paint for protecting architectural steel in concrete, inside of standpipes, and all hydraulic equipment and submerged steel, is described and its advantages in contact with alkalies are stated in a folder of the Semet-Solvay Co., Syracuse, N. Y.

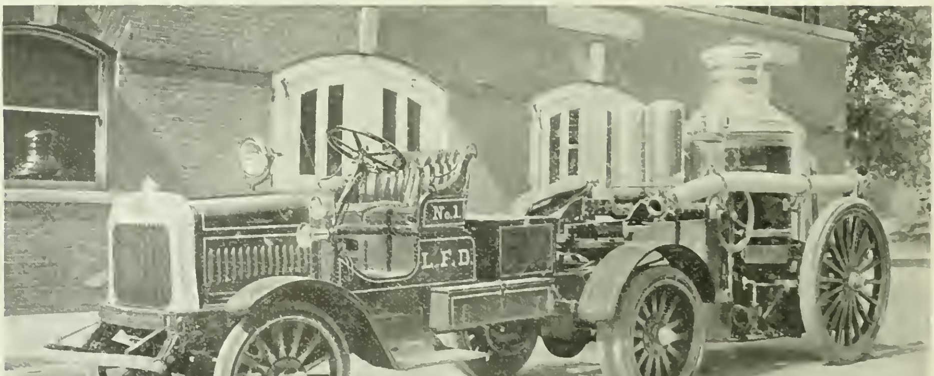
FIRE DEPARTMENT



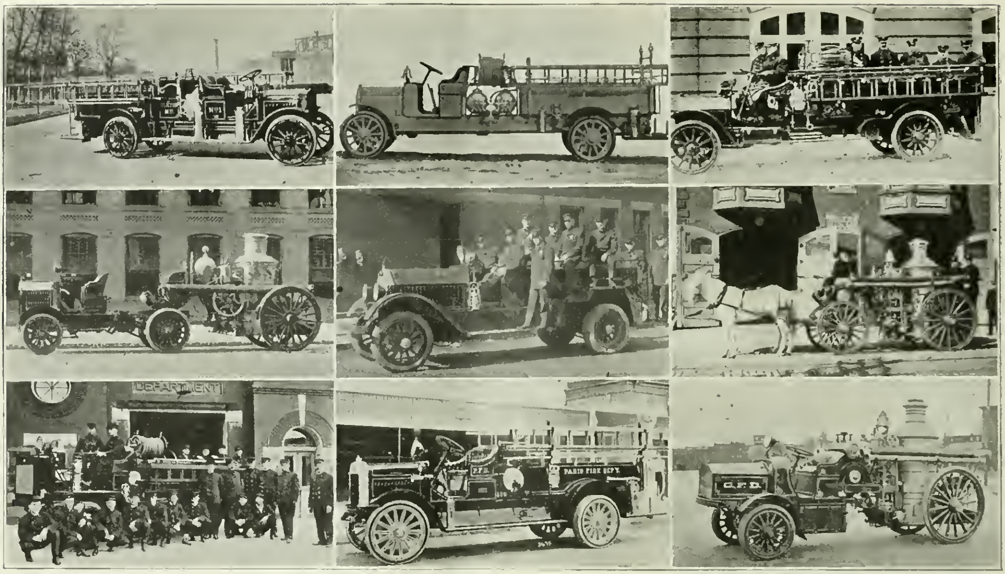
Early Chicago Fire Department

The first Chicago Volunteer Fire Company was organized three years before the original town was established. In January, 1831, the state legislature passed an act authorizing the trustees of any town or village to organize fire companies, not exceeding thirty members, and exempting them from jury service, and military service except in time of war. Anticipating by a whole year the incorporation of Chicago town, the Washington Volunteers came into substantial being. There is now extant evidence that applications for membership were made, and that such were formally passed upon, but that was all. The company had not even nominal existence, for more than a few months, and there was less need of fire companies than of measures for fire prevention. Barely three months after the organization of the town, a fire prevention ordinance was passed. It forbade the passing of any stove-pipe through the roof, partition or side of any building, unless guarded by tin or sheet iron, 6 inches from wood, under penalty of $5, and if the cause of complaint was not removed within forty-eight hours, the fine was to be repeated. Under this ordinance a fire warden was appointed—Benjamin Jones. Upon the division of the town into four wards, each ward was given a fire warden. These were charged with the duty of enforcing the stove-pipe ordinance. They were required each to make once a month a tour of their respective wards to see that there were no violations of the ordinance. Their one other duty was to direct the movements of citizens who responded to the alarm of fire. Only domestic pails were available for the passing of water from dips in the river, to where the fire might happen to be. It was made imperative to have in every dwelling-house or other building containing one fireplace or stove, one good painted leathern fire bucket, with the initials of the owner's name painted on it, and every building with two or more fire-places or stoves, two buckets. The penalty for breaking this order was a fine of $2 for each absent bucket, and the further sum of $1 for each month the owner neglected to provide himself with buckets as required, after notice was given him by a warden. Every able-bodied male inhabitant possessing a bucket, who did not repair to the place of a fire and work under the direction of the fire warden, was liable to a fine of $5.

Now there was felt a need of something more than a bucket company, and accordingly the company of Fire Kings was organized, December 10, 1835. The next step was to se-



HORSE-DRAWN STEAMER, MOTORIZED WITH A 3½-TON GRAMM-BERNSTEIN TRACTOR. OPERATED BY THE CITY OF LIMA, OHIO.



RECENT DEVELOPMENTS IN MOTOR FIRE APPARATUS.

G. M. C. COMBINATION HOSE & CHEMICAL, AS OPERATED BY ELKTON, MD.

GARFORD COMBINATION CHEMICAL & HOSE, AS OPERATED BY AMITYVILLE, ILL.

FEDERAL TRIPLE COMBINATION, AS OPERATED BY SYRACUSE, N. Y.

KNOX TRACTOR, AS USED TO MOTORIZE HORSE-DRAWN STEAM FIRE ENGINE.

SOUTH BEND MOTOR HOSE WAGON, AS OPERATED BY CLEVELAND, OHIO.

HORSE-DRAWN STEAMER, AS FORMERLY OPERATED BY CAMDEN, N. J.

JEFFERY QUAD COMBINATION CHEMICAL & HOSE, AS OPERATED BY COLLINSVILLE, ILL.

GRAMM-BERNSTEIN COMBINATION CHEMICAL & HOSE, AS OPERATED BY PARIS, KY.

SAME AS ABOVE AFTER MOTORIZATION WITH COMMERCIAL ELECTRIC TRACTOR.

was organized, December 10, 1835. The next step was to secure a site for an engine house, in the public square. But that belonged to the county, and the county commissioners were to be dealt with. After some demur, they relented and allowed a free lease for five years to be taken by the Fire Kings company. An engine house 12x12 feet, and fronting on La Salle street, was erected, and a water cistern of two hogsheads capacity was sunken. All at a cost of $220. Then the Fire Kings proceeded to make laws and rules for their governance. It was decreed that members were to be admitted on petition; and that the foreman, for neglecting to see that his engine was in good order, was to be fined $2, and for neglect of any other duty, $1. The clerk, for failure to perform any of his duties, was to be fined $1. The steward—it was his duty to provide meat and drinks to the members when engaged at fires—was held to a strict accountability, and duly fined $2 each and every time he was wanting, with respect to supplies, or in punctuality. The members were liable to fines for derelictions, as follows: For non-attendance at a meeting, 50 cents; for disobeying the commands of the officer in command, $2; for absence from a fire, $2; for absence from the semi-annual review, $2; for leaving a fire without the permission of the officer in command, $1; for each month he was without a uniform, $1. When a member was not present at the first roll call, but present at the second, one-half the fine was remitted.

The engine ordered by the trustees, thru their agent, Mr. Ogden, did not arrive for some months, and meantime the Hook and Ladder Company waited on events. On March 4, 1837, Chicago was incorporated. A census of the population was then taken, which showed the presence of 4,170 souls. There were six wards, and from each ward there were two aldermen—who also were fire wardens; they, as a body, had power to appoint other wardens and to organize additional fire companies. A chief engineer and two assistant engineers were chosen by the council, but their successors were to be elected annually by the voters of the city. Vacancies in the offices of chief engineer and assistant engineers, if any should occur, were to be filled by election of the council. Company No. 2, still in old firemen's circles, is remembered for its men having run 500 yards and made connections with 300 feet of hose in one minute and seven seconds. Ashley Gilbert was the next chief engineer, and he was followed by Cyrus P. Bradley, who later was influential in local politics.

Fire Department Notes

The city of Dayton, Ohio, which had in service 12 pieces of American-La France apparatus, is at the present time receiving additional equipment comprising 1 4-cyl., 65-ft. aerial truck; 6 combination chemical and hose carts with junior pumps; 6 triple combination pumping chemical and hose cars.

Fall River, Mass., recently standardized their equipment by the installation of 14 pieces of the same make of motor apparatus, bringing their total to 15 pieces, which consist of 1 75-ft. aerial truck, 4 combination chemical and hose cars, 5 pumping cars, 1 85-ft. and 1 75-ft. aerial truck, 1 6-cyl. tractor, 1 chassis for a chemical engine, 1 combination service truck.

Buffalo, N. Y., had in service 3 motor pumping cars and 1 gasoline-electric 85-ft. aerial truck. Within the past few months they have added 15 pieces of motor apparatus, including 1 gasoline-electric 85-ft. aerial truck, 10 4-cyl. and 2 6-cyl. tractors for attachment to steamers, aerial trucks and water towers; 2 pumping cars.

MOTOR TRUCKS

Printed as insert to Municipal Engineering, March, 1917.

Six tons on truck—five tons on each trailer—total 16 tons

The Garford Road Builder

Here is a Road Builder that will build and maintain roads at a lower cost than ever before.

It has been *specially designed and constructed* for that particular purpose.

It possesses tremendous power. And in addition to carrying 6 tons "on its own back" it will pull trailers, drags, scarifiers and other road machinery. Two special drawbars for such work are furnished with each Road Builder.

A hydraulic hoist operates the steel dump body. And the tailgate opening can be regulated for spreading materials in any desired thickness.

The driver controls the entire mechanism—from the seat.

Rear wheels are extremely broad and when necessary can be fitted with special cleats which are furnished as standard equipment.

The Road Builder operates overfills, subgrades and roads under construction.

Write us today for booklet containing detailed specifications and information. Address Dept. 107.

Garford Motor Trucks

The Garford Motor Truck Company, Lima, Ohio

Manufacturers of Motor Trucks of 1, 1½, 2, 3½, 5 and 6 ton capacity. 4½, 7 and 10 ton Tractors

The Garford Road Builder

Distributors and Service Stations in all large cities

MOTOR TRUCK OPERATION AND ACCOUNTING XIX.

By Charles A. Dickens.

Under proper conditions, motor trucks can be profitably operated in the collection and removal of garbage and refuse, while under certain conditions horses are decidedly more economical. It all depends.

There is no doubt but that if more accurate cost accounting methods were adopted by our municipalities, motor truck haulage of garbage and refuse would make a better showing. We must, however, consider conditions and present methods as they actually exist. The following resume, submitted by Mr. B. F. Miller, Jr., City Engineer, City of Meadville, Pa., is consequently worthy of attention as arguments, both pro and con, and substantiated by practical and studious research:

In this age of the motor, when almost every day develops some new use for its power, one might quite naturally imagine that in the collection of municipal garbage and refuse the sooner the horse-drawn vehicles were discarded the better.

However, an investigation of this subject in 125 American cities discloses the fact that there is still much to be said in favor of the horse, especially in the matter of garbage collection.

The writer, in submitting this report, has given the arguments pro and con, which were received in response to a circular letter sent to 225 American cities, from which 125 replies were received. It will be noted that comparatively few cost data have been received, due primarily to the fact that so few cities have used motor apparatus (105 are still using horse-drawn apparatus), or that some of them have not used them long enough to have collected any data of value. The replies received showed an awakened interest among municipalities in the following:

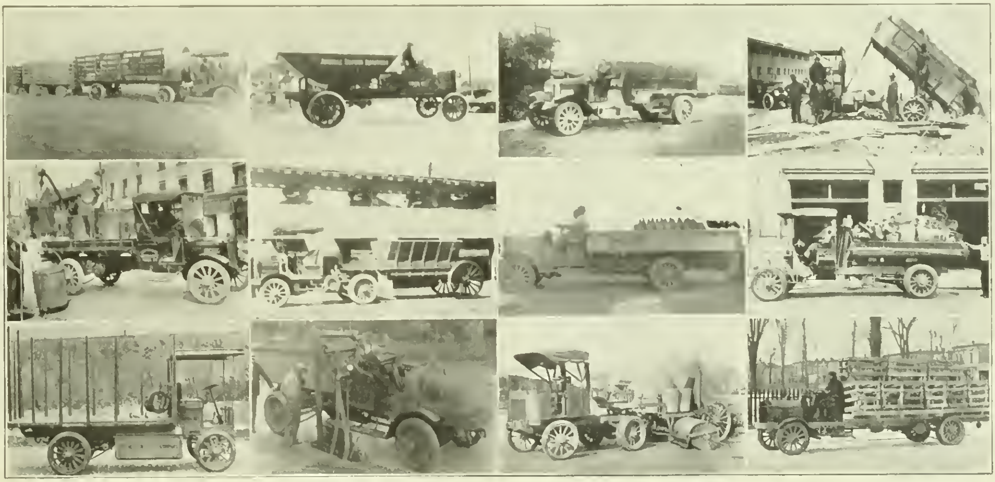
1. A growing tendency toward placing garbage collection under the active supervision of departments of public works, as opposed to supervision by health boards.

2. A decided sentiment in favor of municipal collection instead of the prevailing contract system.

3. An awakened interest in the serious study of garbage collection and disposal, as, for example, the excellent report of Mr. I. S. Osborn on the collection and disposal of garbage for the District of Columbia.

Briefly summarized from the replies received, the principal arguments for the use of motor-driven vehicles for garbage collection, are as follows:

1. Where the garbage can be delivered to a central unloading station and then taken from this point to the disposal plant with motor vehicles, there is, no doubt, much economy in the use of the motor. However, the practicability of a central station is somewhat doubtful, for it would, to be of advantage, have to be located in a somewhat populous



KNOX TRACTOR, AS OPERATED BY WESTERN REINFORCED CONCRETE PIPE CO., LOS ANGELES, CAL.

SIGNAL MOTOR TRUCK, AS OPERATED BY THE SEWER DEPT., CITY OF SPOKANE, WASH.

ATLANTIC ELECTRIC TRUCK, AS OPERATED BY THE BETHLEHEM STEEL CO., BETHLEHEM, PA.

G M C GARBAGE TRUCK, AS OPERATED BY THE SANITARY DEPT., CITY OF ASHEVILLE, N. C.

KNOX TRACTOR, AS OPERATED BY THE DEPT. OF STREETS AND ENGINEERING, CITY OF SPRINGFIELD, MASS.

OTTERSON MOTOR EDUCTOR, AS OPERATED BY MANY LEADING MUNICIPALITIES.

SIGNAL GARBAGE TRUCK, AS OPERATED BY THE CITY OF BOSTON, MASS.

RIKER MOTOR TRUCK, AS OPERATED BY JACOB PRESS SONS, CHICAGO.

TRANSPORT TRACTOR AND STREET SWEEPER, AS OPERATED BY DEPT. OF STREET CLEANING, CITY OF NEW YORK, N. Y.

RIKER GARBAGE TRUCK, AS OPERATED BY THE HEALTH DEPT. OF SEATTLE, WASH.

PACKARD GARBAGE TRUCK, AS OPERATED BY THE STREET DEPT., CITY OF HOMESTEAD, PA.

LEWIS-HALL MOTOR TRUCK, AS OPERATED BY BIG SEWER CONTRACTORS IN SEVERAL WESTERN CITIES.

district, and several cities, notably Seattle, who have tried this plan have discarded it because of the serious objections of people living in the neighborhood of the central station. If some means of eliminating the objectionable odors at the central station were devised, possibly it might become practicable. Of course, with such a station the hauls of the horse-drawn wagons would be shortened and much time would be saved in not having the collectors make the trip to the disposal plant.

2. Los Angeles reports that motors, in residence districts, are advantageous over teams because collections can be made more regularly, and that motor collection is at least as cheap as horse collection under similar conditions. They are using two $2\frac{1}{2}$-ton trucks for garbage collection in their residence district. The first collection is 8 miles from the reduction plant. The cost of collection and delivery to the plant by motor is \$2.75 to \$3.00 per ton; by team it is \$2.37. The trucks are operated by one driver and two collectors and make two loads per day. Each truck travels from 20 to 40 miles per load collected and works 8 hours per day. In the same district a team of 3 horses and driver made 1 load per day, wagon hauling $2\frac{1}{2}$ to 3 tons per load and trucks $2\frac{1}{2}$ to $3\frac{1}{2}$ tons. The cost given above includes maintenance, depreciation and interest. The cost data for horses included depreciation for stock, but no account was taken of extraordinary wear on stock due to long hauls.

3. Pasadena reports using a 7-yard truck costing \$2,450 for refuse collection. The life of the truck is 5 years and costs \$7.11 per day to operate, exclusive of depreciation, but including oil and distillate. This truck averages 42 miles per day, hauling 16 cubic yards average and replaces two 2-horse and two 1-horse wagons. The two 2-horse wagons covered 20 miles per day and the two 1-horse wagons covered the same amount. The truck requires 2 men to operate, while the wagons require 4 men and six horses.

4. Spokane reports that for residence districts, long hauls and heavy loads, one truck takes the place of 4 teams.

5. Tampa reports a 50 per cent. saving in the use of the motor truck, in replacing horse-drawn apparatus, for partial collection only. In street-cleaning apparatus a 50 per cent. saving was effected. No figures were given to prove this statement.

6. Detroit uses motor collection from hotels and restaurants, and also from central collection station.

7. Joliet, Ill., uses motor truck from central station.

8. Brockton, Mass., Montgomery, Ala., Paterson, N. J., and Augusta, Ga., have discarded horse-drawn apparatus and installed motors for house-to-house collection, but are not yet ready to report cost data.

9. The Norfolk Navy Yard expects one motor truck to replace one 2-horse and three 1-horse teams.

LACRE STEEL MOTOR DUMP WAGON, AS OPERATED FOR REFUSE REMOVAL IN ENGLAND.

SCHOENBERG ELECTRIC SANITARY DUMPING CAR, AS OPERATED BY THE CITY OF BERLIN, GERMANY.

OTTERSON MOTOR EDUCTOR, AS OPERATED BY THE CITY OF SPRINGFIELD, OHIO.

BUSSING MOTOR STREET SPRINKLER, AS OPERATED BY THE CITY OF BRAUNSCHWEIG, GERMANY.

MACK TRACTOR, AS OPERATED ON SUBWAY WORK BY JACOB FRADUS, NEW YORK, N. Y.

STOEWER MOTOR GARBAGE TRUCK, AS OPERATED BY THE CITY OF STETTIN, GERMANY.

LEWIS-HALL MOTOR TRUCK, AS OPERATED BY SEVERAL LEADING WESTERN SEWER CONTRACTORS.

FEDERAL MOTOR GARBAGE TRUCK, AS OPERATED BY THE AMERICAN REDUCTION CO.

G. M. C. MOTOR GARBAGE TRUCK, AS OPERATED BY THE CITY OF ASHEVILLE, N. C.

"Hauls 42,000 Brick in 10½ hrs.—Replacing Seven Teams."

That's what one 5-ton HALL did for the Hayes Cartage Co., Detroit, Mich. "And, as a result," states W. E. Hayes, "we are placing an order for our Seventh HALL today!

"One of our 3½-ton HALLS *averages 7.4 mi. per gal.* of gasoline, and all of the six (in hard service more than a year) are living up to pre-purchase tests promised for them!

"Cost of HALL Truck operation is *far below* that of the average truck! We have nothing but praise to offer regarding HALL Design, Construction, Durability and Efficiency! For Hard, Every-Day Service I've seen No truck that *Even Equals* the HALL!"

HALL Trucks are geared to *heavy* duty! Greedy to meet the Time-Saving, Weight-Moving Demands of Contracting Needs! And it's the HALL-AGE—the *low* ton-mile costs—that counts! Got YOUR copy of the new traffic Book, *Speeding Up*, yet? If not—Write for it Today!

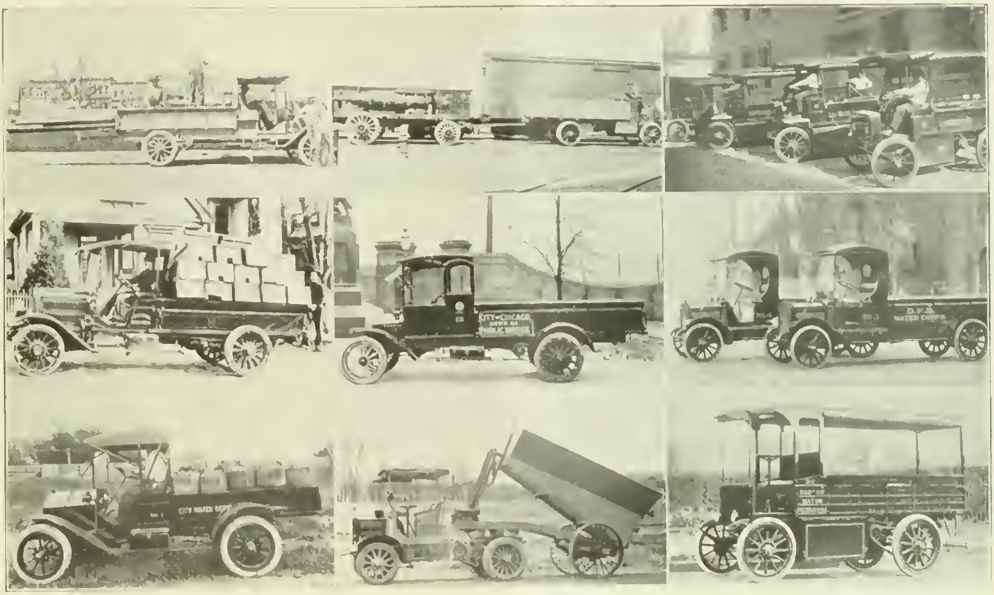
Agents wanted in open territory.

LEWIS-HALL IRON WORKS

MANUFACTURERS OF THE HALL TRUCK

(Established 1873)

Ferry Ave. and Grand Trunk Ry. DETROIT, MICH.



G. M. C. MOTOR TRUCK, AS OPERATED BY THE WATER WORKS DEPT., CITY OF OGDEN, UTAH.

KISSELKAR MOTOR TRUCK, AS OPERATED BY THE WATER WORKS DEPT., CITY OF VICTORIA, BRITISH COLUMBIA.

WILCOX MOTOR TRUCK, AS OPERATED BY THE WATER WORKS DEPT., CITY OF MINNEAPOLIS, MINN.

LOCOMOBILE MOTOR TRUCK, AS OPERATED BY A LEADING CHICAGO CONTRACTOR FOR HAULING WATER PIPE GATE VALVES.

SMITH FORM-A-TRUCK, AS OPERATED BY DEPT. OF PUBLIC WORKS, CITY OF CHICAGO, ILL.

KNOX TRACTOR, AS OPERATED BY LEADING SPRINGFIELD, MASS., SEWER CONTRACTOR.

KENTUCKY MOTOR TRUCK FLEET, AS OPERATED BY THE LOUISVILLE WATER CO., LOUISVILLE, KY.

SIGNAL MOTOR TRUCK, AS OPERATED BY WATER CORPS OF SEVERAL WESTERN CITIES.

WARD MOTOR TRUCK, AS OPERATED BY DEPT. OF WATER, CITY OF NEWARK, N. J.

10. Buffalo is considering central collection depots and motor delivery from this point to the disposal plant.

11. Nashua, N. H., collects rubbish with a truck and finds that one truck does the work of from 2 to 3 teams and shows much economy.

The objections to motor apparatus as given were as follows:

1. The speed gained on the long hauls is more than offset by the time consumed in getting on and off the truck while loading.

2. With a truck a driver would be necessary all the time in addition to the other operators, thus adding extra cost, while with horses a team or single horse can be trained to move from house to house at a call from the driver, who also collects the cans.

3. Either the life of the motor will be shortened due to many stops and starts or, if the engine is allowed to run, excessive use of gasoline results.

4. Many cities place refuse in sanitary fills and motors are not practical in low marshy ground.

5. The cost of motor equipment is considered by many to be prohibitive.

6. The Denver Hog Ranch Co., which collects garbage for the city of Denver, says: "We are using teams to collect garbage from the city of Denver in preference to trucks, our haul being 5 miles. The rainfall in this country is only about 13 to 15 inches per annum, consequently the roads are usually in good condition, except perhaps for a short time in the spring. We have gone over the truck proposition several times with different salesmen, who had an idea they could save us money on the collection and removal of the garbage, but it is our conclusion after careful investigation that the only way a saving might be made would be to have all the garbage collected and removed to a central point and then hauled from the central point to a place of disposal.

7. Motor vehicles are not adapted to pick-up work.

8. In northern climates, where heavy snows are prevalent, motor trucks are not suitable even for long hauls.

9. Syracuse, N. Y., is discarding trucks for house-to-house collection, and using them for hauling from a central station.

10. Toledo has discarded trucks on account of heavy grades and rough roads.

11. Dayton experimented with one truck in house-to-house collection and found that it did not pay. The cost to collect with truck was \$1.37 per ton, as against \$1.09 for horse collection.

Conclusion

From the above replies the following conclusions may be drawn:

1. Motor vehicles are not practicable for house-to-house collection of garbage, except perhaps in a few instances where residences are far apart, as in Los Angeles or Pasadena.

2. Where it is possible to establish central stations (and there does not seem to be a very immediate possibility that they will become very poular) the motor will prove an economy for the long haul.

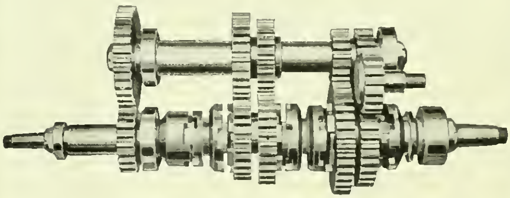
3. In refuse collection motors show considerable economy.

4. In downtown districts it would appear that better service, even tho not as cheap, might be gotten from trucks in collections from hotels and restaurants.

5. Horse-drawn apparatus seems most suitable for house-

Here's a Telegram from Walter S. Milnor Company of Minneapolis, Minn.

"Gramm-Bernstein Trucks have been in *constant* operation all winter. Inspection to-day shows them to be in exceptionally good condition." And there's a lot of satisfaction in knowing that *your* truck has the reserve power and ruggedness to "stand up" and "deliver" in all weathers and over all roads! So make sure it's a Gramm-Bernstein.



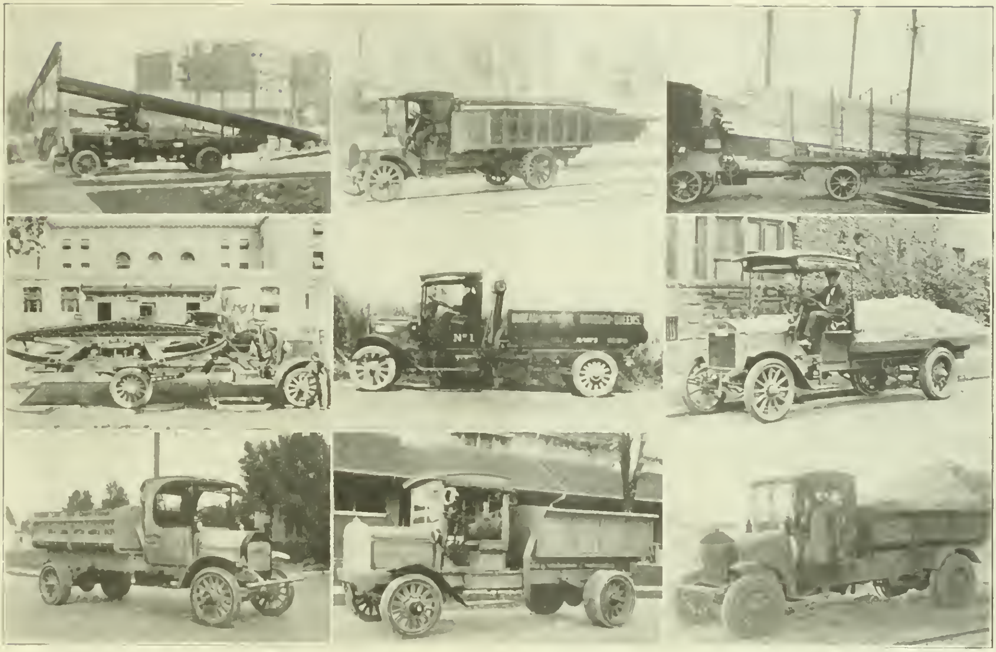
No stripping of gears! Because G-B high-carbon Chrome Nickle Steel teeth *cannot* get out of proper contact. No Grinding! No Gnashing! No corner Chipping! No Shifting! Because G-B gears are *always* in mesh. The G-B transmission is patented—*cannot* be secured on any other truck. Just another reason why Gramm-Bernstein trucks cost less to own.

The G-B is the only transmission that is unreservedly guaranteed for the entire life of the truck.

"I should worry
sure it's rainin'
-in bucketfuls
-roads somethin
fierce but me
Gramm-Bernstein
goes through th'
mud an' puddles
like a duck."
Transmission Tim

The Gramm-Bernstein Motor Truck Co.

LIMA, OHIO.



LOCOMOBILE MOTOR TRUCK, AS OPERATED BY THE MARKET FORGE CO., CHELSEA, MASS.

FEDERAL MOTOR TRUCK, AS OPERATED BY THE MUNICIPAL DOCK & TRANSFER CO., NEW ORLEANS, LA.

HARVEY MOTOR TRUCK, AS OPERATED BY THE WISCONSIN LIME & CEMENT CO., CHICAGO, ILL.

STEGEMAN MOTOR TRUCK, AS OPERATED BY A. V. GAUBATZ, MILWAUKEE, WIS.

SIGNAL MOTOR TRUCK, AS OPERATED BY BUREAU OF HIGHWAYS, BORO OF QUEENS, N. Y.

GRAMM - BERNSTEIN MOTOR TRUCK, AS OPERATED BY JOSEPH BABKA, SIOUX FALLS, S. D.

LOCOMOBILE MOTOR TRUCK, AS OPERATED BY THE CROSS, AUSTIN & IRELAND LUMBER CO., BROOKLYN, N. Y.

G. M. C. MOTOR TRUCK, AS OPERATED BY THE BATCHELDER-WASMUND CO., DETROIT, MICH.

PIERCE-ARROW MOTOR TRUCK, AS OPERATED BY THE EMPIRE LIMESTONE CO., NEW YORK, N. Y.

to-house collections, and for delivery to central loading stations.

Atlanta, Ga., Makes Big Saving.

Atlanta, Ga., effected such a tremendous saving in the collection of garbage after they put their first motor truck at work that they bought several more.

The department in charge of this work carefully compiled operating costs covering service with carts and horses and with motor trucks. Every possible expense, including depreciation, was figured in. The costs were tabulated for one month, and when the checking was over it was shown that carts and horses cost $3,260.41 and motor trucks $755.02, or a saving of $2,505.39 in favor of the motor trucks.

The following table details the cost figures for the month:

A COMPARISON OF THE RELATIVE COSTS OF MOVING REFUSE BY CARTS AND BY AUTO TRUCKS IN THE SANITARY DEPARTMENT OF THE CITY OF ATLANTA, GA.

Interest on investment at 6 per cent.		Carts.	White Trucks.
119 carts at..........$	50.00		
119 harness at........	10.00		
119 mules at..........	250.00		
6% for 1 mo. on....$36,890.00		$184.45	
4 auto trucks at $3,500—			
6% on $14,000 for 1 mo................			$70.00
Depreciation—			
20% on mules, carts, etc., 1 mo., at 25% per year on $36,890.................		614.83	
25% on trucks, 1 mo., at 25% per year on $14,000			291.66
Stable and garage costs, 1 mo (average).		676.13	50.00
Forage and fuel costs, 1 mo. (average)..		1785.00	116.32
Tires, for 1 mo. (average)..............			126.16
Repairs, for 1 mo. (average) (figures in depreciation and stable cost.)			
		$3260.41	$755.02
Pay roll for one month—			
119 carts hauled 5647 tons for..........		3989.65	
4 trucks hauled 1272.8 tons for..........			709.12
		$7250.06	$1464.14
Cost per ton on refuse hauled...........		1.28	1.15

Note.—Cartmen are paid $1.25 per day; truck laborers are paid $1.50 per day; truck drivers are paid $3.00 per day. With the same scale of wages the difference in cost of operation would be greater in favor of the trucks.

An Unusual Motor Truck Eductor.

Elsewhere in this issue will be noticed an illustration of the unique motor truck sewer-cleaner devised by George W.

Otterson, of Seattle, Wash. This eduction machine operates by chain drive, has been proven thoroly efficient and is so constructed that it can also be used for street sprinkling and flushing. By merely taking the baffle plates from the bed, it can likewise be made to fulfill general haulage needs. The truck motor affords adequate power for operation of the machine.

The eductor comprises a 1,200-gallon tank and overhead receptacle, which is divided into various compartments. When the truck arrives at a catch basin, the water in the tank is first made to percolate into the pump, thus priming it. There it is ready to work. The pump is then lowered into the manhole basin and started by the truck motor. The water in the big tank is thus forced downward at a pressure of 50 pounds per square inch, flushing the basin clean and forcing the accumulated refuse up out of the manhole and into the overhead receptacle. The materials pass up thru a pipe into the tank of the motor truck, where the solids drop to the bottom and the liquids and lighter materials continue to flow into the various compartments thru holes in the partitions. After making a complete circuit, the water finally is again ready to be pumped down into the catch basin.

The upward pressure is such that every sort of debris—stones, sodden rags and what not—are unavoidably forced up into the tank. No less than 5 cubic yards of material can be handled in a 5-ton motor truck bed.

Immediately the tank becomes filled with refuse, the truck is run to the city dump where simple manipulation of a lever raises the body end-gate and slowly tilts the bed, including all materials taken from the manholes to slide down the incline upon the dump. The truck bed is thoroly cleansed by the water in the tank.

This method of basin cleaning obviates the old objectionable necessity of allowing malodorous and unsightly filth to stand out until the arrival of collectors with shovels. It makes it possible to clean basins of 6 feet depth in a 6 minute average. The great improvement in sanitary conditions is at once obvious.

This novel cleaning machine was put to the most severe tests on Ludlow avenue, Springfield, Ohio, under the personal inspection of Chief Engineer M. J. Bahin and City Manager Charles E. Ashburner, and it there fulfilled all that was claimed for it.

Of those machines now being operated by western and middle western municipalities, it is said that each cleans from 40 to 50 basins daily. A truck driver and one assistant are sufficient for all phases of the work.

A Big "Clean-up" Job.

Motor trucks, in one week, removed over 1,000 dead animals and thousands of tons of refuse and debris from the streets of Dayton, Ohio, after the late flood. By working them in pairs, using one truck to load and the other by means of a skid and tackle, they loaded carcasses at the rate of eight in three minutes. These animals were then hauled to the temporary dump two miles out on the Springfield road.

It was one of the most remarkable opportunities ever witnessed for comparing old methods of hauling with new. Each truck was capable of removing an average of 50 horses per day, while with a team and wagon the best record was 5 trips with 2 horses to the load. At that, it was necessary to use a motor truck to load the horse wagon in order to avoid serious delay. The truck carried 4 to 6 horses.

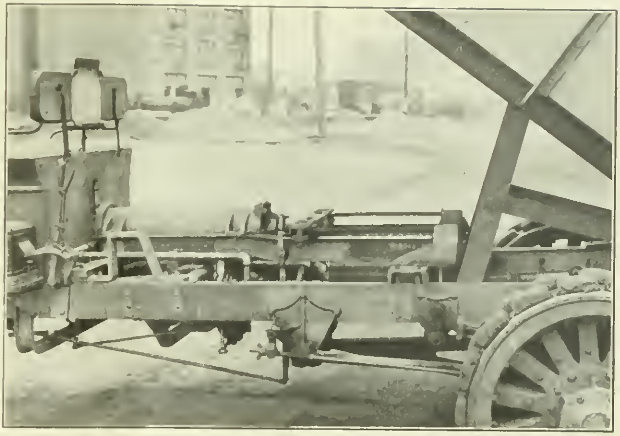
Garbage Trucks in Paris.

The city of Paris, France, has several electric trucks in service in its garbage and refusal disposal departments.

A large majority of the dwellings in the city are in the form of apartment houses which have only a front entrance, which requires the collection of all the household wastes to be made from the front sidewalk. For this reason it has for years been required that each dwelling be provided with one or more large galvanized iron cans. These are set out in front of the house at a very early hour in the morning so that the contents can be collected by the wagons in the minimum time.

While making collection it is required that the wagon run

BYERS AUTO-CRANE LOADING TRUCKS ON CHICAGO TEAM TRACKS. TRUCKS AT WORK ARE THE TRUCKS THAT PAY. A TRUCK CANNOT WAIT LIKE A TEAM WITHOUT EXCESSIVE COST FOR LOADING AND UNLOADING. QUICK LOADING AND UNLOADING ARE THEREFORE ESSENTIAL REQUISITES TO THE ECONOMICAL OPERATION OF MOTOR TRUCKS. ECNOMICAL TRUCK OPERATION REQUIRES HAULING CONDITIONS WHICH MAKE THE RATIO OF RUNNING TO STANDING TIME LARGE.



YOUNG HORIZONTAL HYDRAULIC-AUTOMATIC HOIST ASSEMBLY ON CHASSIS. THE CYLINDER IS LAID HORIZONTALLY ON THE TRUCK FRAME, UNDERNEATH THE BODY AND PROTECTED BY IT, PERMITTING THE BODY TO BE SO MOUNTED THAT THE FORWARD END WILL JUST CLEAR THE BACK OF THE SEAT.

at a very slow speed, with a stop before each house. In this design the box body is entirely separate from the front truck, which latter carries all of the electrical and mechanical motive apparatus and can be at once removed when necessary. The top part of the front truck is occupied by a large box containing 45 storage battery cells, and there is a separate electric motor of 6 horsepower placed against each of the wheels. The standard running speed is 8 miles an hour. The total weight of the wagon is 6.4 tons.

The box body is covered with separate sections of sliding covers, so that only a part of it need be opened at a time. During the collection, while the speed is being kept quite low, a special appliance permits the wagon to be controlled from the side, the object of this being to allow the driver to aid in loading the material into the wagon and at the same time control, guide, start or stop the wagon at will from the sidewalk. This practically reduces the force necessary by one for each wagon. The wagon has a mottom dump for unloading the material into the incinerator or onto the dump.

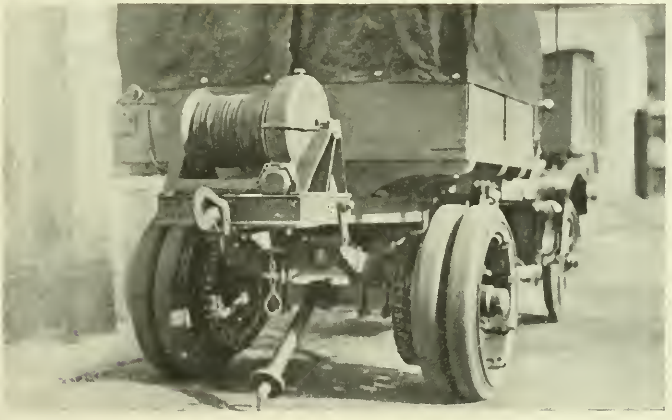
Does Work of Sixteen Horses.

The city of Seattle, Wash., is operating a 5-ton Pierce-Arrow truck, equipped with a 13½-cu. yd. dump body, in its garbage collection department. The weight of the outfit without load is 10,800 pounds, and while it is rated as a 5-ton truck, garbage loads weighing as much as 13,900 pounds have been carried in routine work.

The record of this truck for one month shows 602 tons of garbage hauled in 24 days, traveling a distance of 1,320 miles. The truck is charged with 360 gallons of gasoline and 5 gallons of oil. Approximately 25 tons are hauled 2.1 miles in an eight-hour day at a cost of 32½ cents a ton mile. If road conditions in that territory or a more direct route would permit, twice this tonnage could be handled, as far as the truck is concerned. As conditions now stand, the machine takes the place of 16 horses, 8 men and wagons and never falters.

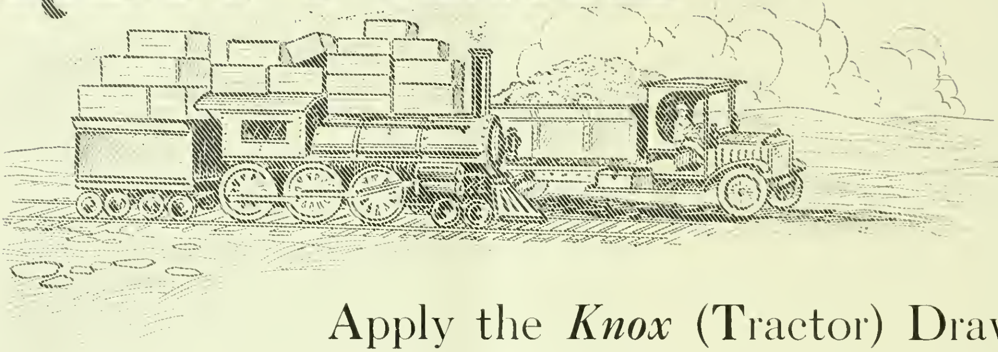
TRUCKS MEAN MORE FREQUENT COLLECTION.

"The city of Seattle," states the health commissioner, "is operating five motor trucks in refuse collection work. We have given the matter of removal separate treatment because this city introduced the method of removing its waste by auto truck two years ago and today is removing nearly 40 per cent. of its waste in this manner. It is believed that within sixty days more than 50 per cent. will be removed by the auto truck. In removing the same by auto truck, the material is taken thru the streets of the city in about one-fourth or one-fifth of the time consumed by horse-drawn vehicles. Seattle is a city of hills and it is therefore safe to say that this material is removed, as a matter of fact, in one-fifth of the time consumed by horse-drawn vehicles. Six tons are removed in one truck bed built for this purpose. It is more easily covered by tarpaulin than would be the same tonnage in three vehicles. It is dumped once instead of three times, thus saving the



KNOX TRACTOR, AS EQUIPPED WITH TOWING WINCH ON REAR FRAME. A 150-FOOT CABLE IS SUPPLIED WITH THE WINCH, THROUGH A PROPELLER SHAFT AND TWO UNIVERSAL JOINTS TO A WORM AND GEAR ON THE WINCH SHAFT. THE WINCH DRUM IS LOOSE ON THE SHAFT AND IS DRIVEN THROUGH A CLUTCH WHICH MAY BE RELEASED WHEN IT IS DESIRED TO REEL OFF THE CABLE.

QUIT PILING~



Apply the *Knox* (Tractor) Draw Bar Pull to your Heavy Haulage! You'll *Reduce your Costs* Two Ways at Once!!

It is Draw Bar *Pull* that moves the world's goods. That's why the pack-load was transferred to wheels! Compare the carrying power of the horse to his Draw Bar *Pull!* If railroads didn't realize that fact, they'd pile their freight on locomotives instead of using a single locomotive to *Pull* trains of many cars.

The Knox Tractor (the highway gasoline locomotive) *hauls* many times as much as the largest motor truck can carry in every field of heavy haulage at the *lowest* cost per ton-mile. And the Knox Tractor is *not* obliged to "idle," as is a motor truck during loading and unloading—trailers are *always* traveling behind the Knox while others are being loaded or unloaded.

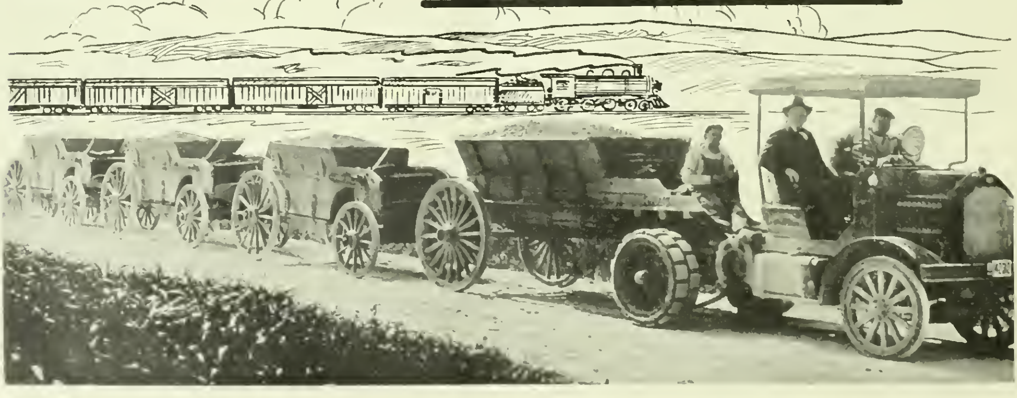
Quit Piling—and Start Pulling! *Use a Knox!!*

KNOX MOTORS ASSOCIATES

"The Power Ahead—the Load Behind."

SPRINGFIELD, MASS.

And~ START PULLING!



blowing about and dissemination of disease-bearing germs. Not as many garbage-laden vehicles pass thru a given community nor are they repugnant to the people as are horse-drawn vehicles. The collections are more regular because the hillsides are slippery during certain seasons and we were occasionally delayed a day or so at a time, as the case might be, by the use of horses.

SAVE 45 CENTS ON THE DOLLAR.

"We have not been operating with the auto trucks long enough to know exactly what the saving is amounting to over the horse-drawn collection. It is our opinion at this time, however, that we are collecting our waste with the auto truck at a saving of not less than 45 cents on the dollar. We have attempted to lessen the price of the haul by installing at different places in the city small bunkers arranged in cells, each cell having a capacity of about 6 tons. These are filled by the horse-drawn vehicles. This material is taken from the bunkers by the auto trucks to the incinerators and also at the present time to a large open dump. Five of these auto trucks are being used by the city in this work. They are the rear dump, with bed 11 feet long and 6½ feet wide. By the use of these trucks we save the long team haul, the most important money-saving feature of our entire scheme."

Relieving Traffic Congestion.

The motor truck, as used in the collection and removal of street refuse and sweepings, does much to relieve traffic congestion, particularly in the downtown districts of the larger cities. The ordinary horse-drawn refuse-collection wagon has an over-all length of about 18 feet, and occupies 90 square feet of area. To house this 1-horse vehicle demands 114 square feet of ground space. The business motor vehicle, which on an average could do as much work as two of the one-horse delivery wagons, has an over-all length of about 10½ feet, or a total of 60 square feet of area, whether on street or in a garage. Here is a saving of valuable street space of practically 33⅓ per cent. and approximately 60 per cent. for dead storage. For larger capacity vehicles the comparison is more startling. A 5-ton horse truck needs 25 feet on the street, or 200 square feet of space; ; the stabling area of the same horse equipment represents 281 square feet. A 5-ton motor truck of equal capacity and doing as much work in some cases as half a dozen two-horse teams takes up only 176 square feet on the street or in the garage.

A motor truck, as used in refuse collection and removal, will easily do, on an average, two and one-half times as much work in an equivalent time as the horse, which increased rate of speed of doing work economizes street space to an extent of approximately 75 per cent. in favor of motorized traffic as against horse-drawn vehicles. In other words, the same amount of work can be done with about one-quarter of the street congestion, or quadruple the present volume of traffic can be accommodated thru general motorization. Municipalities are fast beginning to realize that they should practice what they preach.

MAYBE IT'S HERE.

Many problems requiring flexible treatment may be solved by a combination of trucks and horses.

—The motor truck is the pacemaker for labor. It speeds up the entire job, and it never shirks! It doesn't have to be driven. It drives.

ONE OF THE WORST SNOW STORMS IN TWENTY YEARS RECENTLY VISITED SEATTLE, TYING UP THE STEAM AND ELECTRIC LINES—YET A FLEET OF FIVE FEDERAL TRUCKS EQUIPPED WITH BUS BODIES RAN ON SCHEDULE TIME WITHOUT A MISHAP. THE OWNERS STATE THAT DURING THE MONTH OF NOVEMBER, CAR NO. 5 TRAVELED 2,156 MILES AND CONSUMED ONLY 411½ GALLONS OF GASOLINE AND 56 PINTS OF LUBRICATING OIL. TAKING INTO CONSIDERATION THE GRADES THESE TRUCKS ARE OBLIGED TO NEGOTIATE, THIS SEEMS LIKE REAL ECONOMY IN TRUCK OPERATION.

Motor Apparatus in Fire Departments

(Continued from February number, page 80.)

In the second column of this table, in describing combinations, *ae* stands for aerial ladder equipment; *ch*, chemical; *chf*, chief's car; *ho*, hose; *h.p.*, high pressure; *L*, electric; *l*, ladders carried on combination trucks; *ladd*, city service hook and ladder equipment; *mot*, motorcycle; *pp*, gasoline pumping engine truck; *sal*, salvage corps truck; *sq*, squad wagon; *st*, steam pumping engine; *sup*, supply wagon; *tow*, water tower; *tr*, tractor; *tr. ae*, aerial ladder truck hauled by tractor; *tr. la*, hook and ladder truck hauled by tractor; *tr. st*, steamer hauled by tractor; *tur*, turret. o in column of "Years service" means that apparatus is new or not yet in service. *p*, pyrene cylinders.

1—Cost of gasoline and repairs. 2—Cost of gasoline, oil and tires. 3—55 gallons gasoline, 3 gallons oil. 4—180 gallons gasoline, 10 gallons oil. 5—40 gallons gasoline, 3 gallons oil. 6—105 gallons gasoline, 4 gallons oil. 7—Difference in cost of repairs in the two machines due to pneumatic tires on one and Dayton airless on the other. Both cars now equipped with Dayton airless. 8—Cost of repairs and gasoline and oil. 9—Materials only; repair work done by drivers or mechanicians in fire department. 10—Cost of repairs for all 28 machines in the department. 11—Cost per horse employed in the department. 12—6 gallons. 13—Sum for four American-La France pumping and combination. 14—These cost figures include all three pieces of apparatus and the cost of gasoline and oil includea also some police apparatus. 15—10 miles of streets in good condition, 5 fair, 15 bad. 16—gallons of gasoline. 17—542 gallons gasoline, 30 gallons oil. 18—121 gallons gasoline, 20 quarts oil. 19—214 gallons gasoline, 75 quarts oil; 20—25 per cent good, 40 per cent. fair, 35 per cent. bad. 21—40 per cent. good, 40 per cent. fair, 20 per cent. bad. 22—Two-thirds good, one-third fair.

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
New Jersey (Cont.)													
Chatham	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Deal	ladd	Am.-La France	3	4	70	....	...	235	....	....	....	....	....
E. Orange	ch ho	Am.-La F. (2)	2	4	70	1,400	35	32	....	....	....	....	....
	tr	Am.-La France	2	6	73	....	...	...	....	....	....	....	....
Edgewater	ladd	Am.-La France	1	4	70	....	...	236	....	....	....	....	....
Elizabeth	chf	Apperson	1	6	38	....	...	...	600	....	....	....	....
	pp ho	Am.-La France	4	6	136	1,200	35	30	....	....	....	....	....
	ae	Am.-La France	3	4	70	....	12	410	....	....	....	....	....
	pp ho ch	Am.-La France	4	6	105	1,200	60	30	....	....	....	....	....
	ch ho	Am.-La France	2	4	70	1,200	70	30	....	....	....	....	....
Englewood	pp	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
Franklin	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Freehold	ladd	Am.-La France	2	4	70	....	...	235	....	....	....	....	....
	ch	Am.-La France	1	6	100	200	160	32	....	....	....	....	....
Glen Ridge	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Gloucester City	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Hackensack	ch ho	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Hamilton	ch ho	Waterous	..	..	...	....	...	...	....	....	....	....	....
Highland Park	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Hoboken	pp	Am.-La F. (2)	½	..	...	....	...	...	....	....	....	....	....
Irvington	pp ch ho	Am.-La France	3	6	104	1,000	46	36	127	118	300.00	68.85	....
	ladd	Am.-La France	3	4	70	....	6	235	172	118	175.00	45.65	....
	ch ho l	Knox	8	4	40	1,000	46	24	106	41	50.00	14.00	....
Jersey City	ae	Am.-La F. (4)	3	6	100	....	6	177	....	....	....	....	....
	tr st	Am.-La F. (2)	3	6	100	....	...	...	....	....	....	....	....
	ch ho	Am.-La F. (3)	1	4	90	1,000	60	12	....	150	....	....	....
	ae	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
	chf	Stutz	1	4	60	....	...	...	5,000	1,104	....	....	....
Kearney	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Linden	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Lodi	ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Madison	ladd	Am.-La France	2	4	70	....	...	235	....	....	....	....	....
Manasquan	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Maplewood	pp ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
Margate City	pp ho	Am.-La France	2	6	100	1,400	6	32	....	....	....	....	....
Millville	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Montclair	pp ho	Am.-La F. (2)	4	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La F. (2)	4	4	70	....	...	235	....	....	....	....	....
	pp ch ho	Am.-La France	2	4	70	1,400	35	32	....	....	....	....	....
Newark	pp ho	Am.-La F. (3)	5	6	100	1,200	6	32	....	....	....	....	....
	ae	Am.-La France	3	4	75	....	6	177	....	....	....	....	....
Ocean Grove	pp ho	Am.-La F. (2)	4	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	4	4	70	....	...	235	....	....	....	....	....
	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Passaic	chf	Buick	1	6	55	....	...	...	4,800	....	396.00[8]	....	....
	sq	(2)	..	..	50	....	...	...	....	....	175.00[8]	....	....
	ch ho	(6)	4	4	55	1,400	40	54	130e	281a	833.00[8]	....	....
	tr	(2)	..	4	80	....	...	235	110e	281a	129.00[8]	....	....
	pp ho	Webb	6	4	50	1,200	...	...	98	57	112.00[8]	....	....
Paulsboro	ch ho	Brockway (2)	1	..	...	....	...	...	....	....	....	....	....
Plainfield	chf	Studebaker	6	..	...	....	...	...	1,625	176	....	....	....
	pp	Am.-La France	o	..	...	....	...	...	....	....	....	....	....
	ch ho l	Mack (2)	..	..	...	1,000	120	...	....	....	....	....	....
	pp ho	Nott	4	..	...	....	...	...	....	....	....	....	....
Rahway	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Red Bank	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Rutherford	chf	Ford	1	..	...	....	...	...	....	27	o	....	....
	pp ho	Am.-La France	2	4	75	1,200	6	32	....	....	....	....	....
	ch	White	o	..	...	....	...	...	....	....	....	....	....
	mot	Davis	1	..	...	....	...	...	....	....	....	....	....
	pp st	Am.-La France	2	..	...	....	...	...	....	....	....	....	....
Sayreville	ch ho	Ah.-La France	½	..	...	....	...	...	....	....	....	....	....
Summit	pp ho	Am.-La France	4	4	75	1,200	6	32	....	....	....	....	....
	st tr	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
	pp ch ho	Am.-La F. (2)	4	4	70	1,400	35	32	....	....	....	....	....
Swedesboro	ch ho	Waterous	..	..	...	....	...	...	....	....	....	....	....
Trenton	pp	Webb	7	..	50	1,000	6	61	32	16	....	60.00	840.00
	pp	Webb	6	6	70	1,000	6	...	142	71	74.00	150.00	1,300.00
	ladd	Boyd	..	..	...	....	...	...	....	....	o	36.00	....
	ch ho	Gramm (2)	3	4	60	1,250	...	61	58	71	....	84.00	600.00
	ch ho	Kissel	2	4	60	1,250	...	61	58	71	....	84.00	600.00
	chf	Stanley	4	..	20	....	6	...	....	30	....	20.00	360.00
	sq	Webb	3½	6	110	1,250	6	41	144	12	45.00	60.00	....
	ae	Couple Gear	3	4	60	....	...	...	156	18	144.00	75.00	900.00
	st tr	Couple Gear (2)	3	4	60	....	...	...	258a	129a	o	60.00e	1,650.00a
	ch	Stanley	8	..	...	400	70	...	250	91	125.00	115.00	750.00
Union	ae	Am.-La France	3	4	75	....	6	177	....	....	....	....	....
	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Vineland	ch ho	Brockway	1	..	...	....	...	...	....	....	....	....	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
New Jersey (Cont.)													
W. Hoboken........	tr	Am.-La France	2	6	100	....	6	177	....	....	....	....	....
	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
	ae	Am.-La France	½	4	70	....	...	235	....	....	....	....	....
W. New York......	ae	Am.-La France	1	4	70	....	6	177	....	....	....	....	....
	pp ho	Am.-La France	1	6	38	1,200	40	32	....	....	....	....	....
	ladd	Am.-La France	½	6	55	....	...	235	....	....	....	....	....
W. Orange.........	pp ho	Am.-La F. (2)	5	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	....	....	....
Westwood..........	ch ho l	Brockway	1	4	50	1,400	40	32	....	....	....	....	....
Wildwood..........	ae	Am.-La France	3	6	100	....	6	177	....	....	....	....	....
	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
	pp ch ho	Am.-La France	2	4	70	1,400	35	32	....	....			
New Mexico—													
Albuquerque.......	pp ho	Am.-La F. (2)	5	6	100	1,200	6	32	....	....	....	....	....
Deming............	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Gallup.............	ch ho	Am.-La France	2	6	55	1,400	40	32	....	....	....	....	....
Las Vegas.........	pp ch ho	Am.-La France	½	6	100	1,400	40	32	....	....	....	....	....
Raton..............	ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Roswell............	ch ho l	Am.-La France	½	4	90	1,500	60	120	390	102	7.00	45.60	191.60
	chf	Maxwell	¾	4	33	....	12	...	1,500	223	135.00	47.50	150.00
Silver City.........	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
New York—	4N.								3,000	980	800.00	518.30	4,172.00
Albany.............	chf	Alco	4	4	42	....	...	...	....	....	....	....	....
	ch ho l	Alco	3	4	45	1,000	60	...	....	....	....	....	....
	ch ho l	Federal (3)	1	4	35	2,400	180	...	....	....	....	....	....
	tr	Alco	1	4	45	....	...	327	68	129	28.00	48.75	389.65
Amsterdam.........	ch h	White	3	4	...	1,000	50	23	43	85	14.00	32.00	....
	ch ho l	Federal	1	4	...	1,000	75	...	....	....	....	....	....
Ardsley.............	pp ho	Am.-La France	1	6	38	1,200	40	32	425	142	10.40	36.50	178.00
Auburn.............	chf	Buick	5	4	30	....	3	...	238	132	12.00	76.00	356.00
	ladd	Am.-La France	1	6	73	....	6	239	239	137	16.67	62.47	356.00
	ch ho l	Knox	5	4	48	1,000	36	27	227	122	7.00	57.50	356.00
	ch ho l	Knox	4	4	48	1,000	35	27	....	....	....		....
Babylon............	ch ho	Brockway	1	4	42	1,400	40	32	35	32	0	.......[12]	0
Batavia............	ch ho l	Thomas (2)	½	6	80	1,200	80	36	....	....	....	....	....
	mot	Harley (3)	..	..	...	....	...	...	....	....	....	....	....
Binghamton........	chf	(2)	..	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
	ch ho	(6)	..	..	...	....	...	...	....	....	....	....	....
	ladd	(1)	..	..	...	....	...	...	....	....	....	....	....
Briar Cliff Manor...	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Brockport..........	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Buffalo.............	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La Fr. (2)	3	6	100	1,200	6	32	....	....	....	....	....
	ae	Am.-La France	3	4	75	....	6	177	....	....	....	....	....
	tr	Am.-La Fr. (12)	1	4	70	....	...	...	....	....	....	....	....
	pp ho	Am.-La Fr. (2)	1	6	100	1,200	6	32	....	....	....	....	....
	ae	Am.-La France	1	4	75	....	6	177	....	....	....	....	....
Carthage...........	ch ho	Brockway	1	..	...	....	...	...	7,606	41	40.00	40.92	135.00
Cohoes.............	chf	Cadillac	½	4	40	....	...	...	252	61	11.10	85.26	1,080.00
	pp ho ch	Am.-La France	2	6	100	1,400	40	36	183	60	9.40	51.91	810.00
	tr	Am.-La France	2	4	70	....	...	...	452	97	9.60	46.38	540.00
	ch ho	Am.-La France	2	6	70	1,000	40	36	296	97	17.10	68.44	810.00
	tr	Am.-La France	2	6	100	....	...	312	336	106	24.37	48.64	450.00
Corning............	pp ch ho	Am.-La France	3	6	100	1,200	40	36	106	106	20.00	33.88	460.00
	ch ho	Am.-La France	3	4	70	1,200	40	36	....	....	....	....	....
Cornwall...........	pp ho	Am.-La France	2	4	75	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	1	6	100	1,200	6	32	75	....	....	....	....
Cortland............	ladd	Am.-La France	1	4	85	....	...	175	95	....	....	....	....
	ch ho	Brockway	1¾	4	60	1,000	35	...	85	42a	35.00a	74.00a	....
	ch ho l	Brockway	1¼	4	65	1,000	35	20	....	....	....	....	....
Dobbs Ferry........	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Dunkirk............	pp ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
East Chester.......	ch ho	Brockway	1	4	52	1,400	40	32	....	....	....	....	....
	pp ho	Am.-La Fr. (2)	4	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	3	4	70	....	...	235	....	....	....	....	....
East Islip...........	ch ho	Brockway	1	4	50	1,400	40	32	....	....	....	....	....
Elmira.............	ch ho	Am.-La Fr. (2)	3	4	70	1,000	50	24	....	....	....	....	....
	ae	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
	chf	Overland	3	..	...	....	2	...	....	....	....	....	....
	pp ch ho	Am.-La France	1	..	...	1,000	60	30	....	....	....	....	....
Fredonia...........	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Freeport............	st tr	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
Fulton..............	pp ch ho	Am.-La France	0	..	...	....	...	...	....	....	....	....	....
	ho ch	Brockway	0	6	50	....	...	...	....	....	....	....	....
Goshen.............	pp ho	Am.-La France	2	4	75	1,200	6	32	....	....	....	....	....
Groton..............	ch ho	Brockway	1	..	...	....	...	...	....	....	....	....	....
Hempstead.........	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Herkimer...........	pp ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
	ladd	Am.-La France	½	4	70	....	...	235	....	....	....	....	....
Ithaca..............	ch ho	Am.-La France	2	6	100	1,200	70	32	....	....	....	....	....
	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Jamestown.........	ch ho l	Am.-La France	6	4	75	800	41	20	....	....	....	....	....
	ch ho l	Am.-La France	3	4	76	800	55	20	....	....	....	....	....
	pp ch ho	Am.-La France	2	6	110	1,000	46	30	....	....	....	....	....
	tr	Am.-La France	0	4	70	....	...	...	....	....	....	....	....
	chf	Cadillac	4	4	40	....	p	...	....	....	....	....	....
Kingston...........	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Larchmont.........	pp ch ho	Am.-La France	4	4	70	1,400	35	32	....	....	....	....	....
	ladd	Am.-La France	2	4	70	....	...	235	....	....	....	....	....
	tr	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Lawrence..........	ladd	Am.-La France	1	4	70	....	...	235	....	75	....	....	....
Little Falls.........	chf	Overland	4	4	30	....	12	...	....	....	....	....	....
Mamaroneck.......	ho	Am.-La France	½	4	70	1,200	6	32	....	....	....	....	....
	ho-ch-la	Am.-La France	½	4	70	200	40	235	....	....	....	....	....
Mechanicsville.....	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Middletown.........	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Mt. Kisco...........	ch ho l	Garford	½	4	29	....	...	...	....	....	....	....	....
Newburg...........	pp	Am.-La Fr. (2)	1-3	6	95	1,000	35	16	....	62	....	....	....
	tr	Am.-La France	2-3	6	105	....	...	250	....	62	....	....	....
New Hartford......	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
New York (Cont.)													
New Rochelle	pp ch	Am.-La France	2	...	...	...	...	...	...	...	...	...	...
	pp	Am.-La Fr.	1-12	...	...	...	...	...	...	...	...	...	...
	pp ho	Am.-La Fr. (2)	4	6	73	4,000[13]	160[13]	128[13]	1,846[13]	188[13]	107.13[13]	110.45[13]	1,427.82[13]
	tr	Am.-La France	3	6	73	50	12	142	1,098	80	...	46.29	804.00
	ladd	Am.-La Fr.	1-12	6	73	...	40	235	76	4	...	4.37	...
	chf	Overland	2	6	45	...	6	...	3,397	142	87.50	73.86	396.04
	ch ho la	Internat. (2)	1-12	4	40	2,400	70	...	964	5	...	27.83	...
	ch ho	Knox	3	4	40	1,200	40	32	2,043	...	16.75	37.70	443.15
	pp st	Nott-Christie	...	4	90	...	...	...	27	12	...	38.47	356.95
New York	tr	Couple Gear	4	...	80	...	...	...	...	...	...	...	...
	ac	Couple G. (4)	4	4	60	...	...	...	...	...	...	...	...
	tr	Couple G. (3)	5	4	60	...	...	...	...	...	...	...	...
	pp	Am.-La Fr. (28)	4	...	...	...	...	...	...	...	...	...	...
	ae	Am.-La Fr. (25)	4	6	100	...	6	177	...	...	...	...	...
	tr	Garford	4	4	...	...	...	...	...	...	...	...	...
Niagar Falls	ch ho	Brockway	1	...	...	...	...	...	...	...	...	...	...
N. Tonawanda	ladd	Am.-La France	2	6	55	...	...	177	...	...	...	...	...
	ch ho	Brockway	1	4	42	1,400	40	32	...	...	...	...	...
Olean	ch ho	Am.-La Fr. (2)	5	...	...	...	...	...	...	...	...	...	...
Oneonta	ch ho	Am.-La France	3	4	70	1,400	35	32	...	...	...	...	...
Oswego		Has no moor apparatua at present.											
Oyster Bay	pp	Am.-La France	1	...	...	...	...	...	...	...	...	...	...
	pp ch ho	Am.-La France	½	6	100	1,400	40	32	...	...	...	...	...
Pelham	pp ho	Am.-La France	2	6	100	1,200	6	32	...	...	...	...	...
Pelham Manor	ch ho	Brockway	1	4	42	1,400	04	32	...	...	...	...	...
Penn Yan	ho	Brockway	1	...	...	...	...	...	...	...	...	...	...
Perry	pp ho	Am.-La France	1	4	75	1,200	6	32	...	...	...	...	...
Plattsburg	pp ho	Am.-La France	1½	6	100	1,000	35	20	...	100	53.28	80.00	391.32
Port Chester	tr	Am.-La France	½	4	70	...	...	...	...	...	...	...	...
Port Washington	sq	Garford	2	4	22	...	...	...	...	...	...	...	...
Poughkeepsie	pp ho	Am.-La Fr. (2)	3	6	100	1,200	6	32	...	...	...	...	...
	tr	Am.-La France	2	6	100	...	6	177	...	...	...	...	...
Rochester	chf (7)	Cadillac, Selden Overland	...	4	...	...	...	...	...	...	...	...	...
	ho	Pope-Hartford	...	4	50	...	...	...	...	...	...	...	...
	ch ho	Mack (5)	...	4	32	...	50	...	...	...	...	...	...
	tr	Seagrave (3)	...	6	79	...	...	...	...	...	...	...	...
	pp st	Christie, Ah.-F'x	...	...	...	...	...	...	...	...	...	...	...
	sal	Mack	...	...	...	...	...	...	...	...	...	...	...
	supp	Federal	...	...	...	...	...	...	...	...	...	...	...
Rockville Center	ho	Brockway	1	...	...	...	...	...	...	...	...	...	...
Rome	pp ho	Am.-La France	1	6	100	1,200	...	36	...	70	12.66	58.40	800.00
	ch ho l	Am.-La France	1	6	52	1,200	40	36	...	107	31.40	21.90	320.00
Roslyn	ch ho l	Garford	1	4	29	1,000	6	32	...	...	...	...	...
Saratoga Springs	pp ch ho	Am.-La France	½	4	70	1,500	35	32	...	...	...	...	...
Sangerties	pp ch ho	Am.-La France	½	6	100	1,400	40	32	...	...	...	...	...
Schenectady	pp ch ho	(4)	...	...	...	...	...	...	...	...	...	...	...
	pp ch	(2)	...	...	...	...	...	...	...	...	...	...	...
	chf	Alco	8	4	50	...	3	...	3,500	375	...	...	...
	mot	(1)	...	...	...	...	...	...	...	...	...	...	...
	ch ho	Am.-La Fr. (2)	2	6	55	1,400	40	32	...	...	...	...	...
	pp ho	Am.-La France	1	6	100	1,200	6	32	...	...	...	...	...
	tr	(1)	...	...	...	...	...	...	...	...	...	...	...
	tr	Am.-La France	1	6	73	...	...	...	...	...	...	...	...
	sq	(1)	...	...	...	...	...	...	...	...	...	...	...
	ho	(2)	...	...	...	...	...	...	...	...	...	...	...
	ladd	(2)	...	...	...	...	...	...	...	...	...	...	...
	pp	(2)	...	...	...	...	...	...	...	...	...	...	...
Solvay	ch ho	Chase	3	4	40	1,200	40	60	...	...	2.00	4.25	...
	ch ho	Chase	1	4	50	1,500	40	75	...	16	0	5.00	...
Southampton	ladd	Am.-La France	3	4	70	...	...	325	...	...	...	...	...
Syracuse	chf	Chevrolet (2)	3	4	...	...	...	...	...	...	...	...	...
	chf	Ford (2)	3	4	...	...	...	...	...	...	...	...	...
	chf	Chandler	2	6	35	...	...	...	...	...	...	...	...
	chf	Reo	5	4	32	...	...	...	...	...	...	...	...
	ch ho	Am.-La Fr. (3)	1	6	80	1,600	35	30	...	...	...	...	...
	ch ho	Seagrave (2)	2	6	80	1,000	35	30	...	...	...	...	...
	ch ho pp	Ahrens-Fox	2	6	60	750	...	...	...	...	...	...	...
	ladd	Seagrave	1	6	80	...	40	344	...	...	...	...	...
	pp ho	Ahrens-Fox	1	6	80	1,000	20	...	...	...	...	...	...
	tr	A. & B. (4)	2	6	60	...	80	325	...	...	...	...	...
Tarrytown	ho	Am.-La France	3	6	100	1,200	6	32	...	...	...	...	...
	pp ho	Has no motor apparatus at present.											
Tonawanda		Am.-La France	3	6	100	1,400	6	32	...	...	...	...	...
Troy	chf	Speedwell	3	6	60	...	...	...	1,500	304	1.25	17.80	...
	chf	Speedwell	5	4	50	...	...	...	1,500	304	50.00	15.60	...
	ch ho	Knox	3	4	50	1,200	40	24	75	126	60.00	16.00	...
Tuckahoe	ch ho	Brockway	1	4	42	1,400	40	32	...	...	...	...	...
Union	ch ho	Brockway	1	4	30	200	30	26	...	...	...	...	...
Upper Nyack	ladd	Am.-La France	1	4	70	...	...	...	...	...	...	...	...
Utica	ch ho	Am.-La France	1	4	70	1,200	70	32	...	...	...	...	...
	pp ho	Am.-La Fr. (2)	1	6	100	1,200	6	32	...	...	...	...	...
	ae	Am.-La France	1	4	70	...	...	...	...	...	...	...	...
	ladd	Am.-La France	1	4	70	...	...	325	...	...	...	...	...
Washingtonville	pp ho	Am.-La France	½	4	75	1,200	6	32	...	...	...	...	...
Watertown	pp ho	Am.-La France	4	6	100	1,200	6	32	...	...	...	...	...
Waverly	ch ho	Am.-La France	1	6	55	1,400	40	32	...	...	...	...	...
White Plains	sq	Locomobile	4	4	40	...	6	...	...	...	350.00	...	...
	ch ho l	Knox	6	4	50	...	...	...	...	...	...	...	...
	ch ho l	Locomobile	5	4	40	700	76	28	...	...	...	...	...
Woodmere	ch ho	Brockway	1	4	42	1,400	40	32	...	...	...	...	...
	chf	White	5	4	...	...	...	...	3,080	562	...	61.53	...
	chf	White	5	4	...	...	...	...	2,975	562	...	63.00	...
Yonkers	cbf	White	5	4	...	...	...	...	3,737	562	...	55.58	...
	ae	Am.-La France	4	4	60	...	...	235	411	125	...	55.56	...
	ae	Am.-La France	2	6	90	...	...	210	411	125	...	56.56	...
	pp ch ho	Am.-La Fr. (2)	2	4	60	1,200	40	32	561	100	...	60.34	...
	pp ho	Am.-La France	2	6	90	1,200	50	32	561	107	...	47.18	...
	ch ho	Am.-La Fr. (2)	½	6	100	1,200	70	32	...	...	...	...	...
	pp ho	Am.-La Fr. (2)	½	6	100	1,200	6	32	...	...	...	...	...
	ladd	Am.-La France	½	4	70	...	...	235	...	...	...	...	...

(To be continued in the April number.)

Contracting News

AUTOMOBILES, FIRE APPARATUS AND MOTOR EQUIPMENT.

Bend, Ore.—City contemplates the expenditure of $15,000 for the purchase of apparatus and equipment.

Binghamton, N. Y.—City contemplates the purchase of a motor tractor for the collection of garbage. Trailers will also be used. Add. Commr. of Pub. Wks., John A. Giles.

Binghamton, N. Y.—City contemplates the purchase of a 15-ton road roller.

Boyertown, Pa.—City contemplates the purchase of a triple motor-driven fire engine.

Bradley Beach, N. J.—Board of Comm. contemplate the expend. of $15,000 for motorizing the fire department.

Camden, N. J.—Committee of Streets is asking for bids for three five-ton motor trucks with bodies suitable for hauling asphalt.

Cloquet, Minn.—Fire chief has been authorized to procure plans and specifications for a triple combination. motor fire truck.

Deer Lodge, Mont.—City contemplates the purchase of a combination hose and chemical motor fire truck.

Everett, Mass.—City contemplates the expenditure of $20,000 for the motorizing of its fire department.

Fresno, Cal.—Contemplating the appropriation of $44,000 for motor fire apparatus.

Glassboro, N. J.—City contemplating the purchase of a motor-driven pumping engine for the fire department.

Gouverneur, N. Y.—Plans are being prepared for the installation of a modern fire alarm system.

Hartford, Conn.—City contemplates the purchase of a motor-driven fire truck. Add. Mayor McGarry.

Kansas City, Mo.—Board of Health contemplates the purchase of two more ambulances for the city.

Little Falls, N. Y.—City contemplates the purchase of a motor truck for the fire department. Add. Mayor Zoller.

Muncie, Ind.—City contemplates the expenditure of $22,000 for a new motor fire equipment for stations Nos. 2 and 3. Also $4,500 for a new fire alarm system.

Morrisville, Pa.—City is remodeling its fire house, and contemplates the purchase of complete motor equipment with additional hose.

New Bedford, Mass.—City contemplates the expenditure of about $60,000 for motor fire equipment.

Oswego, N. Y.—Has appropriated $16,000 to purchase motor fire apparatus.

Patchogue, N. Y.—Fire department contemplates the purchase of motor fire apparatus.

Sioux City, Ia.—City contemplates the purchase of an additional motor street flusher.

Stillwater, Minn.—City contemplates the motorizing of its fire department. Add. City Clerk.

South Bethlehem, Pa.—A street cleaning machine to cost about $4,500 is to be purchased by the city.

Syracuse, N. Y.—City contemplates the expenditure of $50,000 for motor fire equipment and hose. Add. W. W. Nicholson, Commr. Public Works.

Vineland, Pa.—Boro Comm. voted $20,000 for new motor fire engine equipment.

BRIDGES.

BIDS REQUESTED.

Anderson, Ind.—Until March 10, for the construction of a reinforced concrete bridge over Lick Creek, and a steel bridge over Fall Creek. Add. County Auditor, Anderson.

Canton, O.—Until March 9 (10 a. m.), for the construction of the Wabash Avenue bridge at Brewster. Add. County Commr. for plans and specifications.

Charleston, W. Va.—Until March 14, for the construction of span steel bridge over Big Sandy Creek near Clendenin. Add. P. J. Walsh, Gen. Supt. and Engr., 507 Kanawha street, Charleston.

Clifton, Ariz.—Until March 15, for the construction of bridges over the San Francisco River. Two 160-ft. spans and one 210-ft. span, creosote wood block floor. Add. A. J. Kerr, Town Engineer.

Fairburg, Neb.—Until March, 12 noon, by the Board of County Commissioners of Jefferson County, Neb., for the construction and approaches of all bridges of the length of 16 feet.

Rock Island, Ill.—Until March 12, for the construction of the fill approaching the Colona Bridge. The fill will be about 6 feet deep and nearly half a mile long.

CONTRACTS AWARDED.

Ann Arbor, Mich.—To J. P. Rusche, Grand Rapids, for the construction of the bridge over Broadway River. His bid was $51,661.11.

Boise, Idaho—To the Missouri Valley Bridge and Iron Works, Boise, Idaho, for construction of 11 I-beam bridges in Ada County, at a cost of $11,191.

Buffalo, N. Y.—T. J. F. Stabell Co., for bridge over river at South Buffalo, at a cost of $113,307.

East Angus, Que.—To Wilfrid Poilin, Marieville, Que., for construction of a steel bridge at East Angus, at a cost of $45,000.

Georgetown, Md.—To R. G. Collins, Jr., 52 Vanderbilt avenue, New York, for the construction of bridge over the Sassafras River between Georgetown and Fredericktown, at their bid of $47,477.

Hampton, Ia.—N. M. Stark Co., Des Moines, Ia., for construction of concrete and steel bridges in Franklin Co., cost $16,250.

Knoxville, Pa.—The Stebbins Construction Co., Wellsboro, Pa., for constructing bridge over Towanesque River on the Little Marsh road. Contract price, $16,000.

Richland, Wash.—To Coast Bridge Co., Portland, Ore, for constructing a bridge over Yakima River below Richland at a cost of $12,000.

Rice Lake, Wis.—To Stein Construction Co., Medford, Wis., for construction of Main Street Bridge at a cost of $26,830.

Rock Hill, S. C.—To Virginia Bridge and Iron Co., Roanoke, for the construction of a steel bridge over the Catawba River. Cost, $42,400.

Sheridan, Wyo.—To Monarch Engineering Co., Falls City, Neb., for constructing four steel bridges at a cost of $19,188.

North Tonawanda, N. Y.—To New York State Dredging Co., at a bid of $649,000 for erecting a railroad bridge over Tonawanda Creek.

Waterloo, Ia.—Thor Construction Co., Cedar Falls, awarded contract for the construction of concrete bridge across Dry River Creek. Their bid was $9,079.

CONTEMPLATED WORK.

Ada, Okla.—County Comm. of Pottawatomie Co., contemplate constructing a bridge over the Canadian River.

Aransas City, Tex.—The Aransas Harbor Terminal Ry. contemplates the construction of a 5,500 ft. trestle.

Baltimore, Md.—City contemplates the construction of a series of bridges in South Baltimore. Add. Board of Estimate.

Cherokee, Ia.—The county of Cherokee is contemplating the construction of 140 bridges and culverts in the near future. Add. County Clerk.

Duvail, Wash.—Plans are being prepared for the construction of a bridge to cost about $35,000. Add. County Engr., Duvail.

Grand Forks, N. D.—City contemplates building new bridges over the Red River at De Mers and Minnesota avenues.

Jacksonville, Fla.—Board of County Commissioners contemplate the construction of a bridge across the St. John River. Add. Howard & Ash, Kansas City, Mo., Supervising Engrs.

Johnstown, Pa.—Construction of a steel plate girder bridge on First street at an estimated cost of from $18,000 to $20,000 is contemplated. For further information, Add. J. B. Crissey, City Engr.

Kansas City, Mo.—City has confirmed contract for building bridge at 27th street from Paseo to Highland avenue at a cost of $75,000.

Lake Village, Ark.—City contemplates the construction of bridges across the drainage canals in Dermott vicinity. Add. E. P. Toney, County Judge, Chicot Co.

Mason City, Ia.—Cerro Gordo Co. contemplates the construction of twelve new bridges this year. County Engineer has plans and specifications.

Middletown, N. Y.—Plans are being prepared by Modjeski & Angier of New York for the strengthening of the Poughkeepsie bridge for up-to-date traffic. Estimated cost $330,000.

Newark, N. J.—Board of Works is planning the construction of two bridges, one at Port street, to cost about $165,000, the other over the Oak Island Station at Lehigh Valley R. R., at cost of $200,000. Add. Morris R. Sherrerd, Chief Engineer.

Newton, Ia.—Jasper County Board of Supervisors contemplate the construction of a new bridge across Squaw Creek on the Riverto-River road.

Philadelphia, Pa.—City contemplates the construction of a bridge across the Delaware River.

Pittsburg, Pa.—City contemplates building a new bridge at Neville Island to supercede old structure.

Pine Bluff, Ark.—City contemplates building a steel bridge acrosa the Saline river at Pool.

Richmond, Cal.—City contemplates the construction of a bridge to span the bar between Point San Pablo of Contra Costa county and Point San Quentin on the Marin county side. Cost, $2,000,000.

Riverside, Cal.—State contemplates the construction of a bridge over the New river near Selloy, Imperial county. Estimated cost, $13,000.

Savannah, Ill.—The construction of a new $3,000,000 bridge over the Mississippi river is contemplated by the Chicago, Milwaukee & St. Paul Railroad Co.

Seattle, Wash.—City contemplates the construction of a swing bridge over West Waterway on West Spokane street. Address A. H. Dimock, engr., 600 County Bldg., Seattle.

Springfield, Mass.—City contemplates the expenditure of $20,000 on bridge work.

Warren, Ohio—City council plans construction of a concrete bridge on South Main street. Estimated cost, $57,850.

Waterbury, Conn.—Plans are being prepared for the construction of a concrete highway bridge to cost about $75,000. Address R. A. Cairns, City Engr.

Whites Place, Ill.—Contemplates the construction of a 70-ft. bridge over Sugar creek.

Tampa, Fla.—County commissioners contemplate the building of two bridges, one over the Little Manatee and the other over the Alafia river.

Yorkville, S. C.—Cherokee and York counties will jointly construct a bridge over Broad river to replace structure destroyed by flood. Estimated cost, $25,000. Address Clerk of York Co., Yorkville.

MUNICIPAL BONDS.

Albion, Ind.—Until April 5, 10 a. m., by treasurer of Noble county, for sale $10,000 highway improvement bonds, 4½ per cent., ten years. Address Roy K. Riddle, treasurer.

Alexandria, La.—City will issue $240,000 drainage bonds. Address C. E. Robinson, president of Rapides Drainage District.

Austin, Tex.—The Attorney General's Department approved city of Houston bond issues of $75,000 for waterworks and $35,000 for paving, both issues being payable serially and bearing 4½ per cent..

Balsam Lake, Wis.—An election will be held in Polk county, April 4, on question of issuing $400,000 road bonds. Address County Clerk.

Barberton, Ohio—A bond issue of $250,000 for sewer improvement will be voted on by the citizens March 6. Address the Mayor.

Barnesville, Ohio—County commissioners are advertising for $132,000 worth of road bonds of which $56,000 will be used for the construction of the Barnesville road and $76,000 for the National road.

Bartlesville, Okla.—Election will probably be held in Washington county in April, to vote on $800,000 road bonds. Address Co. Commrs.

Bradford, Ohio—Village will vote March 20 on a bond issue of $25,000 for the improvement of the waterworks plant of that village.

VOL. LII. — No. 4.

Municipal Engineering

The World's Leading Municipal Publication

APRIL, 1917.

OPPORTUNITIES FOR HIGHWAY ENGINEERS

The demands for better work in building highways have resulted naturally in the demand for more expert men in designing and in supervising construction. The highway engineer does not yet get very large pay, because he must still come in competition with those who have been willing to work at low wages and have learned from their work something, if not much, about building roads. The appreciation of the value of the higher class of service is not yet sufficiently widespread to bring about the employment of any very large number of men at the higher salaries which are available in some states, but the prospects are improving every year and the number of better men demanded to whom will be paid the larger salaries is increasing more rapidly each year. The demand is even greater than the supply at present and will soon show a very serious deficiency in men. This may result in even better salaries.

Professor Agg, of Iowa, says that college graduates in highway work are usually able to secure positions in highway work at a beginning salary of $75 a month with expense allowances in the field; county engineers receive from $900 to $5,000 a year and state engineers from $2,500 to $10,000.

Unfortunately, the great majority of county engineers receive nearer $1,000 than $2,000, but that is being corrected as time goes on. Really, as has been shown by some recent investigations, the compensation of the younger engineers, especially when employed by their older professional brethren, is too low and the new salaries for road engineers compare very favorably with the pay of the younger engineers in other lines. And the better county positions also compare favorably in compensation and each year more favorably in number with those in the other lines. The influence of the National highway organization in these respects will have a good effect wherever the National appropriations are being expended.

EXPERT EVIDENCE BY PROXY

The investigation of the report made by Professor I. O. Baker last fall about Chicago street construction, which was a part of the case before the Chicago Civil Service Commission against several inspectors accused of letting bad work go thru and making erroneous reports, brought out clearly that the report was based, as stated last month, on the reports of others who had made the detailed inspections and measurements, and it brought out also the fact that but a part of the results of these tests and measurements had been reported to Professor Baker, altho he supposed that he had all the evidence before him. It was quite evident that his report would have been materially different if he had possessed all the data which these investigators of detail could have given him.

It is unfortunate that he was misled, but his experience will be a lesson to others to base their reports on detailed information secured at first hand sufficient to be able to check up that supplied by others. One contractor seems determined to make Professor Baker responsible personally for the statements in his report, since he has been sued for damages and if the contractor proves that he has been damaged the courts are likely to take the same position, notwithstanding the fact that Professor Baker was either inadvertently or intentionally, misled by the failure to report to him all the results of the investigation.

MUNICIPAL FINANCING

The sale of municipal bonds was affected in February by the possibilities of war which have developed since the first of the year, but the total of sales was still but little less than that for the February before the war began. The more serious developments in March are likely to make the demand for money for war purposes very great and so to restrict the amount available for municipal purposes even more than the definite rumors of wars in January and February. If we must get into the war there is but one way to do it and we will make all the sacrifices which are necessary to make the end prompt and effective.

ENGINEERS IN THE WAR

Modern war is wholly a matter of expert engineering with many difficult problems in each of the various branches of engineering. It may be that we will not need to go in, but the country must depend on its engineers and they should be choosing the line in which they can work best and finding out how to make the full preparation required so that they can be ready when the call comes. Write to the Engineers' Committee or the U. S. Army Engineer Officers Reserve Corps for your own state.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

THE CONSTRUCTION OF ASPHALT PAVEMENTS

By the Editor.

The construction of asphalt pavements has been so thoroly standardized that it is not necessary to spend time upon the general description of methods of construction, further than to emphasize some points required by the specifications which are sometimes neglected. The article will be devoted more particularly to studies of machinery and details of operation which may at least give basis for thought and discussion by contractors and engineers directly engaged in construction work.

Much of the material presented will apply to maintenance operations also.

The material has been derived from so many sources besides the experience and observation of the writer that detailed acknowledgments are not possible.

A PRELIMINARY to construction of the utmost importance is the adoption of intelligent laboratory control of materials, mixtures and operations. It is no longer necessary to depend blindly upon the expertness of a man whose only knowledge was derived from experience and did not go far beyond the conditions under which he had previously worked. In these modern days both the municipality and the best contractors have learned to depend upon the chemist inspectors, who determine, within the guiding lines of the general mass of experience, what are the qualities of the materials offered, in what proportions they should be mixed, how they should be corrected, and what the manipulations of preparation and laying must be.

This control of operations is often dual, there being on the job technical representatives of both city and contractor. If the city has enough work to warrant it, this technical representative of the city may be the city asphalt chemist, and if the contractor has a large enough business his representative is also his own employe, in the larger organizations being under the supervision of the chief chemist of the company and reporting regularly to him. In case either city or company does not have enough work to warrant the regular employment of a chemist inspector, there are now numerous firms of asphalt chemists and paving engineers who can be called upon for the amount of expert supervision which the amount of work in hand justifies, whether employed by city or by contractor, and the value of such services to the contractor is particularly high, and is much greater than the cost.

Advantages of Chemist-Inspector.

The presence of a chemist-inspector relieves the plant superintendent of much detail work, and enables him to devote his time to the closer and more economical management of the mechanical and operating ends of the plant, the handling and conveying of materials, the management of trucks, and the many other activities which for their proper supervision require the very highest class of attention. He may to great advantage be present thruout the entire operation of the plant, constantly sifting the output of the heaters and thus controlling their feeding; giving detailed directions as to the charging and fluxing of the melting units, so as to secure proper penetrations and exercising entire control of the operation of the mixing unit, taking frequent paper-stain tests of different batches of mixture. He would frequently accompany the trucks to the street, so as to observe intelligently the working of the material, and should tactfully co-operate with the plant superintendent and the municipality's inspector at all times. He should advise the general manager as to the quality of raw materials purchased, and the plant superintendent as to the operation of the heating and melting units.

PHONE MAIN 2558 — L KIRSCHBRAUN, B S CH E, DIRECTOR

CHICAGO PAVING LABORATORY
CONSULTING AND TESTING ENGINEERS
160 N FIFTH AVENUE, CHICAGO

PLANT REPORT

STREET

FROM — TO

CHARACTER TRAFFIC — BASE

CAR TRACKS — CONTRACTOR

ASPHALT CEMENT

KIND OR BRAND		POUNDS CHARGE			
ASPHALT	FLUX	KETTLE 1	KETTLE 2	KETTLE 3	KETTLE 4

PLANT-PENETRATION

PAVEMENT MIXTURE

BOX WEIGHTS	SHEET	STONE TOP	BINDER
Lbs. A. C.			
Lbs. Filler (F C / S D)			
Lbs. Sand			
Lbs. Stone			
Total			
Ave. Temp			
Loads			
Boxes			
Equivalent Y'd'ge			
Size Bin Screen			

SCREEN TESTS: BIN, 200, 80, 40, 10, ¼, ½, ¾, 1, TIME

MATERIALS REC'D TODAY	CAR NO.	CHARACTER OR SOURCE	INSP'D

LOCATION DAY'S TOP

SAMPLES SENT	NO
Asphalt	
Flux	
Mixture	
A. C.	
Aggregate	

CITY

DATE — (REMARKS OVER) — INSPECTOR

The accompanying blank form for Plant Report shows the details of the observations and measurements which must be made at the plant if full control of mixtures is to be insured. Even if there is no chemist-inspector continuously on the job, such reports, with the accompanying samples, sent to the laboratory of an asphalt chemist, will aid materially in keeping the plant running right and the mixture on the street of proper proportions to make a durable street surface, since they would be the basis for reports of analyses and upon the correctness of proportions and mixtures as made.

The second form of Report of Plant Inspection of Asphalt Pavement is one issued by another firm of testing engineers. It includes data for determining the cost of materials and operation. It is on too large a sheet to reproduce in fac-simile, and the items are given in the order they appear on the blank.

Another form of report on Sample of Drum Sand shows the nature of special reports which are sometimes necessary, in this case no one deposit of sand would produce the sand required by the specifications, and therefore it was necessary to mix sands from various deposits and check the mixture by the analysis here reported.

REPORT OF PLANT INSPECTION OF ASPHALT PAVEMENT.
ROBERT W. HUNT & CO., ENGINEERS.
Bureau of Inspection, Tests and Consultation.
General Office, 2200 Insurance Exchange, Chicago.

City Engineer .... Date...............
City of ....
Contractor ....
Street.......................... Car track.........................
From.......................... To..........................
Traffic.......................... Base..........................

Kettle Mixture	1	2	3	4
Refined Asphalt (R. A.)	....	....	....	....
Oil (flux)	....	....	....	....
Penetration (A. C.)	....	....	....	....

STREET MIXTURE.

	Top or Bit'ic	Binder	Asph. Conc.	Per Cent.
Stone	....	....	....	....
Granite	....	....	....	....
Sand	....	....	....	....
Filler (S. D.-P. C.)	....	....	....	....
A. C.	....	....	....	....
Total	....	....	....	....

Weight per box
Number of boxes
Number of loads
Number of tons
Sq. yds. covered by last report
Sq. yds. laid today
Total

Temperature: Maximum.............. Minimum..............
Stain.................... Per cent. of voids....................
Sample sent for analysis.............. Date sent..............

COST DATA.

Foremen.......................... Stone..........................
Men 1st.......................... (P. D.-P. S.)..........................
Men 2d.......................... Misc..........................
Teams.......................... Misc..........................
R. A.......................... Misc..........................
Flux.......................... Misc..........................
Sand.......................... Misc..........................

SAND AND STONE GRADING.

100	....	4	....
80	....	2	....
50	....	⅝ inch	....
40	....	¼ inch	....
30	....	1 inch	....
20	....	1½ inch	....
10	....	2 inch	....

Remarks:
Inspector .... District ....

The following statement from J. H. Campbell, of Robert W. Hunt & Co., Engineers, gives the procedure of a prominent firm of testing and inspection engineers when acting for the city engineer, and gives an idea of the variations in practice:

"We detail to the work a thoroly competent asphaltic chemist, whose duties are to see that the mixing of the flux and asphalt are made in the proper proportions and have the proper penetration. He makes screen tests upon the aggregate to see that the aggregate is properly graded. He keeps a very close watch on the scale weights to see that the aggregate and asphaltic cement are mixed in the proper proportion for the various classes of asphaltic pavements. He examines the asphalt and flux as it comes on to the work, to see that it complies in all respects with the specifications under which he is working. The significance of the tests of the asphalt or bitumen varies, of course, with the different classes of bituminous material. He examines the flux for water and volatile at 163 degrees C. for five hours, and checks penetration after volatilization. We also try the solubilities of the flux in carbon disulphide, and the asphalts are run for solubility in carbon disulphide and carbon tetrachloride. Also the volatilization and penetration test on asphaltic cements. We run the penetration on each kettle of asphalic cement made up, and ductility as each new car of refined asphalt and flux is received. The extraction of the mixed surface for bitumen is relatively unimportant and is done only in times when the plant is not running, as it is a long and tedious process and the results obtained are not extremely accurate, and the aggregate after extraction is not in the best condition to run screen tests, because of the caking together of the finer portions of the aggregate and loss of finer aggregate during extraction.

"It is for this reason we insist that our inspectors pay close attention to the scale weights and the grading of the sand, stone or gravel before mixing with the bitumen, and we examine the bitumen before it is mixed with the aggregate to know that the bitumen is correct before mixing, and make stain tests after mixing.

"The above is, in general terms, the method which we apply on all commissions intrusted to us, but, of course, we are largely governed by the specifications under which we are

IF SAND IS A MIXTURE OF TWO OR MORE SANDS, THE ORIGIN AND PROPORTION OF EACH MUST BE STATED BELOW

SAMPLE OF DRUM SAND

Mixture of
Coarse– Three Rivers
Medium – Chambly,
Fino – Hogan Estate.

Taken at Mixer of
EAST DIVISION ASPHALT PLANT
by Walter C. Adams
8;30 A.M. SEPTEMBER, 16th. 1916.

TEST NO. M-769		RESULTS OF TESTS OF SAMPLE SUBMITTED				MODEL GRADING		VARIATIONS	SPECIFICATIONS Minimum	Maximum	TOTALS
FOREIGN MATTER											
PASSING	HELD ON	Note.—Figures show percentages by weight.									
200	MESH	3	6	3	6				0	5	
100	200	25	2			17			10	25	20 to 40
80	100	12	0	37	2	17	34		6	20	
50	80	25	6			30			5	40	20 to 60
40	50	16	0	41	6	13	43		5	30	
30	40	7	6			10			5	25	12 to 45
20	30	6	8			8			5	15	
10	20	2	0	16	4	5	23		2	10	
MESH	10	1	2	1	2				0	5	
TOTALS		100	0	100	0	100	100	TEST RUN BY A.H.L.			

REMARKS: This sand is quite satisfactory. There are no variations worthy of comment. The admixture of the three sands seems to have been in just about the right proportions of each.

MILTON HERSEY COMPANY, LTD.

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DATE 9-16-16 DIRECTOR OF PAVING DEPARTMENT working and the ideas of the individual engineers for whom we are handling inspection work, our function being to represent the engineer continuously at the mixing plant and to advise him as to conditions and suggest remedies or changes."

The Asphalt Plant.

To the contractor laying out his work the question of plant is one of great importance. If his work is all in one vicinity and is reasonably continuous, he will probably employ a permanent plant such as that of the city of Detroit, shown in one

THE PLANT IN THE FOREGROUND IS THE MUNICIPAL ASPHALT PLANT OF DETROIT, MICHIGAN.

of the photographs, or that in Montreal, shown in another. The Detroit plant belongs to the city and is used mainly in repairs and resurfacing of old asphalt pavements. It has developed from a single unit of the Hetherington & Berner construction as the work assigned to the plant has increased, and is now comparable in capacity with a regular construction plant for a large city. The Montreal plant is one erected for that city by Warren Brothers Company, and is one of four plants distributed about the city in positions to serve the various sections of the city. The chemist-inspector's report to the city on asphalt paving shows the defects in location which are often found and the reasons therefor. Three plants properly located are considered sufficient for the city. One plant is well located, two plants are not on railroad sidings, which is a serious defect as to time and expense of handling materials, too much hauling being required. One plant is not located near enough the center of the work it is doing, and thus requires too long hauls from the plant to the street. In these cases the location of the sand deposits within hauling distance is also a factor in determining the most economical locations.

For the benefit of contractors having comparatively small amounts of work in each of several cities or in widely separated districts in a large city, the railroad plant was devised, F. A. Hetherington being apparently the first designer of such a plant. One of the modern plants of this sort is shown in one photograph. This plant is constructed on two cars, so as to distribute the weight for transportation, and can be set for work on a side track with a small amount of additional structure alongside it. Another photograph shows a plant constructed by the East Iron and Machine Works on a single car. One and two-car plants are built by all the prominent manufacturers of asphalt machinery and of rated capacities up to about 2,000 sq.yds. of standard asphalt top per day.

The railroad plants have one disadvantage in that they must be on the railroad. To overcome this, semi-portable and portable plants have been designed which can be moved readily from place to place and set up with a minimum of expenditure of time, material and labor. These plants can be taken down in sections and loaded on trucks for transportation or hauled off on their own wheels.

One of the accompanying photographs shows a semi-portable plant built by the Iroquois works of the Barber Asphalt Paving Company, in three sections, set up ready for operation, with the bucket conveyors for material to dryer in the foreground and the portable engine for operating the machinery on the left. The bins for aggregate are seen on the tower in the rear and are over the asphalt mixer. The tanks for heating asphalt are in beyond the engine on the left.

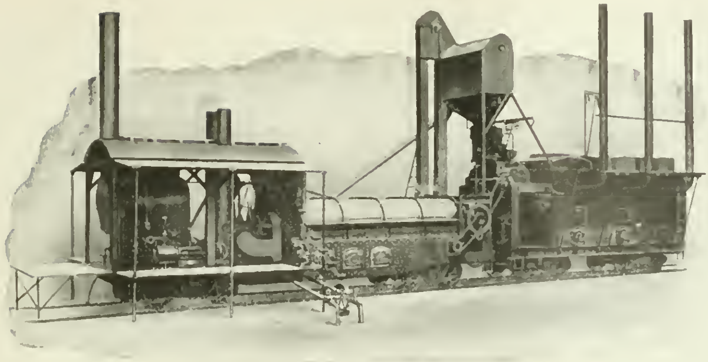
Another semi-portable plant, made in capacities of 500 to 2,000 sq. yds. a day, is shown as built by Hetherington & Berner.

The modern development of the asphalt macadam road has made necessary a strictly portable plant which can even be operated adjacent to the street or road under construction. This plant has proved so successful, and by dividing it into about three units it is so easily transported, that it is used very generally for asphalt paving construction.

One of the photographs shows a Hetherington & Berner plant of some 1,300 sq. yds. capacity for bituminous macadam and fully 1,000 sq. yds. capacity for standard asphalt top.

The pair of small photographs shows two views from opposite sides of a three-unit portable plant built by F. D. Cummer & Sons and used by R. F. Conway Company, contractors,

ONE OF THE FOUR MUNICIPAL ASPLANT PLANTS OF MONTREAL, QUEBEC. BUILT BY WARREN BROTHERS COMPANY.



TWO-CAR ASPHALT HEATING AND MIXING PLANT. BUILT BY HETHERINGTON AND BERNER.

at Joliet, Ill. It differs from the regular Cummer plant only because the Conway Company used a boiler and engine they had on hand instead of the standard portable engine they usually provide for such plants.

These portable plants have been so successful that they seem to be displacing to a considerable extent the large plants, the semi-portable plants and the railroad plants. They have the advantage of flexibility, and capacity can be secured by increasing the number of units in an installation.

Transportation of Materials.

One of the most modern developments is the application of the motor truck to the transportation of materials to and from the plant. This is an economy if the truck is kept moving, but the contractor who does not adapt his loading and unloading devices to the requirements of the motor truck will find himself disappointed in the results.

Loading of the truck must be as nearly instantaneous as possible. This is secured at the railroad car by the use of such a device as the Heltzel loader skip, described and illustrated on page 204 of our November number, which can be filled by shovelers working continuously in the car, and when a motor truck comes into position can be discharged into it, filling it in a few seconds. The auto-crane, with clam-shell or grab-buckets, described on page 241 of the December number, or the more elaborate apparatus shown on page 137 of the March number, are recent additions to this class of apparatus. The steam shovel can be used in loading trucks from storage piles, gravel or sand pits, as shown on page 246 of the December number. Most of these devices have been tried out and found effective, and the contractor must choose which he will use according to the amount of work he has to do and the local conditions of spur tracks, supply of labor, etc.

In hauling paving mixtures to the streets the same necessity for prompt loading exists. A small mixer which requires many dumps to fill a truck may consume so much time that the motor truck loses its economy, while two large-capacity mixers dumping into the same truck may make the truck a great factor in reducing the cost of hauling. The less time required to reach the street delivers the loads of asphalt at more nearly uniform temperatures and at higher temperatures, with material aid to the street gang.

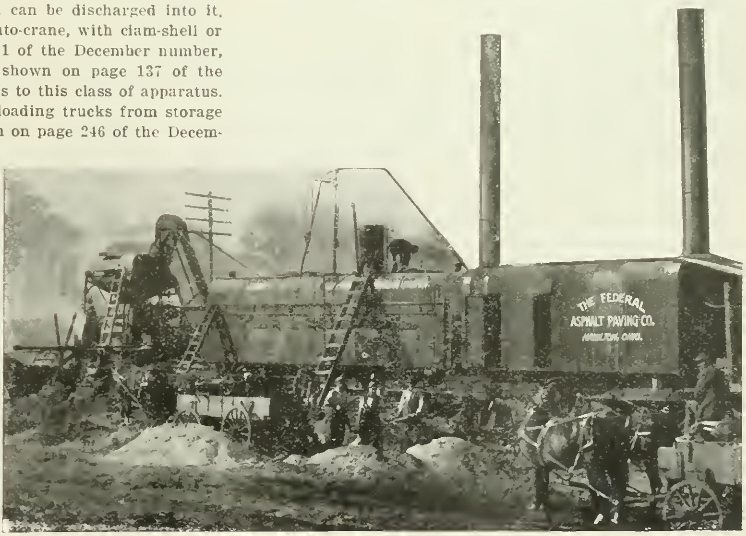
Dumping bodies are essentials both to prompt unloading and proper spreading.

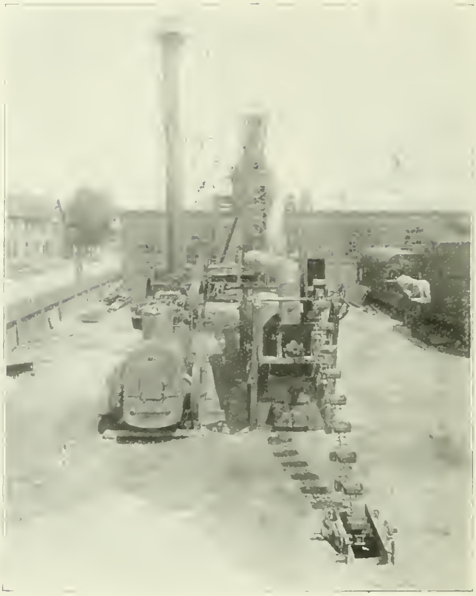
The size of the truck used is of material interest. Too large a truck may cause delay in filling, give rise to difficulties in getting into position for filling or dumping, cause stalling in mud or rough places in the yards or on the approaches to the street under construction, damage to machinery or parts of truck by shocks in running at speed over rough streets, etc., all of which difficulties would be lessened or eliminated entirely by choosing the size and power of the truck to suit the conditions of yard, street pavements and approaches to street under construction. Too small a truck may also prove disappointing because it will not displace teams enough or be strong enough to be durable under such heavy work.

Data concerning the use of trucks and of loading and unloading devices may be obtained in large amounts from the articles on Motor Truck Operation and Accounting which have appeared each month in the Motor Trucks insert to be found in each number of this magazine for nearly two years past.

Two photographs show a motor truck receiving its load from a two-car railroad plant and delivering it to the street, and, with a little knowledge of the ease of handling a truck to reach the desired point of loading or unloading promptly, will indicate its great adaptability, convenience and economy under proper loading conditions.

ONE-CAR ASPHALT HEATING AND MIXING PLANT. MERRIMAN PLANT, BUILT BY EAST IRON AND MACHINE WORKS.





SEMI-PORTABLE ASPHALT HEATING AND MIXING PLANT, BUILT BY THE IROQUOIS WORKS OF THE BARBER ASPHALT PAVING COMPANY.

Manipulation of Materials.

The general method of mixing and laying binder and surface has not been radically changed for many years, altho it has been much improved. The ordinary mixing plant consists of a unit for drying and heating the mineral aggregate, a second unit for melting and fluxing the asphalt, and a third unit for mixing them together. Refinements in plant construction have been brought about within recent years, mainly in the direction of electric motive power, which enables the different parts of the plant to be operated independently, fuel oil heating of the drying units and steam heating of the melting units. Fuel oil heat permits the shutting down of the drying portion of the plant when its work is finished or in the event of a breakdown in some other unit of the plant, without having to rotate the dryers for hours, and without overheating the aggregate, as was necessary under old practice. The steam heating of the melting units acts similarly, and, in addition, prevents damage to the materials and avoids the possibility of fires resulting from foaming of the melting tanks.

In the mixing unit great improvement has been accomplished in the adoption of pneumatic and other types of lifts for conveying the asphalt cement to the mixers and keeping it hot; elevators or screw conveyors for conveying the 200-mesh material which is introduced cold in the mixture, as well as weighing and handling devices for accurately determining the relative quantities of mineral aggregate and asphalt cement placed in the mixers. Recording thermometers act as a check on careless heating. Hoods and other dust-collecting devices have rendered the up-to-date asphalt plant quite as unobjectionable as any other manufacturing plant, and the old "dust nuisances" need no longer exist.

Since the modern "close" or void-filled binder has practically displaced the old-fashioned open binder course in sheet-asphalt pavement construction, the preparation of that course is given the same close attention as the preparation and mixing of the surface course, and it is the constant effort of every one concerned in a well-managed plant not only to turn out mixture, but to turn it out at suitable temperatures, scientifically graded, with its components thoroly incorporated.

Manipulation on the street is now given more intelligent attention than in the past. Where the mixing plant contains two mixing units, so that binder mixture and surface mixture can be turned out simultaneously, the binder and the surface are laid on the street under the supervision of the same foreman, the surface being laid immediately after the rolling of the binder, with the result that sections cut from a finished pavement show such intimate bonding as to make it impossible to find the joint between them; this modern practice absolutely prevents the laying of surface on binder that is cold, dirty or wet. And because this method permits the laying of binder and surface by one organization, there is a resulting saving in cost. The intelligent contractor no longer addresses his mind solely to cost savings. His first consideration is quality, and he achieves his economies rather by intelligent supervision and management than by mere cost-cutting and "skinning" devices.

It is becoming a well-recognized fact that intelligent and sufficient compression of mixture on the street is a larger fac-

SEMI-PORTABLE HETHERINGTON AND BERNER ASPHALT PAVING PLANT, SAME DESIGN AS THAT FURNISHED FOR THE MUNICIPAL PLANT AT FLINT, MICHIGAN.

PORTABLE ROAD ASPHALT PLANT CONSTRUCTED BY HETHERINGTON AND BERNER, WHICH CAN READILY BE ADAPTED FOR BITUMINOUS MACADAM, ASPHALTIC CONCRETE, ASPHALT BINDER OR TOP, FIBERED ASPHALT OR ANY OTHER DESIRED MIXTURE.

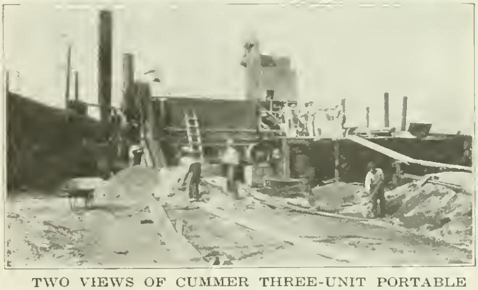
tor in the achievement of durability and quality in sheet-asphalt paving than any other single process involved. Frequent density tests are made by the laboratory, and intelligent foremen, with competent roller engineers, are absolute necessities in present-day practice, since thoro and careful raking and as complete compression to the finished pavement as can be given by rolling are now accepted as prime requisites. Not only must the surface be thoroly rolled back and forth in lines parallel with the curb, but if its width permits it should be cross-rolled at a right angle with the curb; likewise diagonally either at an angle of 45 degrees, or, if the street is too narrow to permit such diagonal rolling, then a similar effect can be obtained by rolling in arcs or semicircles.

A report on the municipal asphalt plants of a large city, made by the chemist-inspectors, shows many of the defects existing in asphalt plants generally, as mentioned in the following brief abstract:

Mixers capable of handling a 1,000-lb. batch can turn out 2,000 sq. yd. of pavement 2 inches thick per day, and should average well over 1,500 sq. yd. every day of operation. They cannot because drum capacity for heating sand and stone and melting and heating capacity for asphalt are insufficient. These are very common complaints in asphalt plants and very seriously cut down their economy and capacity, especially with motor truck transportation.

Melting tank capacity can be somewhat less if asphalt cement is brought in tank cars and is steam-melted to unload it directly into the heater tanks.

Melting kettles, according to this report, should be located at a higher elevation than the mixers, tho excellent modern practice transmits the asphalt from tank to delivery into the



TWO VIEWS OF CUMMER THREE-UNIT PORTABLE ROAD ASPHALT PLANT AS USED IN ASPHALT STREET WORK AT JOLIET, ILLINOIS, THE R. F. CONWAY COMPANY SUBSTITUTING THEIR OWN ENGINE AND BOILER FOR THAT BELONGING TO THE PLANT.

measuring bucket over the mixer by compressed air, in a large number of plants. Melting should be done by steam under pressure in electrically-welded steam coils inside the kettles. Steam-jacketed rotary pumps for moving asphalt are used in recent Hetherington & Berner plants.

Tank capacity for storage of proper reserve of asphalt cement should be provided in stationary plants. It can be secured by the use of tank cars for semi-portable and railroad plants.

Storage in properly separated bins should be provided for all the various sizes and kinds of material required, so that mixtures can be made with accuracy and proportions can be correctly adjusted. Binder and top materials of the different kinds and sizes prescribed sometimes require a number of bins, which should be large enough in any plant to prevent delay on account of failures of transportation or supply.

Dust collectors are essentials when plants are near habitations, business or manufacturing buildings.

Multiple beam scales, which may be automatic, are great aids in making mixtures uniform, save time and defects in pavements due to carelessness or forgetfulness of attendants.

Hoppers of automobile truck capacity should be located under the mixers so as to load the trucks instantly. A truck scale with tare and net beams should weigh each truck and the load put on it, and print the net weight on a card automatically.

ABOVE: MOTOR TRUCK LOADING WITH ASPHALT AT A TWO-CAR RAILROAD ASPHALT PLANT.
BELOW: MOTOR TRUCK DUMPING ASPHALT BINDER ON COMPLETED CONCRETE FOUNDATION.

Lincoln Highway Marker for New York City

This design for a lamp-post and Lincoln Highway marker down 42nd street in New York from Times Square to the ferry is intended to mark the first section of the Lincoln Highway, which is separated from the main highway by the width of the Hudson River. The design is by Ingalls Kimball, architect, and must be placed before the Municipal Art Commission for approval before the posts can be erected.

The persistent work on this highway is beginning to show results and, tho many sections are yet in poor condition and some may be for a number of years, it is almost the only well established thru route in many miles of its course and serves, with its uniform design of markers, to lead the motorist unfamiliar with his way from wanderings over worse and longer roads. The amount of pavement on the highway is increasing each year, and most of the prominent road surfaces are now represented somewhere along its course, tho brick and concrete are perhaps the most popular.

English Utilisation of House Refuse

At the National Economy Exhibition, recently held at the People's Palace, Mile End-road, E., Mr. Reginald Brown, M.INST.C.E., M.I.M.E., ETC., the engineer to the Southall-Norwood Urban District Council, had an educational exhibit in which he showed the various steps in the manufacture of fuel from house refuse by a process of which he is the inventor. His process is briefly described in *The Surveyor.*

Mr. Brown, by a simple process of crushing, pressing and impregnating, is able to produce an excellent fuel from what has hitherto been waste material, which in many districts disfigures the landscape and causes a considerable nuisance. Mr. Brown's process is "utilisation," not "destruction," and is extremely simple, carried on without any possibility of a nuisance arising, and economical.

The cost of the necessary plant, and also the production of finished fuel per ton, will, of course, depend upon the output desired. Speaking generally, the cost per ton would not, we understand, exceed 7s. 6d. (including all charges) and, from the heating value of the fuel alone could be sold at a cost which would not only cover cost of production, but also a considerable profit, while, in addition, the cost of present methods would be saved.

Mr. Brown claims that local authorities, by the adoption of the process, will secure, among other things, the following advantages:

(1) Disposal works can be central, and so save cartage.

(2) Refuse converted as received, and can be stored without any nuisance arising, for any length of time, and used as and when required.

(3) The receipts from sale of the fuel will more than cover the costs of conversion.

(4) Costs of present methods entirely obviated.

(5) The request "Burn your refuse and so save your rates" is brought home more forcibly than ever.

(6) Local authorities may by this means set a real example of "National economy."

The Treatment of Wood Paving Blocks

By C. H. Teesdale, in Charge, Section of Wood Preservation, Forest Products Laboratory, Madison, Wisconsin.

The author is fitted by his laboratory studies of wood preservation to report accurately and without reserve the results of experiments in his department so far as they have been carried. While laboratory experiments must always be checked by actual work upon a commercial scale, the author speaks with most of his laboratory work so checked and therefore as near to practical authority as possible in the present state of the art of wood preservation.

The primary object of treating wood paving blocks is to prevent their destruction by decay. Experience has shown that this can be done with a great variety of coal tar creosote products, provided that the preservative is thoroly distributed thru the wood. There are numerous pavements which have been down from 10 to 15 years which are still in excellent condition. Wherever decayed blocks are found in such pavements the trouble can usually be traced either to lack of penetration or the use of defective wood. There is ample evidence to show that a shallow heartwood penetration may ultimately result in decay, and that an incomplete sapwood penetration is even more serious. The remedy is obviously to thoroly distribute the oil thru each block. This can not always be done in practice, as some timber offers so much resistance that it cannot be completely impregnated. By adopting suitable methods, however, the ideal treatment can be closely approached.

It is almost axiomatic in timber preservation that thoroly air-seasoned wood takes the best treatment. Railroads spend millions of dollars in holding ties in large seasoning yards to get them in the best condition for treatment. Wood blocks are no exception to this rule, as they may be more easily treated in the air-dry condition. However, the sapwood of the blocks is liable to be more thoroly seasoned than the heartwood, and often is very heavily treated, while the heartwood receives a shallow penetration. This is liable to result ultimately in decay of the heartwood. In some cases thoroly seasoned wood accepts the preservative so rapidly that almost no pressure is needed to obtain an absorption of 16 pounds. If the absorption of oil takes place too rapidly the portions of the wood that treat with difficulty receive too little oil, while easily treated portions receive too much. The remedy for such conditions is to always use green timber if possible. In green timber, however, the sapwod contains much more water than the heartwood, and unless this is removed the blocks will contain untreated sapwood, which is almost certain to result in decay. A thoro steaming and vacuum treatment removes the excess of water and leaves the blocks in proper condition to receive the preservative. If air-dry timber must be used it should receive a thoro steaming and vacuum treatment before the oil is injected. While this may add very little moisture to the charge as a whole, the tendency is to add moisture to the sapwood and render it more resistant to treatment, while some drying takes place in the heartwood and it takes a better penetration of oil. The increase in resistance to treatment enables a much longer pressure period to be used, which aids in penetrating those portions treating with difficulty.

The use of wood block paving has been retarded by the so-called "bleeding" and "swelling" troubles. By "bleeding" is meant the condition caused by oil exuding from the wood onto the surface of the pavement, or the forcing of the bituminous filler from between the blocks onto the surface. Usually both of these conditions are present in very severe cases of bleeding. Bleeding of oil from the blocks appears to be caused by expansion of air imprisoned in the wood cells by the preservative. On hot days this air expands and forces the excess oil out of the wood. Expansion of the blocks after they are laid has a tendency to force the filler from the spaces between them onto the surface. While this filler is usually hard when it is first applied, it readily absorbs sufficient oil from the blocks to make it soft, and it may become a nuisance if forced onto the surface of the pavement. Figures 1 and 2 show the condition of two streets where excessive bleeding has occurred. In the first case the traffic was light and the bleeding has resulted in forming a thick mass of bituminous material on portions of the surface. In the second case the traffic was heavy and the tarry material was of such a consistency that it was picked up by the wheels of vehicles and created a very objectionable condition.

Swelling is caused by expansion of the wood due to absorption of moisture. Expansion may cause buckling of the pavement as shown in figures 3 and 4 (left), or it may cause displacement or shearing of the curb, as in figure 4 (right).

Since swelling of the wood and consequent buckling are caused by absorption of water, it is obvious that no swelling can occur if the blocks can be laid and maintained at their maximum size. Green timber can not expand because it is already above what is known as the fiber saturation point, beyond which expansion does not take place. Hence, it is desirable to use green stock for treatment.

Steaming and vacuum treatments, by removing air from

FIG. 1. BLEEDING ON A HEAVY TRAFFIC STREET. THE OIL AND FILLER COLLECTED IN LARGE MASSES WHICH ARE PICKED UP BY THE TRAFFIC.

FIG. 2. BLEEDING ON A LIGHT TRAFFIC STREET. THE OIL FILLER, AND SURFACE COVER OF SAND HAVE FORMED A COMPARATIVELY NON-ADHESIVE MASS ON THE PAVEMENT THAT IS OVER 2½ INCHES THICK AT THE POINT PHOTOGRAPHED.

the wood cells, and by reducing the absorption of oil in the sapwood, tend greatly to prevent the bleeding trouble. The remedy, therefore, both for the bleeding and swelling troubles, is to use green timber and steam thoroly, following with a strong vacuum. If for any reason air-dried stock is used, it also should be steamed. As previously stated, these operations also give better distribution of oil thru the blocks, resulting in greater durability.

Control of the rate of absorption of preservative has been found to be highly desirable, and by giving a better distribution of oil, should tend to retard bleeding and swelling and should increase the durability. If the pressure of the oil is rapidly increased the effect is to obtain too much oil in the sapwood and too little in the heartwood. By gradually increasing this pressure the maximum penetrations are obtained with a given quantity of oil.

The temperature of the oil should also be within well defined limits. If too hot the timber may be damaged, and if too cool it does not penetrate as well.

Rapid growth in the timber is undesirable. Very rapidly grown wood often contains rings which are from ¼ to ¾-inch wide. The summerwood of such rings takes treatment readily, but the open and porous springwood is very difficult to penetrate, and in the average treatment of paving blocks would not be liable to receive more than ¼ inch of end penetration. Such blocks are liable to decay and may give trouble from both expansion and bleeding in the sapwood.

It has been found by experimenting with various types of oil that bleeding may occur with many kinds of preservatives. For example, in experiments made at the Forest Products Laboratory bleeding was obtained with light distillate coal-tar creosotes, very heavy distillate creosotes, coal tar and creosote paving oils, water-gas tars, and even with crude petroleum oils. Hence, the selection of oil would not appear to have a very important bearing on bleeding, except that if bleeding does occur a product containing coal tar is liable to be more objectionable on the pavement because of its sticky and adhesive character. It has been found that distillate creosote oils penetrate the wood more easily than the preservatives containing considerable amounts of coal tars. Of the paving oil mixtures, those containing tars produced at low temperatures and with small amounts of carbon have given the best penetrations. It is preferable to remove the free carbon, as this retards penetration and results in dirty blocks. The best results in treatment, so far as the distribution of oil is concerned, cannot be expected if there is too much tar in the mixture. It has been found, however, that the reduction in penetrating properties of tar and creosote mixtures is not a vital factor where the tars have been properly selected and where the proportion of tar is not too great, 35 per cent. being considered about the maximum permissible.

The selection of timber and treatment with the preservative have an important bearing upon the subsequent laying of the pavement. If expansion troubles are to be avoided it is of first importance to be certain that the wood is expanded practically to its maximum size at the time it is laid. This can only be accomplished by the use of green timber or by thoroly steaming dry timber and by taking suitable precautions to prevent drying out of the material after it is treated and before being installed in the street. Any further tendency for expansion of the wood when these precautions are taken may be provided for by properly spacing the blocks when they are laid, and by using the usual type of expansion joints at the curb. The blocks should not be driven too tightly together, nor should the spaces between them be too great. A space of about ⅛ inch between the blocks is considered good practice, with 3/16 inch as a maximum. After the blocks are laid they should be filled with a suitable bituminous filler, which may be either of asphaltic or coal-tar origin. Unless a good job of fiilling is done water is liable to penetrate to the base of the blocks and cause trouble from expansion. It is the combination of a thoro treatment with oil and the proper filling with a bituminous filler that is depended upon to prevent the trouble of expansion. Sand fillers cannot be depended upon to prevent expansion troubles and should not be used. All of these precautions will be wasted, however, if the wood is allowed to remain piled along the street before laying until it dries out, as creosoted wood

FIG. 3. A WOOD BLOCK PAVEMENT THAT BUCKLED. TROUBLE CAUSED BY EXPANSION OF THE WOOD DUE TO ABSORPTION OF WATER.

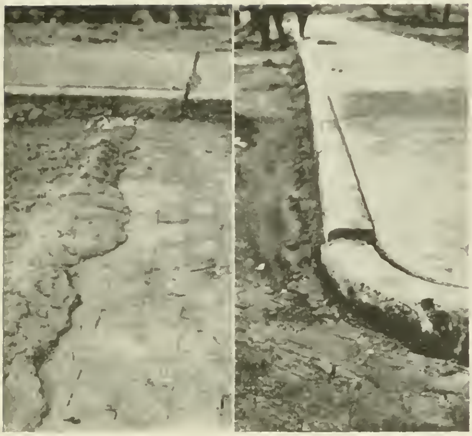


FIG. 4. RIGHT: CURB PUSHED OUT OF ALINEMENT BY EXPANSION OF A WOOD BLOCK PAVEMENT. LEFT: BITUMINOUS MATERIAL SQUEEZED OUT OF EXPANSION JOINT.

will readily lose moisture if exposed under the right conditions. The blocks should be laid just as soon after treatment as possible, and if they do dry out they should be thoroly wet down before laying.

A vital factor in securing a satisfactory pavement is adequate inspection during treatment. A good specification means little if the purchaser has no assurance that it is being carried out. The inspector should be a competent man who knows the reason why the various operations are desirable, and who will see that they are properly completed. Cases where the methods recommended herein have been specified and where bleeding and swelling occurred are known, but the trouble was due in most cases to a failure to follow them.

It will seen that the various phases of selecting material and handling blocks for street paving are intimately related, and most of them have a bearing on durability and the troubles of bleeding and swelling. These factors have been carefully considered in the new paving block specifications submitted by committees in several associations this year, among which is the American Wood Preservers' Association. In these specifications it is provided that preferably material less than three months from the saw shall be used. All wood, green or air-dry, must be steamed at temperatures between 220 and 240 deg. F., and at not to exceed 20 pounds pressure per square inch, for not less than two nor more than four hours. A vacuum of not less than 22 inches must then be maintained for at least one hour. The oil is admitted without first breaking this vacuum and the pressure gradually increased. Fifty pounds per square inch must not be exceeded during the first hour, 100 during the second, and then the pressure is to be maintained at not less than 100 nor more than 150 pounds until the absorption is completed. A vacuum of at least 20 inches maintained at least 30 minutes is then applied. This may be either preceded or followed by a short steaming period to clean tar or dirt from the blocks. An average absorption of 16 pounds of preservative per cubic foot of wood is specified. The preservative in the cylinder must be maintained at a temperature of 180 to 220 deg. F. during the oil pressure period. Specifications are given for either distillate creosote oil or tar and creosote paving oil. In the latter case the tar is limited to 35 per cent. and is so specified that an oil of good penetrating properties is obtained.

It has been found from experience and by laboratory tests that blocks treated in accordance with these specifications, and then given proper care before laying in the street, will not give serious trouble from bleeding and swelling.

MAKING SEWAGE DISPOSAL PLANT ATTRACTIVE

The possibility of beautifying the location of sewage sprinkling filters is shown in the accompanying photograph. It shows the plant at Harrison, N. Y., designed by Alexander Potter, of New York. Much of the prejudice against sewage disposal plants is sentimental and may be emphasized by neglect of the surroundings, but some attention to beauty as well as cleanliness will largely overcome this. A handsome building costs but little more than a plain one of like substantiality. Flowers between the sprinklers look better than weeds or black coated stone and the sprinklers themselves add to the effect.

ELECTROLYSIS

TROUBLES AND THEIR REMEDIES

By Albert F. Ganz, Professor of Electrical Engineering, Stevens Institute of Technology, Castle Point, Hoboken, N. J.

This article is an abstract of a paper by Professor Ganz before the New England Water Works Association in which the principal points of his address are given as fully as our space will permit. The paper will be printed in full in an early number of the journal of the association.

The reasons for electrolysis of underground pipes and conduits, the results of such action and the most feasible methods of eliminating or reducing the damage are clearly and concisely stated.

ELECTROLYSIS is the process of decomposing a chemical compound by means of an electric current, in this paper being restricted to the corrosion of underground metallic structures, such as iron and lead pipes, by stray electric currents which reach these structures and flow to surrounding soil. Dry soil and pure water may be considered non-conductors. Water, however, containing very small amounts of salts, and soil in its natural state being always moist and containing dissolved salts, are practically always electrolytic conductors.

Causes of Electrolysis.

When an electric current flows from a pipe to surrounding soil, chemical decomposition of the metal will take place, resulting in corrosion of the pipe. Concrete, when buried in earth, is moist, and it then becomes an electrolytic conductor, so that an electric current flowing from iron to surrounding concrete will corrode the iron by electrolysis.

Iron is oxidized by electrolysis at the rate of approximately 20 pounds per year for every ampere of current flowing from the iron to surrounding soil. The actual rate may vary in practice from one-half to one and one-half times the theoretical rate. Lead is oxidized by electrolysis under ordinary conditions in soil at a rate equal to approximately 74 pounds for every ampere of current leaving the lead in one year, and this theoretical rate may also vary somewhat in practice. The amount of corrosion produced by electrolysis is independent of the voltage, except in so far as this determines the amount of current flowing, and the smallest fraction of a volt can produce corrosion from electrolysis under suitable conditions.

The rapid corrosion by electrolysis from external currents is usually localized and results in pitting of the metal. Such pitting may, however, in some cases also result from ordinary soil corrosion.

Where the direction of current flow between an underground pipe and surrounding soil reverses more or less continually, it has been found that the corrosion while current flows from the pipe is largely offset by a reversed action while current flows to the pipe. This decreased corrosion decreases with increasing frequency of reversal. In such reversals only once in twenty-four hours corrosion for iron is only about one-fourth of that for constant flow from pipe to soil. Ordinary commercially used alternating currents produce corrosion of the order of 1 per cent. or less that of equal continuous direct current.

Sources of Stray Currents Which May Produce Electrolysis.

Electrical distribution systems which are grounded at two or more points will, by the law of divided circuits, cause currents, called "stray currents," to shunt thru the earth between the grounded points, and these stray currents frequently reach underground metallic structures and corrode them by electrolysis. The most important sources of such stray currents are direct-current electric railways which use the running tracks in contact with ground for part of the electric current.

In such a trolley system as that shown in Fig. 1 the running tracks consist of rail lengths mechanically fastened together by fishplates of steel bridging across the rail ends and bolted to both rails, generally bonded with copper wires or straps across the abutting ends of the rail lengths to afford a good electrically conducting path. The two or four rails are also generally connected together at frequent intervals by cross-bonds. The rail ends are sometimes welded together, or soft steel plates are welded across each side of the abutting rail ends, forming both strong mechanical and good electrically conducting connections. A single rail weighing 90 pounds per yard has about the same conductivity as a copper wire 1 inch in diameter.

If the running tracks are laid upon wooden ties above ground with broken stone for road ballast, the return current will be practically confined to the running tracks. If, however, the running tracks are laid below ground so that the top of the rails is level with the surface of the street, and also if the tracks are laid on a concrete base, part of the returning current will shunt from the rails thru the neighboring earth, as is illustrated diagrammatically in Fig. 2.

Where underground metallic structures, such as gas or water pipes, lie in earth in the path of these stray currents, and where these pipes have electrically conducting joints, such as lead-calked joints or screw-coupling joints, current will flow from earth to such pipes and flow on such pipes towards the power station. In the neighborhood of the power station this current will leave the pipes to return thru earth and the tracks to the negative terminal of the generator, as shown in Fig. 2. Stray railway currents on pipes will tend to leave these pipes to return to the rails in all regions where these rails are connected to insulated negative return feeders, if they are used.

It has been suggested to reverse the usual arrangement of trolley system and make the rails the positive conductor instead of the negative conductor, in which case stray current flows to underground pipes in the vicinity of the power station, and leaves these pipes over widely scattered areas, so that the density of the current leaving will be relatively small. The acute danger usual in the neighborhood of each station is removed, but electrolysis troubles are spread over a greatly distributed area. The total amount of electrolysis must be the same, since the stray currents thru earth are simply reversed in direction, but not changed in total magnitude. This arrangement has been tried in several places and has been used in one large city for about three years. I have had occasion to make tests in this city, and have found that trouble from electrolysis is developing in outlying sections, and some trouble from corrosion of service pipes in such outlying sections has already been found.

The leakage of current from the rails of electric railways increases the total conductivity of the return circuit and decreases the voltage loss in the return, so that there is an actual saving of power for the railway company.

Alternating currents used for electric railways under the usual street conditions cause electrolysis at a relatively very slow rate, produced at the two electrodes, instead of at one electrode only, as with direct current. So far as the writer is aware, no damage from electrolysis due to such stray alternating railway currents has been reported.

General Effects of Stray Electric Currents on Underground Piping.

The distribution of potentials in the rails of a simple electric railway system and in the underground piping is illustrated in Fig. 2, in which convenient values have been assumed. The underground pipes are negative to the rails at points away from the power station, and positive to the rails near the power station. The negative potential of the pipe, plus the drop on the pipe, plus the positive potential of the pipe, equals the drop in the rails. In the case assumed there is a potential difference of 550 volts maintained at the power station; of this, 10 volts is lost in the trolley wire, 520 volts is used by the motors of the car, and 20 volts is left to bring the current back to the power station. If the negative bus bar and the rails at the power station are considered as at zero potential, the rails at the car in the assumed case will have a potential of 20 volts. Thus, for practical purposes, the amount of stray current produced is that due to these 20 volts. If the rails are laid in the usual way the 20 volts in the rails will send some shunting current thru the earth and on the underground pipe, as shown in the diagram. Under the assumed conditions, there is a drop of 8 volts from the rails to the pipe near the car, a drop of 4 volts in the pipe itself and a drop of 8 volts from the pipe thru earth to the rails at the power station.

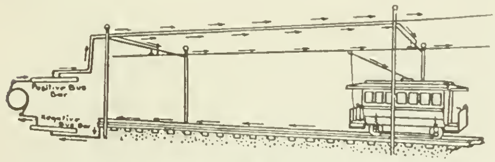


FIG. 1. DIAGRAM OF SINGLE-TROLLEY ELECTRIC RAILWAY SHOWING PATH OF CURRENT FROM GENERATOR THRU POSITIVE FEEDERS, TROLLEY WIRE, CAR AND RAILS, IF THERE IS NO LEAKAGE OF CURRENT.

Where stray currents leave the pipes to flow to the surrounding soil corrosion of the iron from electrolysis will take place. If the pipe line is a uniform electric conductor the pipes will be corroded only in the neighborhood of the power station. If, however, there are high resistance joints in this pipe line, then the current on the pipe will shunt around such high-resistance joints and produce oxidation or corrosion on the positive sides of the joints. Where there are two or more underground piping systems it also frequently happens that current shunts from one system to another thru the intervening soil, producing electrolytic corrosion where the current leaves the pipes. Such shunting currents are often caused by accidental high-resistance joints in one of the pipe lines, and such shunting may occur anywhere and without reference to the location of the railway power station. Where a direct-current trolley system passes thru a town which has an independent piping network, and where the power station supplying the trolley line is in some other locality, stray electric currents may flow on the piping system, and electrolysis of the piping may be produced at the ends of the piping system nearest to the power station.

Where current leaves a wrought-iron or steel pipe for earth, the oxide of iron resulting from electrolysis becomes diffused thru the earth and streaks of it can generally be found in the soil. Electrolysis of wrought-iron or steel pipes usually results in pits, which eventually go entirely thru the wall of the pipe. Where a gas service pipe lies in clay or other tightly packed soil, it may be pitted thru in many places without giving any external sign of leakage, because the soil surrounding the pipe maintains it gas-tight. When cast iron is corroded by electrolysis, the oxides of iron mixed with graphite usually remain in place, leaving the outside appearance of the pipe unchanged. This material resulting from the electrolysis of cast iron usually has the consistency of hard graphite and can be cut with a pocket knife. In many cases of a cast-iron main carrying gas or water without any apparent leak, a light blow with a hammer drove a hole right thru the pipe. The electrolytic action had corroded the iron entirely thru the pipe and the oxide of iron had remained in place, and, together with the surrounding soil, had prevented the pipe from leaking. Under such soil conditions an underground piping system may be suffering severely from electrolysis without giving any outward sign of the damage, a test hammer being required to establish definitely the damage by electrolysis.

There is practically no difference between cast iron, wrought iron and steel in the amount of iron destroyed. The electrical resistivity of cast iron is, however, about ten times as great as that of wrought iron or steel, and the usual lead joints in cast-iron pipes also have a resistance which is many times greater than the screw-coupling joints used with wrought-iron and steel pipes. A given voltage drop thru earth will therefore cause a much smaller current to flow on a cast-iron pipe than on a wrought-iron or steel pipe, thus making cast-iron pipes much less subject to electrolysis than wrought-iron or steel pipes.

Electrolysis Surveys on Underground Piping Systems.

In order to determine the electrolysis conditions of an underground water piping system a potential survey and a current survey are generally made. Where it is also desired to determine what remedial measures should be applied for protection against electrolysis, tests of the current and voltage distribution in the grounded circuits of the electric railway system by which the stray currents are produced should also be made. The description of methods in the paper is omitted here.

Remedial Measures Applied to Pipes.

Attempts have been made to protect underground pipes from electrolysis by insulating them from earth by paints or dips. Practical experience and tests show lack of permanence in the protection in wet soil. The difficulties are to make absolutely perfect coating and to prevent mechanical damage to the coating during shipment and installation of the pipe. Brush coats afford a very thin coating, which, under the conditions of currents and moist soil, disintegrates rapidly, whether the current flow is from the metal to earth or the reverse. Electrolytic action is not always prevented, and very serious electrolytic pittings have been found under apparently good coatings. In most cases the coatings have either been completely destroyed by the effects of the wet soil and the electric currents, or defects in the coating have developed, causing concentrated corrosion at such defective spots. Where it is attempted to apply heated pitch or asphaltum to a cold pipe, it is impossible to completely cover the pipe. A number of layers of pitch with wrappings of fiber can be applied to build up any desired thickness of insulating covering, which, if sufficiently thick and mechanically perfect, will afford pro-

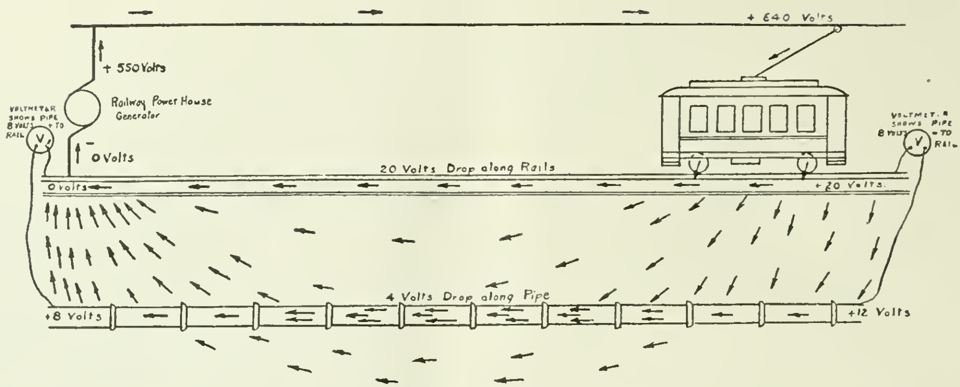


FIG. 2. DIAGRAM SHOWING STRAY RAILWAY CURRENTS WITH ASSUMED DISTRIBUTION OF POTENTIALS CAUSED BY THESE CURRENTS.

tection against electrolysis. The great difficulty in practice is to apply such a covering without leaving defective spots thru which moisture will have access to the metal of the pipe.

The writer has seen cases where a pipe coated with an imperfect insulating covering was pitted nearly thru in one year because of concentration of corrosion on the unprotected spots, whereas a bare pipe in the same locality was very much less affected, because the corrosion was distributed over a larger surface.

Complete protection seems to be afforded by a layer of 1 to 2 inches of coal tar pitch, parolite or asphaltum, not brittle, but yet hard enough to remain in place. The pipe is surrounded with a wooden box and supported upon blocks of creosoted wood or of glass, and the space between box and pipe filled with the molten material, allowing no stones or dirt in the mixture and leaving no bare spots on the pipe. The cost is prohibitive, except in very special cases, such as service pipes in very bad localities or very important individual pipe lines of small or medium size. Embedding a pipe in cement or concrete, even if this is several inches in thickness, will not protect it from electrolysis, because damp cement or concrete is an electrolytic conductor.

Insulating covering, even if imperfect, is useful on pipes where current flows from earth to the pipes, because it will increase the resistance and reduce the amount of current reaching the pipes.

A pipe line laid with every joint an insulating joint has a comparatively high resistance and no substantial current can flow on such a line. Sometimes comparatively few insulating joints break the electrical continuity of the line, but such joints must be installed only after adequate tests. Insulating joints should be installed wherever there is any considerable potential gradient in the earth parallel to the pipe. Their frequency depends upon the potential gradient thru earth and its electrical resistivity. A long insulating joint is to be preferred where there is considerable potential difference across the joint, or where the resistance of the surrounding earth is low. Surrounding the joint and the pipe for from 5 to 25 feet on each side of the joint with a heavy layer of insulating material is equivalent to making a long joint.

Where service pipes are endangered by current which flows to them either from the main or from house piping, such current flow can be prevented and the service pipes protected by placing insulating joints in them at the main or in the building, or at both locations.

Insulating covering and insulating joints can be applied in special cases to individual pipes, but cannot ordinarily be applied in an extensive manner to a piping network.

A method of mitigating electrolysis frequently employed in this country is pipe drainage—that is, connecting the pipes to the railway return circuit at a sufficient number of points to render the pipes at all points negative to the electric railway tracks. Electrical drainage was first applied to lead cable sheaths, but a piping system is much less suited to electrical drainage. Cable sheaths are continuous, while pipes may be more or less discontinuous electrical conductors. The lead cable sheaths are relatively small and are carried in ducts, mostly non-metallic, so that the cables are only partially grounded, whereas underground pipes generally present enormous contact areas to earth, so that when electrical drainage is applied to pipes the currents on them are very greatly increased, increasing the danger of current shunting around high-resistance joints or flowing to other structures.

When two piping systems, such as gas and water, are drained to the negative bus bar, large currents are caused to flow not only on the mains, but frequently to circulate between the gas and water mains thru house service connections, because of varying resistances in the pipe joints, causing serious fire hazard to the buildings. Large currents on mains are also dangerous where repairs are being made, disconnection causing an electric arc, which in numerous cases has set gas or oil on fire, causing damage to property and serious injury to workmen. In many such cases, to be safe, a copper wire jumper must be used across the proposed break.

Maps showing the differences in potential between rails and pipes before and after a drainage system is installed should not be assumed to show that all danger of electrolysis has disappeared. This would be true if the piping were a continuous and uniform electrical conductor, and if there were no other underground metallic structures in the earth in the same locality. But there are always joints of widely varying resistances and other pipes or cables, and current may flow between these various structures. The maps fail to show these troubles, and are, to say the least, misleading. To judge the effectiveness of a drainage system involves many other tests, particularly of currents on pipes, of drop across joints in the pipes, and of potential differences between the drained pipes and all other neighboring underground structures made at a large number of well-distributed locations. It is generally impossible to obtain complete data on all these points.

That electrical drainage, left to take care of itself, is dangerous is shown by such instances as the following:

It was reported that persons received electric shocks by touching water and gas pipes. Investigation showed that in the neighborhood of the railway substation, where the worst trouble had been experienced, the gas pipes were from 50 to 100 volts positive in potential to the water pipes. Tests made on the tracks in the neighborhood of this station showed practically no current flowing in the rails. Further investigation showed that the water pipes were connected to the negative bus bar in the station by a large copper cable, and that this cable was draining the entire station load from the water pipes to the negative bus bar. Still further investigation showed that the connection from the negative return cables to the tracks, directly in front of the substation, had been corroded off so that there was no metallic connection whatever from the tracks to the negative bus bar, and all of the current was forced to return by way of the earth and underground structures, and finally by the water pipe drainage cable to the negative bus bar. This condition of affairs had existed for a number of weeks and had not been discovered by the railway company.

Electrical drainage, applied to a single system of underground pipes, without considering high-resistance joints, etc., costs little and usually relieves the acute danger in the immediate neighborhood of the drainage connections, but becomes a source of serious danger to other pipe systems. If applied to all metallic systems, it will be very expensive to install and to maintain, because of necessary changes due to changes in railway and piping systems. The large increase in current on underground structures also brings about dangerous conditions at scattered and unknown places. Perhaps the most serious objection is the impossibility of complete tests to be sure the system is not still in danger from electrolysis.

In future installations of underground piping systems in the neighborhood of electric railways, precautions should be taken to minimize the flow of stray current to the pipes, such as laying the pipes as far from the tracks as practicable; avoiding metallic contacts with the tracks at the iron gate boxes, etc.; insulating the pipes where they cross steel bridges; insulating joints at the entrance of pipes to car barns, etc.

Remedial Measures Applied to Electric Railways.

The only way to entirely prevent electrolysis from stray railway currents is to prevent leakage of currents to earth from electric railways systems by the use of a separate and completely insulated return conductor, instead of using the running tracks as part of the return circuit. The double underground trolley system in Manhattan and Washington, D. C., and the double overhead trolley system in Cincinnati, O., Washington, D. C., and Seattle, Wash., while entirely effective in preventing electrolysis, have not been generally adopted, probably because of the added expense and complication involved.

While leakage of current from single-trolley electric railways cannot be entirely prevented by any methods that can be applied to these railways, the amount of stray current produced by a single-trolley railway can by adequate measures be reduced to any desired minimum value. This reduction can best be accomplished by the following means, given in the order of their importance:

(1) By increasing the number of direct-current supply stations in systems extending over large areas, so as to reduce the radius to which any one station supplies current, and also by supplying all of the railways in any locality from one supply station in this locality, brought about in several American cities thru the unification of electric light and electric railway interests, whereby the joint utilization of electric light and railway substations for the supply of the railways has been made possible.

(2) By increasing the electrical conductance of the tracks, thru the use of heavy rails, low-resistance rail-joint bonds and cross-bonds, and interconnection of the tracks of all systems.

(3) By removing current from the tracks by insulated return feeders, and by maintaining the negative bus bar insulated from ground at the supply station in all cases where the voltage drop in the tracks would otherwise be excessive. This arrangement is known as the insulated track feeder system or the insulated return feeder system.

(4) By increasing the resistance between tracks and earth as much as practicable, thru draining the roadbed, and, on private right-of-way, placing the rails on wooden ties above ground and using broken stone for ballast. On elevated structures the rails can be fastened to wooden ties, and, supplemented where necessary with negative feeder cables also insulated from the structure, can then be used for the return conductor.

It has been proposed to employ a three-wire system for distributing current to an electric railway. Pairs of generators in the power station are connected in series, and the junction point between the two generators is connected to a neutral

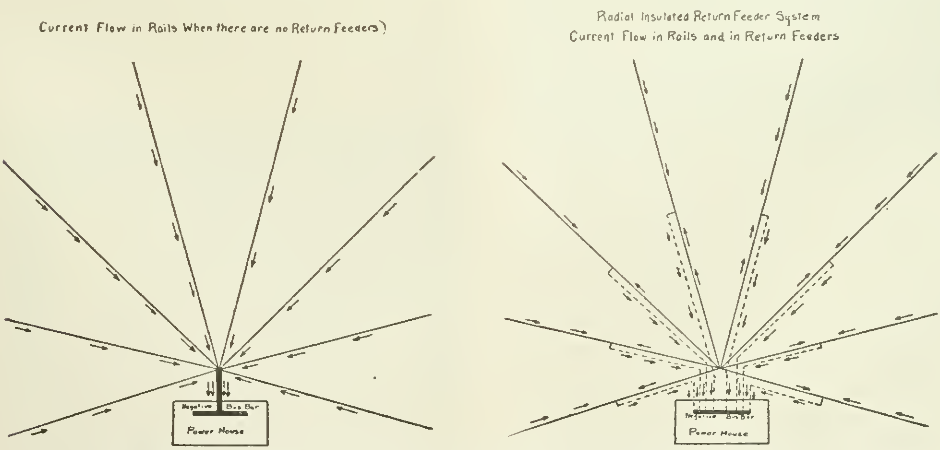


FIG. 3. DIAGRAM SHOWING TROLLEY LINES RADIATING OUT FROM POWER STATION WITH AND WITHOUT INSULATED RETURN FEEDERS AND SHOWING PATH OF RETURN CURRENTS.

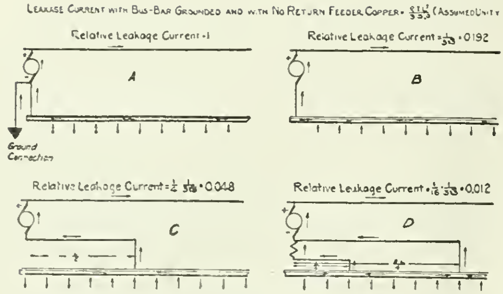


FIG. 4. RELATIVE LEAKAGE CURRENTS WITH VARIOUS RETURN-CIRCUIT CONDITIONS.

bus bar. The trolley line is divided into sections, and half of the sections are connected to the positive side of the generators and the other half to the negative side. The tracks become the neutral conductor and are connected to the neutral bus bar at the power station. With this arrangement current flows in the tracks between the positive and negative line sections. The current flowing in the connection between tracks and the neutral bus bar at the station is the difference between the current used on the positive and negative lines, and is therefore a relatively small current. This current also reverses more or less continually in direction, owing to the continually shifting loads, so that the polarity of the tracks with reference to underground structures at the power station also reverses more or less continually. The concentrated positive zone in the neighborhood of the power station is thus removed, and a low reversing potential condition results. Currents flowing in the tracks between the positive and negative sections are also relatively small, which very greatly reduces the track voltage drop and correspondingly reduces the total amount of corrosion from electrolysis. The remaining corrosion from electrolysis is distributed over widely scattered areas. The three-wire system has been in use to some extent in Europe and experimental three-wire installations are now in operation in two American cities.

The insulated track feeder system, in conjunction with proper track bonding, usually affords the most feasible means for reducing track voltage drop and thereby reducing stray currents thru earth in an existing electric railway. In this system feeders insulated from earth are connected from the negative bus bar to selected points on the track network.

Diagrammatic sketches illustrating the negative connections of an electric railway with and without the insulated return feeder system are shown in Fig. 3. The railway lines radiate out from the power station. In the left-hand diagram the rails are shown connected to the negative bus bar at the power station only, and all of the current on the eight lines flows towards the power station in the rails. The stray currents also concentrate in earth and on the underground piping in the neighborhood of the railway power station, where they must return to the rails to get back to the negative bus bar.

If this connection between the negative bus bar and the rails at the power station is removed, and the currents are collected from the rails at points near the center of each railway line by means of insulated track feeders, as shown in the right-hand diagram of Fig. 4, the concentration of current in the neighborhood of the power station is entirely removed. The current on each line tends to flow away from the rails at both ends and toward the rails near the center of the line, so that only one-eighth as much current is collected from the rails at any one point, as is shown in the left diagram. The total stray current thru earth in the right-hand diagram will be only one-fourth that of the left-hand diagram, so that at any one point the danger from electrolysis will be one-thirty-second that near the power station with the first arrangement. The actual reduction is very much greater, because the track-feeder connection points can be chosen so as to be located where the ground is dry and of high resistance. Instead of connecting one insulated track feeder to the middle point of every line, as indicated in the figure, a number of such feeders may be connected to a number of properly selected points in every line. In this way the drop in the rails, and consequently also the stray current produced, can be reduced to any desired low value.

The diagrams of Fig. 4 illustrate the possibilities in this way. With the negative bus bar grounded thru a connection of negligible resistance and connected to the rails at the power station, the greatest amount of stray current is produced, which is assumed unity for the purpose of comparison, and shown by diagram A. Disconnecting the negative bus bar from earth at the station, but not from rails, reduces stray currents to one-fifth of their former value, as illustrated by diagram B. Disconnecting the negative bus bar from earth and from the rails at the station, and returning the current by means of one insulated track feeder from the center of the line, reduces stray currents to 5 per cent. of their former value, as illustrated by diagram C. By using two insulated track feeders, with the negative bus bar insulated, the stray currents are reduced to 1.2 per cent. of their former value, as illustrated by diagram D.

The insulated track feeder system is frequently confused with the system of paralleling the tracks with return feeders, which has been most commonly used in American electric railways. From the standpoint of reducing track voltage drop the two systems are, however, totally different. With copper feeders paralleling the tracks, the voltage drop in the tracks is reduced only in the proportion that the conductance of the track circuit is increased. For example, an amount of paralleling copper equal in conductance to the tracks could at best only reduce the drop in these tracks to one-half. It is therefore evident that where the voltage drop in tracks is high, this system would require a prohibitive amount of copper to reduce the voltage drop to reasonably low values. With the insulated track feeder system, on the other hand, the voltage drop in the insulated feeders does not occur in the tracks nor in the earth, and therefore may be made as high as economy dictates. It should be emphasized that with insulated feeders the tracks in the immediate neighborhood of the power supply station should be connected to the negative bus bar only thru a suitable resistance, since a direct connection at this point would practically convert the insulated feeder system into a system of feeders paralleling the tracks, because both ends would then be in contact with earth.

In a city of moderate size the direct-current railway substation is located on one side of a river. On the opposite side of this river is the city pumping station and a large number of well pipes. A great deal of trouble was experienced from electrolysis, particularly of the well pipes and suction mains, because the negative bus bar in the substation was connected to the tracks directly at the station, and there were no return feeders carried beyond the station, so that all of the current used by the railway system returned thru the tracks and earth. A large amount of stray current reached the water piping system thruout the city, flowed toward the railway substation and then left the water pipes in the station grounds to return to the railway return circuit, the average current being 50 to 100 amperes, causing the destruction of this piping by electrolysis. The railway company repaired all defective track bonding and installed an insulated return feeder system, in some cases with resisters in series, from the substation to four points at some distance from the station, and the connection from the tracks to the negative bus bar at the substation was made thru a resister so proportioned that the tracks in the neighborhood of the substation would not be the point of lowest potential in the track system. When fully adjusted, at no point were pipes at all times positive to the tracks, and even in the neighborhood of track-feeder-connection points the voltage, of continually reversing polarity, averaged less than one volt. The reduction in these currents is very great; from 27 amperes to 1.3 amperes; 33 to 2.4; 8 to 0.5; 8 to 0.07; 18 to 0.6; and 3.7 amperes to 0.9 ampere. The remaining relatively small currents reversed more or less continually in direction. The reduction in electrolysis troubles in this city is therefore very much greater than expressed by the reduction of currents on the water mains, and, in fact, with the continually reversing currents and potentials, there should now be little, if any, trouble.

The insulated track feeder system can be adopted by single-trolley railways to minimizing electrolysis troubles without changing the system of operation, and at a cost which is well within practical limits. However, power losses are increased over what they would be if the same amount of copper were employed in parallel with the tracks, a necessary and legitimate expense for reducing stray currents injury to underground structures.

The railway companies and the pipe-owning companies are public utilities, operating under public franchises and utilizing city streets, and should co-operate in determining causes and extent of any danger from stray currents, and by co-operation only can a satisfactory solution of the electrolysis problem be found. Electrolysis is an engineering problem and can be handled by engineering methods in such a manner that no hardship need be imposed on any one. There is no reason why the negative feeder system should not be laid out along the same engineering lines as the positive feeder system. On the other hand, for example, the judicious installation of a few insulating joints will save a lot of money in railway track feeders, and in such cases such joints should be installed.

A most important step towards securing the co-operation which is absolutely necessary in order to obtain adequate and permanent relief from electrolysis was made by the formation in 1913 of the American Committee on Electrolysis, including representatives of the electric railways, water, gas, electric light and telephone interests. The committee has already accomplished a great deal towards producing a closer co-operation, and is working on recommendations which will reasonably safeguard underground piping systems against electrolysis.

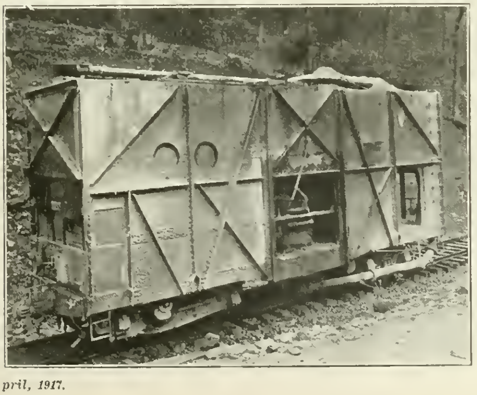
CAR FOR CONCRETING TUNNEL LINING

The accompanying photographs show a car which was designed and built for a special purpose, and would seem to be applicable in many similar situations.

The Sandy Ridge tunnel on the Carolina, Chrichfield and Ohio railway was lined with concrete after it had been put in regular use. It was necessary to have the apparatus for the work movable, therefore, to get it out of the way of traffic.

The plan includes the car which carries a supply of materials and a concrete mixer with pneumatic delivery, so that the concrete can be placed on sides or in arch by direct delivery; and an elevated track with bins over a siding, whereby concrete materials brought in on cars can be dumped into the bins on the connecting car without handling.

The car is a McKeen gasoline motor-driven steel car which, when loaded with stone, sand, cement and water at the siding, is run into the tunnel and the spouts located for delivering



the concrete mixture where it is wanted. The old compressed air outfit used in driving the tunnel was retained in place and, by means of regularly placed taps, connection is made with the pneumatic mixer and delivery, so that the mixer and elevator for materials is run by compressed air as well as the transportation of the concrete.

The outside view of the car shows the delivery pipes for air and for concrete, the mixer inside the door and the small pipe for delivering water to the mixer. Stone may also be seen in one of the material bins on the top of the car. The view of the car in the tunnel shows the material bins on the top and one of the pipes set for connecting the arch. A sandbag bulkhead retains the concrete until set, being built up as the concrete in place rises in the space between rock and form.

Blaw collapsible forms were used; steel for side forms and timber on steel ribs for the arch.

WORKERS IN THE FIELD

Warren Patent Decision

The Editor of MUNICIPAL ENGINEERING:

Sir—A suit entitled Warren Brothers Company vs. W. C. Evans for the threatened infringement of the Warren basic patent, under which the bitulithic pavement is laid, was recently before the Circuit Court of Appeals for the Fourth Circuit sitting in Philadelphia, wherein both the validity of the patent was attacked, and its threatened infringement denied.

Judge Buffington, in delivering the opinion of the court, stated: "This patent has been considered by the various Federal Courts and its validity established," and also that "The present case turns on the question of infringement."

The specifications under which the contract in suit was awarded, which it was claimed would necessarily require the construction of a pavement infringing the claims of the Warren basic patent, provided for the use of bitumen, limestone dust or portland cement; stone, ¾-in. hard crushed; and sand, coarse to fine.

The court held that under these specifications the contractor was called upon to use stone of one grade only, viz., ¾-in. stone, "which was not the run of the crusher," and that this was not the composition called for by the specifications and claims of the Warren patent.

After considering the several claims of the patent sued upon, all of which require the use of a graded mineral aggregate, and after referring to the several cases of Warren Brothers Company vs. Owosso, 166 Fed. Rep. 309; Warren Brothers Company vs. New York, 187 Fed. Rep. 831, and Warren Brothers Company vs. Grand Rapids, 216 Fed. Rep. 231, in all of which cases the validity of the patent in suit was sustained and injunctions issued to restrain its threatened infringement where the pavement had not already been laid before suit was commenced, the court pointed out that in the New York case the mineral aggregate "was the resultant run of the crusher, which would necessarily have smaller grades of stone." The court summarized its conclusion by saying: "It will thus be seen that in all these cases there was a series of graded stones. In the present case there is but a single grade of stone, namely, that which will pass thru a ¾-in. mesh and that which is caught on a ½-in. mesh."

As neither "run of the crnsher" nor different sizes of stone were required to be used, the court said there could be no infringement in this case, and the suit was accordingly dismissed.

The decision raises the following questions:

1. The practicability of actually furnishing a stone in large commercial quantities of the uniform size which the court construes to be required by the specifications referred to, to-wit: Stone *all of which* "passes thru a ¾-in. mesh and that which is caught on a ½-in. mesh." Certainly no such finely screened, uniformly sized product has ever been furnished by any crushing plant operating along commerial lines. Furthermore, stone about 1-in. size, that is, passing a 1¼-in. screen and retained on ordinary dust jackets in the crusher plant, is the size of stone most generally in demand for most purposes, such as building construction, sidewalks, etc. The use exclusively of the intermediate portion ("which will pass a ¾-in. mesh and that which is caught on a ½-in. mesh" as defined by the court to be "¾-in. stone") of this ordinary crusher product in the quantities required for the wearing surface of a street pavement would evidently very greatly increase the cost of stone, and doubtless most stone producers would not agree to furnish stone of this limited size.

More particularly, approximately 50 per cent. of the ordinary stone crusher product is of 1-in. and finer sizes. Of this total of 50 per cent. finer than 1-in., approximately 50 per cent., that is 25 per cent. of the entire crusher product, is coarser than ¼-in. size. Of this 25 per cent., only 40 per cent. or a total of 10 per cent. of the product of the crusher is of the uniform size which the court in this case decides is described by the specifications in suit, to-wit: that which "will pass a ¾-in. mesh and that which is retained on a ½-in. mesh." In other words, to comply with such specifications a contractor can use only 10 per cent. of the product of his crusher or from the crusher from which he purchases his supply, and other disposition must be made of the other 90 per cent. For instance, given a paving contract to be laid at the rate of 1,000 square yards, requiring 75 cubic yards of crushed stone per day, and a crusher plant having a rated capacity of 150 cubic yards per day, that crusher would only furnish 15 cubic yards per day or one-fifth of the daily requirements of stone for such a paving contract. In other words, it would take five such crushing plants to keep the paving plant in operation, and the person supplying the stone would have to find another market for 90 per cent. of the product of his crushers. Aside from this, the production of such a stone would require additional intermediate separating screen and bin facilities, which are not commercially used, and which could be installed only at great expense and inconvenience. In other words, the court has excluded from the scope of the patent in suit the use of a stone which has never been particularly produced, and cannot be produced without such increased expense and inconvenience that at least most owners of crushing plants would not undertake to do so, and then, under that extreme construction of the specifications says that Warren's basic patent, No. 727,505, would not be infringed.

2. It is a self-evident fact that neither as high degree of stability nor freedom from voids can be produced by a mineral aggregate consisting of such a uniform sized stone and sand as is produced by the construction generally adopted, in which various sizes of crushed stone or gravel, sand and pulverized

stone are used in such definite proportions as will produce the highest degree of stability, freedom from voids and utility.

3. Even tho such a construction, using uniform sized stone (passing ¾-in. and retained on ½-in. screen) and sand be held to come outside of the Warren basic patent No. 727,505, it is very clearly directly in the teeth of the Warren patent No. 695,421, the single, very clear claim of which is as follows:

"A wearing layer of a street sheet pavement composed of a dense mineral body consisting only of relatively large elements, ½-in. and upward in diameter, and relatively small elements, one-tenth of an inch in diameter and less, having predetermined proportions and intimately and uniformly associated thruout the body to eliminate voids, provide stability and a wearing surface and a uniting weatherproof, bituminous vehicle intimately associated with all the mineral elements serving to combine and unite them, fill the voids remaining unfilled and to form with the mineral body a solid, stable, homogeneous, tenacious, elastic, bituminous wearing layer."

As far as we know this patent, No. 695,421, has never been infringed in any actual construction.

Very truly yours,

Warren Brothers Company,

Geo. C. Warren, President,

Boston, Mass.

An Opportunity for Efficiency of Benefit to the Contractor and Equipped Municipalities

The Editor of Municipal Engineering:

Sir—While considerable time and attention are being devoted to careful thought of what the pavement shall be, the preparation of proper specifications, and the fulfillment of the contract by the contractors, let us not overlook another important factor of benefit to the contractor as well as the taxpayers.

It is mutually understood that with dull tools, second-class equipment, inferior materials, incomplete organization of men without ability to operate, efficiency cannot be attained. The contractor possessing the proper means with which to operate is going to be successful, and the taxpayers will be benefited with good work. I have devoted fifteen years to the various paving industries, with experience, and careful study given to its construction, production and sales, in both large and small cities. During that time I have witnessed the growth and success of some contractors, as well as the downfall of others, due to the efficiency or inefficiency of their respective methods.

The successful paving contractor must consider three units of importance—his office, his plant and the work under construction. In covering all the ground thoroly, and accomplishing good results, he must adopt system, and concern himself both in the little details to battle successfully with the other fellow who has adopted twentieth century methods.

At this time I am going to refer to the office and plant, in connection with the asphalt paving industry. I consider the plant the most important factor in connection with this kind of work, for the good results that the contractor and the taxpayers are to enjoy depend upon its output, and that depends upon its location for haul to the work, its access to railroad to handle the materials used at the plant, and management at the plant, who must economically handle labor and materials used in its productions, as well as be capable of repairing any breakdowns immediately.

You contractors who have been closed down for the past three or four months, on account of weather conditions, who carried over uncompleted work awarded last year, as well as work awarded this year to date, should have commenced overhauling your plant not later than March 1, for you cannot estimate too safely the time and the cost of the repairs in connection with putting the plant in first-class condition.

The contractor's office must get away from antiquated methods in accounting for losses and profits, as well as other information of value, such as the old bank book records, that never told how, where and when.

You cannot apply too much time and attention to the careful preparation of an estimate of cost that will cover all phases of the work in view, before bidding upon it. Likewise, you should adopt a cost system that will account to you for the expenditure of all labor and material used in that work daily, so that you can keep in closer touch with your operations, and permit yourself to remedy any of your failings by locating the fault immediately, instead of going along, being misled, and in the wind up of the work find yourself in a hole that you cannot get out of.

I really believe that it is in just such instances, and at such times that the contractor resorts to questionable measures that speak for themselves before the end of the guarantee period. Naturally, the taxpayers are then misled into belief that some other class of pavement should have been selected by them. Consequently the contractor who gives considerable of his time and expense in anticipation of being awarded future work of like nature, does not get any consideration from the taxpayers, and they then select another kind of pavement, which may in all probability cost them more, and not be the proper pavement required to meet surrounding conditions, and again they are misled.

A great deal can be said of certain existing conditions that could be overcome by the contractor with benefit to him from an efficiency point of view. However, I am more concerned in the asphalt plant at this time, and I am desirous of suggesting, for his benefit, that he install a cost system, adaptable to existing conditions. For a demonstration, I am showing one of my reports, that was used in Chicago by my employer to cover plant operations during the year 1914, when 500,000 sq. yds. of paving were completed.

Prior to that time, a separate report for each mixture turned out daily was used, but in this one report, not only did it save in the cost of stationery, which was quite an item, but when prepared and placed before the interested party, it required very little time to digest carefully the operations of the plant concerned. This report can be filed on peg files, opened full face, or folded and filed in documentary order.

Referring to column 1, I have described the materials generally used in all mixtures across the page, with open lines to insert any other material that might be used.

Column 2 reports the mixture produced for new work, viz: binder, asphalt surface and asphaltic concrete surface, the number of boxes turned out by the plant that day, the weight of each box and the total weight of the materials used, this class of work being measured by boxes of so many cubic feet.

Column 3 reports the materials used in private work and maintenance. In describing this work and making a distinction from new work, class your repair work, for which you receive compensation, as private work, and that class of work done for the upkeep of streets, under guarantee as maintenance.

Column 4 reports the materials used in mixtures prepared for sales, or shipments to branches.

Column 5 reports the materials used in bituminous binder mixture which can be better described as an asphaltic cement, and used in poured work.

Column 6 remains blank, for the purpose of reporting something new.

Column 7 reports the material used in the production of limestone dust.

Column 8 reports the mixtures delivered to the streets

\# 1 \# 2 \# 3 \# 8 \# 9

DAILY PLANT REPORT, ______________ PLANT. ______________ 191__

		MATERIALS USED IN NEW WORK						MATERIALS USED IN P. W. & MAINT.				MIXTURES DISTRIBUTED			PAY ROLL					
		Bxs. Binder		Bxs. Surface		Bxs. Asp. Concrete		Bxs. Binder		Bxs. Surface		To Street, Foreman, & Shipts.				LABOR			DISTRIBUTION	
		Box Wts.	Quantities	Box Wts.	Quantities	Box Wts.	Quantities	Box Wts.	Quantities	Box Wts.	Quantities	Binder		Boxes	Occupation	No.	Hrs	Rate	Account	Amount
Asphalt	Lbs.											"	St.		Foreman				Bind M. N.W.	
"	"											"	"		Mat'l. Man				Surf." "	
Oil	"											"	"		Clerks				Asp. Con. "	
"	"											"	"		Chemists				B.M.P.W.& M	
Dust	"											Surface			Chauffeurs				S. M. " "	
Cement	"											"	"		Engineers				Bind. M.S.& S.	
Sand	"											"	"		Fireman				Surf. M. "	
Stone Binder	"											"	"		Kettle Men				Bit. Bind. M	
Granite Screenings	"											Asp. Con.	"		Mixer Men				Dust.	
" Coarse	"											"	"		Watchman				Dust. Prod.	
Coal Lump	"											"	"		Water Boys				Plant Repairs	
" Screenings	"											P. W. & Maint.			Laborers				Expense	
												Binder	F		"				Tools Yard	
												"	"		Dust Mill Men				" Street	
												"	"		Crane Men				Sundries	
Total			\# 4				\# 5		\# 6		\# 7	Surface	"		Blacksmiths				Winter Wages	
		Materials Used in Sale and Ship'ts.		Asphalt Mix.		Bit. Binder Mix.				Dust Productions		"	"		Carpenters				Idle Time	
		Bxs. Binder		Bxs. Surface		Gal. Produced				Tons Produced										
		Box Wts.	Quantities	Box Wts.	Quantities	Mix	Quantities		Quantities	" Shipped		"	"		Stable Men				Team Expense	
Asphalt	Lbs.											"	"		Teamsters				Mat'ls Unload	
"	"											"	"						Asp.	
Oils	"											Asp. Mix. Sales & Ship'ts								
"	"											Binder To,							Oil	
Dust	"											"								
Cement	"											Surface To,							Dust	
Sand	"											"							Cement	
Stone Binder	"											Bit. Bind. Mix.		Gals.					Sand	
" Screen's. Dust.	"											To							Stone Binder	
Coal Lump	"											"							" Screens.	
" Screenings	"											"							Granite, Coarse	
Coke	"											Dust		Tons.					" Screens.	
												To							Coal Lump	
												"							" Screens	
Dust Sacks	No.											"							Coke	

under construction in new work, the mixtures to the foremen handling the private work and maintenance and the mixtures and limestone dust sold and shipped to their respective destinations.

The street foremen, in turn must report the number of boxes of mixtures received by them from the plant, which grants a check on the plant, and the railroad weights and receipts taken for deliveries grant a check on the plant for the mixtures sold and shipped to branches.

Column 9 reports the pay roll at the plant and its proper distribution. The total distribution from the reports daily must balance with the pay roll time book, prepared by the plant at certain periods, when pay day is required. This report should be prepared by the plant foreman, or clerk, and delivered to the office the next morning.

The street foremen's reports must also be in the office that morning, and all reports carefully checked, extensions made, etc. Having the materials used assembled, their prevailing prices at hand, and the pay rolls distributed, makes it an easy task to place before the proper authority the unit cost of the previous day's work, and if any dissatisfaction is shown in that cost, steps can be taken before noon that day to adjust any faults.

It will be seen that this report is not at all complicated, and any one with a little clerical ability combined with his knowledge of the asphalt paving industry can collect the information required daily while the plant is being operated, which when combined with reports from the street will give the contractor valuable information, as well as dependable results.

Sam L. Jones,
Cincinnati, Ohio.

A New Sand Sieving Machine

The Editor of Municipal Engineering:

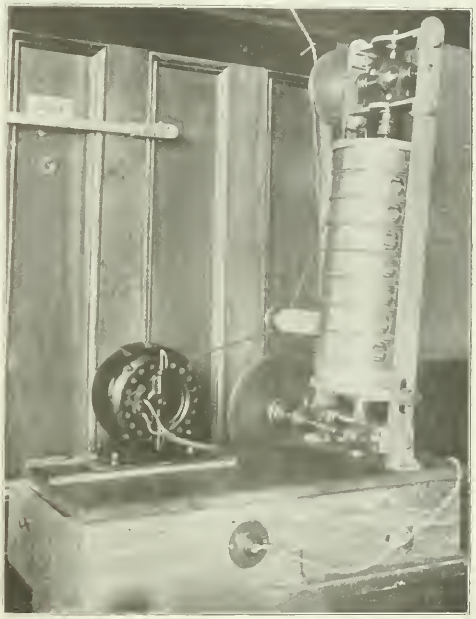
Sir—The accompanying illustration is of a recently deeloped sieving machine that is a part of the equipment in the Montreal paving laboratory of the Milton Hersey Company, where it is used for making the screen analysis of sands for asphalt pavement, concrete work and other similar tests. There are two other machines like it in existence; the original model at McGill University, and one other that was specially built for a large mining and smelting company.

This machine is so constructed that it may be readily and accurately adjusted to the requirements of different classes of material. The inclination of the sieves may be set to suit the work in hand, the weight of the tap or blow may be governed, and the speed of the revolutions and number of blows may be changed by using different sized pulleys or a motor with different speed. The standard adjustment, however, is the result of much very careful experimenting on the part of Professor Bell, who sought and found the combination of movements that would with the least wear and tear and in the shortest period of time furnish results that would be sufficiently uniform for scientific purposes. The results were carefully checked over by Walter C. Adams, chemical engineer of the paving department of the Milton Hersey Company, and were found to apply to the needs of the paving department.

In operation the nest of sieves is forced down by a cam, on the horizontal shaft above, against a spring in the base of the machine. When the cam releases the sieves they are forced upward by the spring thru a distance of about one-tenth of an inch; and in being brought to a sudden stop the grains of material on the sieve cloths are thrown upward in a manner tending to clear the apertures. The force of the spring-blow may be adjusted as desired, but an 18-pound pressure has been found to be satisfactory. The distance of the upward throw of the sieves can also be adjusted.

A satisfactory adjustment for general purposes was found to be 400 taps per minute, while the sieves were revolving at the rate of 2½ full turns per minute. The rate of rotation of the sieves in conjunction with their inclination distributes the material over the screen cloths, by causing the grains to reach the highest point and then slide down again. They journey in a more or less elliptical path.

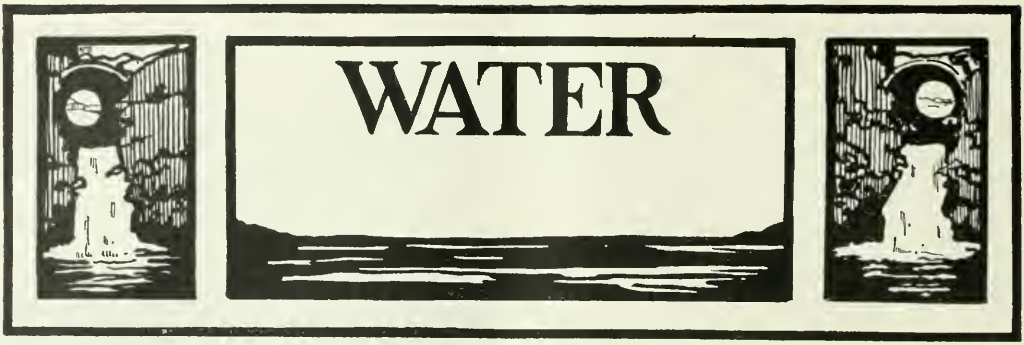
The best inclination for each class of material would vary slightly, as for coarse sand and hydraulic cement, for instance, but for practical purposes a satisfactory compromise is easily determined.



So far, no move has been made to manufacture this machine on a commercial basis, tho it is much superior to anything at present on the market, and was developed for use in connection with some very important investigations, in which it was found that other machines did not give sufficiently accurate results. It is the invention of John W. Bell, M. Sc., assistant professor of mining engineering at McGill University, Montreal, which probably accounts for the fact that no move has been made to take commercial advantage of the invention to date. Others want the machines today, tho, and there is no place to get them except to have them specially made at considerable expense.

The Milton Hersey Company, who highly value their own Bell machine, in their general paving report submitted to the chief engineer of the city of Montreal, Paul-E. Mercier, have recommended that a similar machine be installed at each of the four municipal asphalt plants owned and operated by the city, and in connection with the operation of which the Milton Hersey Company render a specialized service to the chief engineer, covering investigation, inspection, testing, reporting and advising in all matters practical, economic and scientific.

Charles A. Mullen,
Director of Paving Dept., Milton Hersey Co.,
Montreal, Que.



Economical Handling of Materials in Cleveland Water Tunnel

By Iverson C. Wells.

In building a water tunnel of concrete segmental block, more than three miles into Lake Erie, Cleveland, Ohio, convinced itself that a municipality can undertake its own great public improvements and do it efficiently and economically.

Construction costs, as estimated prior to the decision of the city to handle the contract itself, have been cut from 20 to 50 per cent., and the lessons learned not only will be of great value to other municipalities, but to contracting firms generally.

Speed was the keynote in the efficiency program from the concrete block manufacture to the excavation and construction work in the tunnel bore.

In the manufacture of the segmental block and the delivery of these to the construction department the greatest saving was made, the estimated costs having been cut as much as 50 per cent. in some features of this work.

While many machines and devices have had a decided influence in the cost reduction the efficiency of the plant really rested on the handling of the raw and finished materials without loss of time, so that no single factor in the entire plant had to wait. Since the handling of the raw and manufactured materials depended upon transportation and this efficient transportation depended on the haulage system employed, first thought was given to this portion of the equipment.

Compressed air, or electric haulage, until recent years, seemed to be the safest motor power where ventilation was uncertain and, while the gasoline motor has been developed to a remarkable state of efficiency in the last half a decade, there still remained distrust in the minds of many as to its desirability under ground.

On account of the expense, Commissioner C. F. Schultz, of the Department of Public Utilities, Water Division, soon began to look around for some means to cut down costs. The gasoline industrial locomotive was given full consideration and the conclusion reached that most of the motors on the market gave little or no trouble from gas fumes, and one or two none whatever.

After a careful consideration of the designs on the market Commissioner Schultz selected a locomotive of the friction-drive transmission type. By the employment of the friction-drive the inefficient gears were eliminated; the motor could be started up full speed and thus develop all its power immediately. There was no question of high or low speeds, nor any shifting of gears. The operator could start his locomotive under full power and at any speed required—fast or slow, 'so that heavy loads, impossible to other engines, could be handled easily by this type.

After the first year's practical test of one such locomotive alongside of the compressed air motor, Mr. Schultz reported as follows:

"This type of friction-drive locomotive, the Plymouth, cost us just about one-third less to buy and install than the compressed air motor.

"While there is no difference in the labor cost in the two motors, as only one operator is required on either and we pay 32 cents per hour for each man, it uses but four gallons of gasoline per day of eight hours. We paid (figures based on first year's operation) 13 cents per gallon for gasoline. We used but one pint of lubricant per day, at a cost of 30 cents per gallon. This made a daily fuel cost of 52 cents and a lubricant cost of 3¾ cents. It cost us 15 cents per hour for coal fuel with the compressed air motor, or $1.20 per day, which is a difference of 68 cents per day in favor of the Plymouth in fuel cost."

While the fuel cost was less, it was in the speeding up of the entire manufacturing plant that the greatest gains were made.

The little Plymouth works twenty-four hours a day. Stone, gravel and cement are rushed to the concreting plant where the segmental block are made, and finds time to rush away with a full train load of the finished blocks from the plant to the storage yard, and again, when required, another train load from the storage yard to the tunnel.

The plant where the blocks are made is a one-story frame structure with saw-tooth roof, built specially for the purpose. It has been enlarged at two different times since the work was begun early in 1914 and now covers an area of 100 by 211 feet. The plant is well planned and the loss in the manufacture and handling of the block has been less than one block in every 700 made.

Sand and stone are brought to the building in hopper-bottom cars by the Plymouth locomotive and, the trucks being elevated 26 feet above the main floor, are dumped into the storage bins, from which they are removed thru chutes by gravitation to the hopper of the half-yard Smith mixers. These hoppers, however, are so large that gravitation alone will not move the material efficiently, so that an ordinary drag scraper, connected up with a double-drum hoisting engine, is employed to keep the stone and sand within reach of the chutes.

This hoisting engine is located in a decking above the bins and operates the drag scraper both forward and backwards, the cables being carried thru block and tackle hooking into the rings at suitable points around the walls of the bins, thus enabling the scraper to cover the bins thoroly.

The Smith mixer dumps into the buckets of two telphers—a very novel feature of the entire equipment, an adaptation of the Brownhoist mine telpher.

The conveyors run on overhead I-beams, a series of which are carried thruout the plant, one over each casting alley. They are operated by electricity supplied by trolley wires paralleling the I-beams, and each carries a half-yard side-dumping concrete bucket and a seat for the operator.

The buckets have a somewhat restricted discharge in order that the concrete may not be dumped faster than it can be spaded into place.

A series of switches make it possible for the operator to direct the line of travel down any desired alley.

The two telphers also are used to handle the finished block, by means of tongs, onto the cars. The Plymouth locomotive takes these cars then to the yard for curing of the block. On the return trip the train takes back a load of cured blocks to the tunnel and returns to the plant.

Three shifts of men are worked at the plant, but pouring is done only by one shift, the day crew, which works from 8 a. m. to 4 p. m.

The average output is 240 blocks per day, but added to this are some 300 or more key blocks and an equal number of plugs.

The day crew is composed of the following men:

Operating Plymouth locomotive	1
Unloading material	5
Feeding stone and sand into hopper	1
Feeding cement into hopper	1
Operating Smith mixer	1
Tending switches and cleaning tracks	1
Operating Brownhoist telphers	2
Dumping concrete from buckets	2
Distributing and tamping	6
Miscellaneous work—assembling, pointing up, spotting forms, placing steel, making keys and plugs and finishing and dating	14

There are only two men in the second shift, which works from 4 p. m. to midnight. Their duty is to strip the block from the forms cast the previous day.

The third shift consists of twenty men. This crew goes on duty at midnight and works until 8 a. m. It cleans, oils and assembles the forms and operates the Plymouth locomotive and one Brownhoist telpher in getting the cured blocks to the storage room.

It is significant that the Plymouth locomotive is about the only portion of the crew or equipment that works thru the full twenty-four hours of the day, six days in the week. It is seldom stopped for any purpose other than to take on a fresh supply of gasoline, and might be said to be in continuous operation.

The entire job will require some 65,000 concrete blocks and it is a matter of record that by speeding up the concrete work thru the efficient method of handling the raw and finished product a saving of $1 on each block has been made by the city, or a total of some $65,000.

April, 1917.

Concrete Dams in Salt Lake City (Utah) Water Supply

By Sylvester Q. Cannon, City Engineer.

The Lake Phoebe-Mary reservoir site consists of two glacial lakes at the head of Big Cottonwood Canyon, twenty-eight miles from Salt Lake City, and seven miles from Park City, the nearest railroad point. The project consisted in placing a dam at the outlet of Lake Phoebe of sufficient height to cover this lake and Lake Mary adjacent thereto, to a maximum depth of 55 feet of water.

The location of the dam site is excellent. At both ends the granite bedrock is more or less exposed, especially at the north end.

In working out designs for the dam various types were considered and the arched rubble concrete type was finally decided upon. A small amount of exploratory work had been done prior to the letting of the contract for the dam, but not sufficient to fully determine the actual bedrock conditions. Consequently, as the work of excavation progressed, it was found to be more economical to modify the design and make it a straight gravity type.

In the excavation of the dam-site it was expected that the contractor would use the rock removed for placing in the rubble concrete, but he considered it more economical to waste this material and to quarry new stone in connection with that to be crushed for concrete aggregates. The sizing plant consisted of a jaw crusher, rolls and suitable screens, which gave fairly well graded products.

The location of the crushing and mixing plant some 200 feet distant from the nearest end of the dam required the gravity delivery of the concrete by means of a track and side-dump cars.

In mixing the concrete it was found that an excess of water caused the grout to separate, leaving the aggregate so compacted that the concrete could not be worked satisfactorily. Therefore, great care had to be exercised in the addition of water to secure the proper plasticity.

The specifications called for 1-3-6 concrete mixture, and provided that stones varying in size between 6 inches and 4 feet should be embedded in the mass, and that the proportion of large to small rubble should be such as to leave as few voids as possible. It was further specified that the spaces between stones be not less than 2½ inches.

Under these conditions it was considered that with great care it would be possible to place 60 per cent. of rubble in the mass. However, the contractor was not provided with suitable equipment to handle such large stones. As he had only a hand-operated derrick during a part of construction and the average of stones embedded was about 2 cubic feet in volume, he succeeded in placing only about 26 per cent. of rubble in the mass.

Sectional forms were used and held in place by cantilever arrangement, with the anchoring of long bolts in the concrete.

In placing concrete next to the forms, coarse material was spaded back and no rubble placed within 6 inches of the face.

Contraction joints were placed in the dam about 66 feet apart. They were of dovetail design with sheet lead water stops and tarred felt at the joints. No waterproofing materials were used, but the contractor was required under the specifications, upon removal of the forms, to plaster any portion of the face that way honeycombed, and to paint the entire exposed faces of the dam with neat cement wash.

Upon filling the reservoir for the first time during the winter and spring of 1916, slight leaks appeared thru the seams in the granite bedrock, within a distance of about 100 feet south of the dam, aggregating in all approximately one-third of a second foot, but no leakage was in evidence thru or under the dam, except a few small wet spots on the downstream face.

increases as the weight times the speed, assuming otherwise like conditions. Heavy loads on narrow or hard tires propelled at high speeds develop strains for which the average road is not designed, and which it cannot successfully carry.

It would seem from the foregoing that automatic speed controls, particularly for commercial vehicles, are becoming necessary, whether from the point of view of the public safety, the protection of the roads, or the protection of the vehicles themselves.

The pleasure car, mounted on pneumatic tires and having flexible spring systems, being of relatively light weight and of greater refinement of design, is more easily handled and,

An analysis of the POSSIBLE PERFORMANCE through the use of the DUPLEX GOVERNOR of a . . . .
of 2 tons capacity Engine Buda Q . Size $3\frac{3}{4}" \times 5\frac{1}{2}"$. Governor set for a maximum permissable Vehicle speed of 15 miles per hour, and a maximum permissable Engine speed of 1600 r. p. m. Engine drive of governor at 66% of engine time, and vehicle drive of governor at ratio of 1.16 to 1 of Propeller shaft time.
from Propeller Shaft Governor r. p. m. 1000 - 997 Model D
Performance No. 240 B Gearset: Make Brown - Lipe Model No. 35 - 4 sp.

Gear	Ratio of reduction	Ratio of reduction	Ratio of reduction	Ratio of engine r. p. m. to rear wheel r. p. m. Total reduction	Maximum permissable r. p. m.	Maximum permissable wheel r. p. m. front Diam. inches	Maximum permissable wheel r. p. m. rear Diam. inches	Maximum permissable vehicle speed miles per hour	Maximum permissable engine r. p. m.	Governor cuts out on the speed of the	Possible horsepower developed at engine at maximum r. p. m.
4th	1.	3.06	2.33	7.13	865	121.4	121.4	13.	865	Vehicle	22.
3rd	1.5	3.06	2.33	10.7	. . .	. . .	121.4	13.	1299	Vehicle	32.
2nd	2.62	3.06	2.33	18.68	. . .	. . .	80.2	8.6	1600	Engine	35.
1st	4.	3.06	2.33	28.52	. . .	. . .	65.	6.7	1600	Engine	35.
reverse	4.61	3.06	2.33	33.3	. . .	. . .	45.	4.9	1600	Engine	35.

To . . . . Date, January 2nd, 1916.

. . . .
Engineer

in speeding, is less a menace both to the public and to the roads. But a steadily growing percentage of the public believes that even these should be provided with automatic controls. There are thousands of car owners who would enjoy their riding more if they knew that under no circumstances could their car-speed exceed a definite reasonable speed.

The commercial car is heavier, of coarser design, and more difficult to handle. It is driven generally by a man of comparatively low intelligence or experience who has not yet been able to get a pleasure-car-job. With it high speed is a menace to the public, to the roads, and to the vehicle. An automatic control would prevent this, and it would besides protect the interests of the truck owner, and the reputation of the truck manufacturer. Viewed from these angles, there is no argument against its desirability.

There are three reasons why every truck is not equipped with speed control: expense of installation and maintenance, poor operation, and certain power limitations resulting from governor design. The first two points are matters of financial consideration only. Quality and dependability cost money and the truck user, or manufacturer, who wishes to pay the price can generally get them. The last reason is the most serious, and to better understand these limitations let us glance at the more important governor designs in use today.

These governors may be divided broadly into three classes —gas-velocity governors, hydraulic governors, and centrifugal governors.

The action of the gas-velocity governors is dependent on the inertia of the gas mixture, or its velocity, in passing from the carbureter to the engine to actuate a regulating valve, and limit directly the maximum gas-velocity, and indirectly the engine speed. No externally moving parts are required, and the internal parts are few. They are used where a cheap governor is desired.

The hydraulic governor is dependent for its action on the head or pressure of the water in the circulating system of the engine, acting on a flexible leather diaphragm, the movement of which is transmitted to a gas-regulating valve located between the carbureter and the engine intake.

Of centrifugal governors there are many types, subdivisions and varieties, together probably including 95 per cent. of all the governors employed today. They may be subdivided broadly into two groups namely:

(a) Constant-engine-speed governors, driven by the engine, which limit the engine speed directly thru curtailing the gas flow, and

(b) Constant-vehicle-speed governors, driven by the vehicle, which limit the vehicle speed thru curtailing the gas flow, or by grounding the ignition.

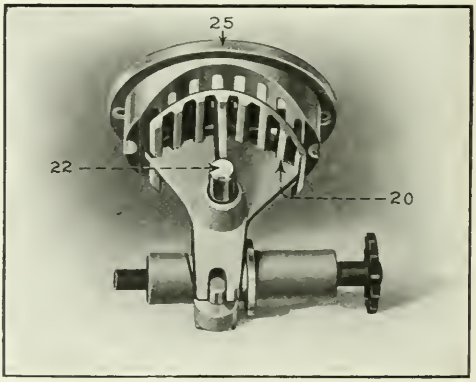
Constant-Engine-Speed Governors.

Governors of this group are driven by the engine, and are so connected to a governing valve, situated between the carbureter and the engine intake as to reduce the gas when the speed of the engine exceeds the speed for which the governor has been set. When a gear is changed, the permissible speed of the engine is not altered. If set for a maximum engine speed of 900 r.p.m., corresponding to a vehicle speed of 15 miles per hour on high gear, there might result 11 miles per hour on third gear, 6 miles per hour on second gear, and 3 miles per hour on first and reverse gears.

Constant-Vehicle-Speed Governors.

This governor is operated from one of the vehicle wheels, or from the propeller-shaft, and permits the vehicle to attain its maximum speed on high gear at a moderate engine speed, and in designs employing such a governor a relatively high axle ratio is generally used. This reduced engine speed tends to prolong the life of the total equipment, to lessen the cost of upkeep, and to increase fuel efficiency. As the drive is stepped down thru the gear train, however, such a governor, aiming at a constant vehicle speed, allows an increased engine speed inversely proportionate to the drop in gear ratio, and thus permits a prohibitive engine speed on second gear, and an absolutely destructive speed on low and reverse gears. In neutral, the engine is entirely free from the influence of the governor, and is permitted to race.

The foregoing are the more serious limitations of governor designs and upon them are based the objections of those engineers who are still opposed to employing them. There are but few builders of trucks today, however, who do not use some form of automatic control, as the disadvantages resulting from omitting it would be far more serious than those resulting from employing it.



THE DUPLEX VALVE.

The Ideal, or Combination Governor.

If a constant-engine-speed governor is employed there results a high gas consumption and a low range of available power, from the low engine speed, for low gears. If a constant-vehicle-speed governor is used the engine is sacrificed as it is without control in idling and on low gears. The logical design would be a combination of the features of both, and this may be described as the ideal governor. Such a governor should automatically change the permissible speed of the engine as the power requirement changes. The valve should be of quick action, and sensitive; it should permit of a full throttle to nearly the point of cut-off; it should be steady and free from valve flutter, or surge; it should be absolutely dependable and capable of handling the vehicle over varying normal grades without a lag or over-running of more than 5 to 8 per cent.

A careful study of the current consumption of electric vehicles in trucking service has shown that the power required on high gear is of an amount equal to only about one-third of the actual power capacities of the engines of gas trucks. It has been equally well determined that trucks operate from 90 to 95 per cent. of their total travel on high gear.

Attention is called to form No. 1, which is an analysis of the vehicle speed and power characteristics of a two-ton truck of well known make. This truck is equipped with a constant-engine-speed governor limiting the vehicle speed to 13 miles per hour at 1,000 r.p.m. of the engine, and developing 30 h.p., which is available for all gears alike. This analysis is typical of the present day truck.

Compare this with Form No. 2, which is a corresponding analysis of the same truck, equipped with a combination, or duplex governor, but provided with a higher axle ratio, and a four-speed gearset having a lower ratio on first gear.

With the constant-engine-speed governor, the available power on all gears is 25 h.p.; maximum vehicle speed, 13 miles per hour; average vehicle speed on low gears, 5.43 miles per hour, and an engine to wheel ratio on first gear of 27.95 to 1. With the combination governor there would be an available power on high gear of 22 h.p.; available power on low gears, 35 h.p.; maximum vehicle speed, 13 miles per hour; average vehicle speed on low gears, 8.05 miles per hour, and an engine to wheel ratio on first gear of 28.52 to 1, showing increases in available power for third gear (35 h.p.) over high gear (22 h.p.) service, 45 per cent.; for low gears over high gear (22 h.p.) service, 59 per cent.; in average vehicle speed on low gears over constant-engine-speed governor, 49 per cent., etc.

Standard Widths for Wagon Tires

As the result of a long series of traction tests on earth and gravel roads, the U. S. Department of Agriculture recommends in Circular 72, of the Office of the Secretary, that the following widths of tire be adopted generally by manufacturers for wagons of different carrying capacities.

Type of wagon.	Gross weight loaded. Pounds.	Width of tire. Inches.
1-horse wagon	2,000	2
Light 2-horse wagon	3,500	2½
Medium 2-horse wagon	4,500	3
Standard 2-horse wagon...............	6,800	4
Heavy 2-horse wagon	7,500	5

These five types, says the circular, should be sufficient to meet all the needs of farming operations and general work, except the heaviest trucking and certain specialized hauling which is likely to be confined to city pavements. The circular recommends, therefore, that a name be adopted for each of these sizes and that the wagons be designated not by the size of skein but according to their gross load capacity. The gross carrying capacity of the wagon should be shown, it is said, by stencil or plate on the back of the rear axle. The size of skein for the five types of wagon named vary, says the circular, from 2½ or 2⅜ inches for a 1-horse wagon to 3½ inches for the heavy 2-horse wagon.

State Control of Main Road Construction

The following conclusions stated in Highway Bulletin No. 2 of Purdue Univ., Lafayette, Ind., by George E. Martin, C. E., are so much to the point regarding the necessity of state control of trunk lines under modern conditions and with the modern pavements demanded by the modern traffic that they follow in full:

Indiana seems to have reached the parting of the ways in the solution of her road problem. She has long stood as a conspicuous example of extreme local control in road matters. Her laws have been drawn to give the people of the smallest subdivision of her territory the greatest latitude in the selection of the roads to be improved and the method to be used for their improvement. The results have been good in the past. Indiana can well be proud of her system of local roads reaching practically all of her people.

However, conditions are rapidly changing. Roads which were entirely satisfactory ten years ago are now inadequate to carry the traffic which comes upon them. Road building is speedily advancing from rule of thumb methods to its proper place as one of the engineering sciences. It is no longer possible for every man to be a good road builder. To build roads to meet present conditions requires extensive training and experience. It is not possible for the small subdivisions to obtain men qualified to design and construct these modern highways.

Federal aid for road building is now a fact. The Federal Government will not treat with anything but a state. Some form of state organization will then be necessary to obtain the benefit of the Federal money.

No two parts of the state can be treated the same but some wise plan for the entire state with the necessary modifications to meet the varying conditions in the different sections, will undoubtedly make our system of good roads a much better one, by strengthening it where it is now weak.

Good Roads Notes

Nine cities in Texas accepted pavements newly constructed to the amount of 7.45 miles or 139,275 square yards. Of this amount 3.18 miles or 56,809 square yards was of asphaltic concrete in three cities; 2.27 miles or 51,593 square yards was of bitulithic in three cities, and 1.89 miles or 29,366 square yards was of various kinds of concrete.

The National Government has already made a good beginning in the supervision of road construction, the amount of road built as experimental roads, post roads, county roads and National Park and forest roads under various appropriations for these purposes being the equivalent of 561.9 miles of road 15 feet wide.

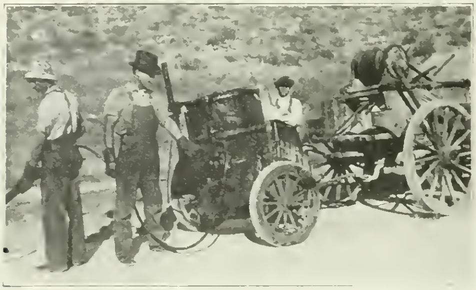
The Illinois Highway Improvement Association at its December meeting decided to appeal to the legislature for increased activity in state road building. The organization resolved to urge the General Assembly to submit a referendum to the people in November, 1918, on the issuance of $6,000,000 of state bonds for hard surfaced roads. W. W. Marr, state highway engineer, outlined a system of 4,000 miles of main roads which could be built for this sum, and presented a plan including 16,000 miles as being what must eventually be built to produce a comprehensive system.

Asphalt Joint Filling Machine

San Bernardino County, California, has built recently about 87 miles of concrete pavement with bituminous carpet, according to the California method, which seems to be successful under California weather conditions. After some experience it was found necessary to fill the expansion joints with a 90 per cent. asphaltic oil heated to 200 deg. or more, in order to insure that the bituminous carpet would stick to the concrete over the expansion joints.

To meet the requirement of pouring the joints economically, J. S. Bright, Jr., chief engineer of the San Bernardino County Highway Commission, devised the apparatus, one form of which is shown in the accompanying photograph, which was reached after some experimenting and some changes.

On the rear of one of the department's repair wagons is mounted an oil tank supplying fuel thru a flexible hose for the heater drawn behind. This heater consists of a 100-gallon drum mounted on a special axle with two Ford automobile wheels and four distillate burners beneath to furnish the heat. A hand rotary pump is mounted on the side



ASPHALT HEATER AND JOINT FILLER MADE ON DESIGN OF COUNTY HIGHWAY ENGINEER J. S. BRIGHT, JR.

of the drum, as shown by the man with his hand on the handle. This pump takes the hot asphalt from the drum and forces it thru the flexible metal hose line and sprays it thru the flattened nozzle at the end of the pipe held by the man at the left in the photograph.

The speed of the pump and the opening of the sprayer's valve regulate the thickness of the coat, provided the temperature is high enough to make it possible to control the flow. A temperature of 300 deg. is desirable.

Mr. Bright gives the cost of the apparatus as follows:

Axle, wheels, tires, fire-box, tongue and blacksmithing on the same	$97.60
Drum	10.00
Blacksmithing on pump, burners, connections and braces	54.05
Two pieces of flexible steel hose, each 10 feet long	15.50
Four distillate burners	5.00
Hand rotary pump	18.00
Total cost ready for use	$200.15

The crew for filling joints consists of foreman, pumpman sprayer, two men to sweep shovel screenings, teamster and team. Where joints have been filled with other material two men are required to pick out the joints ready for filling. The gang has filled the joints on 48 miles of road in a month at a cost of about $10 a mile, hauling oil and screenings 5 to 35 miles.

The fuel oil tank can be mounted on an automobile and the outfit can travel faster on its way to work if long distances are to be covered.

Tractive Resistance on Various Road Surfaces

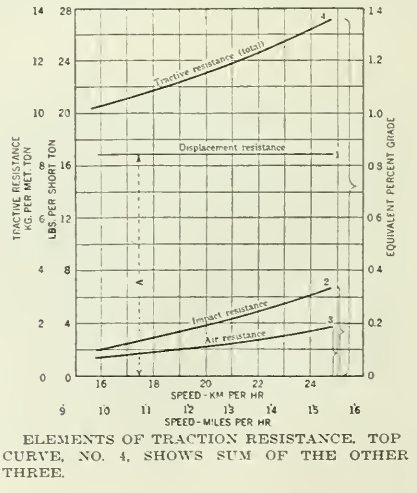
Some data on the tractive resistances of an electric truck with solid rubber tires on asphalt and bitulithic, wood, brick and granite block, water-bonded and tar macadam, cinder and gravel road surfaces have been obtained by A. E. Kennelly and O. R. Schurig in the research division of the electrical engineering department of the Massachusetts Institute of Technology, which are published in Bulletin No. 10 of the division.

An electric truck was run over measured sections, ranging from 400 to 2,600 feet in length surfaced with these various materials, at certain speeds per hour, ranging from about 8 to about 15.5 miles per hour. The result of the observations of speeds, tractive resistances, conditions of surfaces, etc., were collected and studied in various combinations, which can be used by others.

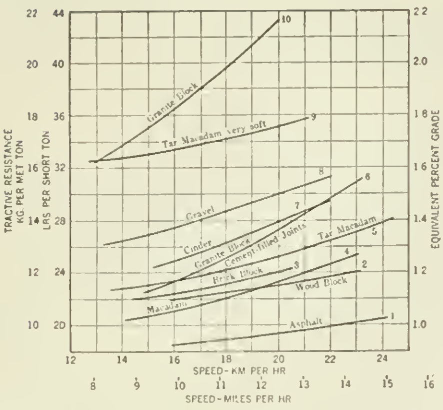
But little was done in the study of the effect of variations in the weight of the load, the gross weight in most of the runs being 4,710 pounds. In a few tests the load was increased 12 per cent. On asphalt or bitulithic pavements, which are considered as equivalent surfaces, the tractive resistance in pounds for short ton was not increased by increasing the weight carried, but on heavily oiled macadam, wet, in fair condition, the tractive resistance per ton was increased 1 to 1½ pounds per ton, or say 3 to 5 per cent. The latter surface was much softer and less resilient than the former.

The tractive resistance is expressed either in pounds per ton or percentages of grade. The tests were made on very nearly level streets, and the tractive resistance is stated also in its equivalent grade since 10 Kg. per metric ton tractive resistance is just equivalent to the force necessary to overcome a 1 per cent. grade. The tractive resistance includes the resistance of still air to the motion of the truck and the resistance of the road to passage over it but does not include the effect of wind nor the electrical and mechanical losses in the truck mechanism as determined by laboratory tests.

The first of the accompanying diagrams gives an approximate analysis of typical tractive resistance into its elements, with special reference to the result on an asphalt road in poor condition.



ELEMENTS OF TRACTION RESISTANCE. TOP CURVE, NO. 4, SHOWS SUM OF THE OTHER THREE.



SUMMARY OF TRACTION RESISTANCE TESTS FOR VARIOUS ROAD MATERIALS, HARDNESS AND ROUGHNESS OF SURFACE.

The line 1 in the diagram indicates the constant resistance to movement which is due to the lack of resilience of the road surface and the wheel tire, or the loss due to displacement of the tire material and the road material. For a softer material than asphalt this line would be moved up several pounds, and for other tires and materials it would be moved up or down but would remain horizontal as for any given combination of tire and pavement the resistance within practical limits is the same whatever the speed.

The curve 2 in the diagram represents the effect of roughness. The rougher the pavement the greater the resistance. The greater the speed on a rough pavement the greater the resistance, so that this portion of the resistance tips the curves up rapidly as the roughness increases, giving most of this tendency shown in the second diagram.

The curve 3 represents the resistance of the air to the passage of the vehicle and, given the vehicle the resistance can be computed for all the speeds of the diagram. It will be the same for uniform speed for all pavements.

Curve 4 represents the sum of the three resistances or the total tractive resistance.

The accompanying table, reproduced from the report, gives a summary of the result on each kind of pavement tested, and is worthy of close and careful study. The second diagram gives in graphical form the same results, still further combined. The relative tractive resistance of the various pavements at the various speeds of the tests are clearly shown in the diagram.

The greater necessity for smooth hard surfaces as the speed of traffic increases is clearly shown. While the tractive resistance of asphalt pavement increases only about two pounds per ton with an increase of speed from 10 to 15 miles per hour, the tractive resistance of a rough granite block pavement with sand filler increases nearly 11 pounds with an increase from 8 to 12½ miles per hour; a lower speed and a smaller increase in speed make 5½ times the increase in resistance. This condition is emphasized again by a comparison of the two granite block pavements; the comparatively smooth granite pavement with cement filled joints showing far more favorable results than the rougher granite block pavement with sand filled joints.

The conclusions drawn from a study of the results of these experiments on urban roads with a solid-rubber-tired motor truck between speed limits of 8 and 15.5 miles per hours are as follows:

(1) The over-all efficiency of the test-truck mechanism, as described in the report, between battery terminals and rear-wheel treads, reached a maximum value of about 78 per cent., under the most favorable conditions.

(2) The mechanical efficiency of transmission from motor shaft to rear-wheel treads, for the truck tested, shaft-driven thru a single-reduction worm gear, was found as high as 90 per cent.

(3) Tractive resistances are most conveniently expressed as an equivalent percentage grade; i. e., a level road of definite tractive resistance may be regarded as a road of zero tractive resistance, but rising uniformly x units in 100 units of road length, or having an equivalent grade of x per cent.

(4) Under the conditions of these tests, the tractive resistance on level roads, in the absence of wind, is composed of (a) displacement resistance, (b) impact resistance, and (c) air resistance.

(5) The displacement resistance varied from 0.85 per cent. equivalent grade, for a hard smooth asphalt or bituminous

SUMMARY OF TRACTIVE RESISTANCES OF DIFFERENT URBAN ROADS AT DIFFERENT SPEEDS

All tractive resistances are expressed in equivalent per cent grade.

Road		Equivalent per cent grade		Per cent increase in tractive resistance from 16 to 20 km. per hr.	Comparative tractive resistance factors referred to asphalt roads	
Type	Condition	at 16 km./hr. (10 miles per hour)	at 20 km./hr. (12.4 miles per hour)		at 16 km./hr.	at 20 km./hr.
Asphalt	good	0.93	0.97	4	1.0	1 0
Asphalt	poor	1.03	1.16	11	1 11	1.20
Wood block	good	1.10	1.15	5	1.18	1.18
Brick block	good	1.12	1.21	8	1.20	1 25
Brick block	slightly worn	1.14	1.27	11	1.23	1 31
Granite block	good	1.83	2.16	18	1.97	2.23
Granite block with cement joints	good	1.16	1.37	18	1.25	1 41
Macadam, water bonded	dry and hard	1.06	1.17	10	1.14	1.20
Macadam, water bonded	fair, heavily oiled	1.63	1.76	8	1.75	1 82
Macadam, water bonded	poor, damp some holes	1.65	1.89	15	1.78	1.95
Tar macadam	good	1.17	1.27	9	1.26	1.31
Tar macadam	very soft	1.67	1.76	5	1.80	1.81
Tar macadam	many holes, extremely poor, soft	2.38	2.75	16	2.55	2.85
Cinder	fair, hard	1.25	1.39	11	1.35	1.43
Gravel	fair, dusty	1.37	1.50	9	1.47	1.55

concrete to 1.6 per cent. for a very soft tar-macadam road, and was practically constant, for all speeds considered, on any given road.

(6) The impact resistance increases with the velocity, with the total weight of vehicle, and with increasing road-surface roughness. In these tests, the impact resistance of good asphalt or bitulithic or other smooth pavement, was practically negligible, and reached its highest values on granite-block roads with sand filled joints, and on badly worn macadam pavements. The rate of increase of impact resistance with speed was most marked on the roughest roads.

(7) At the vehicle speed of 12.4 miles per hour, the air resistance for the vehicle tested, assumed to be dependent only on the speed, was roughly 0.11 per cent. equivalent grade; i. e., from 4 per cent. of the highest, to 12.5 per cent. of the lowest, total tractive resistance.

(8) The following urban pavements are enumerated in the order of their desirability for vehicle operation from the point of view of tractive resistance at 12.4 miles per hour, as found in this investigation. (1) asphalt, (2) wood block, (3) hard smooth macadam, (4) brick block, (5) granite block with cement-filled joints, (6) cinder, (7) gravel, (8) granite block with sand-filled joints.

(9) The equivalent grade at 12.4 miles per hour of a badly worn city macadam road, was found to be nearly three times as great as that of the best asphalt road tested. This means, at this speed, a consumption of energy at wheel treads, of nearly three times as much on level poor macadam roads as on good level asphalt roads.

(1) Increasing the gross weight of the vehicle by 12 per cent., thru loading, was found to have no effect on tractive resistance within the observed speed limits for smooth roads in good condition; but on rough roads, a distinct increase in tractive resistance with this extra weight was observed.

(11) The presence of a layer of dust, say ½-inch thick, on a fair macadam road, was found to increase the equivalent grade of tractive resistance, at all tested speeds, by about 0.15 per cent.

(12) A freshly tarred and therefore very soft tar-macadam road was found to have an increased tractive resistance equivalent, at substantially all tested speeds, of about 0.5 per cent. The tires in this case sank about 0.8 inch into the road bed, the gross car weight being 4710 pounds.

(13) The total range of tractive resistance equivalent grade covered in the tests, was from 0.93 per cent. on the best asphalt road, at lowest speed, to 2.7 per cent. on the worst macadam road, at nearly the highest speed.

Specifications for Wood Block Paving

The specifications for wood block paving and for the oils and tars used in treating the blocks, which were approved by a joint conference in September of representatives of a half dozen societies interested in the subject, were adopted by the American Society of Municipal Improvements in October, 1916, and have now been adopted by the American Wood-Preservers' Association. This is the result of several years of hard work by committees in both these societies and represents very nearly the latest advances in the practice of treating and laying wood paving blocks. A minority report on the preservatives used gave rise to some discussions prior to the convention, which indicates to the reader not immediately connected with the work that one point in the specifications for mixtures of creosote and tar for treatment purposes may not be sufficiently guarded, the criticisms of the adopted specifications made in the minority report not being squarely met in all reports in the reply thereto. The position of the majority regarding the expression of opinion as to the relative merits of the compounds specified may or may not be well taken, but in either case, it should not and need not interfere with the safeguarding of every inlet thru which unsatisfactory materials may have a chance to enter.

Cheaper Excavation

By J. B. Stoncking, M. E.

Contractors and engineers are feeling the acute shortage of the cheaper labor used in excavation work, such as foundations, basements, cellars, water storage reservoirs, trenching, and cuts in street, road and railroad construction and the consequent demand for higher wages. Hence, they are looking for any good method of saving labor, adapting means which have been successful in keeping down costs.

Probably, the chiefest of these is the development and use of the lower grades of dynamite. In rock, the efficiency of dynamite has long been recognized, but when this high grade explosive was used in earth excavation work, the results were far from satisfactory, due to the character of the material being worked, rock work requiring a quick-acting, shattering force to give results, while in earth a comparatively slower-acting and heaving or lifting effect is desired. Recognizing the necessity for an explosive of this kind, the manufacturers have worked out a low-grade, slow-acting, heaving, comparatively insensitive and safe to handle, low-freezing dynamite, which contractors have been quick to adopt in their search for an efficient means of cutting down labor costs . It is used in conjunction and in combination with all types of mechanical excavators to hasten and cheapen the work. In this connection the method generally pursued is to do the drilling or punching of the bore holes, and the firing at a time when it will not interfere with the other operations.

On large projects, even where the steam shovel is used, it is generally necessary to loosen the material by blasting ahead of the shovel where large imbedded boulders, compacted earth, or hardpan are encountered. In order to secure the maximum efficiency of the machine, the shovel must be filled at every trip, hence it is not advisable to make the shovel do very much digging in hard material to fill it, as the yardage handled will be too low for any profit. Often the use of a little dynamite on large boulders, old water mains, large roots, stumps, and other obstructions will save a broken cable and consequent delays.

In shallow excavations where the material is not too hard to plow successfully and where ample room may be had in which to turn, the horse or tractor-drawn elevator-grader gives good results. The use of the wheeled scraper, buck scraper, slip, and "Fresno" scapers are limited to very soft material, hence plowing to loosen same is essential. In hard ground, or where there are boulders, roots, stumps, or hardpan, plowing becomes very unsatisfactory and costly, and sometimes, impossible. By the proper use of dynamite the plowing may be dispensed with entirely at a considerable saving, and, even in easily plowed ground where it is desired to leave the banks and corners of the excavation perpendicular, a great amount of hand picking and shoveling may be saved by blasting out the corners and sloping toes.

Where the work is very small or the areas too restricted for the use of teams in plowing, the question of hand labor is a very serious one. Low-grade dynamite is the salvation of the contractor in this case, and its successful and rational use has been the turning point from loss to profit.

Excavation work should not be done while the ground is frozen, for the costs are considerably increased. If work must be prosecuted regardless of weather conditions, the most efficient labor-saver is the low-freezing dynamite. Care should be taken not to blast too far ahead of the shovel and scrapers or the material may consolidate again.

Asphaltic Concrete Pavements Laid in 1916 and Proposed for 1917

Descriptions of Pavements as laid, cost per square yard and total cost.

Design, Cost and Quantity are shown.

City	Sq. yds. laid 1916	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd.	Total cost, inc. (1) (2) (3) (4)	Kind of asphalt	Estimated constr. for 1917
Alabama—											
Gadsden	...	5	1:2:5	2	7-11%	2	7-11	1.36	40,800	Oil	[1]18,341[2]
Arkansas—											
Ft. Smith	26,000	...	...	...	...	...	...	0.90	...	...	9,453
California—											
Berkeley	36,660	5	1:3:6	...	...	2	T	1.15-1.20	61,400	...	96,600
Long Beach	15,413	4	...	...	...	4	...	1.02	...	...	...
Pasadena	2,612	6	...	...	...	...	...	0.82	2,485	...	...
Richmond	9,585	...	...	...	...	4	...	1.21	...	California	10,000
San Bernardino	12,539	4	1:2½:5	...	...	⅜	1[30]	0.81	(1)	...	...
San Francisco	21,519	6	1:2½:7	0	...	2½	...	...	46,191	Santa Cruz Rock	...
Stockton	194,200	5	1:2:4	2½	...	1½-2	...	(1) (2)	373,296	Topeka	220,000
Vallejo	40,350	4	1:2½:5	Paint	...	1-1½	T	1.08	53,588	Cal.-Std.	85,840
Colorado—											
Denver	25,000	...	...	...	...	...	...	...	...	...	...
Connecticut—											
Ansonia	1,700	...	...	...	...	...	...	...	...	...	...
Bridgeoprt	290,714	...	...	...	...	2	...	1.20	...	...	...
Georgia—											
Atlanta	18,047	6	1:3:6	0	...	2	...	...	19,851	Nat. Lake	...
Tifton	37,000	Conc.	...	...	...	2	...	1.53	...	...	...
Illinois—											
Arlington Hts.	97,790	...	...	...	...	...	...	...	...	...	...
Berwyn	38,677	6	...	...	...	2	...	1.77	...	Trinidad	132,800
Chicago	128,000	6	...	2	...	...	...	1.671	2,688	Mex.-Trin.	...
Chicago Heights	50,000	6	...	...	...	2	...	1.60	102,000	Tex.-Azt.	30,000
Cicero	73,242	...	...	...	...	...	...	...	...	...	...
Des Plaines	5,770	...	...	...	...	...	...	...	...	...	...
Elgin	36,095	...	...	...	...	2	...	1.48	...	...	...
Evanston	23,627	...	...	...	...	...	...	...	...	...	...
Harvard	42,660	...	...	...	...	...	...	...	...	...	...
Joliet	80,401	5	...	1	...	2	...	1.85[46]	177,553	...	49,735
Kankakee	22,000	...	...	...	...	2	...	1.60	...	...	...
LaGrange	23,171	6	1:3:6	...	...	2	8%[11]	1.36	42,000	Bermudez	170,000
Lake Forest	6,500	...	...	...	...	2	...	1.00	...	...	...
Oak Park	185,241	6	1:3:6	...	...	2	...[47]	1.55[48]	412,616	Trinidad	53,800
Park Ridge	9,525	...	...	...	...	...	...	...	...	...	...
River Forest	5,700	...	...	...	...	...	...	...	...	...	...
Riverside	44,425	...	...	...	...	...	...	...	...	...	...
Rock Island	5,760	...	...	...	...	...	...	...	...	...	...
Springfield	17,632	...	...	...	...	...	...	...	...	...	...
Indiana—											
Angola	12,325	...	...	...	...	2½	...	1.79	...	...	...
Bloomington	26,394	...	...	...	...	...	...	...	...	...	...
Elkhart	15,100	6	1:3:5	...	...	2	8%[31]	1.35	310,000	Texaco	0
Fort Wayne	72,786	6	1:3:6	...	...[110]	...	...	1.60	170,409	Bermudez	80,000
Frankfort	4,565	4	...	...	...	2	...	1.70	13,198[62]	Tar	...
Greenwood	14,000	...	...	...	...	2	...	1.75	...	...	...
Indianapolis	104,479	...	...	...	...	...	...	...	...	...	...
Michigan City	17,102	6	1:3:5	6	...	...	...	1.51	...	Texas	...
Mishawaka	6,200	...	...	...	...	...	...	...	...	...	...
North Manchester	13,148	...	...	...	...	...	...	...	...	...	...
South Bend	37,444	5	1:7G	2	8-11 [11]	...	...	1.45	65,577	...	5,380
Iowa—											
Cedar Rapids	35,000	4	1:3:5	...	...	2	...	1.49	65,150	Trinidad	...
Davenport	49,604	5	1:3:6	1½	...	1	...	1.59-1.77	102,126	...	100,000[9]
Des Moines	85,106	...	...	...	...	2	...	1.671	...	...	...
Dubuque	4,410	5	1:3:5	...	...	2	...	...	8,701	Trinidad	20,000
Forest City	4,686	4	1:3:5	...	...	2	Topeka	1.46	7,388	Texaco	...
Ft. Dodge	40,000	5	1:3:5	...	...	2	T	1.57	85,000	Trinidad	...
Greenfield	18,288	4	1:3:6	...	...	2	...	1.58	41,338	Trinidad	...
Iowa Falls	51,000	...	...	...	...	2	...	1.62	...	...	...
Muscatine	3,564	5	1:6G	...	...	2	...	1.51	6,382	Bermudez	0
Oelwein	32,000	5	1:3:5	...	...	2	...	1.30	60,705	Trinidad	...
Webster City	16,622	5	1:3:6	...	...	1½	T	1.65	1.65	Bermudez	15,000
Kansas—											
Eldorado	38,747	...	...	...	...	...	...	...	...	...	...
Emporia	9,875	4	1:2½:5	...	...	2	9%[12]	1.27[33]	17,650	Texaco 54	10,000
Erie	...	...	...	...	...	...	...	...	...	...	20,000[9]
Girard	43,000	...	...	...	...	2	...	1.25	...	...	...
Great Bend	41,800	4	1:2½:5	...	2	2	T	1.26	...	Texaco	...
Iola	32,500	...	...	...	...	...	...	...	...	...	...
Kansas City	6,600	...	...	...	...	...	...	...	...	...	...
Manhattan	39,930	5	1:5	...	...	2	...[34]	1.22	1.66	Texaco 54	16,500
McPherson	7,000	...	...	...	...	...	...	...	...	...	...
Parsons	...	...	...	...	...	...	...	...	...	...	15,000
Peabody	22,000	...	...	...	...	...	...	...	...	...	...
Pittsburg	5,876	4	1:2:5	...	...	2	8½%[12]	1.32	15,602	Tex.-Stano.	...
Salina	20,000	...	...[35]	...	...	2	...	1.00	29,000	Trinidad	...
Topeka	64,120	5	1:2½:5	...	...	2	T	1.35	1.68	Texaco	45,000
Wellington	80,005	4	1:2½:6	...	...	2	...	1.23-1.30	150,556	El Oro & Tex.	13,000

City	Sq. yds. laid 1916	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd.	Total cost, inc. (1) (2) (3) (4)	Kind of asphalt	Estimated constr. for 1917
Kentucky—											
Louisville	20,092	6	1:3:6	...	....	2	....	1.68	......	Tr'n.-Mex.	5,000
Mount Sterling	10,000	...	.....	...	....	....	....	......	......	....	......
Owensboro	.....	...	.....	...	....	....	....	......	......	....	75,000[9]
Louisiana—											
New Orleans	14,602	...	.....	...	....	....	....	2.09	......	....	......
Shreveport	21,120	5	.....	...	....	2	....	......	1.60	Texaco	63,360
Maine—											
Waterville	3,620	...	.....	...	....	....	....	0.90	......	....	......
Massachusetts—											
Boston	5,120	...	.....	...	....	....	....	......	......	Hassam	......
Chicopee	10,000	...	.....	...	....	....	....	......	......	....	......
Leominster	39,000	...	.....	...	....	....	....	......	......	....	......
Manchester	38,000	...	.....	...	....	....	....	......	......	....	......
New Bedford	20,896	5½	1:3:6	...	....	2	7% a.c.	......	......	Aztec	......
Revere	1,194	2	.....	...	....	....	....	1.41	......	Tarbinder	0
Michigan—											
Battle Creek	63,943	5	.....	...	....	2	....	......	81,561	Trinidad	......
Bay City	19,133	5	.....	...	....	2	T	1.58	39,531	Bermudez	16,000
Coldwater	5,010	4½	1:6 or 7	...	....	1½	....	1.21	6,254	Barrett C	0
Detroit	535,428	6	1:3:6	...	....	....	....	1.845	2.74	....	......
Grand Haven	......	...	.....	...	....	....	....	......	......	....	10,000
Grand Rapids	14,110	5	1:3½:7	...	....	2	7½[36]	1.65	28,670	Azt. & Mont.	......
Grosse Pointe	49,600	...	.....	...	....	....	....	......	......	....	......
Hillsdale	14,950	6	.....	...	....	2	....	1.75	40,000	Trinidad	12,000
Holland	9,500	...	.....	...	....	....	....	1.20	......	....	......
Jackson	5,577	...	.....	...	....	....	....	......	......	....	......
Kalamazoo	20,506	...	.....	...	....	2	....	1.685	......	....	25,000
Ludington	700	6	1:6	...	....	2	T	1.05	1,054	Stanolind	40,000
Muskegon	7,810	6	1:6G	...	....	2½	8[37]	1.45	16,087	Warner	30,606
Petoskey	13,160	...	.....	...	....	7	....	1.465	......	....	......
Pontiac	24,809	...	.....	...	....	....	....	......	......	....	......
Spring Lake	15,000	...	.....	...	....	....	....	......	......	....	......
Ypsilanti	9,275	5	1:3:6	...	....	2	....	1.50	1.625	....	......
Minnesota—											
Duluth	2,667	...	.....	...	....	....	....	......	......	....	......
Minneapolis	63,023	old pave.		...	....	2	....	1.00	......	Tex. & Pierce	50,000
St. Paul	91,690	5	1:2½:5	...	....	2	....	1.60	151,096	Oil	60,000
Mississippi—											
Greenwood	8,930	4	1:3:5	...	....	2	8½:9½	1.48[33]	19,232	Trinidad	40,000
Missouri—											
Independence	12,511	5	1:3:5	...	....	....[39]	18:82	......	1.35(1)	Texaco	50,000[9]
Kansas City	44,617	...	.....	...	....	....	....	......	......	....	......
St. Joseph	4,255	old macad.		1½	....	1½	....	1.50	6,895	Min. Rub.	......
St. Joseph	55,289	3	.....	...	....	2	....	1.52	104,698	Asphalt	......
Springfield	7,073	4	1:3:7	...	....	2	T	1.22	1.41	Texaco	12,000
Montana—											
Anaconda	75,511	3	.....[40]	...	....	2	....	1.65	161,145	California	50,000
Nebraska—											
Beatrice	36,100	5	1:3:6	...	....	2	....	1.57	......	Texaco	40,000
Lincoln	33,300	5	1:3:6	0	....	2	....	1.62	......	Trin.-Cal.	......
Norfolk	63,000	6	1:5G	...	....	2	T	1.51	1.59	Texaco	50,000
Omaha	107,279	5	1:3:6	...	....[121]	....	....	1.60	181,817	Mex.-Berm.	100,000
New Hampshire—											
Nashua	3,000	...	.....	...	....	....	....	0.75	......	....	......
New Jersey—											
Bayonne	5,300	5	1:3:6	1½	....	1⅓	....	1.15	......	Berm. & Oil	......
Boonton	25,000	...	.....	...	....	2	....	1.00	......	....	......
Elizabeth	6,756	4	1:3:6	1	....	2	....	1.65	1.85	Mexican	......
Guttenberg	4,100	6	.....	..	....	2½	....	......	1.41	....	1,000
Hackensack	7,900	...	.....	...	....	2	....	0.80	......	....	......
Jersey City	56,987	...[41]	.....	1	....	2	....	......	54,103	....	50,000
Montclair	56,800	5	1:3:6	1½	5%[12]	1½	8½%[12]	1.80-2.17	154,501	S. O. & Mex.	170,000
Ridgewood	......	...	.....	...	....	....	....	......	......	....	6,000
Trenton	23,334	5	1:3:6	...	....	2	....	1.72-1.78	......	Bermudez	20,000
Union	30,000	5	.....	...	....	2	....	1.30	45,000	Montezuma	15,000
West Hoboken	9,610	...	.....	...	....	2½	....	1.15	......	....	......
West New York	10,317	...	.....	...	....	2½	....	1.50	......	....	......
New York—											
Albany	13,393	6	.....	Paint	....	2	....	1.71	......	Std. Oil	5,000
Batavia	1,800	5	1:2½:5	2	T	Seal Coat		1.75	4,200	War.-Quinn.	5,000
Buffalo	122,410	repaving		...	....	....	....	......	......	....	......
Johnstown	......	...	.....	...	....	....	....	......	......	....	20,000
New York—											
Bronx	14,096	...	.....	...	....	2	....	1.75	......	....	......
Brooklyn	17,252	...	.....	...	....	....	....	1.10	......	....	......
Queens	93,900	...	.....	...	....	2	....	1.00	......	....	......
Richmond	13,893	...	.....	...	....	2	....	1.12-1.48	......	....	......
Niagara Falls	1,560	6	1:3:6	...	....	2	7-11%[12]	2.40	24,105	Trinidad	......
Port Washington	20,500	...	.....	...	....	....	....	......	......	....	......
Salamanca	13,542	7	1:2½:5	...	....	....	....	1.56	1.92	....	......
Syracuse	1,460	6	1:3:6	2	....	....	....	1.68	3,385	Montezuma	182,000[9]
Whitehall	15,625	...	.....	...	....	....	....	......	......	....	......
North Carolina—											
Asheville	9,275	...	.....	..	....	....	T	0.90	9,074	....	......
Greensboro	17,100	4	1:3:6	...	....	2	....	1.50	......	Oil Asph.	......
Raleigh	70,000	4	1:3:6	...	....	2	T	0.63	......	Montezuma	100,000[9]
Shelby	26,232	...	.....	...	....	....	....	......	......	....	......
Ohio—											
Bowling Green	......	...	.....	...	....	....	....	......	......	....	6,570
Chillicothe	10,196	...	.....	...	....	....	....	......	......	....	......

City	Sq. yds. laid 1916	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd.	Total cost, inc. (1)(2)(3)(4)	Kind of asphalt	Estimated constr. for 1917
Cleveland	8,900	...	...	...	...	2	...	2.00	...	...	...
Cleveland Heights	81,945				...	...	...	...	...	...	...
East View	28,300				...	...	...	...	...	...	...
Euclid	27,365				...	...	...	...	...	...	...
Galion	10,070	5	1:3:5		...	2½	...	1.58	22,087	Texaco	13,000
Kenton	5,840	...	...		...	...	...	...	...	...	...
Lima	9,852		...		...	2	...	1.72	...	...	...
Massillon	9,818	5	1.96		...	2	...[42]	1.14	...	Tarvia X	...
Newark	13,243	...	...		...	...	...	1.58	...	...	...
Piqua	15,889	4-5			...	2	T	1.42[46]	31,268	Trinidad	...
Springfield	19,600	...	...		...	2	...	1.70	...	...	...
Toledo	12,174	6	1:3½:6		...	2	...	1.85	3.17	...	...
Van Wert	13,774	...	...	...	...	...	...	...	...	...	...
Wapakoneta	9,210	...	...	...	...	...	...	...	...	...	...
W. Jefferson	3,770	...	...	...	...	...	...	...	...	...	15,500
Oklahoma—											
New Wilson	...	...	...	...	...	...	...	...	...	...	...
Oregon—											
Albany	6,813	...	...	3	bit	2	...	1.05	9,800	California	...
McMinnville	49,360	...	...	...	...	...	...	1.14	...	...	...
Portland	18,313	5	1:3:6	1	...	1½	...	1.30	33,714	California	6,000
Portland	6,204	3	...[34]	...	...	2	...	1.17	11,579	California	...
Salem	1,153	6	1:2:4	...	...	...	...	...	1,179	California	40,000
Salem	9,213	3½	...[44]	...	...	1½	...	...	0.971	California	...
Salem	6,000	...[41]	...	...	...	2	...	...	0.90	California	...
Pennsylvania—											
Harrisburg	10,361	...	...	...	...	2	...	1.34	...	...	4,000[9]
Hazleton	5,269	...	...	...	...	...	...	...	...	...	...
Mt. Penn	7,600	...	...	...	...	...	...	...	...	...	...
Northampton	4,372	5	1:3:5	...	...	2½	...	0.86	...	Amiesite	7,500
Philadelphia	94,318	1-6	1:3:6	1-0	...	1½-2	...	1.36	143,035	...	2,012
West Reading	8,000	...	...	...	...	2	...	1.87	...	...	...
Rhode Island—											
Pawtucket	21,269	...	...	...	...	...	...	...	...	...	...
South Carolina—											
Greenville	62,000	4	1:3:6	...	...	2	...	1.30	1.51(1)	...	65,000[9]
Greenwood	40,000	4	1:3:6	...	...	2	...	1.31	78,000	Bermudez	6,000[9]
South Dakota—											
Huron	23,883	...	...	...	...	2	...	1.89	...	...	...
Mitchell	26,512	5	1:5½	...	...	2	...	1.795	60,850	Trinidad	25,000
Sioux Falls	84,213	5 & 6	1:2½:5	...	...	2	...	1.59	1.69(1)	Tex. & Cal.	50,000[9]
Tennessee—											
Chattanooga	32,126	5	1:3.6	...	...	2	...	1.46	2.32	Distil.	...
Dyersburg	12,000	...	...	...	...	...	...	...	...	...	...
Knoxville	10,478	...	...	...	...	...	...	...	...	...	...
Lenoir City	13,651	...	...	...	...	...	...	...	...	...	...
Murfreesboro	12,600	...	...	...	...	...	...	...	...	...	...
Newport	9,908	...	...	...	...	...	...	...	...	...	...
Texas—											
Amarillo	23,716	...	...	...	...	...	...	...	...	Texaco	...
Amarillo	38,560	...	...	...	...	...	...	...	65,303	Trinidad	10,000[9]
Bryan	320,661	...	...	...	...	...	...	...	...	Texaco	...
Cleburne	...	5	...	...	...	2	...	1.55	108,500	Trinidad	70,000
Corsicana	58,648	4-5	1-6	...	...	2-2½	...	1.25-1.70	93,858	Texaco	16,000
Dallas	3,177	...	...	...	...	...	...	...	...	Texaco	123,500
Denison	11,606	...	...	...	...	2	...	1.71	...	Texaco	...
Hillsboro	13,000	...	...	...	...	...	...	...	...	Texaco	...
Houston	126,917	6	1:3:6	...	...	2	...	1.80	255,000	Texaco	25,000
McKinney	50,325	...	...	...	...	...	...	...	...	Texaco	...
San Antonio	48,120	5	1:3:6	...	...	2	...	1.80	2.00	Mex.-Trin.	60,000
Sherman	12,250	...	...	...	...	...	...	...	...	Texaco	...
Taylor	130,000	5	1:2:4	...	...	2	T	1.40	300,000	Texaco	60,000
Temple	12,099	...	...	...	...	...	...	...	...	Texaco	...
Waxahachie	20,000	5	1:8	...	...	2	7-11[12]	1.36	28,500	Bermudez	200,000
Wichita Falls	7,500	...	...	...	...	...	...	...	...	Texaco	...
Utah—											
Ogden	7,900	...	...	...	...	...	...	...	...	...	...
Salt Lake City	12,200	4	1:3:6	...	...	2	...	1.75	22,950	California	13,000
Virginia—											
Suffolk	6,000	4 & 5	1:3:6	...	...	...	...	1.60-1.73	...	Texaco	5,000
Washington—											
Aberdeen	1,458	6	1:3:6	...	...	2	...	1.60	3,212	...	
Bellingham	1,576	6	1:3:5	...	...	2	1:1½	1.20-1.30	...	...	...
N. Yakima	39,593	4	1:4:6	...	...	2	9:13%	1.17	61,262	California	17,528
Seattle	2,294	5-6	1:3:6	...	...	2	...	1.40	...	...	2,000
Walla Walla	61,167	2½	...	...	...	1½	...	0.95-1.05	99,133	...	...
West Virginia—											
Charleston	96,690	5	1:2½:5	...	...	2	8-10[11]	1.74-1.82	2.14-2.38	Azt.-Trin.	...
Elkins	834	6-9	1:2:3	...	...	...[122]	...	1.87	2,216	Mo.	1,000
Wisconsin—											
Beloit	9,439	5	1:3:6	...	...	2	...	1.18-1.22	8,250	Trin.-Azt.	...
Burlington	8,310	...	...	...	...	...	...	1.58	...	...	...
Columbus	12,000	...	...	...	...	...	...	1.36	...	...	...
De Pere	23,600	...	...	...	...	2½	...	0.41	...	...	...
Fond du Lac	22,475	5	1:3:5	...	...	2	7%[11]	1.53	...	Mex.-Stand.	30,000[9]
Kenosha	11,700	...	...	...	...	...	...	...	...	...	...
Madison	9,000	...	...	...	...	...	...	1.46	...	...	...
Milwaukee	94,097	...	...	...	...	2	...	1.25	...	...	...
Oshkosh	3,933	5	...	...	...	2	...	1.63	7,638	Aztec	...
Portage	...	...	...	...	...	...	...	...	...	...	3,000
Racine	5,577	5	1:3:5	...	...	2½	...	1.78(1)	11,495	Trinidad	4,400
Richland Center	36,313	...	...	...	...	...	...	...	...	...	...
Waukesha	11,013	6	...[27]	...	...	2½	2 gal.[1]	0.92	16,448	Stanolind C	...

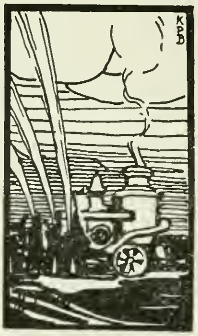
(*For footnote references see page 65 of February number.*)

City	Sq. yds. laid 1916	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd.	Total cost, inc. (1) (2) (3) (4)	Kind of asphalt	Estimated constr. for 1917
Kentucky—											
Louisville	20,092	6	1:3:6	...	....	2	....	1.68	......	Tr'n.-Mex.	5,000
Mount Sterling	10,000	...	.....	...	....	....	....	......	......	....	......
Owensboro	.....	...	.....	...	....	....	....	......	......	....	75,000[9]
Louisiana—											
New Orleans	14,602	...	.....	...	....	....	....	2.09	......	....	......
Shreveport	21,120	5	.....	..	....	2	....	......	1.60	Texaco	63,360
Maine—											
Waterville	3,620	...	.....	...	....	....	....	0.90	......	....	......
Massachusetts—											
Boston	5,120	...	.....	...	....	....	....	......	......	Hassam	......
Chicopee	10,000	...	.....	...	....	....	....	......	......	....	......
Leominster	39,000	...	.....	...	....	....	....	......	......	....	......
Manchester	38,000	...	.....	...	....	....	....	......	......	....	......
New Bedford	20,896	5½	1:3:6	...	....	2	7% a.c.	......	......	Aztec	......
Revere	1,194	2	.....	...	....	....	....	1.41	......	Tarbinder	0
Michigan—											
Battle Creek	63,913	5	.....	...	....	2	....	......	81,561	Trinidad	......
Bay City	19,133	5	.....	...	....	2	T	1.58	39,531	Bermudez	16,000
Coldwater	5,010	4½	1:6 or 7	...	....	1½	....	1.21	6,254	Barrett C	0
Detroit	535,428	6	1:3:6	...	....	....	....	1.845	2.74	....	......
Grand Haven	......	...	.....	...	....	....	....	......	......	....	10,000
Grand Rapids	14,110	5	1:3½:7	...	....	2	7½[36]	1.65	28,670	Azt. & Mont.	......
Grosse Pointe	49,600	...	.....	...	....	....	....	......	......	....	......
Hillsdale	14,950	6	.....	...	....	2	....	1.75	40,000	Trinidad	12,000
Holland	9,500	...	.....	...	....	....	....	1.20	......	....	......
Jackson	5,577	...	.....	...	....	....	....	......	......	....	......
Kalamazoo	20,506	...	.....	...	....	2	....	1.685	......	....	25,000
Ludington	700	6	1:6	...	....	2	T	1.05	1,054	Stanolind	40,000
Muskegon	7,810	6	1:6G	...	....	2½	8[37]	1.45	16,087	Warner	30,606
Petoskey	13,160	...	.....	...	....	7	....	1.465	......	....	......
Pontiac	24,809	...	.....	...	....	....	....	......	......	....	......
Spring Lake	15,000	...	.....	...	....	....	....	......	......	....	......
Ypsilanti	9,275	5	1:3:6	...	....	2	....	1.50	1.625	....	......
Minnesota—											
Duluth	2,667	...	.....	...	....	....	....	......	......	....	......
Minneapolis	63,023	old pave.		...	....	2	....	1.00	......	Tex. & Pierce	50,000
St. Paul	91,690	5	1:2½:5	...	....	2	....	1.60	151,096	Oil	60,000
Mississippi—											
Greenwood	8,930	4	1:3:5	...	....	2	8½:9½	1.48[33]	19,232	Trinidad	40,000
Missouri—											
Independence	12,511	5	1:3:5	...	....	....[39]	18:82	......	1.35(1)	Texaco	50,000[9]
Kansas City	44,617	...	.....	...	....	....	....	......	......	....	......
St. Joseph	4,255	old macad.		1½	....	1½	....	1.50	6,895	Min. Rub.	......
St. Joseph	55,289	3	.....	...	....	2	....	1.52	104,698	Asphalt	......
Springfield	7,073	4	1:3:7	...	....	2	T	1.22	1.41	Texaco	12,000
Montana—											
Anaconda	75,511	3	.....[40]	...	....	2	....	1.65	161,145	California	50,000
Nebraska—											
Beatrice	36,100	5	1:3:6	...	....	2	....	1.57	......	Texaco	40,000
Lincoln	33,300	5	1:3:6	0	....	2	....	1.62	......	Trin.-Cal.	......
Norfolk	63,000	6	1:5G	...	....	2	T	1.51	1.59	Texaco	50,000
Omaha	107,279	5	1:3:6	...	....[121]	....	....	1.60	181,817	Mex.-Berm.	100,000
New Hampshire—											
Nashua	3,000	...	.....	...	....	....	....	0.75	......	....	......
New Jersey—											
Bayonne	5,300	5	1:3:6	1½	....	1⅛	....	1.15	......	Berm. & Oil	......
Boonton	25,000	...	.....	...	....	2	....	1.00	......	....	......
Elizabeth	6,756	4	1:3:6	1	....	2	....	1.65	1.85	Mexican	......
Guttenberg	4,100	6	.....	...	....	2¼	....	......	1.41	....	1,000
Hackensack	7,900	...	.....	...	....	2	....	0.80	......	....	......
Jersey City	56,987	...[41]	.....	1	....	2	....	......	54,103	....	50,000
Montclair	56,800	5	1:3:6	1½	5%[12]	1½	8½ [12]	1.80-2.17	154,501	S. O. & Mex.	170,000
Ridgewood	......	...	.....	...	....	....	....	......	......	....	6,000
Trenton	23,334	5	1:3:6	...	....	2	....	1.72-1.78	......	Bermudez	20,000
Union	30,000	5	.....	...	....	2	....	1.30	45,000	Montezuma	15,000
West Hoboken	9,610	...	.....	...	....	2½	....	1.15	......	....	......
West New York	10,317	...	.....	...	....	2½	....	1.50	......	....	......
New York—											
Albany	13,393	6	.....	Paint	....	2	....	1.71	......	Std. Oil	5,000
Batavia	1,800	5	1:2½:5	2	T	Seal Coat		1.75	4,200	War.-Quinn.	5,000
Buffalo	122,410	repaving		...	....	....	....	......	......	....	......
Johnstown	......	...	.....	...	....	....	....	......	......	....	20,000
New York—											
Bronx	44,096	...	.....	...	....	2	....	1.75	......	....	......
Brooklyn	17,252	...	.....	...	....	....	....	1.10	......	....	......
Queens	93,900	...	.....	...	....	2	....	1.00	......	....	......
Richmond	13,893	...	.....	...	....	2	....	1.12-1.48	......	....	......
Niagara Falls	4,560	6	1:3:6	...	....	2	7-11%[12]	2.40	24,105	Trinidad	......
Port Washington	20,500	...	.....	...	....	....	....	......	......	....	......
Salamanca	13,542	7	1:2½:5	...	....	....	....	1.56	1.92	....	......
Syracuse	1,460	6	1:3:6	2	....	....	....	1.68	3,385	Montezuma	182,000[9]
Whitehall	15,625	...	.....	...	....	....	....	......	......	....	......
North Carolina—											
Asheville	9,275	...	.....	..	....	....	T	0.90	9,074	....	......
Greensboro	17,100	4	1:3:6	...	....	2	....	1.50	......	Oil Asph.	......
Raleigh	70,000	4	1:3:6	...	....	2	T	0.63	......	Montezuma	100,000[9]
Shelby	26,232	...	.....	...	....	....	....	......	......	....	......
Ohio—											
Bowling Green	......	...	.....	...	....	....	....	......	......	....	6,570
Chillicothe	10,196	...	.....	...	....	....	....	......	......	....	......

City	Sq. yds. laid 1916	Concrete Thick	Concrete Propor.	Binder Thick	Binder Propor.	Surface Thick	Surface Propor.	Cost per sq. yd.	Total cost, inc. (1) (2) (3) (4)	Kind of asphalt	Estimated constr. for 1917
Cleveland	8,900					2		2.00			
Cleveland Heights	84,915										
East View	28,[illegible]										
Euclid	27,365										
Galion	10,070	5	1:[illegible]:5			2½		1.58	22,[illegible]87	Texaco	13,000
Kenton	5,810										
Lima	9,852					2		1.72			
Massillon	9,818	5	1 9:6			2	4-	1.14		Tarvia X	
Newark	13,213							1.58			
Piqua	15,889	4-5				2	T	1.42[6]	31,268	Trinidad	
Springfield	19,600					2		1.70			
Toledo	12,171	6	1:3½:6			2		1.85	3.17		
Van Wert	13,771										
Wapakoneta	9,210										
W. Jefferson	3,770										15,500
Oklahoma—											
New Wilson											
Oregon—											
Albany	6,843			3	bit	2		1.05	9,800	California	
McMinnville	19,360							1.14			
Portland	18,313	5	1:3:6	1		1½		1.30	33,714	California	6,000
Portland	6,204	3	[34]			2		1.17	11,579	California	
Salem	1,153	6	1:2:4						1.179	California	40,000
Salem	9,213	3½	[44]			1½			0.971	California	
Salem	6,000	[41]				2			0.90	California	
Pennsylvania—											
Harrisburg	10,361					2		1.34			4,000[9]
Hazleton	5,269										
Mt. Penn	7,600										
Northampton	4,372	5	1:3:5			2½		0.86		Amiesite	7,500
Philadelphia	94,318	4-6	1:3:6	1-0		1¼-2		1.36	143,035		2,012
West Reading	8,000					2		1.87			
Rhode Island—											
Pawtucket	21,269										
South Carolina—											
Greenville	62,000	4	1:[illegible]:6			2		1.30	1.54(1)		65,000[9]
Greenwood	40,000	4	1:3:6			2		1.31	78,000	Bermudez	6,000[9]
South Dakota—											
Huron	23,883					2		1.89			
Mitchell	26,512	5	1:5½			2		1.795	60,850	Trinidad	25,000
Sioux Falls	81,213	5 & 6	1:2½:5			2		1.59	1.69(1)	Tex. & Cal.	50,000[9]
Tennessee—											
Chattanooga	32,126	5	1:3.6			2		1.46	2.32	Distil.	
Dyersburg	12,000										
Knoxville	10,178										
Lenoir City	17,654										
Murfreesboro	12,600										
Newport	9,908										
Texas—											
Amarillo	23,716									Texaco	
Amarillo	38,560								65,303	Trinidad	10,000[9]
Bryan	320,661									Texaco	
Cleburne		5				2		1.55	108,500	Trinidad	70,000
Corsicana	58,648	4-5	1-6			2-2½		1.25-1.70	93,858	Texaco	16,000
Dallas	3,177									Texaco	123,500
Denison	11,606					2		1.71		Texaco	
Hillsboro	13,000									Texaco	
Houston	126,917	6	1:3:6			2		1.80	255,000	Texaco	25,000
McKinney	50,325									Texaco	
San Antonio	48,120	5	1:3:6			2		1.80	2.00	Mex.-Trin.	60,000
Sherman	12,250									Texaco	
Taylor	130,000	5	1:2:4			2	T	1.40	300,000	Texaco	60,000
Temple	12,099									Texaco	
Waxahachie	20,000	5	1:8			2	7-11[12]	1.36	28,500	Bermudez	200,000
Wichita Falls	7,500									Texaco	
Utah—											
Ogden	7,900										
Salt Lake City	12,200	4	1:3:6			2		1.75	22,950	California	13,000
Virginia—											
Suffolk	6,000	4 & 5	1:3:6					1.60-1.73		Texaco	5,000
Washington—											
Aberdeen	1,458	6	1:3:6			2		1.60	3,212		
Bellingham	1,576	6	1:3:5			2	1:1½	1.20-1.30			
N. Yakima	39,593	4	1:4:6			2	9:13%	1.17	61,262	California	17,528
Seattle	2,294	5-6	1:3:6			2		1.40			2,000
Walla Walla	61,167	2½				1½		0.95-1.05	99,133		
West Virginia—											
Charleston	96,690	5	1:2½:5			2	8-10[11]	1.74-1.82	2.14-2.38	Azt.-Trin.	
Elkins	834	6-9	1:2:3			[122]		1.87	2,216	Mo.	1,000
Wisconsin—											
Beloit	9,439	5	1:3:6			2		1.18-1.22	8,250	Trin.-Azt.	
Burlington	8,310							1.58			
Columbus	12,000							1.36			
De Pere	23,600					2½		0.41			
Fond du Lac	22,475	5	1:3:5			2	7%[11]	1.53		Mex.-Stand.	30,000[9]
Kenosha	11,700										
Madison	9,000							1.45			
Milwaukee	94,097					2		1.25			
Oshkosh	3,933	5				2		1.63	7,638	Aztec	
Portage											
Racine	5,577	5	1:3:5			2½		1.78(1)	11,495	Trinidad	3,000
Richland Center	36,313										4,400
Waukesha	11,013	6	[27]			2½	2 gal.[1]	0.92	16,448	Stanolind C	

(For footnote references see page 65 of February number.)

FIRE DEPARTMENT



Double Duty for South Bend

The city of South Bend, Ind., has in operation its new South Bend Double Duty aerial and pumper. The aerial truck is drawn by a four-wheel tractor and carries a 75-foot extension ladder, which folds to 37 feet. A three-inch line of hose extends the full length, has a nozzle at the top and can be operated from the ground. The ladder has a nozzle at the top and can be operated from the ground. The ladder is hoisted by two spiral springs and can be rapidly put in place. The weight of the hoisting device is carried on the rear of the tractor and with the additional rear wheels of the truck, making three seats, enabling the driver to attain a speed of 35 miles an hour and turn corners with ease.

The Double Duty pumper is driven by a 140-horse-power six-cylinder motor and is capable of throwing 1,000 gallons of water per minute, and 750 gallons in the same length of time when pumping from the river or wells. A stream can be thrown over the tallest building in South Bend. Two 9-ft. length hard suction hose are carried for river work as well as 20-ft. of soft suction hose for hydrant use. Both pieces of apparatus are equipped with two independent ignition systems of feeding from 35-gallon gasoline tanks that are carried.

Both pieces are furnished by the South Bend Motor Car Works.

The Knox Fire Tractor

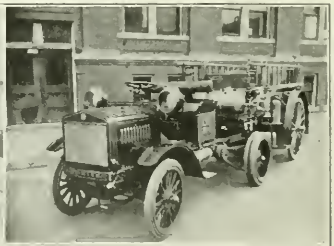
The tractor as illustrated is equipped with two sets of brakes, one set being operated by hydraulic power and consequently insuring a very positive degree of braking control.

This type of tractor is readily and easily detachable, as the fifth wheel, or platform, is so constructed as to fit the platform of almost any type of steamer, truck or other form of regulation fire apparatus. The coupling is made by way of an ordinary king bolt.

"The fire tractor," states a well-known chief, "enables a department to retain its old apparatus. It makes the original investment produce by enabling us to get horse-drawn apparatus to the fire in record time.

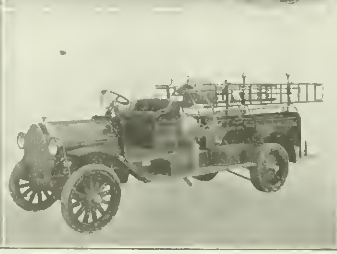
GRAMM-BERNSTEIN COMBINATION CHEMICAL AS OPERATED BY THE CITY OF FARRELL, PA.

WICHITA TRACTOR WITH AERIAL LADDER TRAILER AS OPERATED BY THE CITY OF ENID, OKLA.

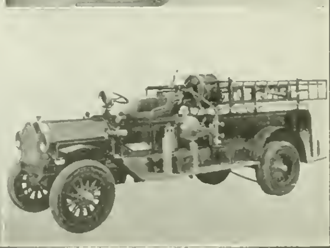


WICHITA TRACTOR WITH COMBINATION CHEMICAL AND HOSE OPERATED BY ANADARKO, TEX.

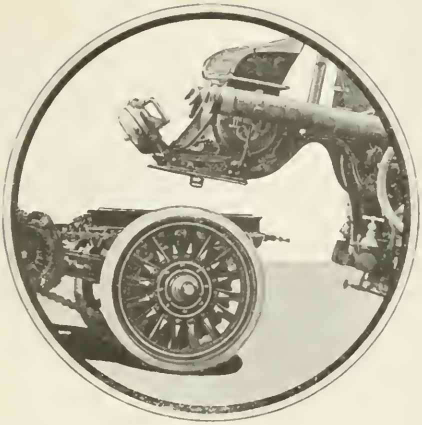
KNOX FIRE TRACTOR AS NOW USED BY MANY MUNICIPALITIES IN MOTORIZING THEIR HORSE-DRAWN EQUIPMENT.



HALE - VELIE COMBINATION CHEMICAL AS OPERATED BY KANSAS CITY, MO.



HALE - VELIE COMBINATION CHEMICAL, WITH SEWELL CUSHION WHEELS, OPERATED BY PITTSBURGH, PA.



"The tractor eliminates the constant expense of horse upkeep and a tractor will turn even shorter than a team, which means unusual ease of operation at the fire or when plowing thru congested traffic. A tractor is also easily detachable and can be transferred whenever repairs are necessary or any other apparatus to be pulled."

Presents City with Fire Truck

A Reo fire truck was recently installed in the fire department of Sayville, L. I., N. Y., with the compliments of Commodore Bourne, president of the Singer Sewing Machine Company.

By changing the gear ratio a speed of from 30 to 35 miles per hour was developed. The only other change in the standard chassis was to oversize the rear tires and add an electric starting and lighting system.

The seat for the driver and his assistant is heavily upholstered in black leather. Running boards on both sides and at the rear are standard fire department type, with polished brass hand rails extending full length on both sides of the body. The car has two 35-gallon copper tanks for holding the chemicals, and a reel carrying 200 feet of four-ply chemical hose, receptacles for carrying extra acid jars and containers for soda with which to recharge the tanks.

A 24-foot extension ladder and a 12-foot ladder equipped with folding hooks are mounted on either side of the body of the truck, which also carries fire axes, crowbars and two three-gallon regulation fire department type hand extinguishers. The truck has a ten-inch locomotive bell, a hand siren, nozzle holders for carrying two play pipes, a pike pole, lanterns, basket for carrying rubber coats, fire lanterns, etc. In the body of the truck is space for carrying 1,200 feet of 2½-inch regulation fire hose.

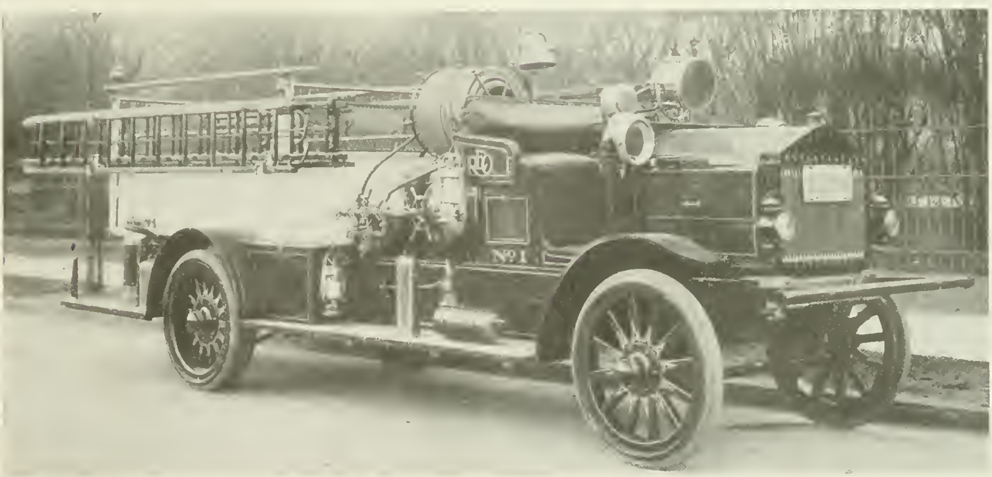
The Northern Trailerpump

We are illustrating an entirely novel type of fire apparatus as embodied in the Northern "Trailerpump," which consists of a gasoline motor of standard make geared direct to a Rotary Fire Pump, mounted on a light-weight four-wheeled trailer chassis.

NORTHERN RAILER PUMP

This apparatus is a single duty fire pump. It is to be coupled to the rear of any other fire apparatus and trailed to the desired fire hydrant, where it is uncoupled and left in charge of the engineer who rides on the rear step.

The illustration show the first machine made of this type. This machine, which is equipped with a 30-horse-power, S. A. E. rating, four-cylinder motor, pumps 410 gallons per minute against 135 pounds pressure, drafting water twelve feet.



REO 2-TON COMBINATION AS OPERATED BY SAYVILLE, N. Y.

Motor Apparatus in Fire Departments

(*Continued from March number, page 161.*)

In the second column of this table, in describing combinations, *ae* stands for aerial ladder equipment; *ch*, chemical; *chf*, chief's car; *ho*, hose; *h.p.*, high pressure; *L*, electric; *l*, ladders carried on combination trucks; *ladd*, city service hook and ladder equipment; *mot*, motorcycle; *pp*, gasoline pumping engine truck; *sal*, salvage corps truck; *sq*, squad wagon; *st*, steam pumping engine; *sup*, supply wagon; *tow*, water tower; *tr*, tractor; *tr. ae*, aerial ladder truck hauled by tractor; *tr. la*, hook and ladder truck hauled by tractor; *tr. st*, steamer hauled by tractor; *tur*, turret. o in column of "Years service" means that apparatus is new or not yet in service. *p*, pyrene cylinders.

1—Cost of gasoline and repairs. 2—Cost of gasoline, oil and tires. 3—56 gallons gasoline, 3 gallons oil. 4—180 gallons gasoline, 10 gallons oil. 5—40 gallons gasoline, 2 gallons oil. 6—105 gallons gasoline, 4 gallons oil. 7—Difference in cost of repairs in the two machines due to pneumatic tires on one and Dayton airless on the other. Both cars now equipped with Dayton airless. 8—Cost of repairs and gasoline and oil. 9—Materials only; repair work done by drivers or mechanicians in fire department. 10—Cost of repairs for all 28 machines in the department. 11—Cost per horse employed in the department. 12—6 gallons. 13—Sum for four American-La France pumping and combination. 14—These cost figures include all three pieces of apparatus and the cost of gasoline and oil includes also some police apparatus. 15—10 miles of streets in good condition, 6 fair, 15 bad. 16—gallons of gasoline. 17—642 gallons gasoline. 30 gallons oil. 18—121 gallons gasoline, 20 quarts oil. 19—214 gallons gasoline, 75 quarts oil; 20—25 per cent good, 40 per cent. fair, 35 per cent. bad. 21—40 per cent. good, 40 per cent. fair, 20 per cent. bad. 22—Two-thirds good, one-third fair.

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
North Carolina—													
Asheville	chf	Hudson	1	..	...	....	...	...	....	....	....	....	....
	ch ho l	Seagrave (2)	4½	..	80	1,500e	45e	32e	300e	110	....	....	....
	ladd	Seagrave	2	..	80	....	45	200	300	110	670.37a	500.08[14]	....
Charlotte	pp ho	Am.-La France	3	4	75	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Concord	pp ho	Am.-La France	½	4	75	1,200	6	32	....	....	....	....	....
Durham	chf	Overland	1½	4	35	....	...	...	6,800	79	123.99	171.02	200.00
	pp ho ch	Am.-La France	1	6	73	1,000	46	36	455	79	2.58	67.25	272.20
	ladd	Am.-La France	1	6	35	200	46	237	507	79	3.40	33.79	250.00
	ch ho	Webb	4½	4	70	1,000	46	36	350	27	20.80	64.23	265.80
Elizabeth City	ch ho l	Am.-La France	2	4	75	1,200	46	30	150	54	2.50	24.00	....
Gastonia	pp ho	Am.-La France	2	4	75	1,200	6	32	....	....	....	....	....
Goldsboro	ch ho	Am.-La France	3	4	70	1,200	70	32	....	....	....	....	....
Greensboro	chf	Pullman	1	4	32	....	...	...	....	....	....	....	....
	pp ho ch	Am.-La Fr. (2)	2	6	105	1,200e	50e	30e	300e	125	30.00e	140.00a	....
	mot	(1)	..	..	...	....	...	...	....	....	....	....	....
Greenville	ch ho	Am.-La France	1	6	100	1,400	40	32	....	....	....	....	....
Hamlet	ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Henderson	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Hickory	pp ho	Am.-La France	3	4	75	1,200	6	32	....	....	....	....	....
High Point	chf	Studebaker	1	4	40	....	...	...	....	29	3.00	....	....
Lumberton	ch ho	Am.-La France	2	4	75	1,200	6	32	....	....	....	....	....
New Bern	pp ch ho	Am.-La Fr. (2)	2	6	90	1,000	150	30	....	114	0	60.00	....
Oxford	ch ho	Am.-La France	1	4	70	1,200	70	32	....	....	....	....	....
Raleigh	chf	Chalmers	2	6	57	....	...	...	....	....	....	....	....
	ch ho	Am.-La Fr. (2)	3	4	50	1,200	40	36	250	127	0	....	....
	ppho	Am.-La France	1	6	73	1,200	...	...	257	146	....	....	....
	ae	Am.-La France	½	6	73	....	6	177	....	50	....	214.00a	....
Rocky Mount	ch ho	Am.-La France	3	4	70	1,200	70	32	....	....	....	....	....
	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Salisbury	ch ho	Am.-La France	4	4	70	2,000	6	32	....	....	....	....	....
Tarboro	ch ho	Am.-La France	4	4	70	2,000	6	32	....	....	....	....	....
Washington	ch ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Wilmington	ch ho	Am.-La Fr. (2)	4	4	70	2,000	6	32	....	....	....	....	....
Wilson	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Winston-Salem	pp ho	Am.-La Fr. (2)	4	6	100	1,200	6	32	....	....	....	....	....
Fargo		Am.-La France	½	6	100	1,400	40	32	....	....	....	....	....
Jamestown	pp ch ho	Has no motor apparatus.											
Ohio—													
Akron	ae	Couple G. (2)	3	..	...	85	...	...	....	....	....	....	....
Alliance	chf	Chalmers	7	4	40	....	6	...	3,933	74	106.75	52.18	216.00
	ch ho l	Sampson	4	4	35	1,000	41	113	86	67	52.50	21.45	420.00
	pp ho ch	Robinson	2	6	110	1,200	46	45	158	76	....	40.88	840.00
Ansonia	ch ho	Waterous	..	..	...	....	...	...	....	....	....	....	....
Ashland		First motor fire apparatus received in November.											
Barberton	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Bellaire	ch ho l	Peerless	..	6	60	1,200	35	37	86	50	75.00	50.00[16]	....
	ch ho l	Seagrave	2-3	6	80	1,500	40	41	54	47	0	40.00[16]	....
	pp ch ho	Seagrave	2-3	6	110	1,500	40	41	111	71	....	125.00[17]	....
Bellefontaine	pp ho ch	Ahrens-Fox	2	6	79	1,400	45	46	36	58	2.50	16.75	280.00
Canton	pp ch ho	Robinson(3)	4½	6	110	1,200e	...	...	....	....	....	....	....
	chf	Chalmers	4	6	60	100	6	10	....	....	0	....	....
	ch ho	Am.-La France	4	6	100	1,200	70	32	....	....	....	....	....
	sq	Robinson	4½	6	80	1,000	40	26	....	....	....	....	....
	ch ho	Robinson (3)	4½	1	60	1,200e	40e	36e	....	....	....	....	....
	ch ho	Seagrave (2)	4½	6	80	1,000e	40c	36e	....	....	....	....	....
	ladd	Robinson	2	6	80	....	...	...	....	....	....	....	....
	ladd	Seagrave	4½	6	110	....	...	235	....	....	....	....	....
Cleveland	tr st	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
Conneaut	pp ho ch	Am.-La France	3	6	110	1,100	46	36	200	60	0	26.29	900.00
	ae	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
	pp ch ho	Am.-La F. (6)	½	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La F. (6)	½	6	100	1,200	6	32	....	....	....	....	....
Dayton	ch ho	Am.-La F. (3)	4	4	70	1,400	40	32	....	....	....	....	....
	tr	Am.-La F. (5)	1	4	70	....	...	...	....	....	....	....	....
	ae	Am.-La F. (2)	1	4	70	....	...	235	....	....	....	....	....
	ladd	Am.-La France	1	4	70	....	...	235	....	....	....	....	....
	ch ho	Am.-La France	1	4	75	1,200	46	32	....	....	....	....	....
Delaware		Has no motor apparatus at present.											
E. Cleveland	chf	Holliday	..	6	40	....	...	...	....	....	....	....	....
	ch ho l	Am.-La France	1	6	72	750	40	205	348	105	....	....	....
	pp	Am.- La F.	1-12	6	75	750	...	35	....	....	....	....	....
	pp	Robinson	4	6	110	750	...	20	....	105	....	....	....
E. Liverpool	ae	Am.-La France	3	6	100	....	6	177	....	....	....	....	....
E. Youngstown	ho ch	Jeffery	..	4	29	1,800	100	...	....	....	....	....	....
Elyria	chf	Willys-Over.	3½	4	25	....	6	...	300	72	40.00	42.40	....
	pp	Robinson	5	6	110	1,000	12	32	104	53	135.00	76.00	707.51
	pp	Robinson	5	6	110	1,000	12	32	86	49	25.00	61.00	707.51
	tr	Peerless	2	4	40	250	46	263	103	66	6.00	39.20	....
Galion	pp ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Gallipolis		Has no motor apparatus at present.											

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Girard...	pp ho	Am.-La France	1	4	75	1,000	6	32	...	....	....	....	....
Greenville	pp ho	Am.-La France	3	6	100	1,200	6	32	...	....	....	....	....
Hamilton..	ho	Am.-La Fr. (2)	5	..	18	1,000	6	41	200	180	150.00	23.00	365.00
Lakewood.	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	3	4	70	....	...	235	...	....	....	....	....
Lancaster.	ch ho l	Seagrave	1-6	..	80	1,200	31	90	....	....	....	....	....
	pp ho ch	Seagrave	1-6	..	80	1,300	46	78	...	....	....	....	....
Lima.....	chf	Overland	3	4	35	....	6	...	1,000	260	40.00	60.00	250.00
	ch ho	Gramm-Bern.	1	4	45	1,250	46	36	485	185	0	74.40	500.00
	pp ho ch	Gramm-B. (2)	1	4	85	1,250e	46e	36e	55[illegible]a	162a	0	114.40a	1,000.00a
	tr	Gramm-B. (2)	1	4	45	....	...	...	119a	12[illegible]a	0	105.80a	1,500.00a
Lorain...	ch ho l	Nott (2)	2	6	90	1,100	45	50	...	...	......	....	....
	ch ho l	Seagrave	5	6	80	1,100	15	50	.	...	......	....	....
	ae	Boyd	2	6	110	....	12	285	...	....	......	....	....
	ae	Seagrave	5	6	80	....	12	237	....	....	......	....	....
	tr st	Nott (2)	2	4	90	....	..	..	...	...	....	....	....
Marietta..	ch ho	Jeffery	½	4	40	1,000	35	30	72	62	25.00	80.20	548.46
	pp ho ch	Robinson	4	6	110	1,200	35	20	105	....	......	....	....
	tr	Robinson	2	4	70	....	...	...	...	....	....	....	....
Marion.......	pp ho	Robinson	..	6	93	1,200	12	20	131	53	202.50	28.52	....
	pp ho	Robinson	..	6	93	1,200	12	32	222	18	0	33.45	....
	pp ho ch	Seagrave	..	6	80	1,200	32	32	111	27	0	23.30	....
Newark	ch ho la	Indiana	1	4	50	1,200	41	46	133	....	95.10	34.06	240.00
	ch ho la	Seagrave	..	6	90	1,200	41	55	...	....	....	....	....
	ladd	Seagrave	1	4	50	....	46	225	255	130	110.42	45.25	300.00
Niles..............	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Norwalk......	pp ho	Am.-La France	5	6	100	1,200	6	32	....	....	....	....	....
Norwood. .	pp ho	Am.-La France	3	6	72	1,000	50	36	300	75	....	....	....
	ch ho	Seagrave (2)	3½	6	89	1,000	50	36	250	75	....	....	....
	tr	Seagrave	3½	6	89	....	...	325	200	....	....	....	....
Ottawa.......	ch ho	Am.-La France	4	4	75	1,200	40	32	....	....	....	....	....
Painesville...	chh o l	Ford	1	..	20	200	40	30	1,125	38	25.00	10.00	....
Portsmouth...	chf	Paige	..	6	49	....	...	...	....	....	....	....	....
	ae	Seagrave	0	6	100	....	...	..	....	....	....	....	....
	pp ch	Seagrave	0	6	110	1,200	...	...	....	.. .	....	....	....
	pp	Webb	0	6	90	1,000	...	...	.	....	....	....	....
	pp ho	Seagrave	0	6	140	1,500	...	...	..	....	....	....	....
Richmond..........	pp ho	Am.-La France	4	4	75	1,200	6	32	....	....	....	....	....
Salem..............	pp ch ho	Robinson	0	.	...	....	...	...	....	....	....	....	....
	ch ho	Robinson	0	..	...	....	...	.	....	....	....	....	....
Shelby.............	ch ho	Am.-La France	5	..	...	...	...	.	....	....	....	....	....
Sidney.............	pp ho	Am.-La France	3	6	100	1,200	6	32	. ..	...	....	....	....
Springfield.........	ch ho	Am.-La Fr. (2)	1	..	...	....	...	...	..	...	....	....	....
Steubenville........	pp ho	Am.-La France	4	6	100	1,200	6	32	. ..	....	....	....	....
	ch ho	Am.-La France	2	4	75	1,200	40	32	....	....	....	....	....
Tiffin...............	chf	Overland	2	4	26	....	...	..	6,000	66	36.40	164.79	....
	pp ho	Am.-La France	2	6	73	1,300	41	30	200	....	....	....	....
	ladd	Am.-La France	2	4	48	....	6	235	550	....	....	....	....
Toledo............	ae	Am.-La France	2	6	100	....	6	177	....	...	....	....	....
	mot app	(50)	..	..	...	....	...	...	...	...	....	....	....
Wellston...........	ho ch	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Wooster............	chf	Buick	½	6	...	200	36	..	350	21	0	13.91	....
	ch ho l	Seagrave	..	6	80	1,500	46	155	150	18	0	21.38	210.10
Youngstown......	chf	Firestone-Col.	4½	4	40	....	...	...	2,500	...	....	....	....
	sq	Seagrave	3	6	79	800	100	34	1,199	181	....	....	....
	ho	Mora	3½	2	20	600	...	...	50	70	....	....	....
	ch ho	4	1	1	...	800	40	34	404	190	....	....	....
Zanesville..........	pp ho	Am.-La France	1	6	100	1,200	6	32	...	....	....	....	....
	ae	Am.-La France	1	4	70	....	...	235	....	....	....	....	....
	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
	ch ho	Am.-La Fr. (2)	1	..	...	....	...	...	..	..	....	....	....
Oklahoma—													
Bartlesville........	ch ho	Am.-La France	5	..	..	....	...	.	...	....	....	....	....
Checotah...........	pp ch ho	Am.-La France	½	..	...	....	...	..	...	....	....	....	....
Chickasha..........	pp ho	Am.-La France	½	6	100	1,200	6	32	....	....	....	....	....
Claremore..........	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
Duncan............	ch ho	Am.-La France	1	..	...	....	...	...	...	....	....	....	....
El Reno............	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Guthrie............	chf	Ford	2	4	22	....	3	...	8,000	160	2.60	47.00	....
	ch	Studebaker	2	4	35	1,000	12	30	826	110	....	17.50	....
	ch ho	Studebaker	½	4	40	1,000	12	34	340	60	....	7.00	....
	ch ho l	Robinson	6	4	80	1,200	52	20	1,100	160	9.00	42.00	....
Holdenville.........	ch ho	Am.-La France	1	6	55	1,100	40	32	....	....	....	....	....
Hugo...............	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Marlow.............	ch ho	Am.-La France	½	6	55	-,400	40	32	....	....	....	....	....
McAlester..........	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Muskogee..........	pp ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
	tr	Am.-La France	1	4	70	....	...	...	....	....	....	....	....
Norman............	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Oklahoma City.....	chf	Buick	5	4	45	....	6	...	....	....	....	....	....
	chf	National	4	4	26	....	3	...	....	....	....	....	....
	ch ho l	Am.-La France	5	4	45	1,000	76	24	....	....	....	....	....
	pp ho	Am.-La France	2	6	103	1,200	41	24	....	....	....	....	....
	ch ho l	Knox	2	4	40	1,200	46	24	....	....	....	....	....
	ch ho l	Reo	1-3	4	26	1,200	41	24	....	....	....	....	....
	ch ho l	Northern	2	4	35	1,000	41	24	....	....	....	....	....
	ladd	Am.-La Fr. (2)	4	4	40	....	...	...	....	....	....	....	....
	ladd	Seagrave	4	4	40	....	713a	...	...	....	....	....	....
	pp tr	Am.-La Fr. (2)	5	4	40	....	...	...	....	....	....	....	....
	tr	Knox (3)	2	4	40	....	...	...	....	....	....	....	....
	tr	Indiana	1-12	4	35	....	...	...	....	....	....	....	....
	tr	Thomas	5	4	40	....	...	...	2,221a	678	2,000.00a	517.00a	3,960.00a
Okmulgee..........	pp ch ho	Am.-La France	½	4	70	1,400	40	32	....	....	....	....	....
Ponca City... ...	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
Sapulpa............	ch ho	Am.-La France	1½	4	75	1,200	76	30	69	57	4.50	14.20	....
	chf	Ford	½	..	...	....	...	...	....	11	....	15.25	....
	pp ho	Webb Thomas	6¾	4	70	1,000	12	26	7	18	3.89	12.40	....
Shawnee...........	chf	Velie	2	4	40	....	...	...	....	....	....	....	....
	ho	Thomas (2)	0	6	60	1,200	9	24	....	....	....	....	....
	pp ho	Thomas	0	6	90	1,500	9	...	....	....	....	....	....
Tulsa..............	ch ho	Hale	..	..	...	....	...	...	....	....	....	....	....
Woodward.........	ch ho	Am.-La France	1	6	100	1,400	40	32	....	....	....	....	....

(To be continued in the May number.)

MISCELLANEOUS

Meetings of Organizations

April 10-14, at Horticultural Bldg., Ottawa, Ont. Dominion Good Roads Association. Geo. A. McNamee, sec'y, 909 New Birks Bldg., Montreal, Que.

April 16-17, at Palace Hotel, San Francisco, Cal. Spring convention of Portland Cement Association. Special train leaves Chicago, Northwestern station, at 8 p. m., April 13.

Apirl 17-20, at Birmingham, Ala. U. S. Good Roads Association. J. A. Rountree, sec'y, 1021 Brown-Marx Bldg., Birmingham, Ala.

May 7-9, at Kansas City, Mo. National Conference on City Planning. Flavel Shurtleff, sec'y, 19 Congress St., Boston, Mass.

May 7-11, at Richmond, Va. American Water Works Association. J. M. Diven, sec'y, 47 State St., Troy, N. Y.

June 11, at Buffalo, N. Y. New York State Conference of Mayors and Other City Officials. W. P. Capes, sec'y.

Civil Service Examinations

At any time papers are sent in: Architectural draftsman in Bureau of Yards and Docks, Navy Department, at $3.04 to $6 a day; electrical draftsman in Navy Department, at $3.52 to $6 a day; structural steel draftsman in Bureau of Yards and Docks, Navy Department, at $3.04 to $8 a day; architectural draftsman in same bureau, at $3.04 to $6 a day.

April 10: Mechanical draftsman, Ordnance Bureau, Navy Department, at $3.52 and $4.24 a day.

April 11: Engineer, Indian Service, at $600, $720 and $840 a year.

April 11, 12: Laboratory assistant in Bureau of Standards, Department of Commerce, at $900 to $1,200 a year; architectural draftsman in office of supervising architect, Treasury Department, at $1,200 to $2,000 a year.

April 18: Assistant inspector of engineering material, at $4 to $4.48 a day; skilled laborer qualified as elevator machinist in Department of Agriculture, at $900 a year.

April 18, 19: Architectural and structural steel draftsman in offices of inspectors of lighthouse districts in Milwaukee and Buffalo, at $1,500 a year.

Technical Society Notes

The Society of Terminal Engineers has been chartered in New York to promote the study of railroad terminals and mechanical freight handling. It will hold regular monthly meetings. J. Leonard, secretary, 1133 Broadway, New York City.

The American Association of Engineers of Chicago has established its first engineering university chapter at the University of Illinois, Urbana. Victor A. Pecchia, secretary.

The Granite Paving Block Manufacturers' Association of the U. S. held its annual meeting at the Belmont Hotel, Boston, Mass., February 29, and elected eleven directors from New England, New York, Georgia and North Carolina. Zenas W. Carter is field secretary.

On March 8-10, at El Paso, Tex., the Southwestern Society of Engineers was organized, with over 100 charter members from all branches of engineering and architecture in active practice for at least six years. A number of excellent papers were read. The officers elected included Dean A. F. Barnes, of the New Mexico College of Agriculture and Mechanic Arts, president, and Forest E. Baker, El Paso, Tex., secretary.

Miles City Light, Heat and Water Plants

Superintendent J. J. McGill, of Miles City, Mont., electric light, steam heating and water supply plants, shows very excellent results for the last calendar year.

The electric light and power plant, after allowing interest and depreciation gained $21,907.77, or about 25 per cent. of the net revenue. The city is now well covered with distribution lines, 3½ miles having been added last year, also new 300-h.p. boiler, 375-h.p. engine, 150 Kw. generator, and new switchboard panel. Boilers are not up to engines in total capacity, viz., 1,050 h.p., as compared with 1,175 h.p. of engines.

The steam heating plant increased from 3 customers to 24 during the year and the revenue was $3,700. The water plant pumped 690,177 gallons a day, ranging from 331,800 minimum to 1,305,600 maximum, and the monthly pumpage varied from 12,268,400 gal. in January to 29,727,600 gal. in August. Sulphate of alumina, as used as coagulant in pumping the water, 2.94 grains per gallon.

Increases during the year were 21 per cent. in electric output with a decrease of 1 per cent. in fuel used, making 22 per cent increase in efficiency of fuel; 6½ per cent. in operating wages. The decrease in coal used was in the face of an increase of nearly 3,000,000 cu. ft. in the amount of space heated by the connected heating plant.

Personal Notes

B. W. Macy is city engineer of Salem, Ore.

E. O. Hathaway is the engineer of the Federal Department of Public Roads and Rural Engineering at Minneapolis, Minn., in charge of the fourth district, composed of Minnesota, Wisconsin, North Dakota and South Dakota, under whom some $425,000 of the national appropriation will be spent the first year, which is less than half the total cost of the roads so constructed.

Clifford Goplerud, Osage, Ia., is the new county engineer of Mitchell county.

Guy H. Miller will have supervision of the roads constructed under federal aid in the district comprising New England, New York, New Jersey and Delaware, with offices in the postoffice building at Troy, N. Y.

Charles Lawrence has been appointed city engineer at Warren, O.

Newell D. Darlington has been selected as chairman of the California State Highway Commission in place of Charles D. Blaney, resigned.

J. J. Pastoriza, who is responsible for the unique system of taxation in use in Houston, Tex., has been nominated for mayor, which is equivalent to an election.

G. C. Brehm has been appointed city engineer of Marlboro, Mass., having been taken from a similar position at Waynesboro, Pa.

George H. Frost, founder of *Engineering News* and of technical journalism in the civil engineering field, died on March 15, at the age of 79.

E. Kemper Carter has resigned his positions of city engineer and superintendent of water works of Liberty, Mo., which he has held for the past four years, to represent the Standard Asphalt and Rubber Co. of Chicago and Kansas in Missouri, Kansas, Iowa, Nebraska and Oklahoma. His headquarters for the present will be in Liberty where he will also act in an advisory capacity for the city for some time.

Paul P. Stewart, chief engineer of the Ketler-Elliott Erection Co., has been appointed a national director of the American Association of Engineers, Chicago, Ill., in place of A. H. Koom who has become general manager of the association.

J. R. Wemlinger, C. E., president Wemlinger Steel Piling Co., and secretary American Society of Engineering Contractors, has been appointed to the rank of first lieutenant in the Engineer Officers Reserve Corps of the United States Army.

Garbage for Fuel

On March 13 a test was made of Oakoal bricks made of about equal parts of paunch manure from the packing houses at the Union Stockyards and screened Indiana coal, with about 5 per cent. of tar. At the same date a test was made of the coal regularly used in the Willoughby building, where the test was made. The test was supervised by engineers of the Consumers' Ice and Coal Company, two of the Chicago packing houses and others, and detailed report was made by Armour & Co.'s engineers. They report, among other things, that in the $2\frac{3}{4}$ and 3-hour tests made, 587 pounds of fuel of each kind were used, Oakoal evaporating 3,409 lb. of water and coal 3,291 lb. Practically the same amount of ash was made by both fuels. Oakoal evaporated 5.82 lb. and coal 5.73 lb. per pound of fuel. Overall efficiency is stated to be 54.35 per cent. for Oakoal and 40.9 for coal. B.t.u. per pound of Oakoal amounted to 10,850, with 2,800 left in the ash, and were 13,925 per pound of coal, with 8,450 left in the ash. Equally good results are reported to have been obtained from Oakoal fuel made from the ordinary run of garbage and refuse of the usual city collection.

Building and Engineering Construction in 1917

The F. W. Dodge Company report totals of their reports each year from 1910 to 1916 inclusive of the money spent in constructing buildings and engineering structures. In each district into which the country is divided the amounts spent in 1916 are materially greater than in any preceding year by twenty to fifty million dollars, except the central west, Indiana to eastern Kansas and Michigan to Wisconsin, where the excess, in this case over 1915, is nearly $150,000,000. The total excess over 1915 in the states north of the Ohio and east of the Missouri is over $400,000,000. Some of this may be due to more thoro reports but undoubtedly the figures give the right idea, and the reasons are not far to seek.

Publications Received

The American Institute of Architects has just issued an illustrated volume showing recent striking progress in city planning. Its cost is $1, and it can be obtained of the journal of the Institute, the *Octagon*, Washington, D. C.

The paper by F. W. Ballard, constructor of the Cleveland, O., electric light and power plant, before the Cleveland Engineering Society, on the operation of the Cleveland municipal electric light plant and the 1915 audit, is a defense of the bookkeeping employed in the early history of the plant, which asserts at the end that even with the restrictions and changes of entries made by the auditor, the plant in 1916 could have paid more than 7 per cent. interest on its investment, with a maximum rate of 3 cents per kw.-hr. Mere bookkeeping, therefore, could not conceal the financial success of the plant.

The Classification Scheme of the Library for Municipal Research at Harvard University, by Joseph Wright, superintendent of the library. Paper, 26 pp., 50 cents. Harvard University, Cambridge, Mass.

Specifications for Fire Hose and report thereon by the Rochester, N. Y., Bureau of Municipal Research. James W. Routh, chief engineer.

Public Road Mileage and Revenues in the Southern States in 1914, being Bulletin No. 387 of the U. S. Department of Agriculture.

A booklet entitled "Your Streets," showing many views of concrete roads and streets, is distributed by the Portland Cement Association, Chicago, Ill. Integral curb for concrete pavement is a companion booklet.

Report of Tuberculosis Survey of Michigan, by the State Board of Health, John L. Burkhart, secretary, Lansing, Mich.

Report of Detroit, Mich., Water Commissioners, Theo. A. Leisen, general superintendent.

Report of Water Commissioners of Danvers, Mass., for 1916. Henry Newhall, superintendent.

Boston, Mass., Statistics for 1916, issued by the city statistics department.

The annual edition of the Bulletin of the Affiliated Engineering Societies of Minnesota for 1916 has just been issued. T. D. Sterling, business manager, St. Paul, Minn.

The annual volume of proceedings of the Municipal Engineers of the City of New York for 1915 has just been received. Engineering Societies building, New York.

The weekly numbers of the "Official Index to State Legislation," published by the joint committee on national legislative information service of the American Association of Law Libraries and the National Association of State Libraries, contain full information down to date of publication regarding every bill in every state legislature in session, corrected and cumulated each week. The bills are arranged numerically and are fully indexed also by subjects, so that they can be found in any way desired. An annual cumulated edition puts the data in form for preservation and ready reference. The service is very valuable to those in its line and is a very expensive service, as well as of use to a limited number of organizations. A subscription to the entire service of weekly and annual numbers and supplements is $100.

Trautwine's "Concrete" is a reprint from Trautwine's "Civil Engineer's Pocket Book" of the pages in various parts of the book treating of concrete and the principles of strength of materials and of design applicable to that material, making a compact little book, easy of reference and very fully indexed, covering the essentials of the subject, and including a directory of selected results of experiments by many experts and a digest of the most authoritative specifications for all classes of work.

Comparative Financial Statistics of cities under council and commission government for 1913 and 1915. Compiled by the U. S. Bureau of the Census.

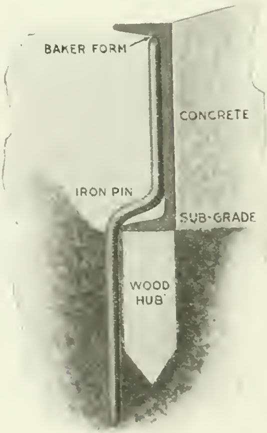
MACHINERY AND SUPPLIES

Setting Up Side Forms

The first essential in building a concrete road is the side forms. It is not economy to buy wood or light steel forms. The wooden ones usually are not fit to use the second time, and the light steel forms are easily bent in handling and do not lock securely at the joint. A depression or unevenness at the joint means a depression in the road surface.

We are illustrating a method by which iron pins can be used to prevent the concrete from spreading the forms.

The bottom of the side form does not always rest on the subgrade. Workmen will often stand on the forms and drive



their shovels down on them or drop heavy material across them. The result is, if suspended upon a sharp iron pin, they go down, and a depression occurs in the road.

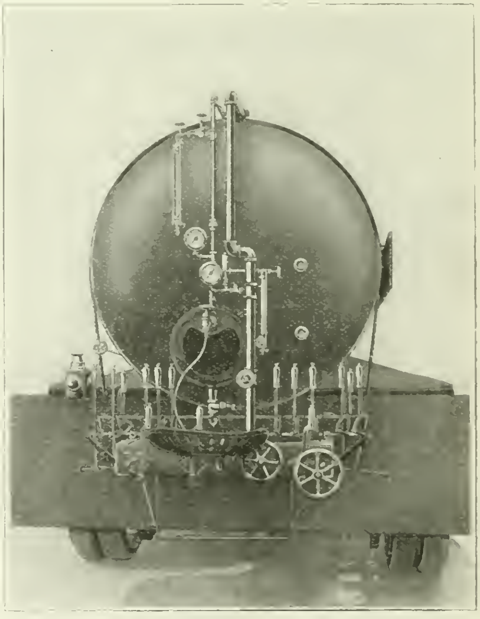
We recommend the stretching of a line to the grade at the top of the form, then driving under the line every five feet a wooden hub 2x2-in and 3-in. to 5-in. long (depending on the subgrade) till its top is 6-in. below the line. If the side forms are then set on the hubs and held in place by two iron pins to each section, there will be no settlement or knocking out of line. The hubs can be used over and over again and add little, if any, to the cost of setting forms.

High-Pressure Road Oiler

The Worley-Logan Atomizing Oiler heats and applies the oil at an exceedingly high temperature. "The oil is displaced by means of air pressure," state the manufacturers, "and is applied to the surface in a form of mist, under 100 to 125 pounds of air pressure. By so doing we acquire an even and equal distribution of oil to each and every square inch of surface, forcing it to penetrate instantly to a depth which, with ordinary machinery, would take days or weeks to accomplish, and at no time do we apply oil heavy enough to close the pores of the earth to prevent penetration, because it is applied in the form of a mist or vapor to prevent sealing the pores.

"There will be no pools or puddles of oil when applied with this outfit, as the horse tracks, ruts or lower portions of the road receive no greater amount than knolls or high portions of the road.

"The idea and system of oiling one side of the road or street, covering the surface completely and closing same to traffic, thinking and believing it will in time penetrate, is incorrect and should be dropped. If the surface is hard and penetration cannot be had and an application of oil is



END VIEW OF WORLEY-LOGAN ATOMIZING ROAD OILER, TAR AND ASPHALT SPREADER, SHOWING HEATER, STEAM AND AIR GAGES, OIL AND WATER GAGES, TOGETHER WITH LEVER CONTROL.

necessary for sanitation, dust purposes, or to renew the life of asphalt oils previously applied, it should be distributed in extremely light quantities. Boulevards should receive about 1/10 and not to exceed ¼ of a pint of oil per square yard, evenly and equally distributed under high temperature and should be atomized and applied in the form of mist. When this is done by and thru the system of atomization you will find a vast difference in final results."

Auto-Crane a Labor-Saver

The average contractor is rather unwilling to tie up large sums of money in special machines, the use of which is confined to certain seasons and to individual kinds of work. One of the features which should most commend the Byers Auto-Crane to contractors harboring that viewpoint is its genuine adaptability to a wide variety of work under variable working conditions.

The Auto-Crane is a cross between a locomotive crane and a motor truck, with all the advantages that are apparent in that combination. It is a small, high-powered steel derrick that travels readily over the ground on its own power to any place it may be needed. The experiences of contractors now using the outfit show it to be the equivalent of twenty or more ordinary laborers. It eliminates many salaries and the nuisance of constant supervision to keep overly large gangs from "stalling" on the job. Incidentally its operating expense is only a fraction of the pay roll for the hand laborers it displaces. One round trip of boom and bucket per minute is guaranteed by the manufacturers and, it is said, that the record can easily be bettered by a good operator.

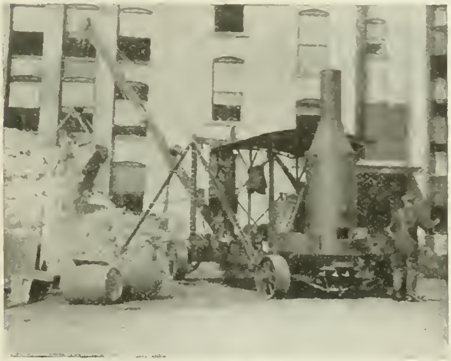
The outfit is delivered entirely set up and ready for work after putting on the boom and wheels. It is easily shipped from job to job by either road or street, inasmuch as its size comes entirely within railroad and highway clearances for both city and country. It will travel almost any place that a motor truck will go and spots cars by means of a winch head. All operations are controlled by a single operator at his stand; bucket control, boom swing and peaking, two-way traction and steering.

"The Auto-Crane saves us $10 per day in labor bills alone,'" states A. H. Read, of the National Roofing Company, Omaha, Neb. "On account of range of boom we readily place materials into bins and thence by gravity into wagons or trucks at the rate of a truck in three-fourths of a minute. We use this device chiefly for car-unloading, altho it would be as practical for excavating, backfilling, etc., did our work necessitate."

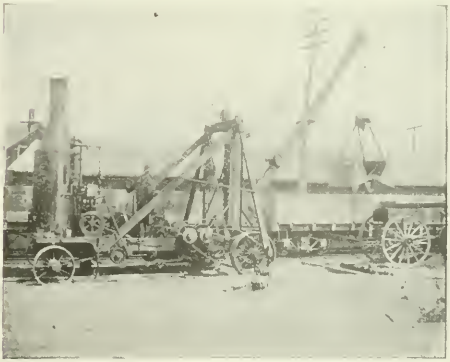
The Hoffman-Townsend Company, Mt. Carmel, Illinois, use this device in the loading of hauling cars which run on portable track. "It would not be fair to make performance comparisons with manual labor," states this concern, "as in our case it does the work of 40 men. A saving on the average

DIGGING DRAINAGE DITCH IN INDIANA. M. W. HOLBEN, GARY, IND.

CHARGING TRACTION PAVING MIXER SKIP ON STREET WORK. GERMAN ROCK ASPHALT CO., BUFFALO, N. Y.



HANDLING STEEL SHAVINGS IN AMERICAN HARDWARE CO. YARDS., NEW BRITAIN, CONN.



UNLOADING GRAVEL FOR STREET WORK AT FLINT, MICH. CITY OF FLINT, OWNERS.

DIVERSIFIED USE OF BYERS AUTO-CRANE.

of $50 per day would be a conservative estimate. The machine moves from place to place under its own power and on hard ground requires no planking at all. It has a full half-swing and works from either side. We have had this machine in operation eight months and repair bills average $5 per month, principally for new cable."

The P. M. Johnson Company, St. Elmo, Illinois, use the Auto-Crane principally for unloading sand and gravel from railway cars. "This outfit is within all clearance regulations," writes Mr. Johnson, "and planking is seldom required, as the broad traction wheels keep it from sinking in. The boom range enables us to overcome many obstacles presented by disadvantageous location of cars and size of bins into which the material must be placed."

The Granite City Lime & Cement Company, Granite City, Illinois, use this outfit in car unloading and estimate their "savings over manual labor were from $50 to $75 per day, as the Auto-Crane enables us to unload a car of sand or gravel in about 20 minutes. Its traction is positive, as we have moved it a distance of 8 miles over country roads (under its own power)."

The Harrison Engineering & Construction Company, Buffalo, New York, use their Auto-Crane in the handling of materials from cars to road and from cars to trucks. Their experience is that the device "saves the salaries of from 10 to 25 men, depending on the size of the job. It costs but $11 per day to operate the crane: Engineer, $5; firemen, $3; craneman, $3."

The Marsh Engineering Company, Des Moines, Iowa, use their Auto-Crane for ditching, excavating and loading. "We find this outfit as practical for one purpose as for the other," writes Mr. Marsh. "It excavates for bridge abutments, ditches on river cut-offs, unloads cars and drives piles (with swinging leads) for which purpose it is especially valuable to us. We have used it for driving false work across several streams, it being able to travel over and drive ahead. It has driven 250 piles and sheeting down and filled the same with earth. We now have it on false work in the Des Moines river, where we intend to use it soon for driving cofferdam sheeting with a steam hammer, as the boom can command the greater part of the area required and the boiler furnish the steam. Altogether, we find it a very handy piece of equipment on work to which it is adapted. For excavation we use a one-half cubic yard Owen clamshell and have taken out from 200 to 300 cubic yards a day in ordinary earth."

Water Test at Boston Show

In order to demonstrate that the Pittsburg Paving Joint will remain consistent in all temperatures and in fluctuating changes of extreme temperatures, The Asbestos Protected Metal Company conducted a series of water tests at the recent Good Roads Show held in Boston.

"This test," states Mr. R. George Miller, "comprised three tubs nearly full of water, one tub containing water at a heat of 160° F.—this temperature was obtained by the use of an electric immersion heater. The second tub contained water at a temperature of 65° to 70° F. and the third tub contained water at a temperature of 28° F.—this was obtained by forming a brine thru the mixture of ice and salt. In each tub a floating thermometer was placed so that all those who were interested in the test could see for themselves the temperature of the water in the tubs. Samples of Pittsburg paving joint were placed in the water in each of the tubs and allowed to remain there during the whole period of the convention and were only taken out for demonstration purposes.

"The samples, when taken from the water at a temperature of 160° F., altho, of course, softer, showed no signs of bleeding or melting, and a temperature of 160° F. is never obtained in a road on the hottest day in summer. The average temperature of a road being about 115°. Samples taken from the water at 28° F. showed no signs of cracking or breaking and were as pliable as those samples which were not immersed in water. It is a known fact that asphalt will take up the temperature of water in considerably less time than it will take up air temperature, in fact, asphalt remaining in water one hour has absolutely taken up the temperature of the water in that time. To give an idea of the interest that was shown, it took four of us and we were kept busy practically the full period of the show."

The booth was in charge of Mr. Miller, manager of the Pittsburg Paving Joint department; Mr. H. W. Littlefield, Buffalo representative; Mr. F. Wm. Stocker, eastern representative, and Mr. Frank B. Goodman, Toronto, Canada, representative.

Hammer Drills on Asphalt Pavement

By J. H. Henning.

The adaptability of hand air-hammer drills to numerous special purposes was illustrated in an interesting manner a year or two ago by J. P. Moran, a Salt Lake City contractor.

Mr. Moran secured a contract which required the removal of a strip of asphalt and concrete pavement on Main street,

LINING THE ASPHALT WITH CHANNELING BIT.

Salt Lake City, alongside the tracks of the street railway, so that the rails might be shimmed and new pavement laid. In order to reduce time and labor in this work, Mr. Moran purchased two Sullivan DC-19, 40-pound hammer drills, operated by a small steam-driven air compressor.

A line was laid out a foot from the outside of the rails and the drills were equipped with a special channeling bit to cut off the asphalt. When a sufficient distance had been channeled, a gadding bit was used and the surfacing material was removed, as shown in the second picture, exposing the concrete. The gadding bit was again used in breaking up the concrete. This was done by holding the drill in a nearly vertical

REMOVING THE ASPHALT WITH DRILL AND GAD.

position for wedging off pieces of the concrete. In this manner pieces from 4 to 8 inches square were broken off.

One man with the Sullivan drill was able to take up the asphalt and concrete at an average rate of 6 linear feet in fifteen minutes, while three men "double-jacking," by the old method of hand work, required an average of forty minutes to remove a like amount; that is, hand work required two hours to accomplish the same results secured in fifteen minutes with the machines.

It would seem that two or three drills of this or similar type, and a gasoline engine-driven portable air compressor to operate them, would form desirable equipment for contractors having road and street repair work to perform. The following comparison, based on the job described above, may be interesting.

This shows the cost of machine work would be less than half that of hand work as follows:

MACHINE WORK COSTS.
(Based on costs and prices in June, 1914.)

Cost of plant—	
One Sullivan WK-3 portable compressor outfit (20-h.p.)	$1,780.00
Two DC-19 hammer drills	170.00
Hose, steel, etc	50.00
Total	$2,000.00
Interest on plant at 6 per cent	$120.00
Depreciation, 15 per cent	300.00
	$ 420.00
Operating 175 days per year, per day	$2.40
Engineer, per day	3.50
Two drill operators at $2.50	5.00
Gasoline, 20 gallons at 23c	4.60
Oil, waste, etc.	.50
	$16.00
Progress per day, 8 hours, 384 feet; cost per foot of work	116

New Drag Line Excavator

The Pawling & Harnischfeger Company have recently perfected a new type of drag line which can be used not only to excavate, backfill and hoist, but is equally adaptable for the cleaning out of ditches, etc.

As a drag line of ½-yard capacity, this outfit comes into direct competition with several ½-yard land dredges now on the market, but enjoys the distinction of being a self-propelling machine of about 12 tons weight and equipped with corduroy tractors. This outfit is not only appropriate for lateral digging and large tile work, but is equally as well adapted for backfilling purposes.

To the sewer and drainage contractor this new device will appeal as a universal outfit. It is equipped with a special self-acting scraper for backfilling purposes. This scraper has a 6-foot cutting edge and will handle a full cubic yard of excavated material at one trip and in the hands of a good operator this scraper should make from three to four trips per minute. No men will be required to handle the scraper, as the machine operator (one man) handles all levers, which are banked within his easy reach. By means of this new machine the sewer contractor will be able to unload heavy cast iron and vitrified sewer pipe from cars to trucks, as well as place same in the trench. The pulling of piling should also be numbered among the diversified accomplishments of this new outfit, thus combining the working capabilities of a locomotive crane in conjunction with the united performance of separate backfilling and excavating units.

This machine is equipped with a 30-foot boom, which swings in a full circle. It can be operated as a ½-cubic yard clamshell or ½-cubic yard orangepeel. As a drag line, it is particularly adapted to the excavation of open or sloping bank ditches. As a clamshell, it will be used for the unloading of screenings, crushed rock, sand, gravel and similar materials from gondola to trucks or wagons, and any work requiring the operation of an orangepeel will be within the capacity of this outfit. As a backfiller, it will follow any size of trench excavator now on the market and will be able to handle any narrow alley work where an excavator can be used.

This outfit, which will be known as the P. & H. drag line excavator Class No. 205, is equipped with a 30-h.p. motor, rotating at a speed of 3¼ revolutions per minute. A corduroy traction supports the heavy part of the machinery which carries a turntable of 4 ft. 7½ in. diameter. The steering wheels have a 16-in. face and are 40-in. in diameter. Machine weighs about 12 tons.

Cutting Ends Off Pipe

We are illustrating a Strickler No. 7 ratchet pipe cutter, as used in cutting the damaged ends of four carloads of 20-in. cast iron pipe, which were damaged in shipment, arriving with ends badly cracked.

In all previous cases of this kind it was necessary to take each length to a machine shop for lathe cutting, after which it was taken back to the job.

The machine, as illustrated, weighs approximately 250 pounds and cuts any pipe 16 to 24-in. in diameter, inclusive. The cutting blades make a channel cut around the pipe and do not leave either burrs or ragged edges, consequently no

CUTTING DAMAGED ENDS OFF OF FOUR CAR LOADS OF 20-INCH CAST IRON PIPE WITH A NO. 7 STRICKLER CUTTER—THREE MEN ON THE MACHINE. NOTE THE PIECES CUT OFF. PERFECT CUTS MADE ON ANY PIPE ¾ IN. TO 30 IN.

filing or reaming is required. This type of cutter opens wide, easily centers up and is fastened by the tightening of one swing bolt. The ratchet head (which holds the handle) is equipped with dogs engaging the teeth on the body of the machine (which holds the star-fed cutting bed). As the machine rotates around the pipe the star feeder sends the cutting tools in automatically. This type of cutter is made in the following sizes:

No. 1—which cuts ¾-in. to 2-in. inclusive.
No. 2—which cuts 1¼-in. to 4-in. inclusive.
No. 3—which cuts 2½-in. to 6-in. inclusive.
No. 4—which cuts 4 -in. to 8-in. inclusive.
No. 5—which cuts 8 -in. to 12-in. inclusive.
No. 6—which cuts 12 -in. to 16-in. inclusive.
No. 7—which cuts 16 -in. to 24-in. inclusive.
No. 8—which cuts 24 -in. to 30-in. inclusive.

Segment Block Construction

"Our installation of 42-in. circular Natco lock joint segment tile on Cedar street, Perth Amboy, N. J., insures freedom from deposits and is of sufficient smoothness to permit the uninterrupted flow of sewage," states Mr. Jens W. Rohr, engineer.

"The installation referred to, 1700-lin. ft., permits of the avoidance of sharp bends and produces an irregular continuous mortar joint between the inner and outer courses. In our opinion, the triple lock tongue and groove joint feature insures great strength and our experience justifies the statement that this type of construction can be laid up with greater speed and with considerable less labor than most other types.

"The use of half lengths makes it easy to start or close with a square end as well as to tie into an old sewer section. We laid the blocks without an underdrain and no water accumulated (after the first invert tile was laid) to retard the placing of the sides and arch.

"All of the blocks were laid in the trench, altho it would have been readily possible to build half or whole sections outside the trench and then lower same into position in case we were working in swampy ground. On this job we used a center frame construction 12-ft. in length in forming the arch and when we had placed the last tile necessary to complete the arch, length of center, we dropped center and moved forward. It is our opinion that this type of construction unquestionably does allow a smoother, unobstructed flow line than an unglazed surface, thus greatly increasing sewer capacity."

"Our commissioners are satisfied with our segment tile sewer, which is of the Natco lock joint double-ring circular type," write Philips & Swanson, Gibson City, Ill.

"The installation on Fourth street is as follows:

"1,092-lin. ft. of 45-in. (internal diameter).
" 188-lin. ft. of 40-in. (internal diameter).
"2,024-lin. ft. of 38-in. (internal diameter).

"In this piece of construction we used a wooden half circle; also a whole circle, which we even more successfully moved along as the work progressed. These circles were used as a support for the outer segments while the lower half of circle was laid and until such time as the backfilling was tamped into place. We also made use of a built-up center of suitable length for constructing the arch and thru use of this center we found it readily possible to lay up arch, drop center, move forward to new position and backfill without waiting for the mortar to set.

"Our experience in the construction of segment block sewers is that this type of construction permits of greater speed and economy in erection, as the work necessitates less equipment and calls for smaller amounts of perishable materials," states S. F. Crecelius, engineer, Louisville, Ky.

"We have placed 48-in. and 78-in. circular shaped segment tile sewers in alleys in Beechmont, Highland Park and Oakdale. The tile which we installed was of the Natco lock joint type, and while some of our work required a tile underdrain during construction, on account of unusually abnormal conditions, it is safe to state that in normal conditions it would require no underdrain at all. We made use of a built-up center of suitable length for constructing the arch and consequently it was possible for us to lay up arch, drop center and move forward as well as backfill without waiting for the mortar to set.

"This type of construction permits of the avoidance of sharp bends and the glazed wearing surface insures a smoother, unobstructed flow line than other types and on account of this fact, the capacity for both storm and sanitary purposes is greatly increased."

Grout Machine and Grout Gun

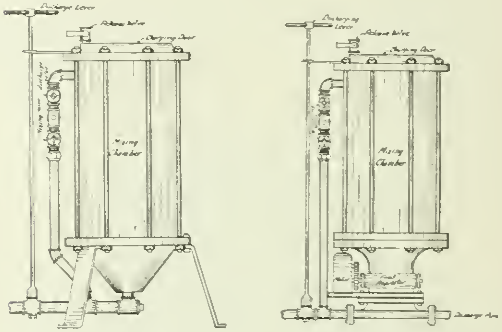
R. J. Gillespie, superintendent for the T. A. Gillespie Co., engineers and contractors of High Falls, N. Y., makes several interesting observations as to the Ransome-Canniff grout mixing machines and guns which his concern has been using on their big construction Contract No. 12 of the Catskill Aqueduct, near High Falls. The work is being done for the Board of Water Supply of the city of New York, N. Y.

"We have fourteen of this type of mixers on this job," Mr. Gillespie asserts, "and have been using them for three years past. We have had as high as three separate batteries, consisting of three machines each, working at different points in the big tunnel. In this way, we are able to obtain a constant flow of grout at any required pressure, from 30 to 300 pounds per square inch, and certainly the results have been most satisfactory.

"We have placed as high as 1,100 batches per day with a single battery of three machines and I have no hesitancy in saying that this amount could be greatly increased by having sufficient area to take the grout.

"Owing to the compactness of these machines, and the fact that there are practically no parts to wear out, we find them very convenient and economical for tunnel, and for all other kinds of grouting.

The particular machines to which Mr. Gillespie refers (illustrated herewith) are constructed along the simplest lines possible.



The body of the grout mixer is a tight steel cylinder with a conical hopper bottom and a flat top in which is located the charging door. The mixer is mounted on a three-legged base and the piping for the supply of air and the discharge of the grout is located on the side of the mixer, as shown. The control levers are easily accessible.

The grout gun is of the same general design, with the additional mechanism necessary for controlling the feeding of the grout to the conveying hose. It is adapted for such uses as mortar-coating surfaces of steel, stone and concrete, and where the old hand process is often unsuccessful in making the mortar stick.

Trade Notes

Contract has been awarded to The J. G. White Engineering Corporation by the Eastern Pennsylvania Light, Heat & Power Company for the engineering and construction work in connection with the following extensions and improvements to the latter Company's power station at Palo Alto, Pennsylvania: Installation of 7,000-kw. turbo-generator and transformers of 3,000-kw. capacity, together with condensers, auxiliaries and necessary switching equipment; the addition of one 500-kw. railway rotary with transformers, and the installation of superheaters on all boilers.

Walter T. Sewell, Sales Manager of the Sewell Cushion Wheel Co., is providing automobiles for their salesmen in St. Louis, Pittsburg, Baltimore, Newark and New York City, to increase the efficiency of their selling organizations.

The Asbestos Protected Metal Co., of Pittsburg, Pa., announce the appointment of Meyer Davis, formerly chief engineer, as manager of its San Francisco office in the Hobart building.

Contracting News

AUTOMOBILES, MOTOR TRUCKS AND FIRE APPARATUS.

Akron, O.—City contemplates the purchase of two motor tractors and ten trailers for the collection of garbage and two motor flushers. Address Service Director Beck.

Athol, Mass.—Chief Frank P. Hall has asked for an appropriation for the purchase of a motor ladder truck.

Battle Creek, Mich.—A resolution to purchase one more fire auto to cost approximately $9,000 was offered at the city commission meeting by Commissioner MacGregor.

Bloomdale, O.—Bids will be received until April 12 for one motor combination chemical engine of the following specifications: Motor shall not be less than 35 nor more than 75 horsepower, and the equipment to include body with a capacity to carry 1,200 ft. of 2½-in. fire hose, chemical reel and not more than 200 ft. of chemical hose.

Brookline, Mass.—At the annual town meeting in March, an appropriation of $27,000 for the complete motorization o fthe fire department will be voted upon.

Central Falls, R. I.—The city council committee on fire department met at the Broad street station and contemplates the purchase of four motor-driven trucks for the department.

Cloquet, Minn.—The city clerk was instructed to advertise for bids for a triple compound motor fire truck and for a centrifugal pump with a capacity of 5,000 gallons per minute.

Duluth, Minn.—Commissioner Farrell has advertised for bids for furnishing his department with a two-ton truck to replace the present one-ton machine.

Dubuque, Iowa—The city contemplates the purchase of another automobile pumping engine and an automobile combination chemical and hose wagon. A fund of $8,500 is available for the purpose.

Green Bay, Wis.—Mayor Elmer S. Hall advises the purchase of a motor pump chemical and hose wagon and an automobile aerial hook and ladder for station one; also motorizing of the hose wagon at station three.

Holland, Mich.—City contemplates the purchase of motor trucks and additional equipment for the fire department and will vote on a bond issue of $12,000 for the purpose at the April election.

Ladysmith, Wis.—City Clerk Kirvan has been authorized to get bids on an auto truck for use of the Ladysmith volunteer fire department. Same is to have two chemical tanks, each with a capacity of about 40 gallons, so that each tank will be able to throw a stream of chemical fire-quenching composition for a period of approximately 25 minutes. In addition to this equipment the truck is to carry 800 ft. of hose and two ladders, and have room for eight or ten men.

Lockport, N. Y.—City contemplates the purchase of two 4-cylinder, 1½-ton truck chasses for the local fire department for use on the two horse-drawn chemical rigs now in use.

Manitowoc, Wis.—Fire Chief J. H. Kratz has recommended the purchase of additional motor fire equipment for the fire department, including a gasoline pump.

Mendota, Ill.—The Mendota city council is considering the purchase of an automobile fire truck. A committee has been named to investigate the various makes and types of machines of this kind.

Muncie, Ind.—An ordinance appropriating the sum of $16,000 is to be used by the board of safety in motorizing fire stations. No. 2 and No. 3 and for the installation of a new fire alarm switchboard was passed by the city council at its regular meeting.

N. Tonawanda, N. Y.—The Seagrave Fire Engine Co., Columbus, O., was awarded contract for a triple combination auto pumper at a cost of $7,396.

Muskegon, Mich.—Chief Napoleon Belfy has asked for tractors for the hook and ladder truck and the steam fire engine.

Oakland, Cal.—City fire department has ordered fire truck from the American-La France Co., at a cost of $8,350. Engine is equipped with horizontal pump.

Philadelphia, Pa.—Bureau of Highways has prepared specifications requiring one motor-driven truck for removal of ashes to be furnished by contractor in each district in 1917.

Portsmouth, Va.—City contemplates the expenditure of $35,000 on fire equipment, for which amount bonds will be issued. Motor-drawn equipment will be purchased and by the saving in upkeep cost the bonds will probably be paid off in eight years, according to City Manager Shertz.

Provo, Utah—The city commission has decided to purchase for the fire department a triple combination motor truck combining a pumping engine, a chemical engine and a hose cart. The approximate cost will be $8,500.

BRIDGES.

BIDS REQUESTED.

Huntington, Ind.—Until April 10, 10 a. m., for the construction of six reinforced concrete bridges and culverts, and repair of eight bridges. O. E. Eviston, Auditor.

Minneapolis, Minn.—Until April 18, 11 a. m., for the removal of old bridge No. 16, and erecting a new bridge complete in its place, all in the town of Orono; also for contract No. 6, being the removal of old bridge No. 349, and erecting a new bridge complete in its place, all in the village of West Minneapolis. Plans and specifications may be obtained from the county surveyor.

Muncie, Ind.—Until April 14, 1:30 p. m., for the construction of two bridges. F. M. Williams, Auditor.

Springfield, Ill.—Until April 11, 11 a. m., for the construction of three reinforced concrete bridges, known as the Lawson, Brokaw and Babcock bridges. Spans, 16, 12 and 3 ft., respectively. Engineer's estimate of cost, $3,050. Address Clifford Older, Springfield, Ill., for plans and specifications.

Springfield, Ill.—Until April 11, 11 a .m., for the construction of the Indian Ford bridge. One steel span at 140 ft. and one reinforced concrete span at 35 ft.; roadway, 18 ft. Engineer's estimate of cost, $14,680. Address Clifford Older, Springfield, Ill., for plans and specifications.

CONTRACTS AWARDED.

Alma, Kan.—To John Lindgren, Alta Vista, Kan., for the construction of forty-three bridges and culverts in Wahaunsee county, at $10,478.

Columbus, O.—To the Capital Paving and Construction Co. for the erection of the steel bridge over the Little Walnut creek in Madison township. Cost, $27,182.

Georgetown, Md.—To R. G. Collins, Jr., 52 Vanderbilt avenue, New York, for the construction of a bridge over the Sassafrass river, between Georgetown and Fredericktown, at his bid of $47,477.

Horatio, Ark.—To the Vincennes Bridge Co., Vincennes, Ind., for the construction of steel bridge across Little river at Greenwood Shoals, at $11,995.

Kankakee, Ill.—To Montgomery & Parker Contracting Co., Hatfield, Ind., for constructing a reinforced concrete bridge over the Kankakee river at Wallie Warner farm, at a cost of $52,465.

Kansas City, Mo.—To the McMillan Construction Co., Old Colony Bldg., Chicago, Ill., for the construction of a viaduct on Twenty-seventh street, at $90,000.

Knoxville, Pa.—To Stebbind Construction Co., Wellsboro, for construction of a steel truss bridge over the Cowanwaque river on Little Marsh road. Cost, $16,000.

Ocean City, Md.—To the Strobel Steel Construction Co., of Chicago, for the construction of the superstructure of the draw span of the Sassafrass river bridge at a contract price of $14,765.

Paoli, Ind.—The Burke Construction Co., New Castle, was awarded the contract for the construction of a bridge over the Whitewater river at Brookville, at a contract price of $59,000.

Perry, Okla.—To the Monarch Bridge Co., Wichita, Kan., for the construction of a 500-ft. steel bridge over Salt Fork branch of Arkansas river, at a cost of $10,000.

Seeley, Cal.—To the Mercereau Bridge and Construction Co., Pacific Electric Bldg., Los Angeles, for the construction of reinforced concrete bridge across New river in Imperial county, 330 ft. long, at $13,131.

Spirit Lake, Iowa—To the Des Moines Bridge and Iron Co., for the construction of big steel bridges, at a contract price of $15,548, and to J. I. Merryman, of Milford, for the construction of small concrete bridges and culverts at a bid of $12,205.

St. Charles, Mo.—To the Kansas City Bridge Co., Waterworks Bldg., Kansas City, for the construction of the St. Charles highway bridge, at a cost of $148,732.

Washington, Iowa—To R. H. Waugh, Clarksville, Iowa, for the construction of bridges and culverts in Washington county during the coming season. His bid on the contract was $35,206.

CONTEMPLATED WORK.

Bryan, Tex.—County commissioners of Brazos county have authorized the construction of a bridge across the Little Brazos river, nine miles west of Bryan, at a cost of $38,000.

Cameron, Wis.—The question of voting $40,000 for constructing a bridge across Cranberry creek in the village of Cameron, in accordance with the state aid bridge law, will be submitted to the voters of the village at the regular spring election, April 3. Ed. Bion, village clerk.

Columbus, O.—The surveyor was instructed by the county commissioners to prepare plans for new reinforced cencrete bridges to span the Olentangy river at Third and Lane avenues. The bridges will cost approximately $90,000.

Columbus, O.—Braun, Fleming & Knollman, engineers, Columbus, are preparing plans for the construction of the Town street bridge.

Eaton, O.—City contemplates the construction of two steel bridges, one on the Franklin road near James Kautz, and the other on the New Paris and Eldorado road, Jefferson township, near Mackeys and Braggs.

Fort Dodge, Iowa—Plans and specifications for the new North Third street viaduct to Round Prairie, as drawn up by C. H. Reynolds, city engineer, were accepted at a meeting of the city council.

Indianapolis, Ind.—County commissioners contemplate construction of a bridge over Fall creek at North Senate avenue. Estimated cost, $100,000, for which bonds will be issued.

Owatonna, Minn.—The city council has approved plans for a $25,000 reinforced concrete bridge over the Straight river here.

Pittsburg, Pa.—Plans have been prepared by the city and county engineers for the construction of a bridge to run from Essen street to Elwood street, a distance of 1,200 ft., with a roadway of 28 ft. The estimated cost is $312,000.

Santa Ana, Cal.—City Engineer C. C. Bonebrake has prepared plans for the construction of a reinforced concrete bridge across Santiago creek on North Main street, at an estimated cost of $30,000.

Savannah, Ga.—Southwest Georgia Highway Association, Mayor Pierpont, of Savannah, president, contemplates the construction of a bridge to span the Attamaha river to make a highway connection between Savannah and Bainbridge with Jacksonville.

Sea Isle, N. J.—The board of chosen freeholders, Cape May county, Sea Isle, N. J., will let contract as soon as funds have been realized by sale of bonds for constructing three bridges consisting of creosoted wooden block trestle piling, one over Main channel having double lift, Strauss bascule steel bridge. Estimated cost of three, $134,000.

Tulsa, Okla.—County Engineer Mitchell is contemplatindg the construction of a concrete bridge between Tulsa and West Tulsa at an estimated cost of $200,000, for which bonds will be issued.

LIGHTING.

Allegan, Mich.—At the spring election the citizens of Allegan will vote on a bond issue of $8,000 to install a municipal lighting plant.

Berlin, O.—H. C. Wangerien is chairman of a committee of citizens and city officials to make a thorough investigation of the advisability of constructing a municipal lighting plant in this village.

Bluffton, O.—Citizens contemplate the im-

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provement of the waterworks and electric light and power system and will vote March 6 on a bond issue of $35,000 for the purpose.

Centerville, Tenn.—City contemplates the installation of a municipal light plant and water system. J. F. Horner, mayor.

Dell Rapids, S. D.—Plans are being prepared by the Electric Development Co., Omaha, Neb., engineers, for the construction of electric light and power plant to cost about $25,000.

Defiance, O.—The village of Evansport is arranging for the establishment of an electric lighting plant. It will be privately owned, but the current will be available for street lighting in the municipality.

Kansas City, Mo.—Plans are being prepared by Sargent & Lundy, engineers, 72 West Adams street, Chicago, for erecting power plant to cost $6,000,000 for Kansas City Light and Power Co. J. H. Lucas, president, Fifteenth and Grand avenues.

Newton, N. J.—Town committee planning for installation of electric street lighting system to replace present gasoline lamps. Negotiating with National Utilities Co., operating Newton Electric and Gas Co., for improvement.

Oberlin, O.—A committee has been appointed by the council to investigate the cost and advisability of constructing a municipal electric lighting plant in this city.

Ravenna, O.—The village of Atwater is negotiating through Mr. Sampson , formerly with the Cleveland Alliance and Mahoning Valley Railway, for the installation of an electric lighting plant for that village.

Spencer, Iowa—To the Standard Construction Co., St. Paul, was awarded the contract for the construction of a new municipal light plant. Cost, $14,000.

Yazoo City, Mich.—City is contemplating improvements to the electric light plant to cost about $20,000.

MUNICIPAL BONDS.

Amarillo, Tex.—Petition was filed recently with the clerk of the county court asking the county commissioners to order an election for road improvement bonds in the sum of $150,000.

Amityville, N. Y.—The citizens of Babylon Town will be called upon to vote on election day on the issuance of $245,000 bonds to build a system of concrete roads.

Bonifay, Fla.—City has voted a bond issue of $20,000 for construction of waterworks and electric light system.

Carson City, Nev.—City council has passed the Harrington bill providing for $50,000 bonds to be issued for the improvement of its streets.

Canton, O.—Ordinances authorizing a $70,000 waterworks bond issue to allow the enlargement of water mains, the construction of new mains and the purchase of meters will be placed before the council soon, $50,000 of this amount to be used to enlarge and improve the distribution system, $10,000 for new pipe and $10,000 for meters.

Canton, O.—The council has passed ordinances authorizing the issue of bonds in the sum of $138,000, 71,000 of which will be for waterworks improvement. City Engineer Sarver has estimated the cost of paving Sixth, Fourteenth and Bonnett place at 50,000.

Eaton, O.—City wil lissue $30,000 bonds for the payment of improvements of Barron street.

Georgetown, Tex.—The Williamson county commissioners' court ordered an election of the proposed $500,000 road improvement bonds for Taylor commissioners' precinct No. 4. The election will take place on April 17.

Grand Rapids, Mich.—The council has approved a $250,000 bond issue for the improvement of parks and playgrounds and the question will be submitted to the voters at the spring election April 2.

Hazard, Ky.—Sheriff A. B. Combs has advertised an election to be held April 14, in order to give each voter an opportunity to cast his vote on the proposition of issuing bridge and road bonds in the sum of $150,000.

Joplin, Mo.—The city will hold a special election April 3 to vote on a bond issue of $40,000 for the city's share of the cost of a viaduct on East Seventh street.

Joplin, Mo.—City contemplates the issuance of $195,000 bonds for the construction of a municipal light plant. J. F. Lee, commissioner of public properties and utilities.

Mansfield, O.—Service Director Hursh has recommended a bond issue of $35,000 for the installation of electrically-driven apparatus at the new pumping station.

Mansfield, O.—An ordinance authorizing the issuance of bonds in the sum of $35,000 for the purpose of building an extension to the pump room at the main station of the waterworks and for the installation of motor-driven pumps, switchboards and necessary piping, passed.

Meriden, Miss.—Mayor J. M. Dabney contemplates the issue of from $50,000 to $60,000 bonds for the equipment of the fire department.

Muskogee, Okla.—Muskogee county will hold an election April 10 to vote on an issue of $1,000,000 bonds for the construction of good roads and free bridges in the county.

Norwood, O.—City will vote, April 17, on a bond issue in the sum of $35,000 for improvement of Beech street from Park avenue to Harrison avenue.

Peoria, Ill.—Peoria county will vote, April 3, on the question of issuing bonds of $1,700,000 for the improvement of state aid roads.

Perth Amboy, N. J.—Board of aldermen has recently adopted ordinances as follows: $40,000 sewer funding bond issue, $124,000 park funding bond issue, $165,000 street improvement funding bonds, series 1 and 2.

Provo, Utah—County will vote, April 17, on a bond issue of $750,000 for the purpose of paving Utah county roads.

Provo, Utah—The taxpayers of Utah county will be asked to vote on a $750,000 bond issue for building a hard-surfaced state road through Utah county, at an election called by the board of county commissioners for April 17, 1917.

St. Louis, Mich.—Citizens will vote in April on the issue of 25,000 bonds to sin$k wells, construct reservoirs and extend the water mains to supply the residents with pure mineral water, will be submitted to the voters at the April election.

ROADS AND PAVING.

BIDS REQUESTED.

Buffalo, Minn.—Until April 10, 2 p. m., for the construction and furnishing of materials for the following road jobs: Job No. 1, No. 2, No. 3, No. 4, No. 5, No. 6, No. 7. Plans and specifications may be obtained from the office of the State Highway Commission at St. Paul.

Crookston, Minn.—Until April 10, 8 p. m., for the construction of cement sidewalks, cement street and alley crossings, cement curbs and gutters. Plans and specifications on file. Lewis Ellington, Clerk.

Columbus, O.—Until April 13, for the change in location of a portion of the New Lexington-Athens road in Monrow township. Complete plans and details of this work are on file at the office of Clinton Cowen, State Highway Commissioner.

CONTRACTS AWARDED.

Baltimore, Md.—Contracts for paving streets in Baltimore were awarded to the following firms. P. Flanigan & Son, Baltimore, $225,996.55; Baltimore Asphalt Block and Tile Co., $127,585; American Paving Co., $121,893.25; Lawson Construction Company, Norfolk, $188,943.40, and Patrick Reddington & Sons, $24,287.

Baltimore, Md.—To E. Ward Brawn, Port Deposit, for the constr. of a 15-ft. concrete road from Porters Bridge to Rising Sun, in Cecil county, at $73,085.55. The Juniata Company, of Philadelphia, was also awarded a contract for constructing a 15-ft. concrete road thru the town of Elkton, at $15,421.38.

Bloomington, Ill.—To L. D. Lain, city, for the paving of Front street at his bid of $17,005.80. Other bidders were: W. F. Dodge, Monticello, $17,411.18, and Henry Nelson & Son, Springfield, $17,455.98.

Cincinnati, O.—To the Kirchner Construction Co., for the paving of Vine St., from Liberty St. to McMicken Ave., with wood block, on their bid of $30,101.20.

Dayton, O.—To E. Ryan, of Springfield, was awarded the contract for the paving of Jefferson street, at his bid of $61,920.

Eau Claire, Wis.—To Andrew Larson, city, for the paving of streets in the 6th and 9th wards, at a contract price of $36,062. Other bidders were Libby & Libby, Minneapolis, $41,676, and Cast Stone Constr. Co., whose bid was $37,675.

Everett, Wash.—To H. J. Kaiser, city, for paving Bond Road No. 10 near Arlington, at $104, 105. To Boncroft & Morgan, city, for paving Bond Issue Road No. 28, at $74,287.

Franklin, Ill.—J. L. Doris, Jr., Harrisburg, Ill., was awarded construction of two course reinforced concrete pavement and one course pavement, at $78,249.

Grundy Center, Ia.—To the Ford Paving Co., of Cedar Rapids, for the paving of 42 blocks of bitulithic paving, at $1.92 per sq. yd.

Hudson, Mich.—To Johnson & Flodin, Chicago, was awarded the contract for construction of sixteen miles of good roads at a contract price of $93,845. The only other bidder was Bishop & Rowlson Co., whose figure was $134,000.

Jamaica, N. Y.—To the H. C. Mullen Contracting Co., of Jamaica, for the widening and improvement of Rockaway Turnpike from Hook Creek, at a bid of $114,209. The Turnpike is to be widened to 75 feet, 50 of which is to be paved with asphalt.

Pontiac, Ill.—To Lobb & Son, city, for the construction of a brick-block pavement on East Second St., at their bid of $15,993.67.

Princeton, Ill.—To John Cherry, Jacksonville, was awarded three contracts for street paving. West Peru St., $15,612, Euclid Ave., $52,473.50, and Pleasant St., $53,310.20. Other bidders for the same work were Pronger & Fletcher, and Trompeter & Son.

Russelville, Ky.—To F. C. Garrell, of Russellville, was awarded the contract to build a road from this place to Lewisburg. The road will be seven miles long and will cost $35,000.

Rushville, Ind.—To Ed. G. Gant, was awarded the contract for constructing a concrete road running from Rushville three miles on the Andersonville road. The contract price is $45,250.

Tacoma, Wash.—To the Independent Asphalt Paving Co., Tacoma, for the resurfacing of the Puyallup hill road, by paving with bitulithic top two inches thick, at $34,350. Other bidders were P. J. McHugh Paving & Construction Co., H. J. Kaiser, Washington Paving Co. and Joseph Warter.

Wahpeton, N. D.—To S. Birch & Son, Fargo, N. D., was awarded the contract for the installing of 26,000 square yards of bitulithic paving at Wahpeton at a contract price of $80,000.

Waterloo, Ia.—To Bryant Asphalt Paving Co., city, for paving with asphalt on concrete base and asphaltic concrete of about eight miles of streets at a contract price of about $200,000.

CONTEMPLATED WORK.

Anderson, S. C.—The J. B. McCrary Co., of Atlanta, have been retained as engineers by the city of Anderson to prepare plans for street paving to cost about $300,000.

Antwerp, O.—Town has retained C. Ross Lindemuth as engineer to prepare plans and specifications for the paving of River St. at that place for a mile and a half.

Ashland, O.—City engineer Conn has prepared plans for the paving, grading and curbing of East Liberty St and College Blvd. The cost of East Liberty St. is $25,746 and College Blvd. is $10,253.

Bellaire, O.—Engineer R. Rice is completing the survey of the mile and quarter of pike through Morristown which is to be paved as soon as plans are ready. The cost is estimated at $20,000.

Bordentown, N. J.—City engineer is preparing plans for paving a number of streets with macadam pavement, work to be started in summer. Street Department will be in charge.

Boston, Mass.—City contemplates the paving and construction of many sidewalks this year. Total estimate of cost, $750,000. Mayor has provided for these

Tarvia

Preserves Roads
Prevents Dust

How Bexley Builds Good Roads

Bexley is one of the finest suburbs of Columbus, Ohio, in a county which has a great many miles of Tarvia roads.

After proper consideration the authorities adopted a Tarvia pavement, as the most suitable type for their needs, on Columbia Avenue, one of their main streets.

The photographs show the construction, step by step.

On a concrete foundation a mixture of Tarvia and stone was used for a wearing surface. The work was done by McGary & Sparks, Contractors, under the supervision of Jennings, Lawrence & Lindsey, Municipal Engineers.

The finished road is now one of the show-highways of Bexley.

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Everyone is pleased with the satisfactory results obtained.

Both engineers and taxpayers have realized that Tarvia makes an ideal pavement, and, furthermore, that Tarvia is a distinct economy because its use in paving construction reduces the upkeep cost so much, that this saving actually more than pays for the Tarvia.

Tarvia roads are now used by thousands of communities all over this country. You will find them more economical and satisfactory than any other type.

Tarvia is made in several grades to meet varying conditions, each having the same salient feature of bonding the surface, saving the road from attrition and saving taxpayers' money.

If you are interested in the subject write for an illustrated booklet showing Tarvia roads all over the country and telling more fully about the various methods of treatment.

Address our nearest office.

A mile of perfect road at reasonable cost.

Special Service Department

This company has a corps of trained engineers and chemists who have given years of study to modern road problems. The advice of these men may be had for the asking by anyone interested.

If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will have prompt attention.

The *Barrett* Company

New York Chicago Philadelphia Boston St. Louis Cleveland Cincinnati Pittsburgh Detroit Birmingham Kansas City Minneapolis Nashville Salt Lake City Seattle Peoria
The Paterson Manufacturing Co., Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S. Sydney, N. S.

1—Putting broken stone in the mixer.

3—Spreading the soft, hot mixture in place.

5—Rolling down the mixture with roller

2—Discharging stone mixed with hot Tarvia.

4—Raking it to level.

6—Applying squeegee coat of Tarvia and covering with fine stone.

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improvements. Commonwealth Ave. will cost about $150,000. Granolithic sidewalks will cost about $100,000.

Cincinnati, O.—City contemplates the paving of the following streets shortly:

East Liverpool, for paving a number of streets, plans for which are now being prepared by city engineer.

Doylestown, for paving of Portage St. at an approximate cost of $22,000.

Coshocton, paving a portion of Mill Creek Road, plans by the county engineer.

Chillicothe, O.—County surveyor Glenn Perry and his assistants have completed the plans and specifications for $65,000 worth of paving at Frankfort and Kingston and bids will be received on the job, the latter part of the month at the State Highway offices, Columbus, O.

Glenwood, Ia.—The city council has ordered estimates, plans and specifications for about 35,000 yards of paving and 30,000 lin. ft. of curb or combined curb and gutter. Theo. S. DeLay, Engineer.

Hagerstown, N. J.—Borough official negotiating with Board of Freeholders for improvement of Stockton St. with permanent type of pavement to be selected. Also planning for improvement of Broad and South Sts.

Lima, O.—The city engineer is preparing plans and estimates for the paving of eight city streets. The estimates are on brick, sheet asphalt, asphaltic concrete and wood block paving.

Loraine, O.—An ordinance was passed authorizing the paving of Reid Ave. from 12th St. to 31st St. Construction of a five foot sidewalk on the north side of East 28th St. will be commenced soon.

Ridgewood, N. H.—Village Board of Commissioners have decided to spend $100,000 in 1917 for permanent road work, both concrete and asphaltic concrete. R. W. Lunands, City Engineer.

Sacramento, Cal.—County Surveyor Drury Butler presented plans and specifications for approvements of the Winding Way road which covers a distance of 1.2 mile. Bids will be asked for the work and will be started as soon as the rainy season passes.

Staunton, Ill.—City will build 29 miles of sidewalks and paved streets this spring and summer provided the assessment roll amounting to $80,000 is approved by the Cacoupin county court at its April term.

Trenton, N. J.—City Commission has passed ordinance providing for paving of a part of Cuyler Ave., from Hamilton Ave. to Greenwood Ave. with sheet asphalt on 5-in. concrete foundation, and concrete gutters and curbs.

Waukegan,. Ill.—City Engineer M. J Douthitt is preparing plans for the paving of 21 blocks of city streets this year. Kind of material to be used has not yet been decided.

SEWERS.

BIDS REQUESTED.

St. Paul, Minn.—Until April 9, (10:30 a. m.) for the construction of a sewer on Congress St. from the present easterly terminus of the sewer 100 feet easterly of Bancroft St. easterly to a point 10 ft. east of the West line of Lot 3, Paulson's Rearrangement of Block 14, Brown & Jackson's addition. Add. H. W. Austin, Purchasing Agent.

St. Paul, Minn.—Until April 9, (10:30 a. m.) for the reconstruction and extending of existing sewer on Ninth St. from Cedar St. to Robert St., and a relief sewer on Robert St. from Ninth to Eleventh. Add. H. W. Austin, Purchasing Agent, for plans and specifications.

CONTEMPLATED WORK.

Birmingham, Ala.—Storm sewers for the section between Twenty-third and Twenty-sixth sts., and Thirtieth and Sixteenth aves., North, will be provided under an ordinance adopted by the commission. The cost is estimated at $6,000.

Glen Ullin, N. D.—Black & Griffin, city engineers of Mandan, have been engaged to prepare plans and estimates for a sewerage system in Glenn Ullin.

Globe, Ariz.—The city council has retained the Benham Engineering Co., Consulting Engineers, Okla. City, to make investigations, prepare plans and specifications and supervise the construction of a system of sanitary main and lateral sewers, construct storm sewers, waterworks extensions, and street paving. It is estimated that the total cost of improvements will amount to approx. $750,000.

Kingston, Okla.—Benham Engineering Co., Oklahoma City, are preparing plans and specifications for the construction of a sanitary sewer system.

Los Angeles, Cal.—The city engineer was instructed to prepare an ordinance for the sewering of Mariposa ave. between Melrose ave. and Clinton st.

Mansfield, O.—Ordinances were passed for the construction of sanitary sewers on North Mulberry st., from Harker st. north; Longview ave., from Johns ave. east; and Bisbon ave., from Harter ave. to Main st.

Morrisville, Pa.—Council considering installation of sewer system and sewage disposal plant. Lewis R. Bond, borough solicitor, will make investigations of data and costs.

Norwood, O.—H. J. Pierson, Director of Public Service, states that Engineer Allen Kissinger has completed plans for sewers, bids on which will be opened in April. Specifications call for 3,000 ft. of 8 and 18 vit. tile sewer, 3 brick man holes and 30 brick inlets.

Okmulgee, Okla.—The Benham Enginerring Co., Oklahoma City, have been retained as engineers to prepare plans and specifications for the improvement of the water and sewer system. Also to build a sanitary sewer system, a sewage disposal plant and constructing secondary reservoir.

Pottsville, Pa.—The council has voted to obtain plans at once for a modern sewerage system and a sewerage disposal plant. The State Health Commissioner has estimated that the cost of such a plant will be $350,000.

Tuscaloosa, Ala.—The City Commissioners contemplate the construction of a sewer costing appox. $13,000. Mr. Nicoll is City Engineer.

SEWAGE DISPOSAL PLANTS.

Allentown, Pa.—City Council has acquired site of 460 acres for a sewage disposal plant, about 2 miles from city. Proposed municipal sewer system plant estimated to cost $2,000,000.

Austin, Tex.—Hering & Gregory, New York, have been retained as engineers for the designing of a sewage disposal plant for the city of Austin at a cost of about $170,000. Bonds in the sum of $200,000 will be issued for the purpose.

Akron, O.—Service Director Beck has estimated that it will cost $50,000 to provide the city with a proper garbage collecting system. City will operate the system.

Bayonne, N. Y.—Board of City Commissioners considering installation of garbage disposal plant, and now investigating different types. Planned to build two plants on unit type, and third structure later.

Bellefontaine, O.—City contemplates the construction of a municipal garbage plant. Plant would cost about $35,000.

Dallas, Tex.—City Engineer Department has completed plans and specifications for sewage-disposal pumping stations and mains at a cost of $30,000. Hal Moseley is City Engineer.

Haverford, Pa.—Township Committee planning for installation of sewer system, to include a joint sewage disposal plant with Upper Darby Township.

Newark, N. J.—Board of Works considering plans prepared for garbage disposal plant of 300 tons capacity. Proposed structure will be located on Sherman ave., and is estimated to cost $538,000. Board authorized investigations for erection of municipal electric-lighting plant in connection, with additional cost estimated at $350,000. Morris R. Sherrerd, chief engineer.

New Perce, Ida.—The Security Bridge Co., Lewiston, Ida., was awarded the contract for the construction of sewer and sewage disposal plant at about $28,499.

Phillipsburg, N. J.—The State Board of Health has approved preliminary plans submitted by city for the installation of a sewage disposal plant. Specifications provide for fine sewage screen and treatment of sewage with chlorine gas and other purification process.

Sioux City, Ia.—City contemplates construction of a new sewage plant at Morningside. City Engineer T. H. Johnson is preparing plans for same.

St. Paul, Minn.—Commissioner Goss has proposed the construction of a garbage disposal plant at an estimated cost of $30,000, to be run in connection with the workhouse farm.

Wilkes Barre, Pa.—Hanover Township officials have rejected plan to join with city in installation of sewage disposal plant, and will install independent plant.

MISCELLANEOUS.

Chester, Pa.—The City Council will receive bids April 16 for the erection of a new municipal building. Estimated cost, $65,000.

New Bruswick, N. J.—Board of Freeholders has instructed County Engineer to prepare specifications and advertise for bids for a 12-ton steam roller for county work.

Seattle, Wash.—The Pioneer Sand and Gravel Co., Seattle, is in the market for a stone unloader. Office, Northern Bank and Trust Bldg.

WATERWORKS.

Bancroft, Ia.—Until April 9, (4 p. m.) for the construction of a waterworks building, also for the extensions to the present water mains and for improvements to the waterworks plant. Plans and specifications may be seen at the office of the Town Clerk at Bancroft, Ia.

Canton, O.—Mayor Stolberg has estimated the cost of the proposed 2,000,000 gallon basin and pump at $59,858. He is also authorized to advertise for bids for the drilling of about eight wells in the southwest section of the city.

Chester, Pa.—To the Hughes-Foulkrod Co., Philadelphia, for the erection of a filtration plant at its waterworks. Cost, $60,000. Company will make other improvements and extensions in its system to cost about $400,000.

Dayton, O.—Metcalf & Eddy, Boston, have been retained as engineers to make a survey of the city waterworks and arrange plans for the development and extension of the plant for the next 50 years.

East Liverpool, O.—Service Director Daugherty has been asked to make waterworks extensions to the village of Pleasant Heights. City engineer is investigating the request.

Milwaukee, Wis.—H. P. Letton, sanitary engineer, of the U. S. Public Health Service, states that the early construction of a filtration plant is necessary.

Oskaloosa, Ia.—City contemplates the construction of a municipal waterworks system and is looking for an engineer to prepare plans.

Philadelphia, Pa.—Common Council arranging for appropriation of $100,000 for the Bureau of Water for equipment for the city water department. Carleton E. Davis is chief of the bureau.

Providence, R. I.—The engineering staff of the Water Supply Board is preparing plans and specifications for the 3400-ft. dam which is to thrown across the Pawtuxet river valley near Kent to create the great Scituate reservoir.

Redrock, Okla.—Until April 5, (1:30 p. m.) for the construction of a waterworks system as per plans and specifications prepared by the Benham Engineering Co., 13th Floor, Colcord Bldg., Oklahoma City, J. M. Mitchell, Town Clerk.

St. Paul, Minn.—To G. J. Grant Construction Co., was awarded contract for building the new 30,000,000 gallon reservoir at a cost of $246,054.01.

Wausen, O.—The Board of Public Affairs will retain Engineer W. J. Sherman, of Toledo, for the preparation, specification and estimates of cost for a water supply system for this city.

MOTOR TRUCKS

Printed as insert to MUNICIPAL ENGINEERING, April, 1917

MOTOR TRUCK OPERATION AND ACCOUNTING XX.

By Charles A. Dickens.

"There has yet been no mechanical device invented which will satisfactorily control the speed of a truck when coasting," states Mr. John Younger, Truck Engineer, Pierce-Arrow Motor Car Co., Buffalo, N. Y. "The driver alone is responsible for this, and he must be impressed very strongly with a sense of his responsibility. It is just as important to keep the speed of his truck down to about 15 miles an hour when coasting as it is to leave the governor alone.

"The energy stored up in a rapidly moving truck is enormous. The following figures are interesting and decidedly instructive.

"A fully loaded 5-ton truck weighing about 20,000-lbs. gross, traveling at 5 mi. per hour and brought to a stop in one second, travels 3-ft. 8-in. after applying the brakes and dissipates 16,600-ft. lbs. at the rate of 30-h.p. per minute.

"Traveling at 10 mi. per hour and brought to stop in the same time, it travels 7-ft. 4-in. and dissipates 66,400-ft. lbs. at the rate of 120-h.p. per minute. Traveling at 15 mi. per hour and brought to stop in one second as before, it travels 11-ft. and dissipates some 150,000-ft. lbs. at the rate of 270-h.p. per minute. Traveling at 20 mi. per hour and stopping as before, it travels 14-ft. 8-in. and dissipates 265,000-ft. lbs. at the rate of 480-h.p. per minute.

KEEP DOWN SPEED ON HILLS.

"Traveling at 25 mi. per hour and stopping as before, it travels 18-ft. 4-in. and dissipates 415,000-ft. lbs. at the rate of 750-h.p. per minute.

"Traveling at 30 mi. per hour and stopping as before, it travels 22-ft. and dissipates 598,000-ft. lbs. at the rate of 1,080-h.p. per minute.

"It is worthy of notice that the energy in the truck at 30 mi. per hour is only one-tenth that of a 100-lb. weight shell from a 6-in. gun with a muzzle velocity of 2,000-ft. per second. The effect of the impact of such a shell can readily be imagined. The effect of the impact of the truck can be as readily imagined. It should, however, be left to the imagination, as the driver should be so cautious in preventing his truck getting beyond his control that the reality should never happen.

"Besides, this high speed is bad for the truck itself. At 30 mi. per hour the return blow on the truck in running over a stone or a car rail or a single plank is four times as much as it is at 15 mi. an hour, and 16 times as much as at 7½ mi. an hour.

"Keep the speed of the truck down on hills. Some hills are only safe up to 15 mi. per hour. Some hills are safe only at a speed of lower than 5 mi. per hour."

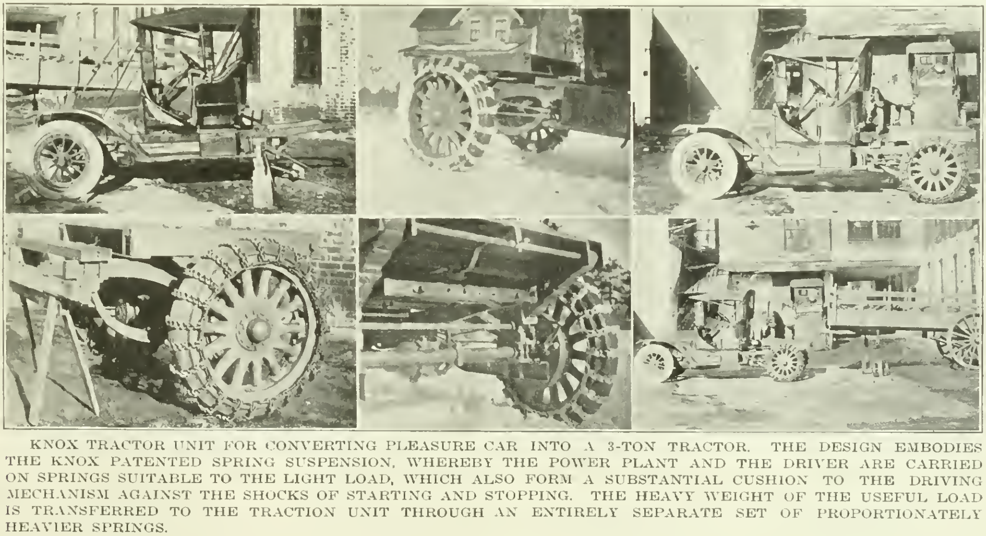
The Truck as a Hill Climber.

"The astonishing efficiency of the motor truck in hill climbing and rapid deliveries and the low cost of its operation, as compared with that of the horse truck for the same performance, furnish facts which are amazing even to those engaged in the manufacture of the trucks," states Mr. C. P. Cary, San Francisco, California. I will give you some of the facts submitted by Mr. Cary and confirmed by demonstration.

"Usually, 18 per cent. grades terminate economic animal haulage, yet a number of 25 per cent. and even 35 per cent. grades are open to traffic in San Francisco. These conditions caused engineers to say a few years ago that vehicular traction in that district was absolutely impractical. Today, however, the fact that motor trucks climb these hills, occasions almost no comment despite the fact that it means a great deal to merchants, real estate and other business men. It is extremely doubtful if a horse could pull an empty wagon, on dry pavements, up a grade of this nature.

DOES WORK OF THREE TEAMS.

"The contract price for a two-horse team, doing a yearly average of 18 mi. a day, and hauling between three and four



KNOX TRACTOR UNIT FOR CONVERTING PLEASURE CAR INTO A 3-TON TRACTOR. THE DESIGN EMBODIES THE KNOX PATENTED SPRING SUSPENSION, WHEREBY THE POWER PLANT AND THE DRIVER ARE CARRIED ON SPRINGS SUITABLE TO THE LIGHT LOAD, WHICH ALSO FORM A SUBSTANTIAL CUSHION TO THE DRIVING MECHANISM AGAINST THE SHOCKS OF STARTING AND STOPPING. THE HEAVY WEIGHT OF THE USEFUL LOAD IS TRANSFERRED TO THE TRACTION UNIT THROUGH AN ENTIRELY SEPARATE SET OF PROPORTIONATELY HEAVIER SPRINGS.

FEDERAL

Assures Schedule Service

With a FEDERAL, you can plan your haulage as you plan the output of your factory. You can schedule your deliveries to fit your needs, knowing that FEDERAL dependability will make good for you.

Scheduled deliveries mean better service to your customers and more economical haulage for you. Here is an instance of the way FEDERAL works for one city in municipal work.

This is the delivery schedule which James Riha, trucking contractor for Sears-Roebuck & Co., contracts to follow.

Truck No.		1	2	3	4
Warehouse	Ar.	7.30	7.45	8.00	8.15
"	Lv.	7.45	8.00	8.15	8.30
Plant	Ar.	8.00	8.15	8.30	8.45
"	Lv.	8.15	8.30	8.45	9.00
Warehouse	Ar.	8.30	8.45	9.00	9.15

Note—These four trucks on a 15 minute headway make a round trip each hour.

The City of Spokane depends upon a FEDERAL for asphalt haulage

Asphalt must be laid quickly after heating—gangs of men must be kept busy. That is why motor trucks, and particularly FEDERALS, speed up municipal work on pavements all over the country.

Chief among these conditions is the fact that a single horse and wagon can carry a ton at a speed of only 4 miles per hour, *while a FEDERAL can carry from 1 to 5 tons (according to size) at a speed of from 10 to 15 miles per hour!*

Realizing these facts, the public works department of Spokane, Wash., uses a FEDERAL for hauling asphalt.

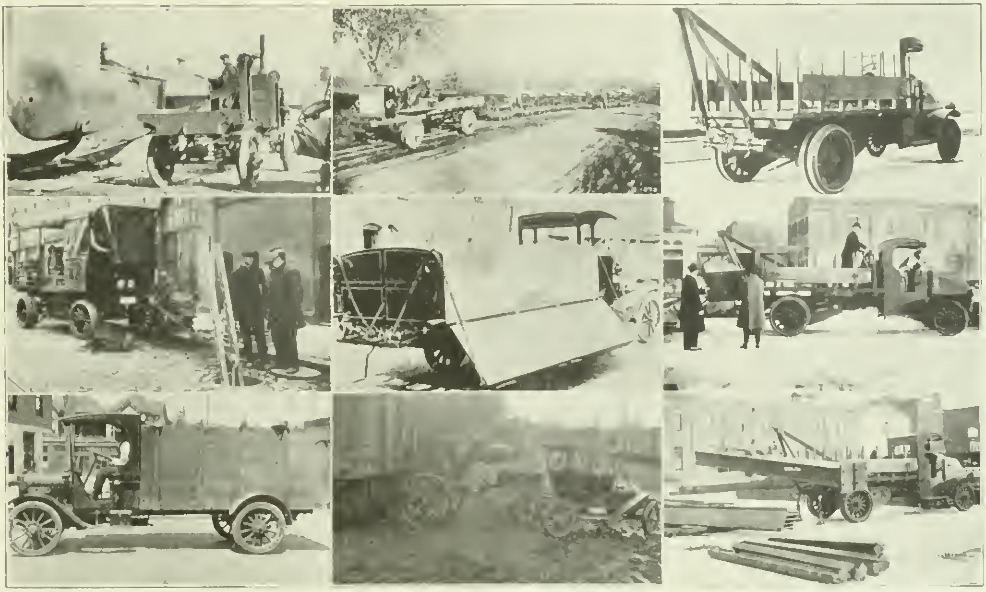
Constantly "on the go"—hauling capacity loads each trip without tiring or delay—this FEDERAL traveled 2205 miles in 99 days recently, at a total average cost of only \$5.77 per day—including driver's wages! Would you be willing to compare the haulage costs of YOUR department with these figures?

Write our Traffic Engineering Department for data on municipal FEDERALS in other cities, and give us data on your own haulage problems. We'll return an analysis that will help you.

"Federal Traffic News" sent on request.

FEDERAL MOTOR TRUCK CO.

22 Leavitt Street
DETROIT, MICH.



JEFFERY 2-TON QUAD EQUIPPED WITH LOG-ROLLING OUTFIT AS OPERATED BY THE DAYTON "D" HANDLE COMPANY, DAYTON, O.

G. V. 2-TON TRUCK, EQUIPPED WITH WINCH FOR PULLING CABLE AS OPERATED BY PITTSBURGH E. R. & L. COMPANY, PITTSBURGH, PA.

SIGNAL 2-TON TRUCK AS OPERATED BY OAKLAND, CAL., IN THE REMOVAL OF DEAD ANIMALS.

JEFFERY 2-TON QUAD PULLING ROAD MATERIAL IN CARS ON INDUSTRIAL TRACK. OPERATED BY HANLON & OKES, SIOUX CITY AND MINNEAPOLIS.

SMITH FORM-A-TRUCK AS OPERATED BY CITY OF KNOXVILLE, TENN., IN COLLECTION OF GARBAGE AND REFUSE.

FORD CONVERTED INTO 1-TON DUMP TRUCK VIA MARTIN ROCKING FIFTH WHEEL.

MACK $3\frac{1}{2}$-TON TRUCK EQUIPPED WITH SPECIAL WRECKING OUTFIT AS OPERATED BY FIRE DEPT., BOSTON, MASS.

USED IN TEARING DOWN WALLS, EXTRICATING ANIMALS FROM MANHOLES, ETC.

EQUIPMENT CONSISTS OF REMOVABLE DERRICK, SKIDS, POWER WINCH, ETC. (FULLY DESCRIBED IN THIS ISSUE.)

tons a load, including one driver, in the city of San Francisco, is $8 a day. The average speed of such a team is 3 mi. an hour. Therefore, under the conditions of delivery, such as are considered in this case, it would require three such teams at a daily cost of $24 to equal the performance of a Garford truck at 40 mi. a day, the cost of which has been accurately figured at approximately $12.24. The difference between $24, cost of three teams, and $12.24, cost of 3-ton truck, as operating charges in this case, results in a balance of $11.76 a day, making a total of motor savings for each year of 300 days of $3,522 over animal haulage.

"In housing, the horse, wagon and feed space require approximately two and one-half times that of the motor truck, and each truck being equal to three or four such teams, the space pertinent to this equation is 7½ to 1 in the truck's favor. You can scarcely overestimate what saving this means in valuable rental space."

Used as an "All Purpose" Machine.

The city of Franklin, Pa., purchased a 2-ton Armleder and put it in active service July 3, 1916. Aside from the time consumed in making minor adjustments and inspection, it has shown no loss of time, a feature that shows up especially well when compared to the lost time attributed to the use of horses in the same class of work. The truck worked at hauling a street sweeper and at gathering up the sweepings. It also hauled a scraper in grading dirt streets. All of this work required much running in low gear and a great many stops with the engine running, but in spite of these conditions, tending to increase the consumption of gasoline, the cost of operations for 3,296 mi. figures out at 9 cents a mi. Truck costs amounted to $265.00, depreciation and interest was placed at $200.00, making the total truck expense $465.00. With this expenditure the truck did a great deal more work than had been accomplished by two teams the previous year at an expense of $614.92.

Tractors From Pleasure Cars.

In commercial road transportation the two great objects to be obtained are low capital investment and low maintenance cost. The Knox Motors Associates have been studying this problem from the road tractor point of view and now announce that in addition to their powerful 8 to 10-ton tractors they are prepared to supply a traction unit which converts a pleasure car into a 3-ton tractor by replacing the rear axle and rear portion of the body of the pleasure car.

This is designed in particular to afford an outlet and a use for the hundreds of thousands of used pleasure cars for which there seems to be almost no market at the present time.

The 3-ton traction unit is being sold at $550. This, together with a used car and a dray for load carrier, make a complete outfit available for men of moderate means and those whose business requires the use of their capital in other directions.

The engineers of the Knox Motors Associates have devised a very ingenious method for attaching the traction unit to

6 to 8 miles per gallon

HAUL it in a HALL

Some Record! And "it's an *average* record based on a year's operation of HALL 5-ton trucks" by the Detroit Artificial Stone Co., Detroit, Michigan.

"And that *average* of 6 to 8 miles to the gallon," states Mr. Henry Mincel, "was not made on smooth, hard streets, either, but on ***unpaved roads*** and by-ways, many of which were not driveways at all.

"And in spite of this continual hard going, in which the HALL ***easily*** did the work of five teams, there has been practically no repairs!"

The above is just another reason why it pays to "Haul it in a HALL." Detail for detail the HALL Truck is the ***Strongest Truck in the World***—it's the Big Brute of its class—built to meet Russian Army Specifications!

Agents wanted in open territory.

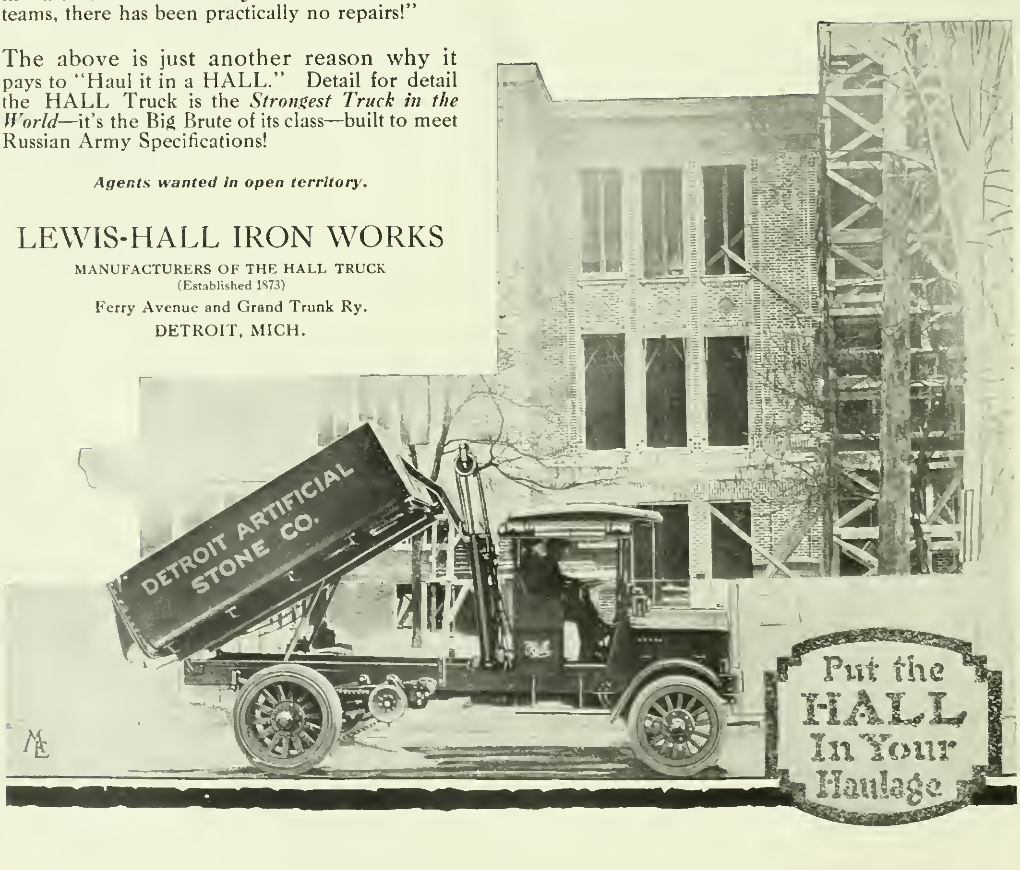
LEWIS-HALL IRON WORKS

MANUFACTURERS OF THE HALL TRUCK

(Established 1873)

Ferry Avenue and Grand Trunk Ry.

DETROIT, MICH.



GARFORD, PACKARD AND U. S. MOTOR TRUCKS AS OPERATED IN CONJUNCTION WITH STEAM SHOVELS, CRANES AND OTHER TYPES OF MACHINERY BY CONTRACTORS IN NEW YORK, CHICAGO, LOS ANGELES, ALBANY, PHILADELPHIA, BROOKLYN AND HANNIBAL. (FULLY DESCRIBED IN THIS ISSUE.)

the pleasure car frame so that variations in the frame width make no difference in the traction unit. This unit is claimed to be the first device constructed and thoroly tested out with which a pleasure car chassis can be converted and have a useful load capacity of 6,000 lbs. and include the advantage of a road tractor and motor truck.

The design embodies the same patented spring suspension as the large Knox tractor, whereby the power plant and the driver are carried on springs suitable to the light load which also form a substantial cushion to the driving mechanism against the shocks of starting and stopping. The heavy weight of the useful load is transferred to the traction unit thru an entirely separate set of proportionately heavier springs. The necessary gear reduction is accomplished thru an internal gear driven rear axle so that the motor may be run at normal speed and its full power developed under conditions on which its original design was based.

This construction gives large capacity with low fuel cost and long tire life and its maintenance cost is, therefore, exceptionally low.

The evolution of this hauling outfit is an exceedingly simple yet interesting change. The old pleasure car is first stripped of its body, from the rear as far forward as the back of the front seat and the rear axle and springs removed. Next the cross channel of the traction unit is slipped over the stripped pleasure car frame, squared up and after the drilling of four holes in the car frame bolted down into place. The propeller shaft is then connected to the internal gear drive axle by means of the special universal joint flange, furnished with each unit, and the brake rods hooked up. The tractor is then ready to operate.

If a horse-drawn dray is to be used as a load carrier, the front axle with its wheels and pole is removed and the special bolster plate furnished with the unit properly fastened in place. The tractor is then backed under the load carrier, which has had its front end jacked up to permit of this operation, the load carrier lowered into place on the tractor turntable and the completed outfit is ready for immediate service.

Hauls, Rolls and Pumps Oil.

A 3½-ton worm truck, operated by Marion county, Missouri, not only trails a road oiler but pumps the oil from the tank car into the oiler.

"I have pulled a 10 per cent. grade with it," states the driver, "and have graded some road and have pulled as much as 14 tons on short hauls. That is, I pulled a large Mogul tractor that weighs 14 tons."

While De Guehery keeps a record of costs and mileage, the work of the truck varies so much every day that he says it is nearly impossible to give exact figures, except that recently in hauling gravel a mile and a half, the truck displaced five teams for four days, and that the truck hauled more than the teams would have in this time, and spread the gravel on the road with half the labor.

"On road patching the truck works fine," says De Guehery, "because we can roll the rock into the ruts with the rear wheels of the truck, and two men can do more with the truck than six can with a team."

"'Tis dead aisy drivin' th' Gramm-Bernstein through th' rainy sloppy roads-sure Im thinkin she can swim
Transmission Tim

The G-B Co. are the only manufacturers in America who guarantee their transmission, springs and radiator for the entire life of the truck.

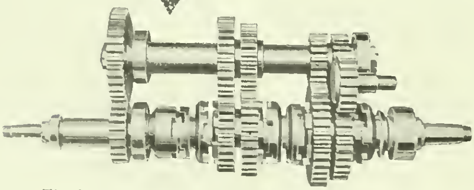
C. A. Ransberger of Cleveland says:—

"Am using twelve motor trucks of several different makes, but think my Gramm-Bernsteins have the best transmission on the market."

Before buying any truck it's a good idea to "ask the man who owns one," but if you want real unprejudiced advice, ask the man who owns several different kinds—he can tell you their relative merits, based on experience with the very same sort of work.

With the G-B transmission the verdict is unanimous because this trouble-proof gear box nips a large proportion of your ordinary truck ailments in the bud. That's why the operating cost sheets of G-B owners are minus so many expensive "lay-offs" and repair bills.

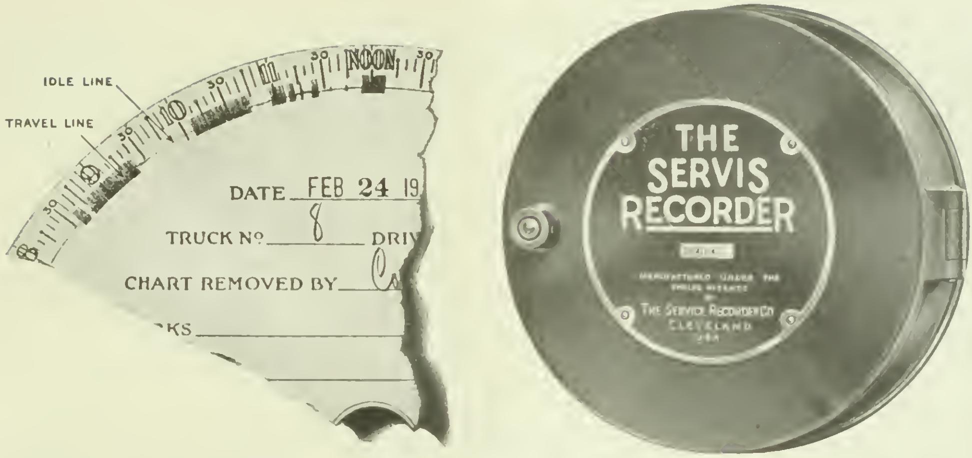
No concern could stay in business like we have for 16 years, and make good on the broadest guarantee given with any truck in America, if the car itself did not make good.



The famous trouble-proof, constant mesh transmission.

The Gramm-Bernstein Motor Truck Co.

LIMA, OHIO.



SERVICE RECORDER DESIGNED TO ACCURATELY CHECK THE TIME ELEMENT OF MOTOR TRUCK OPERATION. CONSISTS OF AN EIGHT-DAY CLOCK MOVEMENT TO TURN RECORD SHEET. (DESCRIBED IN THIS ISSUE.)

De Guchery opines that a truck cannot be used more profitably in any service than in country work and road building.

Loads Its Own Logs.

An unusual motor truck has just been designed. It is a 2-ton Jeffery Quad with 142-in. wheel base, upon which is mounted a log-loading outfit.

Logs are rolled on the flat body of the truck over a pair of skids, by means of a device driven from the transmission. Two uprights with pulley arrangements are on one side of the vehicle's body. Wire cables are simply looped over the logs to be loaded, and when the motor is started they are pulled up over the skids. The owners are using this outfit to haul logs to the factory. Besides its self-loading feature, the truck is able to negotiate all kinds of rough going because of its power being distributed on all four wheels.

Truck Used as Switch Engine.

In this issue we illustrate a Garford 5-ton truck (bucking a freight car) as operated by the George Solms Company, Brooklyn, N. Y. "I am a dealer in building materials," states Mr. Solms, "and a year ago bought a second-hand Garford motor truck, 5-ton capacity. It had been used then somewhat over a year, I understood, and I liked the way it worked, so bought it. As is often the case in big yards like mine in Richmond Hill, it is necessary to move freight cars loaded with cement or coal or some heavy material from one part of the yard to another.

"We used to 'pinch' the cars along by hand with a pinch bar, a slow and difficult process. One day a Garford salesman from your office happened along and saw what we were doing. 'Why don't you make your Garford do that for you?' he asked. No sooner said than done! So today our Garford truck—almost human it is—pulls or pushes a car full of material to where we want it, then trundles itself around to the freight car door and almost loads itself with cement—or whatever it is—and whisks it away to the waiting contractor."

Utilizing the Pleasure Car.

In this issue we illustrate a Ford as it appears converted into a 1-ton truck by means of the Martin Rocking Fifth Wheel attachment.

"A pleasure car runabout may be used as a tractor and can safely draw a ton," states Mr. Martin. "It can thus do duty as a commercial vehicle as well as a pleasure vehicle. This is surely an advantage worth considering. Another great advantage is that idle time of the motor can serve a

SIGNAL MOTOR BUSSES AS OPERATED FROM POMONA TO LOS ANGELES, CAL.

United Trucks Meet Every Municipal Requirement

During the warm months—when municipal work is at its height—**United Trucks** become doubly valuable.

They are designed essentially for the hard, rush work encountered. Their unfailing reliability, rugged construction and faithful endurance—their tremendous power and ability to transport the *biggest* loads in quick time—are factors of prime importance on *big municipal jobs* where time means money.

Standardized construction throughout — every mechanical detail well known by name, reputation and practical experience. Made in 2, 3½, 4 and 5-ton sizes—all worm drive—all for heavy duty hauling.

Write now for complete information.
We can make prompt deliveries.

United Motors Company

690 North Street GRAND RAPIDS, MICH.

United Trucks

FEDERAL 3½-TON DUMP TRUCK AS OPERATED BY ALDENBROOK, CONTRACTOR, NORFOLK, VA., IN HAULAGE OF OVER 3,000,000 POUNDS PER MONTH AT A COST PER TON OF 15 CENTS.

number of trailers—one trailer loading, another unloading and a third on the way. The Estes Lumber Company, of Birmingham, Alabama, are using a Martin Semi-Trailer in connection with a Ford runabout. They state that with this system they deliver as much in one day as they could with three single teams—that they are not only getting better service, but are saving a great deal of money."

Trucks Empty Manholes.

In springtime and after heavy rainfall, considerable trouble is experienced by the underground department of the Pittsburg Electric Railway & Light Company, of Pittsburg, Pa., because the manholes are without adequate drains and flood with water above the cables.

The cable ducts above the manholes permit the water to flow from one manhole to another, until many of them completely flood and make it necessary to pump them dry before any cable work can be done. The old fashioned way of meeting this exigency was with a hand pump, but work with that device was very tedious and oftentimes required from one to two or more hours continuous pumping. It was finally decided to design an electrically driven pump.

The electric light company claims by this method to have reduced cable-pulling costs from 2.4c to 1.1c per foot (using a 2-ton G. V. motor truck) as against hand pulling.

In Conjunction With Steam Shovels.

In this issue we illustrate several makes of motor trucks as loaded with Thew steam shovels and Browning locomotive cranes. The trucks illustrated are used by the following contractors: Watson & Spicer, Los Angeles, California; R. T. Ford & Company, Albany, New York; Murphy Rivinac Company, New York City; W. J. Newman & Company, Chicago, and McDowell Bros., Philadelphia, Pennsylvania.

Thirteen Cents per Ton-Mile.

A 3½-ton Federal dump truck as operated in the general haulage of cement by Aldenbrook, contractors, Norfolk, Virginia, for the month of August, 1916, averaged 60 tons per day. Following is a good month's average record:

Days of service	25
Number of trips	407
Weight of pounds carried	3,048,750
Miles traveled	975
Tons delivered per day	60.9
Miles traveled per day	39
Round trip distance	2.4
Miles per gallon of gas	4.3
Cost per day	$9.50
Cost per mile	.24
Cost per ton	.15
Cost per ton-mile	.13

Boston's "Wrecking" Truck.

Wrecking is one of the most important features of the work of a fire department, and in line with the rapid and almost universal motorization of fire-fighting equipment has come the motorization of the wrecking portion of Boston's fire department. For this purpose a 3½-ton AC model Mack chassis, furnished by the International Motor Company, of New

KNOX TRACTOR AS OPERATED BY PETERS & BAIRD, WADSWORTH, O. HAULING SEMI-TRAILER AND FOUR DUMP WAGONS (BOTTOM DUMP) ON SIX-MILE HIKE.


Butter & Egg Co.

York, has been fitted with a special wrecking outfit which is interesting.

The work of this truck will be to aid in wrecking during a battle with the flames and for subsequent clearing of traffic and removal of dangerous ruins. For example, picture a warehouse burning in an inaccessible portion. This truck, thru its special equipment, will be able to tear down whole walls, giving the firemen a chance to reach the base of the fire. If vehicles obstruct the way so that the fire engines and trucks cannot reach the scene, the wrecking truck will be called upon to move them to one side, regardless of how disabled they may be. Derailed street cars can be replaced on the rails, trucks and fire engines may be extricated from holes in the street caused by caving in. In a fire in a railroad yard this truck may move freight cars from the source of danger or burning ones away from combustible surroundings.

The equipment of the vehicle comprised a removable derrick at the rear end, a platform body with stakes, two large skids, carried one on each side of the body, a power winch with 250 feet of ⅝-inch cable, two powerful jackscrews, and miscellaneous wrecking tools.

The winch may be used for all sorts of purposes, such as in the pulling over of dangerous walls, where it serves to pull the cable of the derrick. It can tow disabled vehicles, or, by removing the derrick and attaching the skids, it may pull such a wreck onto its own body.

The jacks are placed under the rear end of the body when the derrick is used, so as to take the stress from the springs and axle.

Sprags are fitted to take the thrust when using the winch for pulling. The truck is painted a bright red and has electric starting and lighting, for a quick light-up and get-away in an emergency.

Such a vehicle has a field of usefulness not confined to fire department work, since it can also be used by construction companies, contractors, house-wrecking concerns, etc.

An Aid to Service Records.

The service recorder, about 8 inches in diameter, has been designed to check accurately the time element of motor truck transportation. This device must be installed to face either the front or back, but need not be mounted on a perfectly vertical surface. Ordinary vibration, like the running of the motor, has no effect upon it, but as soon as the truck starts it begins its record.

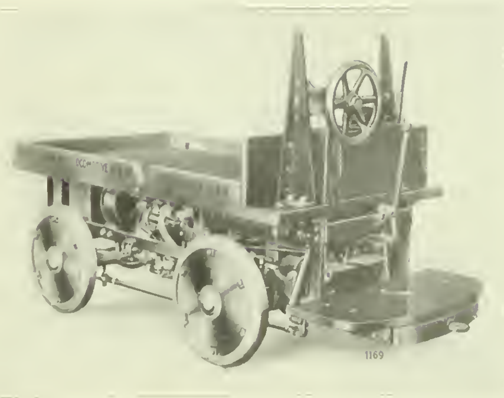
The screws holding this instrument to the truck are within the instrument, so that when it is locked it can neither be removed nor tampered with. This feature at once becomes the friend of the conscientious driver, preventing dispute or suspicion.

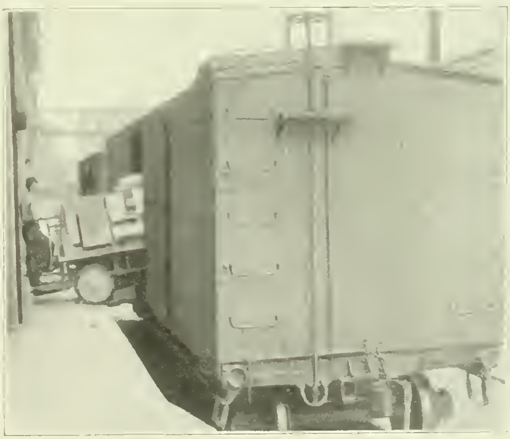
This device somewhat resembles a double clock face in that it shows a complete 24-hour period. On this disc are reproduced the time movements of the vehicle to which it is attached.

Moving time is shown by broad black marks, as seen in the cut, while the idle time is shown by the blank spaces between the black marks. One big advantage of this record is that each running and idle period is shown at the exact time it occurs. These record sheets must be renewed each working day.

The following facts are easily determined from records recorded by this device:

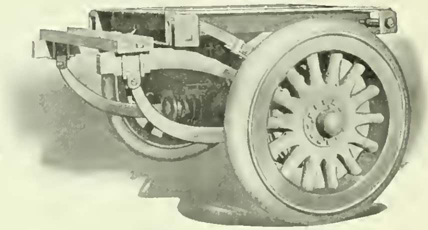
When did each truck begin work?
When did each truck stop work?
How many hours of actual service for each?
How much delay for loading?
Is your shipping system efficient?
Which drivers are most punctual and reliable?
Are the stops too long?





MILWAUKEE LOCOMOTIVE TRACTOR-TRUCK CAPABLE OF PULLING TRAILER LOAD UP TO 3½ TONS (INCLUDING WEIGHT OF TRAILERS) SUBJECT TO CONDITION OF ROAD AND GRADE. TRUCK STEERS BY FRONT WHEELS WHICH ARE ATTACHED TO A FRONT AXLE BY STEERING KNUCKLES AS IN AUTOMOBILE CONSTRUCTION.

A KNOX TRACTION UNIT



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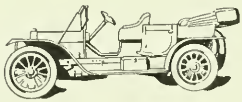
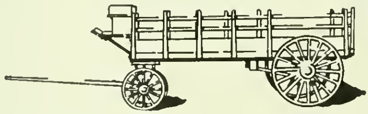
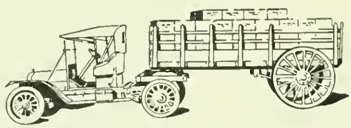




CAR AND HORSE DRAWN DRAY INTO



A THREE-TON MOTOR HAULING EQUIPMENT

IN FIVE HOURS TIME AT AN EXPENSE OF

$550.00

Catalog giving full details of all size units on request.

KNOX MOTORS ASSOCIATES

SPRINGFIELD, MASS.

Vol. LII. — No. 5.

Municipal Engineering

The World's Leading Municipal Publication

May, 1917.

STREET PAVING PROBLEMS We hope that our readers who find anything in the series of articles on Street and Road Pavements with which they are not in accord, will give their point of view and reasons for differing, if they do, or will ask any questions necessary if the articles are not clear.

There are many chances for difference of opinion, especially in the classes of pavements under consideration in the current numbers and one purpose of these articles is to induce discussion in a scientific spirit of these points where differences of opinion occur, so that the facts can be agreed upon as nearly as possible. Then the differences of opinion will be reduced to a minimum, perhaps even to the point of eliminating all but those based on commercial exigencies.

The articles do not present a single point of view but quotations are made from various authors, engineers, chemists and constructors, which give as nearly the facts in the various cases as possible, and also present some of the differences in opinion based on these facts. To a certain extent they reflect the editor's conclusions, drawn from his study and experience, but no one could agree with all that is given in the articles at one and the same time. But even if they were such a statement of his opinions, he would welcome discussion. If you have anything to say, write it down at once and send it in.

ENGINEERS AND THE WAR How many of our readers have put their names down on the numerous lists of engineers who may be called upon in case of need for war service? Universities, societies, national and local, committees on preparation for the war, are all distributing lists of questions the answers to which are intended to show the qualifications of every engineer, the kind of work in which he thinks he would be most efficient and the apparatus or material which he has on hand or can secure which would be usable in case of need.

It seems probable that but little of this material or but few of the men will be required, but the most efficient and prompt service can be secured at the least cost of disarrangement of present industries, as well as of time, money and loss of opportunity, if all the resources of the country are catalogued and filed as the system, of which these questions and answers form a part, contemplates.

Much of the service will be rendered in this country and much will be of such nature that the limits of military age and physical ability do not apply to it, so that you should fill the blanks with due statement of such limitations and disabilities, so that you can be used at home, releasing those of military strength for service abroad when they are needed. Put your names and qualifications in the catalog, either thru your college or society, or directly thru the Engineer Reserve Corps of the Army at the U. S. Army Headquarters of the Division for the state in which you live.

CHANGES IN STANDARD SPECIFICATIONS The chairman of the Committee on Standard Specifications of the American Society of Municipal Improvements, George W. Tillson, Boro Hall, Brooklyn, N. Y., expects all changes in specifications proposed by the sub-committees to be in his hands on or before September 15, that the reports of the committees may be printed with the advance papers for the convention to be held in New Orleans, November 12-16. Those desiring any such changes must therefore present them to the chairman of the proper subcommittee in ample time for discussion by the subcommittee and incorporation in its report, at least as early as September 1. Copy of the proposed changes should also be sent to Mr. Tillson. It is understood that no proposals for change of specifications will be considered by the committee at the convention or by the convention itself which has not been first presented as above provided.

Mr. Tillson is also chairman of a special committee to consider changes in the constitution of the society and members can make to him any suggestions regarding changes which they may deem advisable. The report of the committee on revision of constitution will also be printed with the advance papers and any communications regarding it should reach Mr. Tillson by September 1.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

THE CONSTRUCTION OF BITUMINOUS PAVEMENTS

By the Editor and Others Quoted.

In the preceding article the plant section of the construction of asphalt pavements was considered. For other bituminous pavements requiring mixing of materials the general operations at the plant should be carried on under the same principles, tho details vary greatly for the different bituminous pavements, ranging from bitulithic to bituminous macadam, mixing method, and only such differences will be mentioned here and later. The operations on the street are also different, mainly in detail, and that end of the work of construction is the principal topic of this article.

IT is assumed that the foundation of the street is properly laid and that only the placing of the bituminous wearing surface is to be considered in this article, the material therefor being supplied by the plant as described in the preceding article.

Laying Asphalt Pavement.

The asphalt wearing surface is an intimate mixture of sand and asphalt with the proper proportion of stone or cement dust to temper the softness of the mixture and aid in filling the voids. In theory every particle of mineral matter, large or small, must be covered entirely with a film of asphalt, which in this finely drawn out condition has an enormous surface tension, tending to hold the particles of mineral matter close together when they are in proper proportions of larger and smaller sizes from sand to the finest dust to make the voids in the mixture of mineral matter a minimum, and the mixture has been thoroly rolled into place so that the particles are forced into as close relations with each other as possible. The result of this process, when 9.5 to 13.5 per cent of bitumen by weight is used, is a dense pavement, waterproof and capable of withstanding heavy wear. The percentage of bitumen by volume is greater than the above percentage by weight, since bitumen has a lower specific gravity than the mineral matter.

The unstable sand, mixed with an asphalt cement, which could not carry traffic if used alone, produces a compound, if properly proportioned, tempered, and mixed, which forms a stable and durable paving mixture, for the reasons above suggested and fully elaborated by Clifford Richardson and others. The necessity of close adherence to the proportions fixed by the chemist and of most thoro mixing and rolling are thereby demonstrated, as well as the necessity of treating the mixture as to heat, standing in truck or on street, and handling, so that there will be no separation of the mineral matter from the bitumen.

Experience has shown that the wearing surface mixture does not surely adhere to the concrete or other foundation even when it is left rough in an attempt to form a bonding surface, and that pavements so laid roll and shove. The standard specifications therefore require a binder course which is a mixture of 4 to 7 per cent of bitumen, 15 to 35 per cent of material passing a 10-mesh screen and 20 to 50 per cent passing a ½-inch screen, according to character of material and traffic conditions. This mixture does not have the voids in the larger stone completely filled, and is quite porous and permits a close union of the wearing coat with the upper surface of the binder. In this way, if neither binder nor wearing surface is too soft and neither binder course nor the surface of the concrete is lubricated or injured by the absorption of water, there will be no shoves or rolls in the completed pavement. While the mixture for the binder course need not be as carefully designed or mixed as the wearing surface, it is a very important part of the pavement and must have its full share of careful attention. All inequalities in the foundation must be taken up by the binder course and the top surface when finally rolled must be parallel with the finished surface of the wearing coat.

The care with which the binder course must be laid is indicated by the standard specifications that temperature must be carefully regulated; that spots showing an excess of asphaltic cement after rolling (due, probably, to imperfect mixing or to separation of mixture in transporting and handling) must be cut out and replaced with better mixed material; that any binder showing a lack of bond or whose bond is broken after rolling or is otherwise defective shall be cut out and replaced with good material. Each spot of defective binder which is covered by the wearing surface without correction is a source of danger from rolling or shoving or crushing under load or disintegration.

The binder course must be clean when the top is laid on it, swept if necessary, and the top should be laid before the asphaltic cement of the binder has become cold. The best results are obtained when the wearing surface is laid promptly after the completion of the rolling of the binder course. Failures occur not seldom from laying top on wet binder.

The limit of variation in irregularities in the concrete or other foundation which can be taken up by variations in the thickness of the binder is rather large, 40 per cent of the average thickness. Thus, if the average thickness is 2 inches, the thickness of the binder course may vary from 1.2 to 2.8 inches.

The thickness of the binder and surface coats varies according to local conditions of traffic, temperature, etc., according to the limitations of cost, and according to the preferences of the designing engineer. The variations found in practice are shown in the article in this series on the design of bituminous pavements.

The asphalt surface is so smooth that contractors are sometimes careless in making it uniform and even. This is a serious defect in construction even when the longitudinal grade of the street is heavy because the depressions in such an uneven surface will hold water and no pavement will withstand the action of water and of frost on water for a long period of time. One reason for inequalities in the rolled surface can be removed by a little care. When the asphalt mixture is

LAYING BERMUDEZ ASPHALT CONCRETE ON RIVERSIDE DRIVE, NEW YORK, ON CONCRETE FOUNDATION. TWO LAYERS OF $1\frac{1}{2}$ INCHES EACH TO INSURE PERFECT COMPACTION.

dumped from the truck in which it is brought to the street it consolidates somewhat under the weight of the mass, and the material shoveled and raked out to form the layer does not have this initial consolidation so that it will settle down under the roller more than the undisturbed area at the place of dumping. The inequalities in the surface which result can not be rolled out. The remedy is to dump the truckload of mixture where it must all be shoveled into its proper place, thus giving the roller practically the same work to do on every square foot of the surface. The small amount of extra labor required for shoveling the whole load instead of only what can not be raked out is much more than compensated for by the less difficulty in rolling and the greater uniformity of surface. On level streets, where drainage must be secured by change in depth of gutter, uniformity of surface is absolutely essential, especially at the summits of the gutter grades where the curb has the least height and the crown of the street is the least. Here the smoothness of the surface is the only dependence for adequate drainage. Expert raking of the asphalt to surface, prompt first rolling so that any deficiencies in thickness due to errors in raking can be corrected before the mixture becomes too cold to rake up to receive the new material, are essentials of accurate work in producing uniform surface. A straight-edge 12 or 14 feet long is a material aid in securing the necessary uniformity of surface, particularly when the rakers are not highly expert or are not dependable workmen.

Cold mixtures are producers of uneven surfaces. For short hauls horse-drawn wagons are most economical, but the loads should be as large as possible, to retain the heat on leaving the plant as nearly as possible. For long hauls the loads should be as large as possible for the same reason and the motor truck will be found desirable to carry the large loads and to reduce the time of haul from plant to street. The trucks should have steel inner linings, asbestos interlinings and wood outer linings and should be equipped with light steel and asbestos covers, all for the purpose of keeping the heat in the load until it is ready to spread on the street. Light oiling with the residuum oil used for fluxing will prevent the load sticking to the steel lining, but the least possible quantity should be used.

The loading of trucks is most important from the point of view of economy. A truck should be built to carry a certain load, says 5 tons, over rough ground such as may often be found near the plant, especially if it is a railroad or semi-portable plant located off the paved roads. It must often travel over roads also at or in the vicinity of the street to be improved. In case the yard at the plant and the approaching streets are well paved and the streets on the way to the job are also in good condition the truck may be loaded safely to 7½ tons, with a considerable increase in economy. But it does not pay to overload a truck. Breakdowns, causing delays or transfers of loads, trucks out of commission, cost of repairs, all mount up fast and soon wipe out any economy shown by figures based on safe operation of trucks as to loads and speed. Good judgment in suiting loads to roads to be traveled is worth much money.

It is the opinion of some engineers that failures of asphalt pavements are due more frequently to binder troubles than other causes. They may be any one or more of the following: Laying binder on green or very wet concrete or on a dirty, unswept concrete; use of insufficient bitumen or burned bitumen; too large maximum size stone in aggregate; lamination in stones; laying mixture when too cold; rolling too much when cold; allowing traffic on binder before top is laid; laying top on dirty, defective or wet binder. To these may be added as causes for failures of asphalt pavements sub-grade difficulties, such as settlements from careless backfilling or lack of time allowance for settling of fills and poor drainage; foundation failures due to defective concrete materials; too little cement or mortar or imperfect mixing of concrete; and failures of the surface coat due to failure to suit the amount of filler and the hardness of the bitumen to the kind of traffic and the climate, or to the action of frost on water getting into the joints along curbs, manholes, and street railway tracks.

The following by Lester Kirschbraun adds weight to what precedes:

"One of the most striking advantages of a bituminous surface is its smoothness. It is by no means a simple matter to produce a smooth surface in a bituminous pavement, and it requires constant and faithful attention to details of workmanship in order to accomplish this desirable result. In order to produce a smooth surface on mechanically mixed work it is desirable that the course upon which the surface is laid be as even as possible so that a uniform thickness of surface may be applied. It is desirable that the mixture be brought to the work at a temperature at which it may be easily manipulated. The paving composition should be broken up thoroly to free lumps of partially compacted mixture. The raking should be of such character that the mixture is broken up and combed out to a uniform degree of looseness, so that when the rollers are run upon the surface an even degree of compression will result. It is very frequently the practice for the mixture which arrives on the work to be dumped too close to the spot on which it is to be laid, and for the rakers to walk upon the mixture. Any such detail of workmanship which results in a raked mixture of uneven density will inevitably result in an uneven surface. An even thickness of uniform density of loose material is a prime requisite for a smooth surface.

"The compression of the raked mixture by rolling is the

STONE-FILLED ASPHALT PAVEMENT ON MANSFIELD STREET, MONTREAL, QUEBEC.

next operation. The roller should be of the maximum weight per inch of tread which is permissible without imparting too much movement to the raked material. The size of the roller and the stage at which it is applied is, to a certain extent, dependent upon the type of mixture. A mixture of large aggregate and of great stability is best rolled with the heaviest possible roller applied just as soon as the mixture is spread. Mixtures of this kind are too dense to squeeze out under a light roller. Sheet asphalt mixtures, on the other hand, may be rolled advantageously with lighter rollers, applied usually after the mixture has partially cooled and obtained sufficient stability to avoid excessive movement or picking up on the rollers. The rolling is most advantageously done by working from the gutters toward the crown of the street, and the pavement should be rolled cross-wise, diagonally, with various modifications thereof as permitted by the width of the pavement and the conditions under which the work is handled. Rolling should be carried on slowly, at an even speed, without jar or impact, and with particular attention to smoothness of operation in reversing the roller. The length of time during which rolling will be effectively continued is a variable with the temperature and condition of mixture, but it is always desirable to continue just as long as the roller makes any impression on the surface.

"In connection with sheet asphalt pavements, too little attention is paid to rolling of the binder course. This course is the element which provides the stability for the sheet asphalt construction, and its thoro rolling and compaction is essential not only to a smooth surface of the finished pavement, but to the maintenance of a smooth surface under traffic."

Laying Bitulithic Pavement.

Bitulithic pavement being an asphaltic concrete, composed of broken stone, sand and asphaltic cement, laid in one layer, the operations of the plant differ from those described in the preceding article in some details. It is not necessary to change mixers or mixtures for two layers. The stone and sand being separated into several sizes, usually three, and mixed in definite proportions by weight, they are elevated to a rotary dryer like that in an asphalt plant and the hot materials from the dryer are elevated to a rotary screen with mininum opening of 0.1 inch and maximum of 1½ inches. A sample specification of the intermediate sizes is that of Portland, Ore., as follows:

Aggregate passing 1½-in. screen and retained on ½-in., 36 to 50 per cent;

Passing ½-in. and retained on ¼-in., 12 to 20 per cent;

Passing ¼-in. and retained on 10-mesh, 8 to 12 per cent.

To this is added, aggregate passing 10-mesh screen and retained on 200-mesh, 24 to 32 per cent;

Passing 200-mesh screen, 4 to 7 per cent.

Bitulithic cement, 7½ to 9½ per cent.

It is also specified that from 50 to 70 per cent of the aggregate passing a 10-mesh screen shall pass a 40-mesh screen, and from 20 to 35 per cent of the sand shall pass an 80-mesh screen.

These sizes of stone pass from the screen into separate bins and are drawn in the proportions fixed between the above limits into a box on a scale with multiple arms so that the proportions are held exactly, any necessary fine material not obtained from the stone being added.

The proportions stated are varied in different localities according to conditions of temperature, climate, kind of stone and sand and kind and hardness of bitumen. Usually a softer bitumen can be used than with sand mixtures.

The definite weights of the various sizes of stone are mixed in a mechanical mixer with the bitulithic cement at 250 to 300 deg. F. temperature and dumped into a truck for carriage to the street, where the single course is placed, shoveled, raked and rolled in a manner similar to that described for asphalt pavement, to produce a layer usually 2 inches thick, but varied according to traffic, solidity of foundation, etc.

A coating of ¼ gallon of bitulithic cement per square yard is placed over the surface and a thin layer of 25 pounds of hot stone chips per square yard, not exceeding ¼-in. size, is then spread and rolled thoroly into the wearing surface to make a solid, dense bituminous cement.

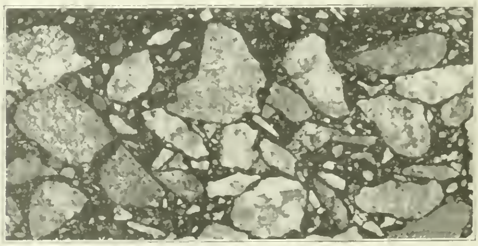
Bitulithic and Warrenite pavements are laid on cement concrete, on bituminous concrete, on gravel bituminous, on broken stone or gravel bases, on old macadam or gravel if well compacted and on solid sub-grade.

Other asphaltic concretes differ from bitulithic in the proportions of the various sizes of stone used and in methods of mixing and laying follow approximately the same program.

Other Asphalt Concretes.

Amiesite is an asphaltic concrete which is laid cold in two courses on cement concrete or other sound foundation. The mixture is made at a central plant, the asphalt cement being haeted for this purpose, and shipped in cars to the place for use. To heat the mass in the cars so that it can be shoveled out steam is used, forced into holes dug in the mass, so that the heat of the escaping steam reaches the whole mass. A 2½-inch course of the binder is laid and thoroly compacted and is followed by ½ inch of the wearing surface, also thoroly rolled.

The so-called Topeka mixture has been modified until it has become a fairly satisfactory asphaltic concrete. Some of the proportions of various sizes of stone used in various varieties of asphaltic concrete are shown in the accompanying table.



SECTION OF ENDURITE PAVEMENT AS LAID BY WARREN BROTHERS COMPANY.

PROPORTIONS OF SIZES OF AGGREGATE AND BITUMEN IN PRINCIPAL SPECIFICATIONS FOR ASPHALTIC CONCRETE PAVEMENTS.

Screen Mesh	Bitulithic Portland Ore.	Asphaltic Concrete Portland Ore. %	A. S. M. I. "	Topeka %	Stone Filled %
1½ in.—½ in.	36-50	.....	.....	.....	.....
½ in.—¼ in.	12-20	5-9	5-10	10-	.....
½ in.—10-mesh	.....	.....	.....	.....	20-35
¼ in.—⅛ in.	.....	.....	15-20	.....	.....
¼ in.—10-mesh	8-12	27-31	.....	8-22	.....
⅛ in.—20-mesh	.....	.....	10-20	.....	.....
10—40-mesh	.....	13-17	.....	25-55	7-25
10—200-mesh	24-32	.....	.....	.....	.....
20—40-mesh	.....	.....	10-25	.....	.....
40—80-mesh	.....	.....	10-25	.....	11-36
40—200-mesh	.....	28-33	.....	18-30	.....
80—100-mesh	.....	.....	.....	.....	.....
80—200-mesh	.....	.....	10-20	.....	7-25
Passing 200-mesh	4-7	6-10	7-10	5-11	7-14
Asphaltic cement	7½-9½	9-12	7-9	.....	8-12

First column: Screen sizes of specifications; stone passing the larger screen and retained on the smaller screen. Percentages given opposite them are percentages by weight of the total amount of aggregate. In the Topeka specification the percentage of stone passing ½-inch and retained on ¼-inch screen is "less than 10 per cent."

Second column: Percentages specified for bitulithic in Portland, Ore. Specifications vary in other cities according to kind of stone and its action in crushing.

Third column: Percentages specified for asphaltic concrete in Portland, Ore., not infringing the bitulithic specification.

Fourth column: Percentages specified in the standard specifications for asphalt concrete adopted by the American Society of Municipal Improvements. This specification is accepted by the owners of the bitulithic patents as not an infringement.

Fifth column: The so-called Topeka specification percentages, being those fixed by a Kansas district court decision as not infringing the bitulithic patents.

Sixth column: The so-called stone-filled asphalt specification percentages in use in Montreal, Que., presumably not infringing the bitulithic specification.

None of these specifications are under patent protection except the bitulithic in the first column.

The proportions given for bitulithic are those specified in Portland, Ore. Those for asphaltic concrete are also those specified for Portland, Ore. The column headed A. S. M. I., gives the proportions specified by the American Society of Municipal Improvements. The column headed Topeka gives the proportions given in the decree in the Topeka case as being a mixture which would not infringe upon the bitulithic patent. The column headed Stone Filled gives the proportions specified in Montreal, Que., for the mixture so called, which has been laid also in Schnectady, N. Y., and Milwaukee, Wis., by C. A. Mullen and is an approximation to the proportions used on the Riverside Drive, New York, which is pointed to by the Barber Asphalt Paving Company as one of their most successful installations of this class of pavement. The photograph on page 227 shows it under construction. Another photograph shows the stone-filled asphalt pavement on Mansfield street, Montreal, Que.

A pavement closely resembling asphalt concrete in structure tho differing somewhat in method of construction is endurite, laid by Warren Brothers Company. It can be laid on a concrete foundation or on an old macadam road if the surface of the macadam is scarified and brought to a uniform surface or up to grade if necessary. On the foundation thus prepared is laid 2 inches of relatively coarse stone, stone screenings and sand mixed in a suitable mixer with bituminous cement which is relatively harder than would be used on a surface exposed to traffic. This layer is not compressed, is naturally loose and open to receive a surface layer ½ inch in thickness made of sand or fine mineral matter and a large proportion of bitumen somewhat softer than that used in the lower layer. The total thickness of 2½ inches of bituminous mixtures is then rolled thoroly in one operation so that the finer mixture of the top is well incorporated in the lower layer, thus compacting them into a single layer without joint, as shown by the accompanying photograph. The fine-grained wearing surface is of varying thickness and rather thin and is so thoroly incorporated with the coarser mixture that it has no tendency to separate from it. Neither does it show under traffic as it would if it were of the usual 2-in. thickness of the wearing coat of asphalt pavement. A comparatively soft stone can be used in the lower mixture and a harder mineral matter in the wearing surface.

Constructing Bituminous Macadam Pavements.

All the above described pavements may properly be classed as asphaltic concrete. Some of the better grades of those following are so classed by some engineers, but as there is no predetermined effort in any of them to form mixtures or to select products of stone crushers which have stability in themselves, or any very close approximation to uniformity in grading of sizes, the line between asphaltic concrete and bituminous macadam is drawn at this point.

Perhaps the nearest approach of pavements of the bituminous macadam class to those of the asphaltic concrete class will be found in the specifications adopted by the American Society of Municipal Improvements for a pavement (styled bituminous concrete) with mineral aggregate composed of one product of a stone crushing plant. This specification provides that all the stone shall pass a 1¼-in. screen; that 1 to 10 per cent shall be retained on a 1-in. screen and 3 to 10 per cent shall pass a ¼-in. screen. This follows, in principle, specifications in common use for all classes of macadam pavements, tho the detail of exact sizes may differ.

The process of laying a bituminous macadam pavement is well described in the following from a paper by E. H. Townsend, engineer under the Massachusetts Highway Commission:

The surfacing was laid on a foundation of 6 in. of gravel and 8 in. of large stone fragments with about 2 in. of broken stone screened from the old macadam. Upon this was placed the 2-in. surface consisting of a mixture of broken stone and asphalt.

The stone used in the mixture was a hard local trap. All of the crusher product passing a 1¼-in. screen was used in the aggregate. The matrix material was a cut-back petroleum product with the trade name of Texaco No. 54 paving cement. This is a heavy bituminous material of specific gravity about 1.03 and a penetration of about 75.

The bitumen was to be thoroly incorporated with the stone by means of a mixing machine. The apparatus used by the contractor on this construction was a Cummer Asphalt Plant.

The asphalt and aggregate were measured to the proper proportion by weighing and each was introduced directly to the mixer from the scales. The asphalt was heated to about 350 deg. F., which temperature seemed the lowest at which asphalt of such consistency could be readily mixed with stone. The stone was heated to about 225 deg. F. This temperature is sufficiently above the evaporation point of water to insure the rapid vaporization of the moisture contained in the mass of aggregate.

As soon as the asphalt was thoroly incorporated with the stone a slide was opened in the bottom of the mixer allowing the material to drop into a waiting cart beneath. About ten batches, each containing 4 cu. ft. of stone, were necessary for one load. As the average rate of mixing was one batch per minute, 10 minutes were necessary in filling the cart. As soon as the cart was filled the mixture was teamed to the road and dumped on a steel dumping board whence it was placed on the road by shovels and brought to the proper thickness and cross-section by means of rakes. The mixture was best handled when it was placed on the road at a temperature of not less than 200 deg. F. At this temperature it was sufficiently plastic to be readily spread and rolled. A lowering of this temperature was followed by a marked stiffening or setting up in the mass with a consequent reduction in ease of handling. The rolling was kept up as close as possible to the spreading of the mixture, a space of 6 ft. to 8 ft. usually intervening between the two operations.

The proportion of the mixture as specified was 16 gal.

asphalt measured at air temperature to 1 cu. yd. of loose aggregate. This proportion was used at the start, but it was obvious at once that more asphalt was needed to coat thoroly the particles of the aggregate. Eighteen gallons per cubic yard was then tried. This proportion coated the aggregate thoroly, but it was found after placing and rolling the mixture that the surface was porous to a depth of about 1 in. In other words, after thoro compression, the pavement lacked density, due apparently to a preponderance of large particles in the aggregate. It became apparent at this time that one of the chief problems with the mixture would be the attainment of a dense surface which would seal over during the process of rolling.

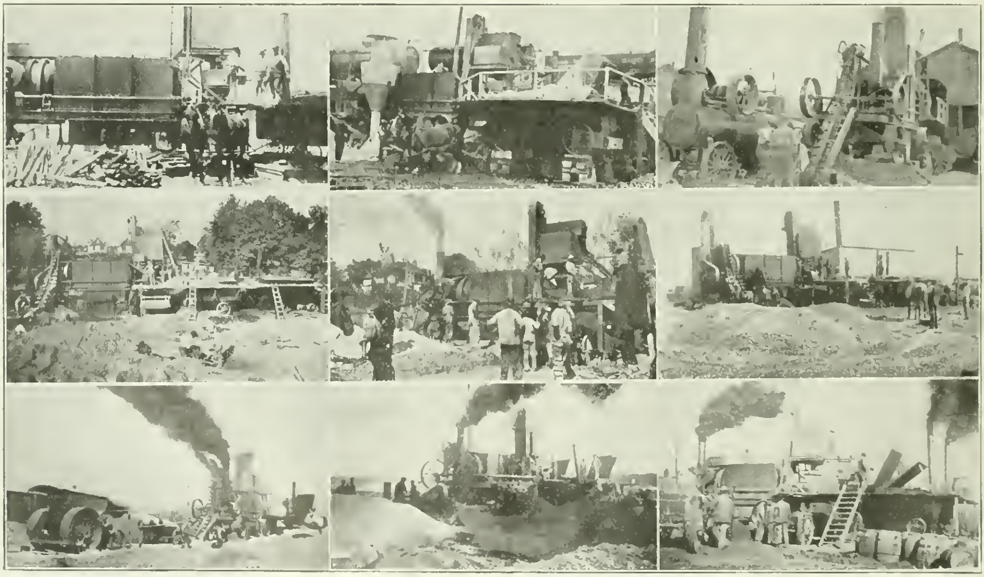
Therefore, in the solution of this problem two things were necessary, the introduction of more fine particles into the aggregate and consequently the use of more asphalt, as subquent experiments showed that a finer aggregate, having more particle surface required more asphalt to coat this surface. Some adjustments were made in the crusher, the jaws were set closer and the method of screening was changed. The result was that the output contained a larger percentage of fine particles. This required the use of more asphalt per cubic yard of stone and the amount was increased from 18 to 20 gal. and then to 21 gal. The resulting pavement was denser than the first experiments and showed a much greater tendency to seal over under rolling. The surface, however, was still porous, the top particles protruding from the denser part of the pavement from ¼ in. to ½ in. There apparently was no other way of obtaining a denser pavement with the aggregate available. Further adjustments of the crusher resulted in no appreciable increase in the amount of small particles in the aggregate and the introduction of more asphalt into the mixture was found to be impossible. The aggregate was supplied with as much bitumen as it would carry, for additional asphalt ran out of the mass and was lost in transit.

The specifications made no allowance for the introduction of a finer material by adding to the aggregate a sand or fine crusher product. We were restricted to the use of a crusher run and after experimenting with the product until the aggregate contained the least amount of voids, as nearly as could be determined without actual analysis, we still had a pavement which was porous on the top and doubtless would soon pick up under the heavy usage of the traffic. Furthermore, the entire pavement was opened to penetration by moisture and the resulting disintegration caused by water standing on an asphalt surface.

The use of a flush coat to seal over the surface and obtain a water-tight pavement was determined upon, and the same kind of asphalt was used as in the mixture. The asphalt was applied to the surface from pouring pots and wiped down to a uniform thickness with squeegees, care being taken to pour and to carry the strokes of the squeegee lengthwise of the road.

As little asphalt was used as would insure sealing over the surface, this amount being about 2/3 gal. per square yard. It was found that the asphalt was most easily wiped down to a uniform thickness when it was applied at a temperature not less than 375 deg. F. Immediately after application it was covered with a clean ¼-in. grit, spread at the rate of about 20 lb. per square yard.

The applying of the flush coat was performed as close to the spreading of the mixture as possible. By so doing the



CUMMER PORTABLE ROAD ASPHALT PAVING PLANTS IN OPERATION.

AS OPERATED BY F. J. McGUIRE, CONTRACTOR, NORFOLK, VA.

AS OPERATED BY PACE BROTHERS, CONTRACTORS, CLEVELAND, OHIO.

AS OPERATED BY EDWARDS CONSTRUCTION CO., TAMPA, FLA.

AS OPERATED BY CITY OF PROVIDENCE, RHODE ISLAND.

AS OPERATED BY FULTON COUNTY COMMISSIONERS, ATLANTA, GA.

AS OPERATED BY D. J. RYAN CONST. CO., CONTRACTORS, DAVENPORT, IA.

AS OPERATED BY WESTERN PAVING CO., CONTRACTORS, SEATTLE, WASH.

AS OPERATED BY GEO. F. BRACKETT, CONTRACTOR, CLIFTON, N. J.

AS OPERATED BY MUNICIPAL PAVING CO., NASHVILLE, TENN.

advantage of placing the flush coat on a clean, warm surface was gained. In gaining this advantage the use of a pressure distributer was precluded. It should be kept in mind that no penetration of the stone was required, as all particles were already coated. The mere sealing over of the surface was the end in view and the method of application adopted was apparently effective in attaining this end.

At the time of applying the flush coat was scarcely 1 16-in. in thickness. The action of the traffic gradually pressed the covering of grit into the flush coat until it became a part of the wearing surface. The result was that the flush coat by the addition of this grit increased in thickness to 1/4 in. to 3/8 in.

The resulting surface is similar in appearance to some patented pavements of similar construction. It has a smooth, rubbery appearance peculiar to asphalt surfaces, which appearance is probably pronounced in the case of surfaces constructed with a mixture and finished with a flush coat.

During the warmer months of the year the surface was sufficiently receptive to give a good footing for horses. But when the weather is colder the pavement becomes hard and slippery, not so much so as a sheet asphalt or wood block pavement, but enough to give insecure footing for horses hauling heavy loads on the grades. This condition is not unusual in pavements of this type and can probably be remedied by the application of a coarse grit during the warm period when the pavement is sufficiently soft to receive this grit under the pressure of the traffic.

This description shows the difficulties which are met in the construction of bituminous macadam under the simplest specifications and the reasons for the modifications which have been made in such specifications in proportioning the sizes of stone as far as legal restrictions will permit, in adding fine material, in putting comparatively fine material in the wearing surface, in using a seal coat, and in the methods of operation of the paving plant to secure the desired results.

The temperatures and conditions named were worked out in the field for the bituminous cement actually used in the work. They should be changed more or less if other cements are used according to their characteristics. These changes are given in considerable detail in the specifications of the American Society of Municipal Improvements next above quoted, unfortunately without giving the names of the asphalts and tars which are covered respectively by the five specifications given for asphaltic cements and the two specifications for refined tars. Any of these seven bituminous cements are satisfactory for use in bituminous macadam pavements, but they cannot be selected properly or used according to a blanket specification broad enough to cover them all. Hence the seven specifications.

There are many specifications for this class of pavement, producing all grades of results, but out of the many experiments and trials standards are gradually emerging such as those referred to.

Penetration Method.

The points to be considered in the use of bitumens in the penetration method of constructing bituminous macadam pavements are briefly stated in the following extract from a letter written by Walter H. Flood, chemical engineer, Chicago, Ill.:

Bituminous macadam is best constructed by applying the heavier bitumens after being properly liquefied by heat evenly and uniformly upon successive layers of broken stones which have been placed upon a sufficient foundation, each layer being properly rolled by steam roller until of uniform contour and well compacted. The bitumen should be applied by mechanical sprayers so constructed as to force the material as deeply as possible into the voids or interstices between the stones so as to cover thoroly each fragment of stone with bitumen on all its angles. The successive applications will then form a homogeneous mass thoroly compacted and cemented together with bitumen. The surface is finished by applying stone chips or clean, sharp gravel. Each layer should be thoroly compacted by rolling and the bitumen applied under pressure at as high a temperature as practicable without injury to the material. The total amount of bitumen used in all the applications will average one to two gallons to each square yard of surface, dependent upon the grade or viscosity.

MOTOR DISTRIBUTER APPLYING BITUMEN TO SURFACE OF ROLLED BROKEN STONE LAYER IN CONSTRUCTION OF BITUMINOUS MACADAM PAVEMENT.

In bituminous road construction there are probably more factors to be taken into consideration than in any other type of paving; for the life of the pavement depends not only upon the quality of the bitumen, but also to a very great extent on the correct grading of the mineral aggregate and proper handling of the materials. Naturally, the different types of construction will require bituminous cements of different characteristics. Other factors such as climate and traffic also materially affect the requirements of the bitumen.

On penetration macadam roads the bituminous material will of course be of relatively soft consistency. With asphalts the penetration will depend upon traffic and climatic conditions and also upon the nature of the asphalt itself. In colder climates a softer material should be used, while a much traveled road will require a somewhat harder asphalt than one subjected to less traffic. An asphalt such as the California types, which are considerably affected by temperature changes, will require to be used softer than those not so affected in order that it will not become too brittle in cold weather. Trinidad asphalt, on the other hand, is laid at a harder consistency, as its mineral matter naturally would tend to lower the apparent penetration of the bitumen.

The nature of the aggregate is another factor which influences the asphalt. Large stone having greater stability than small material, will take a softer asphalt, and one with less ductility might be used than where the aggregate is relatively fine.

In the handling of all kinds of bituminous materials which solidify or partially solidify when cold it is first essential that such material be properly liquefied by heat in order that it may be sprayed or otherwise distributed upon the road surface. When properly heated the material may be readily and most efficiently sprayed, preferably under pressure, by mechanical sprayers. Many kinds of apparatus have been devised for this purpose in this country and abroad. It is, however, the consensus of opinion that the most practical apparatus is a distributer which will properly heat the material and distribute it in the form of an atomized spray in volume as desired, under artificial pressure, the advantage being that the pressure forces the material into the voids between the stones much more thoroly and effectually than gravity. The apparatus should be constructed to be drawn by horses, automobile or traction engine and should be adapted to the varying conditions under which it may be used. For road construction it is important that the distributer be drawn by a tractor or auto rather than by horses, as the horses disturb the prepared or rolled stone surface. On the other classes of work—resurfacing, repairing or dust-laying—the machine may be handled either by automobile or horse power. The apparatus should be so constructed as to distribute properly any and all kinds of bituminous material, either hot or cold, and in volume as desired.

Pumps for furnishing pressure are in general use. Both the automobile and horse-drawn types of the distributer are also equipped with heating and circulating systems insuring heating efficiency with no liability of injury from overheating material.

In handling the heavier grades of bituminous materials requiring high temperature no moisture should be allowed to come in contact with the material in the process of heating. A little water will cause the bitumen to foam and become useless for road work. Leaky steam pipes have this effect. Direct heat from kerosene oil burners or wood fires conveyed thru tubes placed in the interior of the tank reduces the danger from moisture and from overheating.

In distributing the bitumen precaution must be taken to prevent walking or driving over it before it is covered with sand, otherwise bare spots will be exposed which will have to be patched up before the road can be finished.

The excessive use of bituminous material should be avoided. It results in uneven and wavy surface and will exude toward the shoulders of the road.

The following description of the construction of a bituminous carpeted macadam road gives a full statement of the process of constructing one of the cheaper forms of bituminous macadam penetration method. It is by Henry Marshall Olmsted, highway engineer, Brooklyn, N. Y., and is a more than usually practical article regarding details. It appeared in a recent number of *Good Roads:*

In July of last year the writer commenced the construction of a road in Bayonne Park, Bayonne, N. J. The road is about 1.17 miles long and is 30 feet wide except on one section about 800 feet long, where the width is 35 feet. The date of the start of the work is given because of its bearing on the methods of construction.

The roadway consists of two courses of broken trap rock carpeted with Tarvia B and washed pea gravel. The stone used was Rockland Lake (N. Y.) trap rock having a specific gravity of 3.0. The stone used in the bottom course was known as 2½-in. stone, and was defined by the specifications as stone passing a 3¼-in. ring and retained on a 2⅛-in. ring. The 1½-in. stone used in the top course was broken to pass a 2¼-in. ring and to be retained on a 1⅛-in. ring.

Frequent tests of the size of the stone were made with a pocket tester consisting of a piece of pine wood ¼ in. thick in which were bored holes, one 3¼ in., one 2⅛ in., one 2¼ in. and one 1⅛ in. in diameter. The results of two tests of 1½-in. stone are given in the following tables:

TEST OF MATERIAL FROM BARGE NO. 3.

Size of Stone.	Number of Stones. Test No. 1	2	3	Total.	Percentage.
Proper size	40	47	34	121	42.5
Under size	38	26	39	103	36.2
Thin slabs	14	27	20	61	21.3
Total	92	100	93	285	100.0

TEST OF MATERIAL FROM BARGE NO. 4.

Size of Stone.	Number of Stones. Test No. 1	2	3	Total.	Percentage.
Proper size	79	95	100	274	66.0
Under size	17	60	45	122	27.0
Thin slabs	3	13	15	31	7.0
Total	99	168	160	427	100.0

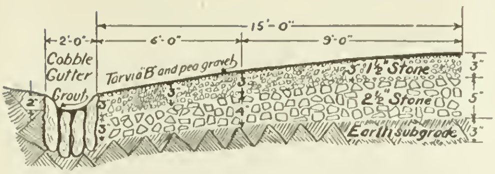
The material from barge No. 3 was rejected and that from barge No. 4 was accepted. At least 75 per cent. of the stone for the top course should be of the proper size, that is, out of 100 stones picked up at random 75 should meet the ring test as to size. Strikes, delays, lateness of the season and conditions beyond control forced our acceptance of some stone only 35 per cent. to 50 per cent. perfect.

Prior to the writer's connection with the work there had been ordered trap rock screenings designated as "¼-in. to ½-in. particles free from dust." A few loads were delivered, but satisfactory results could not be obtained with the material. It would not enter the voids and possessed no binding value. It was finally rejected and the screenings from ⅛-in. to ¼-in. in size and dust, the latter amounting to about 30 per cent. of the entire volume, were used. These screenings possessed sufficient cementing power to hold the stone in place until the application of the "carpet" and gave good results.

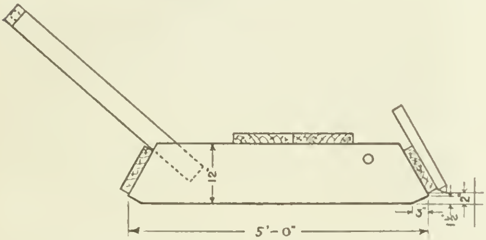
The material was delivered to the work by 2½-yd. dump wagons and 5-yd. Packard motor trucks. As a rule six teams and two trucks were used. The distance from the dock to the work was 2 miles. The trucks made 20 round trips daily, delivering 100 cu. yds. at a cost of 10 cents per cu. yd. The teams made 7 round trips a day, delivering 17½ cu. yds., at a cost of 30 cents per cu. yd. The trucks were valued at $5,100 each and the teams at $800 each. In addition to the cheaper transportation cost with the trucks there was a decided advantage in placing the stone, as the trucks spread the stone on the road in a long ribbon of any required thickness.

In the construction of the road it was necessary to rebuild only a few parts of the sub-grade. The stone was generally spread by the wagons or the trucks, but it was occasionally necessary to dump the stone in piles, shoveling it on the road later and bringing it to the proper thickness and proper level. The first course before rolling was 4 in. deep at the gutters, 5 in. deep at the shoulders and 6 in. at the crown. The rolling reduced this to 3 in. at the gutters, 4 in. at the shoulders and 5 in. at the crown. The second course was spread 4 in. deep over the entire road and rolled to 3 in., making the thickness of stone in the completed road 6 in. at the gutters, 7 in. at the shoulders and 8 in. at the crown.

The loose stone was spread to the required thickness by means of the stone leveler, designed by the writer. A side elevation of this is shown in one of the accompanying sketches. It consisted of two runners of 1½-in. plank, 5 ft. long and 12 in. high, placed upright side by side and held 7 ft. apart, with pieces of 1½-in. plank at the ends for spreading the material. The end runners were shaped at the front and back as shown



CROSS SECTION OF PARK ROADS—HORIZONTAL SCALE ¼ VERTICAL SCALE.



SIDE ELEVATION OF STONE LEVELER

in the sketch. The cross plank at the front acted as a plow, but at the same time allowed the stone to flow under it, while the cross piece at the rear dragged the stone along for a way and then permitted it to slide under the edge. To facilitate the plowing action a 2x4-in. stake, pointed at the lower end, was attached to the center of the front cross piece. The leveler was drawn by two horses hitched to the leveler by chains thru the holes in the front of the side pieces.

On a measured area of 1,000 sq. yds. covered with irregularly piled stone heaps, 2 and 3 ft. high, the stone was leveled to a thickness of 4 in. in 3 hours at a cost of $2.10. To do this by hand would have taken 20 men 9 hours and would have cost $40. Wood blocks, 4, 5 and 6 in. high, set on the road, were used to guide the laborers in leveling. The rolling was done with 12-ton rollers. The sub-grade was thoroly rolled and the bottom course of stone was rolled five times before placing screenings. The roller was started at the gutters and worked up to the crown by 8-in. laps of the rear wheels. After rolling the bottom course a 1-in. layer of screenings was applied by shovels from piles along the road. The best results were obtained by covering the area to be filled lightly several times, rolling while spreading was in progress. In damp weather the screenings stuck in the upper part of the stone course and had to be worked down into position by means of fiber push brooms. After the lower course had been filled the screenings were broomed off and out of the surface to a depth of about ¼ in. in order to leave the stone sticking up to form a bond with the second course. About 1 in. of screenings were required for the lower course. After the screenings were all in place the surface was watered. A 700-gal. sprinkling wagon was used and was run about five times over the first course.

Screenings to a thickness of ¾ in. were required for the top course. They were worked into the stone by the same methods employed for the lower course. After filling this course it was watered, about eight trips of the sprinkler being made. The course was again rolled and a thin layer of screenings applied to the surface, leaving screenings to a depth of ⅛ to ¼ in. remaining on the road. The adequacy of the rolling was determined by the "feel under foot," by the "feel conveyed to feet of roller man," by "watching rear wheels and noting that surface did not creep or give," and finally by the change in the color of the surface from a solid to a dappled gray, the white spots being the tops of stones beginning to show.

After the completion of the macadam all dust and surplus screenings were brushed from the surface, first with wire push brooms and then with fiber push brooms. This exposed the surface stones to a depth of about ⅛ in. On completing this operation the necessity for perfect 1½-in. stone became very apparent, as smaller stones would be broken loose from the surface by the operation. In one part of the road where under-sized stone had been used, we were obliged to dig out the old material, put in fresh screenings, roll, water and roll again and then broom the entire area a second time. This sweeping of the surface removed from the total area of 21,500 sq. yds. about 12 wagon loads of surplus screenings which I later used again. After brooming, the surface presented a rough, uniform surface. A part of the screenings were used to form ridges on the inside of the gutters to prevent the surplus bituminous material from running into the gutters.

The material for the "carpet" consisted of Tarvia B, which was applied from a 1,200-gal. motor distributer. The material was applied thru spray nozzles under 20 lbs. pressure. Four trips were required to cover the 30-ft. width of road. The material was applied hot when the road was perfectly dry, the penetration being about ½ in. The material was applied at the rate of about 0.5 gal. per sq. yd. In mild, sunny weather the Tarvia was allowed about 24 hours to penetrate the road, but in damp weather about twice as long.

The Tarvia was covered with clean washed pea gravel free from sand and consisting of particles 1/16 to ¼ in. in diameter. This was applied from piles placed on the side of the road, 1 cu. yd. covering about 100 sq. yds. of road surface. After application the gravel was leveled by wooden garden rakes, any over-sized particles being removed at the same time. The road was then rolled twice, the dust ridges removed from the gutters, and the road opened to traffic.

The cost of the work per square yard, exclusive of grading, the building of gutters, bridges and drains, was as follows:

Stone	$0.3851
Screenings	0.1220
Pea gravel	0.0200
Tarvia B	0.0459
Teams	0.0160
Rolling	0.1030
Labor	0.3080
Total, per square yard	$1.0000

Under favorable market conditions the work could have been done for 75 cents per square yard. The estimated cost of maintenance is $300 per year, or 1.4 cents per square yard annually. This indicates a total cost at the end of ten years of $1.14 per square yard.

Municipal Garage at Grand Rapids, Mich.

A system of cost accounting is a necessary part of the economy of a municipal garage such as is described in this article. The accounting system shown requires a minimum of time to keep it and could well be more detailed, particularly as to certainty and fullness of daily reports. MUNICIPAL ENGINEERING *believes this work to be of so much importance that it has devised a system of daily reports with monthly and annual summary sheet for the convenience of its subscribers.*

WITH the operation of a municipal garage and a comprehensive system of cost accounting, the board of public works at Grand Rapids, Michigan, has increased the efficiency of the department by a generous per cent. The features have not only given the department as a whole a higher standing, but they have solved the problem of motor truck operation and placed this branch on a smooth-running basis. Cutting the cost of maintenance and operation, preventing loss from both the inside and the outside, and organizing all movements to an advantage—these are the results that the double plan has achieved.

The garage is a fireproof building, 53 feet by 86 feet in dimensions, adjoining the repair shop of the water works department. The thirteen trucks in service are operated entirely from this central point. Two specially constructed cars are used by the highway and street repair departments for trimming electric lighting wires; one large car for construction work, and eleven small capacity cars for repair work and service. All calls for work, repairs and service are placed with the foreman of the garage by the heads of the various departments. He transmits the orders to the drivers and operatives. This feature alone, by focalizing the various endeavors, is the medium for a great saving of time.

A skilled automobile mechanic serves as the foreman of the garage and directs the work of three sub-mechanics. Repairs on cars are negotiated easily, at the lowest possible cost for materials. Any special work of an unusual nature requiring large machines is done in the regular repair shop of the department. The garage has a repair pit, a complete outfit for vulcanizing tires and an acetylene gas welding outfit. The pit is equipped with electric lights and provides for the highest grade of workmanship. Vulcanizing and repair on tires is done as well as, if not better, than it would be at a public garage. This is also true of the welding. Drains and wash pits are provided and it is required that each driver shall wash his car at least three times a week. This is in conformity with the idea that the public's impression of any municipal department counts for much, and cleanliness in equipment has much to do with creating the favorable impression.

All gasoline and oils are stored in the garage and no driver is permitted to secure a supply of either without passing a requisition thru the foreman. These requisitions are then turned in to the department heads and checked back once a month. The plan obviates all waste and losses thru injudicious buying. Money is saved on the initial purchase of the oils as well as on all repair parts and necessities, a better price being obtainable in quantity lots. Formerly, where private garages were patronized, the city was constantly victimized by unscrupulous dealers. Figures computed by Lewis D. Cutcheon, general manager of the board of works, show a saving of over 25 per cent. on all expenses.

On repair work the saving has kept pace with the buying expense. The time of the employe is saved because he is required to lend his efforts to the task where, in a private garage, he would be watching another workman do the duty. No time is lost on any job, the chief idea being, under the direction of the foreman, to get the truck back into service as soon as possible. Especially is this true in the case of tire trouble, changes being made in very short order.

In connection with the garage, and a contributing feature to the increased efficiency of both the garage and the departments, is a complete cost accounting system. A large card (Fig. 1) for every car is kept at the garage and each night, before a driver leaves for home, an actual account of the day's operations and expenses is noted. All repairs and running expenses are jotted down, including the daily reading of the speedometer, the amount of gasoline and cylinder oil used, the character and kind of any repair work that is done, punctures to tires, blowouts and displacements, in fact, every

Arc Trimmer #2

Board of Public Works Auto. Report Card, Month of Nov. 1916

DAY	SPEEDOMETER READING	Miles Per Day	GASOLINE Used	GASOLINE Rec'd	CYLINDER OIL Used	CYLINDER OIL Rec'd	REPAIRS	TIRE REPORT
10/31	5121							
1	5152	31		5		1 qt		
2	5185	33		5			4 spark plugs	
3	5215	30						
4	5258	43		5				
5	Sunday							
6	5286	28		5		1½ qt		2-30"x3½"
7	5317	31						outers.
8	5357	40		5		1½qt		
9	5390	33		5				
10	5421	31		5				
11	5485	64		5				
12								
13	5516	31						
14	5555	39		8		1½qt		
15	5593	38						2-31"x4"
16	5628	35		5		1 qt		outers
17	5651	23						
18	5714	63						
19	Sunday							
20	5751	37						
21	5787	36		5				
22	5826	39		8		2 qt		
23	5877	51						
24	5884	7						
25	5899	15					2 spark plugs.	
26	Sunday							
27	5939	40		8		2 qt	I Radiator hood	
28	5976	37					I set skid chains	
29	6033	57		5				
30	Not operated.							
31								
Totals		912		79		10½qt		

Entries on this report must be made every day when day's work is finished, and card left where machine is kept.

Operator will return card to office on first of each month. In Repair Space note nature of repair and by whom made. In Tire Space note punctures, blow outs or replacements, giving No. of wheel. If machine is in trouble notify office at once for instructions.

No. 1 — No. 2 — Sign Harry Amstutz.

Drive

Auto No. 1127046

C300329 — No. 3 — No. 4 0282988 — License No. 12

feature of the day's activities. At the end of each month these cards are turned in to the city accountant and checked. Thus an accurate check is had on every expense of truck operation, and this, in turn, may be used as a check against all purchases made and time used. It also provides for a complete set of figures on cost and operation for any budget figures to be submitted to the city at the end of the year.

It is figured that the garage alone has worked untold value for the city from the standpoint of centralization. It makes it possible to dispatch the trucks on work without loss of time that would certainly occur without the focal arrangement. With the constant cry of the public for service, the department has more than ingratiated itself in countless instances. This time saved also constitutes a saving in money and a consequent agreeable situation. With the accounting system, and its saving of more than 25 per cent. of expense in operation and maintenance, the idea has a double value. It has grown into recognition as an institution and its permanency, as one of the city's best assets, is assured.

MUNICIPAL GARAGE AT GRAND RAPIDS, MICH.

SHOULD A STEAM BOILER BE COVERED?

By F. Webster Brady, Electrical and Mechanical Engineer, Scranton, Pennsylvania

It often happens when equipping a power plant that some very excellent apparatus is selected, but it is installed in a way that prevents its full efficiency from being attained. In case the theoretical expectations are well known, the results will cause disappointment. In fact many engineering ventures are wrecked because they are built on a half-truth for a foundation. In most instances, however, the losses are not realized, owing to those in authority not having any engineering training. They operate with the peaceful idea that "what you don't know doesn't hurt you."

An illustration of a loss with satisfaction is shown by the case of a marine type of boiler as found in a municipal water works plant. This boiler has been operated for several years without any covering. Its purchase was recommended by the plant operator, when an extension of the water works became necessary, as it was claimed that this boiler was self-contained and complete so that no extras would be needed to install it. Also, by means of its two 3-foot Morrison furnaces the fire is "inside the water," which gives a greater efficiency.

Thereupon, an exact appropriation was made by the City Fathers to cover its purchase and installation ready for service. As the boiler is of high-grade workmanship, there has been no trouble in its operation, and everyone has been satisfied—excepting for one little ripple on the sea of municipal happiness.

An agent for boiler coverings came along one day and tried to show the "powers that be" what a great saving of fuel would result from covering the boiler. The estimated cost of the covering was \$150. However, it was not purchased for several reasons: First, the boiler had been bought as a complete unit and all the appropriation was expended; second, the fireman said he could easily keep up steam, and the boiler was so efficient that a covering was not necessary; and third, no one could see any loss. So the matter was dropped and the plant has been operated without any interruption ever since.

However, a condition of this kind in a plant always brings up a question in the mind of the front-line engineer, namely, "Will it pay to cover this boiler?" After figuring out the problem the readers who are operating engineers will likely take a look over their plants to see if there are any economies possible. The plant herein described is not an isolated case by any means. It is a type that is quite common, and the subject of coverings does not apply only to steam boilers.

The following is one method of working out the problem:

Boiler diameter, 9 feet 6 inches; length, 12 feet. Area of boiler shell that could be covered, 9½ by 12 by 22/7 feet, or 358 square feet.

To this area should be added about 12 square feet that could be covered on the ends, making a total of 370 square feet.

Steam at 175 pounds gage has a temperature of 377 degrees Fahrenheit, and if the average boiler room temperature is 77 degrees, the net difference will be 300 degrees. Tests have shown that the heat loss from uncovered boiler plate is as much as 3 B. t. u. per degree difference per square foot per hour. Also, it has been found that a good covering will reduce the loss to about .4 B. t. u. Therefore, the gain from the covering in this case would be (3 minus 0.4) by 300, or 780 B. t. u. per square foot per hour. The total heat saved per hour will be 780 times 370, or 288,600 B. t. u.

This plant is operated 18 hours per day, and the fires are banked for 6 hours, and for half time, or 183 days per year. The estimated heat loss per year that could be saved by the boiler covering is 288,600 times 18 times 183, or 949,648,400 B. t. u.

The coal used is an excellent quality of run-of-mine bituminous, costing \$2.25 per ton delivered. With a boiler efficiency of 70 per cent this coal will surely produce as much as 9,500 B. t. u. per pound. If so, then the yearly loss is equivalent to 949,648,400 divided by 9,500 and multiplied by 2,000, or 50 tons. This coal costs \$112.50, or nearly the same as the boiler covering. It should be understood that this estimated saving might not be entirely realized in practice. The boiler covering would either deteriorate or become cracked in service and less heat would be saved. It seems possible, however, to save from \$75 to \$100. If so, is it worth while to cover this boiler, or any other one doing similar duty?

CONSTRUCTION OF VITRIFIED PIPE LINES

By J. F. Springer, New York City.

This article, while quite elementary in its nature, collects together some details of construction in convenient form for use and may aid both engineer and contractor. It is one of a series of articles by the same author which has appeared at intervals.

THE basic material used in the manufacture of vitrified sewer pipe is either shale or clay. As it is not general practice to ship such pipe long distances, the character of the basic material will vary for pipe made and used in different parts of the country.

The preparation of the shale or the clay before molding has much importance. For example: The amount of surface pimpling on salt glazed pipe is less when clay is used that has been passed thru a 16-mesh screen than clay which had been passed thru an 8-mesh screen. A finer screen gives but little better results. The experimenter responsible for the foregoing discovered, or was of the opinion that he had discovered, that pimpling was due to "the incipient fusing, bubbling and swelling of small particles of shale, lying close to the surface of the pipe." Other makers of pipe found that pimples apparently arose from the oxidation during burning of the iron contained in the clay. The pimpling may be reduced by the proper management of the temperatures during the burning process and by carrying out the glazing only at a time when the flame is good and clear.

After clay pipe has been molded to form it is allowed to season under cover to give opportunity for a reduction of the water content by natural means. A slow drying and burning in the kiln is the next procedure. During this period the defects known as fire cracks develop. These may zig-zag more or less, but usually they have a general circumferential direction. They are possibly caused by sudden local changes of temperature brought about by the direct action of hot flames or cool currents. Another type of defect is the network of water cracks, thought to be due to a too rapid heating at the beginning of the kiln operations. Blisters are probably due to improper heating at the beginning.

As vitrification proceeds heat cracks of all kinds are brought into evidence by the shrinkage attendant upon vitrification. A single fire crack is not to be regarded as a fatal defect, it being permissible to have one at the spigot ⅛ inch wide, 2 inches long and penetrating the full thickness of the shell. Blisters on the interior, if unbroken, not higher than ¼ inch, and having a diameter of say 2 inches, do not warrant condemnation of the pipe section.

Since nearly all classes of defects may either be eliminated or reduced in amount by proper manufacture, considerable care ought to be given to any deserved reputations of concerns within a practicable shipping distance of the point of use.

In England, a distinction is made between sewer pipe made from fire clay and that called by them stoneware pipe. This latter is rated as "stronger and better able to resist the decomposing effects of the sewage." The pipe is salt-glazed inside and out, except on the surfaces of bell and spigot where the jointing material comes into contact with the pipe. Here an unglazed surface is preferred.

The British have devised a form of spigot end which prevents carelessness in setting spigots out of center with the bells in which they are inserted. The spigot end is given a slight flare and it is only necessary to force the pipe well home. An additional advantage is a reduction in amount of jointing material required.

Vitrified sewer pipe not being well adapted to perform the service of a beam, they should be supported evenly when in place along their length and generally all over the under surface. Hard spots in the supporting soil may easily convert the sewer into a series of short beams. Ordinarily, it is not considered good practice to place vitrified sewer pipe immediately upon rock. The latter is excavated for perhaps 6 inches below the sewer level and a filling of gravel or fine material put in. At the bells it is sometimes required that the full depth of the softer material be maintained, requiring bell holes in the rock.

Sewers of vitrified material sometimes give way because of the overhead load. In such cases, following the theory of stresses, the pipe breaks into four longitudinal pieces, each of which is roughly a quadrant of the circumference of the pipe. The points of breakage are at the ends of vertical and horizontal diameters. "For this reason fire cracks and slight imperfections which do not cause the rejection of a pipe should be placed at a point about 45 degrees above the horizontal in laying, and not at the top."

The pressure of the back fill on top of the pipe may be reduced in many cases by sharply narrowing the trench at a level somewhat above the top of the sewer. The ledges or berms thus produced become the resting places for the ends of an earthen arch. The natural narrowing of the trench in excavating aids this arching action even if the berm is not formed. The narrowing is sometimes so great that local enlargements in the excavation must be made for the bells.

The tamping iron used in filling in the space around the pipe should be given a weight of not more than 7 pounds. It is recommended that the tamping face be not greater than 1½ by 5 inches. "A tamper of even smaller size made be used to advantage until the filling is brought well up above the springing line of the pipe."

With small sizes of pipe, the side thrust is probably negligible or nearly so in most cases. Such pipe will carry a full overhead load of, say, 8 or 10 feet of backfilling. But the nature of the backfilling will cause variations in the character of the load transmitted to the pipe. Gravel will often tend to form an arch. Its weight will accordingly be partially removed. Clay when wet forms a rather poor arch, so that the load transmitted is a large part of the overhead weight.

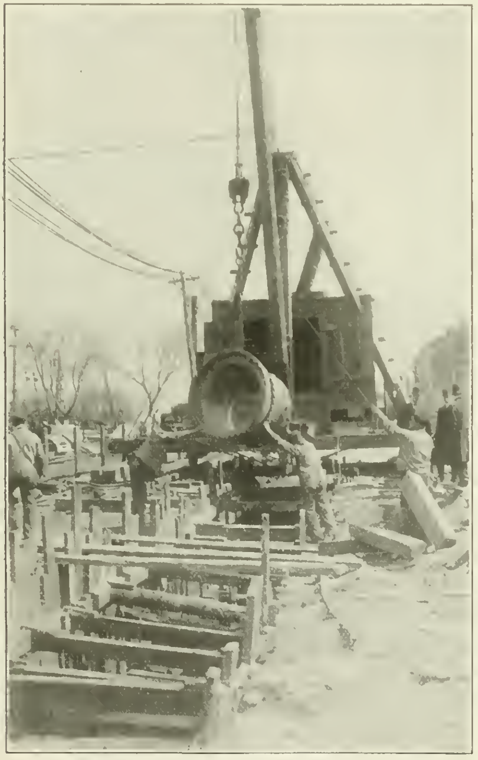
A thin covering of backfill transmits loads moving on the surface over the sewer, such as loaded wagons, road rollers, etc., whereas with deep fills these loads will be distributed at the sewer level so that the sewer itself will get but a small share, if the arch action does not take up the moving load entirely.

Much trench tamping is now done by machinery. The apparatus used at Wilmington, Del., was provided with a vertically moving ram having a tamping face 8 inches square. The ram is provided with a long vertical rod, to whose sides are secured contact strips of wood. Two cams rotate continuously in opposite directions. When the high parts come around close together they grip the rod and lift it until the high parts pass. Then the ram drops and gives the tamping blow. A gasoline engine runs the apparatus, which, operated by two men, does the work of five or six men. Hand tamping is used for 2 or 2½ feet up from the springing line and above that the machine is employed.

The laying of vitrified sewer pipe often becomes rather difficult when the trench is in water-bearing soil. Wakefield wood piling may be made water-tight and can be made from material close at hand. Steel sheet piling drives easier than wooden piling and thru more difficult soils. Some types are reasonably water-tight, and other types require plugging, which may be done in rather simple ways. Steel piling may be obtained in very light weights, so light, in fact, that 10 or 12-foot lengths many be handled by one man. If the soil is not too difficult, light-weight piling may be driven by hand, a maul or light hammer being used. It will often be necessary, however, to use a steam or air hammer, or some other means of striking a heavy blow. Such apparatus may be quite portable. It is set up on top of the pile to be driven. Sometimes there will be a step upon which the operator may take his stand, thus adding his own weight. Steel sheeting may be driven by a derrick pile driver, and such apparatus may be mounted on a scow for a sewer line across a body of water. Two parallel lines of piling may be put down and carried out from the shore to some convenient point in the water. A few piles will then be driven to form a transverse wall connecting the two lines. The material in between may sometimes be excavated by hand and often by orange peel buckets. The excavated material may be piled up against the steel sheeting on the outside and thus aid in making it water-tight. By pumping out the interior space excavation may be continued comparatively dry. An impervious stratum may be expected not far below the bottom of a body of still water, and if not too far down the piling can be driven down to it, thus relieving the difficulty of water coming up thru the bottom of the trench.

Vitrified pipe must sometimes be laid upon a concrete bed. H. S. Watson, a British sewer engineer, gives the following method: A number of bricks are laid flat at distances from each other of about 10 feet. The upper surfaces are set carefully below the invert levels, the thickness of the pipe wall lower than the corresponding levels of the invert. Concrete is then filled in until it reaches the top of the bricks, and is leveled off to the exact grade with a straight edge. The concrete is now allowed to set for, say, two days, if the ground is dry. Bricks to serve as reference marks will now be set on edge aside from the center line 10 feet apart and worked into the concrete to bring the upper edges exactly to the invert level.

VITRIFIED SEWER ACROSS SALT MARSH IN SHALLOW TRENCH, BORO OF BRONX, NEW YORK.



LOWERING LARGE SEWER PIPE INTO PLACE, BORO OF BROOKLYN, NEW YORK.

The pipe is now laid, bells uphill, beginning at the lowest point of the section. Back of each bell a brick is set to support the pipe. This brick will be laid flat or set on edge according to the amount of projection of the bell. A line of pipe will thus be set upon a line of bricks, one brick to a pipe length. As this line of pipe grows in length the jointing is begun by three men. First, the pipe layer applies cement to the lower part of the joint. He does this in such way as to make bell and spigot concentric. As the pipe sections are elevated above the concrete floor he has opportunity to get his fingers beneath the under surface at the joint and make sure that everything is right. The remainder of the circuit of the joint is now filled in with cement by the second man, who follows the pipe layer closely. Any cement which may have gotten inside the pipe is promptly cleared away. The third man puts on a fillet of cement covering the edge of the cement joint, extending the joint cement for ½ or 1 inch. It is claimed for this method of laying pipe that, when the bed has been laid with proper care, the pipe may be set in place very rapidly, little or no packing being required to secure proper grade, also that a small flow of water on the concrete slab will not interfere with the making of the joints. Where pipe is laid directly on the ground or on concrete with depressions to receive the bells so that the pipe rests for its whole length on the bed, there is difficulty in making the joints properly, whether the trench be wet or dry. A water test suggested by Mr. Watson is made next by

VITRIFIED SEWER ON CONCRETE FOUNDATION ON AND NEAR SALT MARSH, BORO OF BRONX, NEW YORK.

☆

filling the section with water and observing the loss. A slate disk, readily broken out afterwards, is fitted in the lower end and in inlets and a right-angled bend at the upper end, and the water filled in. About a half-hour is then allowed for the escape of air bubbles and 15 minutes additional observation will, ordinarily, now suffice to determine whether the line is tight or not. In Mr. Watson's practice a 9-inch pipe sewer 300 feet long is regarded satisfactory if the water level does not drop more than ½ inch in 10 minutes. This is equivalent to about 11,000 gallons per mile of sewer per 24 hours. Defective joints show moisture if the trench is perfectly dry. If there is water in the trench the dropping of water upon water may be noted by the ear or eye. "In fact, a little water in a trench aids inspection, as it acts like a mirror in reflecting the undersides of the pipes." American practice omits this test, but it is becoming each year more desirable as sewage purification works are installed.

The concrete fill is begun by filling in the spaces between brick supports with fine concrete. Thus a firm support is given the pipe line from end to end. The remainder is then put in place. The side faces may often be battered in towards the sewer so as to finish at the level of the horizontal diameter. In American practice it is common in wet trenches to wrap a strand of jute or oakum which has been soaked in cement grout all around the end of the spigot. A wooden tool may be employed in calking the cement or cement mortar into place. More material is often applied than is needed in order to provide for a fillet finish. Sometimes a second gasket is employed after the jointing space has been partially filled. It is claimed that a joint with a fillet is ordinarily more nearly water-tight than one without. A rather wet mortar will probably make the better joint. To overcome the tendency of such mortar to leave the joint a strip of cheesecloth may be wrapped all round. The joint with a fillet requires much more mortar than one made flush, but is worth its cost in bad soil. The following table by F. C. Coffin, given the amounts of mortar required for joints for vitrified clay pipe:

CUBIC FEET OF MORTAR PER JOINT (STANDARD PIPE).

Diameter of Pipe in Inches.	Flush Joints.	Joint with Fillet.
4	0.0045	0.0113
5	0.0054	0.0134
6	0.0065	0.0195
8	0.0080	0.0315
10	0.0100	0.0393
12	0.0140	0.0479
15	0.0220	0.0640
18	0.0270	0.0877
20	0.0300	0.1443
24	0.0350	0.1700

Variations in pipe dimensions will modify these quantities. A Canadian method of jointing pipe requires first that a strip of Russian hemp or like material dipped in neat cement grout be laid in the bottom quarter of the bell at the entrance, and the lower part of the bell be given a coating of stiff cement mortar to line the bell for the lower third, the two insuring the centering of the pipes. The new pipe length is set in place, the spigot being shoved into contact with the shoulder without jamming the hemp piece back into the bell. The joint space above is calked with a suitable gasket just dipped in neat cement grout and the remainder filled with stiff cement mortar. A fillet may be required. Rubber mittens are used in all forming of cement joints. The man calking in the gasket travels two or three joints ahead of the one putting in the cement mortar. A semi-circular wooden scraper is used for cleaning the inside of pipe not larger than 15 inches. If the pipe is 16 to 22 inches in diameter, the joints should be pointed on the lower half of the inside; if larger, the pointing should be carried all round. When a long length of sewer is tested hydraulically the pressure may cause portions of the line to rise. This may be prevented by the use of struts and the like.

Joints are sometimes made by using a mixture of sand and sulphur, a modification of the Stamford joint material, omitting the tar, at one time much used in England. Flour sulphur and sand in equal parts are mixed and heated to 230 degrees, F. The sand should be very fine and contain no grit. It serves two purposes: To prevent shrinkage during the cooling process, and to increase the tensile strength of sulphur from 100 pounds to from 400 to 700 pounds per square inch. If rather coarse sand is employed it will be apt to sink to the bottom of the container. The temperature should not go much beyond 230 degrees, since the mixture then loses fluidity and becomes difficult to pour, regaining it, however, when cooled down. The substance when cold has a high degree of impermeability. The sand is an important factor in its success. A satisfactory sand has an effective size of 0.005 inch, but fine Long Island beach sand was found unsuitable. So experiments with sand proposed for use are recommended to determine whether it is of the right size and quantity to produce a proper cement. The joint is not penetrated by tree roots and is waterproof within one minute after the joints are made. The joint is quite rigid and may give trouble because the material hardens so quickly. Therefore the joint must be poured quickly. A form to fit the pipe and the joint is required and a funnel of clay, says 3 inches high, is advised to give a small head to facilitate the filling process. In cold weather and with large pipe a piece of jute thrown over the pipe close to the joint and lighted will usually provide sufficient heat to prevent cooling too quickly. The cost is somewhat higher than that of ordinary Portland cement joints, but about equal to the cost of the latter if a reasonable effort is made to see that they are really tight.

The use of asphalt for making joints is common in Germany. From Elberfeld come certain points of technique in using this material. The engineer giving the information used an asphalt with specific gravity of 1.32, softening at 131 deg. F. and liquid at 356 deg. At 378 deg. it was sufficiently liquid to pour and reach its place. The light oils in the asphalt are to be retained, consequently the melting container should be kept closed. The surfaces of the pipe within the joint should be made dry and clean before pouring begins. The spigot is set in place in the bell. Then a gasket made of tarred jute, for example, of two strands is calked into the innermost part of the joint space. A rope well smeared with clay is then wrapped round the spigot of the new pipe length and brought up against the bell edge of the old length. Thru a hole made at the top the liquid asphalt is poured. Instead of the rope India rubber may be employed.

TESTING CRUSHING STRENGTH OF VITRIFIED SEWER PIPE, LABORATORY OF BORO OF BROOKLYN, NEW YORK.

P. AND H. TRENCH TAMPER AT WORK COMPACTING A SEWER TRENCH.

A Brooklyn, N. Y., specification for joints demands a material which shall preferably have a bituminous base and shall be quite liquid at 250 deg. F. This temperature is very much lower than that used at Elberfeld. However, the Brooklyn pouring temperature was set at about 400 deg. In pouring a ½-inch space is left to be filled with a guard band of 1:1 cement mortar extending at least 3 inches from the face and outside of the bell.

Another jointing material consists of a mixture of tar and Portland cement. It was extensively used in certain New Jersey sewers where the trenches were quite wet, in preference to cement because cement joints could not be thoroly relied upon to prevent the infiltration of ground water. The mixture was made about as follows: North Carolina tar was poured into a bucket of Portland cement, the mixture being kneaded by hand until a rather stiff dough-like substance was formed. This was rolled on a board into a long rope, which was then calked into the jointing space. A space ½ deep, horizontally, was left, and a cement mortar guard or casing added.

Sometimes the practice is followed, when laying vitrified pipe, of uniting two or even three lengths on the bank. When this can be done without entailing new difficulties, it seems advisable. It is more convenient to make joints on the surface and with pipe lengths vertical. The first length is set up with the spigot end on the ground. The spigot of the next length may then be readily centered in the bell of the bottom length. However, if the bed or floor of the trench is such that the long length formed by the two or three ordinary lengths will not rest properly until considerable settlements and adjustments have taken place, it may be wiser to make all joints in the trench.

One of our illustrations exhibits a 36-inch vitrified, salt glazed, pipe being lowered into a sewer trench in the Boro of Brooklyn. Vitrified pipe of this size is but little used, apparently, in the East, unless the conditions make it especially desirable, as other types of sewer can ordinarily be constructed for less money. The 24-inch size may be regarded as the Brooklyn limit for vitrified pipe where conditions are of an ordinary character. The special object in view in the present case is to get a sewer that will be impervious to leakage in from the outside to keep down the pumping and treatment requirements at sewage disposal points.

The best approved practice with vitrified clay pipe in soft ground provides a concrete cradle. Brooklyn, N. Y., has been using such a cradle and has acquired considerable experience. A wooden platform, upon which the pipe line is blocked up, is used if the bottom of the trench is sand thru which water is moving, otherwise the moving water would destroy the green concrete. Being perpetually submerged the planking will not rot. Where the sand is dry and firm no planking is required, the concrete being placed in immediate contact with the sand. The planks when used may be the ultimate foundation or they may really be part of the capping for a single or double row of wooden piles.

Two of the photographs show sewers in such concrete cradles located in a valley near the Hudson River, half a mile north of the extreme northern end of Manhattan. The land was practically a salt marsh, being only about one foot above mean high water. Wooden piles were put down to considerable depths and cut off at mean high water. The concrete base is supported by them, reaching down one foot below the pile tops and extending up to the level of the sewer grade. The vertical height of the concrete is, accordingly, determined by the two levels.

One photograph shows the sewer in a wide shallow trench and the other where a fill must be made to cover the line. They show the differences in design of the concrete foundation and the manhole supports.

The boro of Brooklyn, New York City, builds a considerable percentage of sewer of vitrified, salt glazed, stoneware pipe. The sizes used run up to 36 inches. Naturally the sewer department needs to determine the degrees in which such pipe possesses certain qualities. The crushing test seeks to determine, for example, the resistance which the pipe when laid may be expected to exert against the load of the back fill. One of the illustrations shows a pipe length in position in the hydraulic press, ready to undergo the crushing test. This press exerts its pressure from above downwards. What is desired is that the pressure and reaction shall be concentrated along a narrow longitudinal path on the crest of the arch and along a similar path beneath the bottom of the invert. Wooden strips are, accordingly, laid lengthwise above and below. However, it is necessary to take special precautions in order to provide for an even bearing. This is done by spreading a thin coat of plaster of paris on the contact surface of the strip. In this way provision is made to develop an evenness of pressure all along the length, in spite of slight irregularities in the pipe surface.

Transforming a Beauty Spot Into a Public Utility

Pleasant Valley, near Salt Lake City, Utah, was admittedly for years one of the beauty spots of the vicinity. People frequented it to admire the scenic effect of the towering mountains cupping the shady valley with its ancient lake in the center. But it was of no utilitarian value until recently the water works department of the city saw its possibilities as a reservoir for augmenting the municipal water supply.

The old lake was simply lined with concrete and thus five million gallons more were placed at the disposal of the water works commission. The cost was $3,744 per million gallons.

(Courtesy of Popular Science Mo.)

King's Highway for Pedestrians

In a recent judgment, Mr. Justice Cross, in dealing with an appeal case in which the Montreal, Que., Tramways Company had been condemned to pay $2,400 damages because of injuries sustained by Francis McAllister, who was struck by a car in Westmount in May, 1913, made some common-sense remarks. In part His Lordship said:

"One cannot but be impressed with the conviction that conditions of present-day city street traffic are quite unduly adding to the perils of the pedestrian. Formerly he had not much to fear but butchers' carts and runaway horses. Now he must look out for tram cars and for silently-running motor vehicles which may come from various directions. Because the great majority of pedestrians, for the sake of bodily safety, run for shelter like hunted animals when they hear the car gong or the motor horn, people are in danger of coming to think that such vehicles have some sort of right of way over foot-passengers.

"That delusion may perhaps be strengthened if it be found that traffic-regulating policemen confine their attention to vehicles as if pedestrians deserved no consideration.

"It should be made clear that such an idea will find no acceptance in a court of law; it should be made clear that the King's highways are for the use of all his subjects and all peaceful wayfarers, and that if there is to be regulation at crossings and busy places it should be in the way of giving the greatest protection to those who need it most."

The judgment of the lower court was upheld.

QUESTION DEPARTMENT

Factors Determining Type of Street Pavement and Method of Assessment

1. What factors would you consider to determine the type of street to be built?
2. What method would you use to assess abutting property according to benefit?
3. What ten cities are the most advanced in street improvements?
4. What books are authority on street construction?
5. Where can I get a list of examination questions such as to call out the qualifications of an efficient highway engineer? B., ———, O.

1. The kind, amount and weight of traffic are the first things to be considered in selecting the type of street to be built. The effect of small quanties of traffic as well as of large quantities should be known and considered. Closely connected with this is the exercise of judgment as to what changes will come in the traffic with the improvement. This is too often overlooked and a pavement for the existing traffic on a road to be improved too often proves woefully insufficient for the traffic developed by the better road or attracted to it from parallel lines, sometimes miles away. The foundation may be such as to require special attention and possibly to modify the choice for the wearing surface, but this does not often happen. The width of the street, actual and in proportion to the traffic, the concentration of traffic on certain lines by tracks, posts, standing vehicles or otherwise, the grade of the street, the ease of drainage, including on flat streets the thoroness and frequency of cleaning, whether traffic is moving or standing still for a considerable portion of the time, especially horse traffic, whether the intersecting streets and driveways are paved or not, are all of them questions of importance. Noisiness is sometimes an important factor. The cost of the pavement is a very important factor, and sometimes first cost has too much effect upon the decision. We do not yet know enough about the relations of the cost of street maintenance and the kind and amount of traffic to be able to design a street most efficiently, so that the street surface we choose will be the cheapest in the long run and the most satisfactory during the life of the pavement, but the older paving engineers have well formed and valuable ideas on this subject, and their advice should be heeded. We are beginning to collect data on this subject and our equipment for intelligent street design is increasing daily.

2. It is generally considered that lots abutting on a street are benefitted in proportion to their frontage on the street. This seems to be true even if the lots vary in depth within the common city limits of such variation. Exceptions are peculiarly shaped lots which have very large or very small frontage on the street in which case the assessment by frontage should be modified. Corner lots are not always benefitted enough by the pavements on the two streets to warrant assessing all the cost of the frontage on both sides. It is customary to reduce the assessment on the long side of the lot, distributing the deducted amount over lots farther from the street by a rapidly decreasing rate per fot. In this case the assessments on the non-abutting lots may well be per square foot of area assessed.

3. It is not easy to select the ten cities most in advance in paving at any particular time, but usually Washington, Buffalo, Rochester, Cleveland, Detroit, Indianapolis are mentioned as among the first and perhaps Boston, Philadelphia, Baltimore and Pittsburg might be added as among the more recent cities doing large amounts of good paving.

4. The standard text-book on street construction are Baker's "Road and Pavements," Tillson's "Street Pavements and Paving Materials," Richardson's "Asphalt Construction," Harger and Bonney's "Highway Engineering Handbook." Two new books are Agg's "Construction of Roads and Pavements" and Folwell's "Practical Street Construction." Still other books are Blanchard's "Highway Engineering," Frost's "Art of Roadmaking," Hubbard's "Dust Preventives and Road Binders," Byrne's "Highway Construction," Whinery's "Specifications for Street Roadway Pavements," etc.

5. Possibly the U. S. Office of Public Roads would be willing to supply a list of questions used in determining qualifications of some grades of its employers. Likewise the highway departments of New York, Massachusetts, Pennsylvania, Illinois, etc.

There have been books published containing such lists of questions, but they are soon out of date.

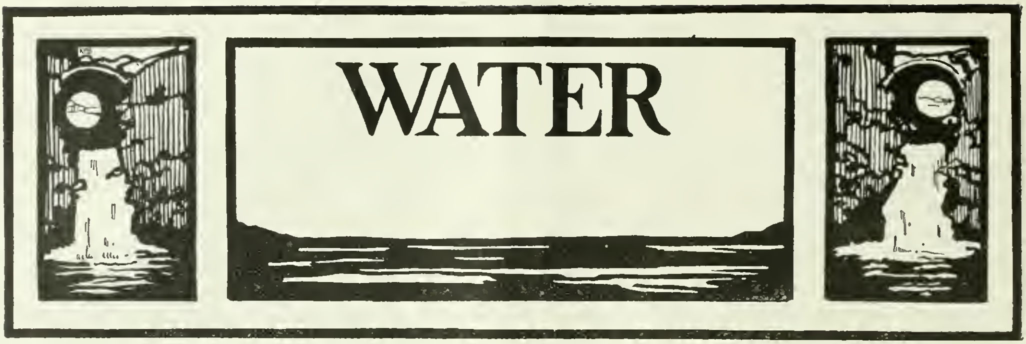
Dealers in Filter Sand

We are in need of filter sand of the Cape May variety, that being the quality of sand we are now using, and I would be pleased if you would give me the address of some concern which handles that sand or the Red Wing, or sand of equal quality. J., Supt. of Water and Lighting Co.,
———, Ind.

Following are names of dealers in and producers of filter sand, most of whom can probably furnish sand equal to the specifications mentioned:

Cape May Sand Co., Cape May, N. J.
Red Wing Filter Sand Co., Red Wing, Minn.
Wausau Quartz Co., Wausau, Wis.
Portage Silica Co., Youngstown, O.
Kelley Island Lime and Transportation Co., Cleveland, O.
Hygeia Filter Co., Detroit, Mich.
National Clay Co., Shamrock, Pa.
National Dredging and Lighterage Co., Fidelity Bldg., Philadelphia, Pa.
New York Continental Jewell Filtration Co., New York City.
New England Quartz Co., 107 William St., New York.
H. Steers Sand and Gravel Co., 17 Battery Place, New York.

If our readers can make any additions to this list or corrections in it, we will transmit them to our correspondent.



Excavation of the Baldwin Reservoir, Cleveland, Ohio

The Fred R. Jones Company are at the present time, engaged in the excavation of the Baldwin reservoir for the water department of the city of Cleveland, Ohio.

Excavation work on the reservoir was begun in May, 1915. The total amount of excavation involved is 750,000 cubic yards, of which 230,000 is earth, 350,000 slate and shale and the remainder, approximately 170,000 cubic yards, a mixture of blue sandstone ledge, slate and shale.

This new reservoir is located on a hill about 100 feet higher than the general level of the ground on the east side of Cleveland. Immediately opposite is the old Fairmount reservoir which is to be abandoned, as the new one will take its place. The Baldwin reservoir will have a larger storage capacity of 140,000,000 gallons of water and will have 40 feet greater head than the Fairmount reservoir.

Problems Encountered.

The organization of the work, the laying out of the tracks and the installation of the plant have in many ways been difficult. It was necessary to grade and lay a half mile of track with a maximum grade of 31 per cent. and a maximum curvature of 21 degrees, from a connection with the New York Central railroad thru the streets and the city park property up to the reservoir site. This track was used to move equipment to the site of the reservoir and for the handling of coal and supplies. The reservoir site is on a hillside.

The 70-C shovel was used to make a hillside cut up to the top of the reservoir site, the excavated material being cast over, and to dig an approach cut into the southwest corner of the reservoir. An abandoned quarry located inside the city park limits was utilized as a dumping ground for the material excavated from the reservoir. This quarry when filled, will become valuable land and an unsightly hole will thus be eliminated. At the foot of this grade there is a sharp curve crossing the intersection of two park driveways. A 100-foot ravine which carries the overflow water from Shaker Lakes, a part of the city park system, has to be crossed by means of a wooden trestle. The above presented many preliminary difficulties to the contractor. Furthermore, inasmuch as the reservoir is within a district occupied by wealthy residents and beautiful homes, and as both sides of the basin are lined with buildings, it has been necessary to use extra precaution in blasting in order to avoid as much as possible unnecessary noise and annoyance.

The Basin.

The extreme dimensions of the basiu are 1,050 feet by 590 feet. This includes an offset or bench of 7 feet running entirely around the basin. This bench, which is 12 feet in depth, is provided in the earth excavation, as may be seen in the photograph. This wall, or in other words, a slab projecting back on the 7-foot bench, which when refilled, will form a bond against any hydrostatic back pressure when the reservoir is empty.

The First Lift.

The preliminary excavations and also the first cut which was entirely in the earth excavation, was made by the steam shovel. This cut contained mostly earth with some loose slate. The shovel worked double shifts and moved 70,000 cubic yards a month. This output is considered very good when the difficulties which has to be overcome and the heavy grades and curves are taken into consideration.

The Second Lift.

The remainder of the excavation was, as stated above, rock work, and the cut averaged about 25 feet in depth. The method of operation is interesting. The excavation of the basin proper was started by means of a series of inclines. In order to understand the method of procedure, it should be kept in mind that the long way of the basin runs east and west. The first incline was cut along the south wall of the basin in such a manner that the south side of the cut came on the rock neat line, thus completing this portion of the south rock face. The incline was started at the west end at grade and ran up on a scale of 3.05 per cent. grade. This incline or cut connected with the upper or bench track at both the east and west ends, thus completing a run-around. The 7-foot bench, which was taken out on the first cut by the steam shovel, had been widened 2 feet on this first cut in order to allow room for the loading track for the first incline.

When the first incline was completed, a track was then laid here, connecting as stated with the bench on both the east and west ends of the basin. Thus loads could be hauled from the pit at both ends. A new incline was then cut to one side of the first incline. This went in at grade until the loading track on the first incline was 8½ feet above the shovel track. The shovel then cut its way up to the east end of the basin on the same grade as the first incline. This incline in turn served as a loading track and a third incline was cut in a similar manner. This process was continued until the entire length of the pit was opened on grade. The shovel was then backed to the toe of the second incline and all but the first incline was removed, a connection from the bottom of the pit being left with this incline in order to serve as a runway out of the pit.

Now that a good working width was provided at the base of the reservoir, the excavation of the main bank was resumed which, as stated, averages about 25 feet in height.

All inclines were 24 feet wide, but half of this was removed on the next cut, sufficient room being left for the loading track. The grades were all 3.05 per cent.

During the excavation of the pit the dump trains were handled in the usual manner. Regular sized trains were

Digging the Second Cut for the Baldwin Reservoir, Cleveland, Ohio. (The Fred R. Jones Co., Contractors.) 100-C Bucyrs Loading 30-Yard Western Cars. Note the Character of the Material. The Upper Cut has been Completed. The 7-Foot Bench may be Seen in Both Lower Corners. This Bench Carries the Run-around Track. Connection with the Loading Track in the Pit is made at Both Ends.

loaded, backed up to the connection with the first incline and then hauled out of the pit.

At the present time the work is being carried on by the 100-C Bucyrus shovel with ten 30-yard cars and four locomotives, an average of 40,000 cubic yards of blasted material being removed per month. Weather conditions, however, have seriously interfered with the work, much time having been lost due to heavy rain and snow storms.

Water is obtained from the city water lines and the locomotives are watered by means of a 6,000-gallon tank with spout attachments.

The drainage of the basin is taken care of by means of a double line of pipe running from a sump, built at the mouth of the approach into the basin, into a city sewer.

Equipment Used.

For the excavation incidental to the construction of this reservoir, the Fred R. Jones Company have used one 70-C Bucyrus shovel, one 100-C Bucyrus shovel, thirty-four 12 and 30-yard air dump cars, four 6-wheel switcher type locomotives, one Cyclone well drill, two Ingersoll-Rand tripod drills, one Ingersoll-Rand turntable wagon drill and two portable boilers. The track is laid with 80-pound rail with standard ties ballasted with cinders.

The Contractor's Camp.

A camp for laborers consisting of three large bunk cars with separate kitchens was provided. These were supplied with city water and garbage disposal service. A first-class repair shop with steam driven machinery is located on the work and equipped with an air compressor, a drill press, a hack saw, a bolt threading and cutting machine, an emery wheel, a 400-pound steam hammer and two power forges. An engine house with washout pit has been built. The contractor's office is a converted standard railroad car. Two large cars are provided for carrying supplies and repair parts.

We are indebted to Messrs. Fred R. Jones and D. B. Hammer, as well as the Bucyrus Company, for the above information.

How to Make Damp Basements Dry or Leaky Cisterns Water-tight

When the necessary precaution has not been taken during construction to damp-proof a basement or to make a cistern water-tight, permanent waterproofing results can be secured by following these simple directions:

If already plastered and it has not adhered to wall in places, which can be determined by striking with a hammer and noting a "dead" sound, remove old plaster. Roughen the surface to be treated by chipping with a cold chisel or similar instrument, and rake brick joints to a depth of ¾-inch, to obtain a bond for the new plaster coat, and clean with a heavy wire or stiff broom to remove all dirt and dust. Clean walls and floor thoroly by scrubbing with a good stiff brush and water, or preferably wash the surface with a solution of 1 part hydrochloric acid to 10 parts water, allowing this to remain about 10 minutes, and then thoroly rinse off the surface with clear water (with a hose under good pressure) to remove the chemical and loose particles resulting from the action of the acid.

To the cleaned saturated surface (or after wetting the surface thoroly) apply a coating of neat cement and water, to which 2 per cent of Medusa waterproofing has been added, mixing to the consistency of thick cream. This grout can be applied with an ordinary brush, but should not be used very far in advance of the plastering, so that the grout paint will not have an opportunity to harden before the plaster is applied.

The plaster coat should consist of one part portland cement, 1½ parts clean sharp sand, and 2 pounds waterproofing powder or paste to 100 pounds cement. The waterproofing powder should be thoroly mixed dry with the dry cement before the addition of sand and water, or the waterproofing paste should be mixed with the water used.

Apply the plastering mortar ½ to ¾-inch thick on the walls and about 2 inches thick over the floor. Special care should be taken to bond the wall and floor coatings, so as to make the waterproofed work continuous over the entire surface.

No more mortar should be mixed than can be used within 30 minutes. It can be applied with a steel trowel, and should be thoroly worked at once with a wood float to make it as as dense as possible. Final finishing may be done with a steel trowel, trowelling for not more than one minute and then leaving undisturbed. Excessive troweling will result in checking.

If there is a continual seepage thru the walls, holes must be bored in the walls and tubes or small gas pipes inserted to concentrate the flow of water and relieve the pressure while the plaster coat is being applied. Calk around pipes with oakum. Drainage pipes should remain open until the waterproofed coat has thoroly set and is capable of resisting the pressure by its own adhesive strength, after which remove pipes and plug holes with cork or wood and cover with waterproofed cement plaster.

If the water pressure is exceedingly great, it will be necessary to sink sumps on the exterior of the walls to a depth below the basement floor level, and keep pumps going continually until the plaster has thoroly set.

The finished surface must be protected from too rapid drying out, by keeping moist for at least a week to allow it to thoroly harden and to prevent hair-cracks.

Reason for Inadequacy of the New Cambridge, Ohio, Water Supply.

In the course of his work as assistant on the engineer corps of the Pennsylvania railroad system, C. B. Feasey made an investigation of the apparent inadequacy of the newly installed water supply of Cambridge, Ohio, and wrote the following report, which so clearly states the sources of such inadequacy in many small plants that it is printed in full:

The situation is this: a system for supplying the city of Cambridge with chemically pure water has been designed and installed. It is composed (1) of a storage reservoir capable of holding a sixty-day supply of water; (2) a filtration system composed of four 750,000-gallon units, three of which have been installed, and (3) a direct pressure pumping system capable of furnishing a maximum of 3,000,000 gallons of water per day to the mains at the pumping station. The system was installed and pronounced ready for use. The pumps and filters were tested and the water turned into the mains. Almost immediately it was found that the system was apparently inadequate. The question naturally arose as to wherein the system was at fault. Was it in the design? Let us investigate.

The city of Cambridge embraces a population of about 13,000 people. The designer estimated that the total consumption per day would not exceed 1,500,000 gallons, or a per capita rate of 115.4 gallons per twenty-four hours. The experience of other cities would show this figure to be somewhat low. Cleveland's rate is 117 gallons; Cincinnati 130 gallons; Pittsburgh 130 gallons; Philadelphia 227 gallons; Chicago 203 gallons, and Washington, D. C., 192 gallons. A fair average for a town situated and composed as Cambridge is would be 125 gallons per capita per day, or a total daily consumption of 1,625,000 gallons. This represents the actual amount of water furnished by the pumps. There are three factors to be considered in arriving at the efficiency of the system, (1) pump slippage, (2) leakage, and (3) waste.

Pump slippage loses 2 to 3 per cent. of the water supplied at the pumps at the intake gate. In other words, the pump delivers into the mains only 97 per cent. of the water supplied to it per stroke. In the case of the local system this would amount to about 48,750 gallons per day.

Leakage is probably one of the main sources of loss of water in any supply system. In many instances where the pipe lines are fifteen to twenty years old, as they are in Cambridge, the amount of water pumped into the mains at the pump house is three to four times the actual daily consumption. To the layman this would appear excessive, but it is not. Think of the condition that the water lines of this city must be in after carrying for twenty years the chemical laden water of Wills creek. Corrosion is an inadequate term for what must have happened to most of them. Then, too, the pressure formerly was extremely low, and the introduction of the present semi-high pressure is bound to make joints open and cause leakage generally. Even in the case of new pipe an allowance of up to 3,000 gallons per mile is made to cover the leakage. Is it not reasonable then to assume that the leakage in the local system would amount to at least three times the actual consumption, or a total of 975,000 gallons per day? I believe it is.

Last comes the problem of waste. A limited amount of this is inevitable, especially where water has previously been used without regard to the value of it; in this case due to the fact that all the supply formerly amounted to was the pumping of water from Wills creek directly into the mains. Time is the only remedy that can be applied to this sort of waste. An allowance of twenty-five gallons per capita per day is generally conceded to be a reasonable figure for waste and in the local system would amount to 325,000 gallons per day. The summation of the quantities of water used by these three factors is 1,348,750 gallons per day.

In addition to this we have the amount of water actually used from the supply pipes in the houses. A good figure for this is thirty gallons per capita per day, or a total of 390,000 gallons per day.

These calculations would indicate that the total amount of water which should be furnished to the mains at the pumps should be 1,738,750 gallons per twenty-four hours. This figure is slightly in excess of the figure found by using a per capita daily rate of 125 gallons, but the discrepancy may be attributed to a slight error in one of the per capita rates for loss.

In its present condition the system is capable of supplying 2,250,000 gallons of water per day, an excess of 521,350 gallons per day over the higher figure calculated. Where then is this excess going? Apparently into leakage and waste. How can it be stopped? The answer is obvious. To dig up all the pipe lines would be both inadvisable and expensive, so that there remains but one thing to do—eliminate the waste and note the result. If this does not render the system adequate, resort to the only remaining action, that of finding and repairing the leaks.

Checking the amount of waste can be economically accomplished in only one way. That is to make a survey of the city embracing every household, and, with the co-operation of the householder, finding and stopping all unnecessary waste. This will require both time and money, but is certainly the first step to be taken. To equip each line with a meter is out of the question because of the high original cost of the meters and the maintenance cost after installation. House meters would cost from fifteen to twenty dollars each and industrial meters from forty to sixty dollars each. This would mean an initial expenditure of around $100,000 for the meters alone, to say nothing of the cost of installing them. A meter system is without doubt the ideal system to have, but cannot be installed all at one time. It would undoubtedly be a good thing to start the installation of a meter system at once, and gradually meter the entire system. But the city of Cambridge cannot wait for the completion of such a system to discover wherein the new water system fails to meet the demand. The sooner then that the water waste survey can be made, the sooner can a course of procedure be outlined. If the stoppage of the unnecessary waste fails to make the supply meet the demand, the addition of the fourth 750,000-gallon unit should be made at once. Then a systematic test of the mains should be carried on. By successively closing the main valves while the pumps are running the amount of leakage in the various lines can be determinerd, and where excessive leakage is discovered the line could be dug up and repaired.

All these suggestions involve the expenditure of more money, but in as much as there are several thousands of dollars already invested in the system, it is economy to use a few hundreds more to put the system in first-class working order.

ROADS AND PAVEMENTS

Gravel Roads for Modern Traffic

It is undoubtedly true that 90 per cent. of the road mileage of a State does not require the highest class of road surfaces and 75 to 80 per cent. require mainly grading and drainage with such surfacing material as may be obtained in the vicinity carefully constructed to shed water and efficiently maintained from day to day. Macadam and gravel are the best surfaces for such lightly traveled roads and a sand-clay surface is very acceptable where nothing better can be obtained. Whether the traffic is all farm traffic, which is accustomed to being held up when the roads are soft in the spring and in rainy seasons or whether it is mixed horse and automobile traffic which wants to get thru at any time, often settles the degree to which a road should be improved.

The township system of road building heretofore in vogue in Indiana has demonstrated beyond question the value of the gravel and macadam forms of road for lightly traveled roads, and if a system of maintenance equal in value to the methods of construction used, crude as they may have been, had been developed it would have been much more difficult than it has been to establish a State Highway Commission to cover the main market roads with harder surfaces. And Indiana is almost the last State to join the ranks of good roads builders.

New Hampshire has been studying this problem under the expert guidance of its State Highway Department and has reached the same conclusions which have developed from the thirty odd years of gravel road building without system and with but little expert supervision anywhere which Indiana has passed thru. Each has shown that the durability of the gravel road under motor truck traffic is greater than that of the macadam road; that the ease of repair is much greater; that the cost of maintenance is much less; that when reasonablly good material is available the cost is less; that the troublesome time with gravel and cheap macadam is when subsoil is soft from rain or outcoming frost; that proper maintenance diminishes the trouble on this account and the time during which the roads should not be traveled in the spring.

New Hampshire has the peculiar condition that the motor traffic on its roads is in the summer when roads are hard and is practically nothing when the roads are soft, and so that State is able to carry the use of gravel roads farther than it can be carried on roads in full use all the year, provided, and they have found this important, that the maintenance of the road with drag and rake and new material and tamper is constant, such as is possible with one man in constant charge of six to ten miles of the road.

The following abstract from a paper by F. H. Colburn, division engineer in the New Hampshire state highway department, shows some of the points demonstrated and the reasons given for the results, corroborating those observed during years of similar construction in Indiana under less scientific conditions and with far less attention to the important subjects of grading, drainage and maintenance. It was given in the short course of highway engineering at the University of Michigan.

The lack of maintenance prior to 1909 had caused the serious deterioration of state aid roads and when the automobile license fund was made available for this purpose the department first directed its attention to repairing those roads which had been built in 1905-06-07-08, and upon which practically no maintenance money had been expended. It was discovered that, although the gravel roads appeared to be in worse condition, they were more easily and cheaply brought back into shape than were the macadam roads. A reshaping and an application of a thin layer of new gravel brought about the desired results, while in the case of the macadam it was practically a case of rebuilding. This led to the adoption of gravel instead of macadam for new construction where that material could be obtained of good quality. It was determined that no matter what the surfacing of the road, drainage, alignment and grade should be taken care of in exactly the same way. If the gravel road proves insufficient to carry the traffic, the old surface, which has been pounded down by heavy traffic, is in a hundred per cent. better condition to receive a surface of bituminous macadam or some other such form of surface than when the road was originally built and the settlement of the foundation of the road has been completed. Therefore a much thinner wearing surface can be put upon this old gravel road than if it had been originally built with no gravel. The traffic has had the use of the gravel road for a number of years, possibly five, and when resurfaced has cost much less than if originally built of the expensive material.

Practically all the foreign automobile traffic comes into the State at its southern extremity and continues nearly to its northern extremity, so that the entire length of the road must be built to accommodate the tourist. Had there been a reasonably good road, rather than the limited mileage of the highest class road, there would certainly have been little or no complaint from the motor vehicle driver. A road maintained so that it is a smooth, easy driving road fully satisfies him. This has been demonstrated by years of Indiana experience so thoroly that it has been difficult to get beyond it on roads so heavily traveled that the maintenance cost is far too high or maintenance in first class condition is impossible.

As to financing road building an assumed example will show the principle on which the decision as to material should be based with the conditions under discussion.

A certain section of modern country road is to be constructed. Some favor a high-class type of pavement, while others favor a gravel road, gravel being plentiful and material for the high-class pavement is within easy hauling distance. The authorities have decided on the issuance of twenty-year bonds at $4\frac{1}{2}$ per cent. A high-class pavement will cost $15,000 per mile. The annual charges for interest on and redemption of the bonds will amount to a little less than $1,200 per annum, which is our minimum cost per mile per year for our improved road, assuming that the road will not require any maintenance, a condition not yet realized.

The average cost for the construction of 966 miles of gravel road in New Hampshire has been $3,900 per mile. The annual charges for interest on and redemption of bonds in this case would amount to approximately $300.00. Theoretically, therefore, it would be economical to spend nearly $900.00 per mile per year for the maintenance of the gravel road.

In this case it is assumed that the gravel road can be maintained in a condition equal to that of the high-class pavement. The governing factor in this assumption is the traffic. The high-class pavement will withstand practically any traffic expected. During the summer season of 1916 the traffic census sheets show that the New Hampshire East Side Trunk Line carried an average motor vehicle traffic of from 800 to 1,100 cars per day. It is a gravel road for practically its entire length. This road was maintained in an excellent condition at a cost of $260 per mile for the year. Another one of the trunk line highways built of gravel and carrying an average traffic of about 400 vehicles per day was maintained at a cost of $207.25 per mile for the year.

In neither case has a bituminous surface treatment been employed. The application of a bituminous treatment to a gravel road should be delayed as long as possible. When traffic becomes so severe that it is impossible to maintain the gravel road in good condition a non-asphaltic or light asphaltic oil may hold the road under the increased traffic. If, however, the traffic continues to increase and a blanket or mat-forming application of tar or asphalt is found necessary, troubles have begun. When the disintegration of the mat takes place a new surface of a higher type of construction is advisable.

The experience of New Hampshire shows that the patrol system is indispensable for the proper care of gravel roads. There is no day when the patrolman employed upon a gravel road cannot be actively busy on thhe road, and if he is busy each day there will be no time except, possibly, directly after several days' rain, when he is behind in this work.

New Hampshire patrolmen are paid from $3.00 to $3.50 per day and furnish a horse, cart and hoe, shovel and small tools necessary for their work. On 70 per cent. of gravel roads the State furnishes a one-horse split-log drag, and on the 30 per cent. of oiled roads a portable heater with which to do patching. A good patrolman will keep about six miles of gravel road in perfect condition thru the summer, and it is much better to give this man enough road to allow for his steady employment rather than a limited number of days worked per week. Steady employment not only makes road work the man's primary occupation, but also increases his efficiency. One of the pre-requisites of a good patrolman is pride in the section of road he patrols.

No excuse is offered for the construction of gravel roads in New Hampshire. Gravel roads were first built on account of necessity, but as a result of experience the State would adopt such a policy if the work was to be repeated with larger sums of money available.

Labor and Roads

With the coming of spring, contractors are getting their equipment together and making plans to begin early work upon their road construction contracts. Many have their machinery and tools already on the ground, left from uncompleted contracts of last year, and others are purchasing new equipment, either for new work or to change the method of operation for faster and more economical means.

The labor situation has been growing steadily worse on account of the large production of manufactured articles necessitated and demanded of the United States to take the place of the curtailment of similar European industries. Raw products are also demanded in larger quantities to supply the added material for manufacture. These conditions have created a heavier demand on all labor, which, coupled with the practical cessation of immigration and the recalling of many foreigners to their home countries to serve in the army, have combined to seriously deplete the supply of what is ordinarily called unskilled labor.

The economic law of supply and demand has immediately asserted its power in raising wages. This is also aided by the constantly increasing cost of living. From the viewpoint of the road contractor, whose success depends upon the supply and cost of labor more than any other factors, the present conditions are most deplorabl. Where it formerly was possible to have an ample supply at all times and to refuse applicants for jobs every day, the contractor now has to search all sources for men, arrange special convenience, and make extraordinary concessions with regard to pay days to attract labor and to hold men on the job after securing them. As an example of what the contractor must face during the coming season, laborers formerly plentiful and satisfied with $1.75 per day, now are restless and scarce at $2.50 per day, and, moreover, are much less efficient for work requiring a slight amount of skill.

The gravity of the situation has led to the adoption of as much machinery and labor-saving devices as possible, not alone for the saving effected in cost, but in order to be sure that the work will be done on contract time, which might not be the case if he were to remain absolutely dependent upon scarce and restless labor.

A contractor on a piece of road in Pennsylvania last year completed his section of the road on time at less cost by the adoption of labor-savers, while brother contractors on different sections of the same road who depended upon hand labor found the cost very high, were hindered by the labor shortage, and unable to finish their contracts within the time limit.

This contractor used dynamite to blast outfall drainage ditches, a steam shovel in all cuts, using low-strength dynamite to loosen the ground and speed up the action of the shovel and automatic dump wagons to haul out the earth. The other contractors dug many of the ditches by hand, and used pick, plow and hard shovels in digging and loading the earth in cuts.

In many instances the size of the contract or depth of cuts will not permit of the employment of a steam shovel, but in these cases the use of plows and dynamite to loosen the material and of wheeled scrapers for hauling on short-distance work will effect a saving.

The contractor should make a careful study of conditions that he may encounter and lay his plans accordingly. All work possible should be done by labor-saving devices. What may seem a heavy initial expenditure for equipment will very probably prove to be a wise investment before the contract is completed. It is worse than folly to use slow, costly methods.

Bitulithic in Warm Climates

The poularity and success of bitulithic pavement in the states with the warmer climates is shown by the reports from Texas and California. The development of bitulithic in Texas has been quite recent, but 333,652 sq. yds. were laid in 7 Texas cities in 1916, and the total amount of bitulithic in use in Texas cities is 3,337,818 sq. yds. This is almost one-third of its total area of pavements of all kinds of pavements, the total of all being 11,975,002 sq. yds. To the amount of bituluthic may be added 13,291 sq. yds. of Warrenite. The amount of bitulithic and Warrenite is one-third more than of brick, which is the next most popular pavement, with 2,598,674 sq. yds., including standard and vertical fiber brick pavements.

In California 27 cities have 1,962,518 sq. yds. of bitulithic pavement ranging from 5,000 sq. yds. in Healdsburg to 455,142 sq. yds. in Los Angeles.

Sidewalk Street Curbing

A novelty in the way of curbing has been developed in Chicago to accommodate automobile users. As illustrated in the accompanying view, which was taken on Fargo avenue, Chicago, the curb has been widened so that it makes a really

usable sidewalk, thus avoiding a walk thru mud or damp grass when autoists enter or leave an automobile that has stopped at a point not directly in front of the cross walk leading from the residence to the curbing.

Comparative Tests of Bricks of Various Materials

A standard test of the comparative qualities of vitrified paving bricks is that in the rattler, giving the percentage of loss by the abrasion occurring by the rubbing of the bricks and the round steel shot used with the bricks as the rattler revolves for a certain number of revolutions.

While this abrasion test is of considerable value in com-with each other, its value in comparing bricks of different materials is not yet demonstrated.

The Standard Brick Company of Crawfordsville, Ind., has paring bricks of the same material, vitrified clay or shale, added something to our stock of information on the subject by making some concrete bricks of the same size as vitrified bricks and subjecting them to the same tests.

Bricks made of the ordinary proportions for construction of concrete roads—1 part cement, 2 parts sand and 3 parts gravel—lost 80 per cent. in 1,000 revolutions of the rattler, ten bricks being run, with the standard 300 pounds of steel balls of two sizes, at the rate of 30 revolutions a minute.

Bricks made with 1 part cement and 1 part sand lost 75.4 per cent. in the full time test of 1,800 revolutions.

Five of the 1:1 cement mortar bricks run with 5 vitrified bricks and the shot showed loss of 15.2 per cent. of the vitrified brick and 70.8 per cent. of the cement brick.

Ten vitrified brick run with the shot lost 15.72 per cent. in 1,800 revolutions.

While these results are interesting, they are not conclusive for several very good reasons, and the difference in value of the two materials for paving purposes is by no means as great as the differences in proportions of loss in the rattler test might indicate.

Relative Values in Public Health Work

Not how many dollars to spend but how to spend the dollars you have for public health activities is the subject of a recently issued pamphlet on "Relative Values in Public Health Work." The author is Franz Schneider, Jr., sanitarian of the Department of Surveys and Exhibits, Russell Sage Foundation, who has conducted public health surveys of Newark, Springfield, Ill., Topeka, Atlanta, and other cities.

Given some 1,400,000 deaths annually in continental United States, of which one in four or even one in three are from preventable causes, the problem of the public health officer is to so spend the city's health funds as to prevent these losses so far as is possible. The health officials "must decide what parts of the losses are preventable, and must determine how the greatest return in prevention can be obtained with the money available. This is the problem of relative values in public health work."

The discussion cannot well be condensed from the already concise presentation in this ten-page pamphlet. It is offered as a basis for the discussion of health budgets by officials and citizens who seek the highest returns on the city's investment in terms of deaths prevented. Among the tests applied are the damage done by the preventable diseases, their preventability, cost of prevention, and communicability—small pox, for example, "must be suppressed immediately upon appearance, almost without regard to cost."

Good Roads Notes

Governor Goodrich of Indiana has appointed the four members of the new State Highway Commission as follows: Lorenzo H. Wright, Indianapolis, master of Indiana State Grange; David C. Jenkins, Kokomo, manufacturer; Haines Egbert, Goshen, lumber; S. W. (or Lewis) Taylor, Boonville, farmer.

In 1910 California voters approved an $18,000,000 road bond issue, with which was constructed a large mileage of concrete roads. The newly constructed roads proved so satisfactory that at the close of 1916 the State approved a new $15,000,000 bond issue by vote of almost 4 to 1. In 1910 Los Angeles county voters were almost 4 to 1 against the proposition, but in 1916 they turned the tables and approved the new issue by a vote of more than 3 to 1. Not a single county voted against the proposition in 1916.

W. F. Childs of the Maryland road building force told a meeting of Virginia road builders that specifications must cover completely and in detail each item in the construction of a concrete road. They should be explicit, not ambiguous; specific, not optional; they should be clear and easy of interpretation, and should not contain clauses of which the meaning is liable to be misconstrued. Inspection is most essential. One inspector should be made chief to avoid conflict of authority and needless antagonism of contractors. If more than one mixer is employed it will be necessary to have an inspector for each mixer as well as for the grading and drainage. If the contractor handles the work so as to complete the grading and drainage before laying the concrete, the inspector on the grading can be employed on the concreting later. The inspector at the mixer looks after the final shaping of the roadbed, the preparation of the sub-grade and setting the forms, as well as mixing and placing the concrete. He must see that the sub-grade is uniformly consolidated, the side forms are clean and true to line and grade, the materials for the concrete are suitable and properly proportioned, the mixing is done thoroly and the concrete placed and finished properly, and that finally the concrete is kept damp and protected from injury until it is cured to a condition that will permit traffic over it without injuring it.

Bitulithic Pavements Laid in 1916 and Proposed for 1917

Descriptions of Pavements as laid, cost per square yard and total cost. Warrenite included.

Design, Cost and Quantity are shown.

State and City	Sq. yds. laid 1916	Base Thick	Base Propor.	Wearing Surface Thick	Wearing Surface Propor.	Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of asphalt	Proposed yardage in 1917
Arizona—									
Ajo	18,705	...	...	...	...	...	...	...	...
Douglas	28,000	5	1:3:6	2	...	$2.35(1)	...	Warren A. C.	30,000
Flagstaff	11,261	...	...	...	...	...	...	...	...
Phoenix	56,646	...	...	...	...	2.12[26]	133,714	...	...
Tucson	67,219	5	1:3:6	...	...	2.155	122,620	California	45,000
Arkansas—									
Hot Springs	4,000	5	1:2:5	2	...	2.00	14,000	Bermudez	...
Little Rock	21,324	...	...	...	...	...	...	...	...
California—									
Berkeley	23,900	6	1:3:6	2	...	1.40	40,700	Warrenite	...
Brawley	9,636	...	...	...	...	...	...	...	...
Fresno	19,828	...	...	...	...	...	...	...	...
Long Beach	5,094	4	...	1½	...	1.42	...	...	...
Los Angeles	104,672	4-6	1:3:6	2½	...	1.58	165,382	...	...
Richmond	95,682	5	1:2:4	2	...	2.16	508,000	California	10,000
San Luis Obispo	...	4	1:2½:5	¾	O & S	1.08	...	90% Asphalt	10,000
San Pedro	52,007	...	...	...	...	...	...	...	...
Santa Monica	15,870	5	1:3:6	2	...	1.395	28,991	California	...
Whittier	8,802	...	...	...	...	...	...	...	...
Wilmington	5,764	...	...	...	...	...	...	...	...
Colorado—									
Denver	25,000	...	...	...	...	...	...	...	...
Pueblo	40,403	...	...	...	...	...	...	...	...
Connecticut—									
Bristol	2,000	5	1:3:5	2	...	...	4,000	Amiesite	...
Danbury	8,000	...[41]	...	2	...	1.05	...[51]	Amiesite	...
New Canaan	8,800	...	...	...	...	...	...	...	...
Stamford	4,624	...	...	...	...	...	...	...	...
Winchester	11,743	...	...	...	...	...	...	...	...
Winsted	9,801	6	Stone	2	...	1.35	16,000	Warrenite	6,000
Georgia—									
Atlanta	12,802	6	1:3:6	2	...	...	28,804	...	...
Idaho—									
Blackfoot	47,091	...	...	...	...	...	...	...	...
Boise	48,394	3	[11] G	2	[11] G	1.64	106,972	California	...
Coeur d'Alene	...	...	...	...	...	...	...	...	8,000
Idaho Falls	47,947	...	...	...	...	...	...	...	...
Pocatello	...	...	...	...	...	...	...	...	20,570
Iowa—									
Ames	11,800	...	...	...	...	...	...	...	...
Creston	47,431	4	1:3:5	2	...	1.89	92,690	Berm. & Tex.	...
Des Moines	82,707	...	...	...	...	...	...	...	...
Grinnell	114,000	...	...	...	...	...	...	...	...
Jefferson	45,300	...	...	...	...	...	...	...	...
Knoxville	13,660	5	1:3:5	2	65% Asph.	1.98(1)	36,191	Berm. & Flux	...
Mt. Pleasant	27,600	5	1:3:5	2	65% Asph.	1.89	72,877	Bermudez	...
Muscatine	25,615	5	1:6G	2	...	1.83	55,091	Bermudez	0
Perry	30,000	...	...	...	...	...	...	...	...
Kansas—									
Kansas City	30,216	...	...	...	...	...	...	...	...
Rosedale	...	...	...	...	...	...	...	...	30,000
Kentucky—									
Owensboro	...	...	...	...	...	...	...	...	25,000[5]
Louisiana—									
New Orleans	188,656	...	...	...	...	...	...	...	...
Maine—									
Lewiston	5,000	...	...	...	...	...	...	...	...
Massachusetts—									
Boston	4,640	...	...	...	...	...	...	...	...
Cambridge	10,310	...[41]	...	2	...	...	2.75	...	...
Dedham	3,568	...	...	...	...	...	...	...	...
Fall River	57,895	...	...	...	...	...	...	...	...
Michigan—									
Sault Ste Marie	4,836	...	1:2½:5	2	...	2.40	14,504	Warren	...
Minnesota—									
Buhl	12,211	...	...	...	...	...	...	...	...
Duluth	21,507	...	...	...	...	...	...	...	...
Eveleth	20,004	6	1:4	2	...	2.50	55,000(1)	...	25,000[9]
Fairmont	14,734	...	...	...	...	...	...	...	...
Gilbert	26,700	...	...	...	...	...	...	...	...
Hibbing	4,687	5	1:3:5	...	...	2.68	18,422	...	40,000
St. Cloud	4,626	5	1:3:5	2	...	2.15	10,500(1)(3)	Bermudez	25,000
Virginia	1,864	6	1:2:4	2	...	2.44	47,606	...	2,000
Missouri—									
Hannibal	6,000	...	...	...	...	...	...	...	...
Joplin	15,411	...	...	...	...	...	...	...	...
St. Louis	6,325	...	...	...	...	1.98	20,000(1)(2)	...	40,000

State and City	Sq. yds. laid 1916	Base Thick	Base Propor.	Wearing Surface Thick	Wearing Surface Propor.	Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of asphalt	Proposed yardage in 1917
Montana—									
Billings	36,893	4	1:3:6	1½		1.91	99,439	California	
Bozeman	34,794								
Butte	22,586	4	1:3:5	2		2.55(1)	79,377		27,000
Ft. Benton	11,609								
Great Falls	18,830	4	1:3:5	2		1.90	43,432	Warren	
Lewiston	12,232								
Livingston	5,379	4		1½		2.06	14,396	California	
Missoula	17,278								
New Hampshire—									
Franklin	2,676								
New Jersey—									
Belleville	9,026								
Bloomfield	8,707								
Harrison	18,512	6	1:3:6	2½		2.29(1)			20,000
Irvington	7,472	6	1:3:6	2		2.40	21,997	Trinidad	11,270
Kearny	11,031								
Neptune City	10,729								
New Brunswick	89,319	5	1:3:6	2		2.65	2.80	Warrenite	......[9]
South Amboy								Warrenite	20,000
Summit	4,340					1.70		Amiesite	
New Mexico—									
Las Vegas	6,342								
New York—									
Binghamton	8,147	6	1:3:6	2		2.30	23,435		
Elmira	10,614	5	1:2½:5	2		2.25	29,171	Warren	
Endicott	23,163								
Gloversville	13,657								
Hempstead	9,276								
Herkimer	8,680	4	1:3:6	2		2.18		Bermudez	8,000
Johnson City	4,692								
Little Falls	9,265	5	1:2½:6	2		2.35	2.85		
New Rochelle	17,132	6	1:3:6	2		1.50	53,615	W. B .California	
New Rochelle	19,297			2		1.29	24,893	Amiesite	
Oneida	4,874								
Rome	25,332								
Salamonica	12,215	...[27]		2½		1.65	2.10	Amiesite	15,000
Utica	38,256								
Yonkers	41,176								
North Carolina—									
Albermarle	20,296								
Greensboro	18,790								
Raleigh	80,000	4	1:3:6	2		1.52	1.70	Warrenite	100,000
Weldon	10,000								
Wilson	40,000								
Winston-Salem	6,022								
North Dakota—									
Mismarck	25,000	5	1:2:4	2		2.38	68,000	Bermudez	20,000
Fargo	35,712	5	1:6	2		2.136	109,907		100,268[9]
Mandan	51,088	5	1:2½:5	2		2.28-2.43	180,181		
Minot	24,634								
Ohio—									
Bixley	12,740								
Bowling Green									2,225
Cincinnati	10,914	6	1:3:6	2	....[28]	2.57	27,768		
Cleveland	6,749			2		2.22			
Lakewood	4,112	6	1:3:6	2		2.20	10,072	Bermudez	
Piqua	21,000	5				1.88	60,000	Bermudez	
Youngstown	15,617	2		2		2.70	35,796	Trinidad	
Oregon—									
Astoria	46,110	4-5	1:3:5	1½-2½	....[29]				45,000[9]
Portland	95,227	4[27]		2		1.37	173,459	California	56,169
Portland	10,361	Redressing		3½		1.04	12,170	California	6,000
Portland	7,556	On old concrete		2		1.10	9,878	California	
Portland	2,566	3		2	G	1.30	4,436	California	7,618
Pennsylvania—									
Allentown	4,110	Old telford		2		1.30		Amiesite	5,500
Altoona	2,929								
Bethlehem	37,738	4 & 5	1:2½:5	2½	½	1.75[46]	74,154	Amiesite	
Hazleton	5,176	...[27]				1.04	7,601	Tex.-Amies.	
Lebanon	10,000	1:3:6		2		1.95	2.10		15,000
Rhode Island—									
Pawtucket	21,269							Warrenite	
Providence	20,552	6	1:3:6	2			2.10		
Woonsocket	7,900	5		2			2.35(1)		
South Carolina—									
Sumter	10,581								
South Dakota—									
Sioux Falls	42,734	6	1:2½:5	2		2.10	2.26(1)	California	50,000[9]
Tennessee—									
Nashville	55,342								
Texas—									
Austin	58,932	5	1:7g			2.00	2.068	War.-Tex.	50,000
Corpus Christi	48,892							Texaco	
Dallas	32,309	5	1:8	2			82,655	Texaco	267,164
El Paso	131,608							Texaco	
Ft. Worth	36,718			2		2.088		Tex.-Cal.	
Paris	24,110	5	1:8	2			2.30(1)		
San Antonio	11,880	5	1:3:6	2		2.30	2.50	California	60,000[9]
Utah—									
Salt Lake City	34,950			2		1.80-2.00	106,100	California	35,000
Washington—									
Kent	22,229								
Vancouver	2,650		.....[27]	2		1.52	4,228		
Walla Walla	19,676	2½		1½		1.29	39,249	Gravel Bit.	
Wyoming—									
Caspar	17,000								
Sheridan	4,941	5	1:3:5	2		2.12	18,000		5,820

MISCELLANEOUS

Meetings of Organizations

May 7-9, at Kansas City, Mo., National Conference on City Planning.

May 7-11, at Richmond, Va., American Water Works Association. John M. Divin secretary, Troy, N. Y. The city planning committee, E. P. Goodrich, chairman, 35 Nassau street, New York, will have an exhibit of photographs, drawings, etc., particularly of water-works structures, to which it desires contributions.

May 8, in United Engineering Societies' building, New York. Annual meeting of the Society for Electrical Development. J. M. Wakeman, general manager.

May 8-9, at St. Louis, Mo. Institute of Paving Brick Manufacturers. H. H. Macdonald, secretary, 830 B. of L. E. Bldg., Cleveland, Ohio.

May 8-10, at Washington, D. C. National Fire Protection Association. Franklin H. Wentworth, secretary, 87 Milk street, Boston, Mass.

May 22-25, at Chicago, Ill. Western Efficiency Society; subject of conference, "The Human Factor in Industrial Preparedness," under a number of sub-titles.

May 23-24, at Saginaw, Mich. Michigan State Good Roads Association. A. A. Anderson, secretary, Hastings, Mich.

May 23-25, at Auditorium Hotel, Chicago, Ill. The Western Efficiency Society, discussing the human factor in administration. Municipalities are expected to take much interest in this meeting and to be represented in the discussions.

June 11, at Buffalo, N. Y. New York State Conference of Mayors and Other City Officials. W. P. Capes, secretary, 25 Washington avenue, Albany, N. Y.

June 26-30, at Hotel Traymore, Atlantic City, N. J. American Society for Testing Materials. Edgar Marburg, secretary, Philadelphia, Pa.

Sept. 11-14, at Hartford, Conn. The New England Water Works Association. Willard Kent, secretary, Narragansett Pier, R. I.

November 12-16, at Hotel Gruenewald, New Orleans, La. American Society of Municipal Improvements. Charles C. Brown, secretary, 702 Wulsin building, Indianapolis, Ind.

Civil Service Examinations

The United States navy needs ship draftsmen and cannot find enough of them. Applicants will be rated on physical ability and education, training, experience and ability, without the ordinary technical examination. Grade 1, $3.28 to $4 a day; 2, $4 to $5.04; 3, $5.04 to $6; 4, over $6 a day. Ask for form of application 1312 at the usual places.

Also architectural draftsmen in Bureau of Yards and Docks, Navy Department. Grade 1, $3.04 to $3.84; 2, $4 to $$5.04; 3, $5.28 to $6; 4, $6.24 to $8 a day.

Also assistant inspector of engineering material, air craft, $4.48 to $5.04 a day.

Also sub-inspector of construction in Navy Department at $3.28 to $5.52 a day.

Also mechanical draftsman in office of Chief of Ordinance, War Department, at $1,000 to $1,400 a year.

Also assistant inspector of wooden hull construction at $4 to $6 a day.

Also mechanical engineers at Frankford Arsenal, Philadelphia, Pa., as follows: Artillery ammunition at $3,000 to $3,600; experimental work at $2,500 to $3,000; optical instruments, etc., at $2,200 to $2,600 a year.

Also draftsman assistant to chief draftsman at Watertown Arsenal, Watertown, Mass., at $2,200 a year.

May 8—Metallurgical engineer in Bureau of Steam engineering, Navy Department, Washington, D. C., at $7.04 a day. Also mechanical draftsman in Bureau of Yards and Docks, Navy Department. Grade 1, $3.52 to $4 a day; 2, $4 to $5.04; 3, $5.04 to $6 a day.

May 15—Radio draftsman in Navy Department, Washington, D. C., at $3.04 to $6 a day.

May 16—Electrical assistant, signal service at large, War Department, at $1,200 a year.

Municipal Reports

Report of the Board of Public Works of Little Falls, N. Y., for 1916. George I. Oakley, city engineer and executive officer.

Report of the St. Louis, Mo., City Plan Commission on a boulevard on Kingshighway. Harland Bartholomew, engineer.

Technical Schools

The University of Wisconsin has issued its preliminary announcement of courses of study in its summer session, June 25 to August 3, at Madison. The College of Engineering offers a number of courses in electrical, chemical, hydraulic, topographical and mechanical engineering.

The formal opening of the new chemical laboratory of the University of Cincinnati, Ohio, took place April 7 with addresses by Emil Pollard, Dr. Lander W. Jones, Dr. John Uri Lloyd and Dr. Charles E. Herty.

The bulletin of New York University for April 3 gives the preliminary announcement of the courses of study in the School of Commerce, Accounts and Finance for 1917-18.

Personal Notes

Gen. George W. Goethals has accepted the position of state engineer of New Jersey, created by an act of the Legislature, passed recently with the co-operation of Governor Edge. The state engineer will have charge not only of the $15,000,000 road system proposed, but of the engineering work of the present or future commissions on tunnels or bridges under or over the Hudson or Delaware rivers, canals, water front developments, etc.

A. R. Taylor has been appointed State Highway Commissioner of Ohio at Columbus.

Christopher Harrison has been appointed as city engineer of Montclair, N. J., going from a like position at Everett, Mass.

Walter Braun, Franklin county engineer, and Joseph H. Fleming and E. P. Knollman of his office have formed the engineering and surveying firm of Braun, Fleming & Knollman of Columbus, Ohio.

H. Peyton Mobberly, recently division engineer of the T. & P. railway, has entered the general practice of engineering at Springfield, Mo.

Alexander W. Graham has been appointed chief engineer of the Missouri State Highway Commission at Jefferson City.

C. M. Dulaney, Bristol, Tenn., is engineer of the Johnson County Pike Commission of Mountain City, Tenn.

O. H. Buckman is the new city engineer of Napa, Cal.

O. J. DeSpain is city engineer of Ritzville, Wash. He is also county engineer of Adams county.

Prof. J. G. Scrugham of Nevada State University has been appointed state engineer.

O. A. Rickers has been appointed city engineer of Huron, S. D.

Chicago Paving Inspectors and Contractors Vindicated

The special trial board appointed by the Chicago Civil Service Commission to try the case against the city paving inspectors accused of incompetency, inefficiency, neglect of duty and making false reports has dismissed the charges. They base their action, as foreshadowed by MUNICIPAL ENGINEERING, on the evidence that Professor Baker made his report, on which the charges were based, from data furnished him by others, in which only notes from field books finding fault with contractors' work were included, and from erroneous information furnished him regarding the general condition of all paving done during 1916. A motive for such action is suggested, and the evidence referred to is rejected as generally untrustworthy. This action is justified by the evidence of the engineers of the Chicago Association of Commerce, who made almost daily inspection of streets under construction, to the effect that the 1916 work was done according to plans and specifications, and that paving inspectors always aided them in correcting any irregularities found.

Records of Official Surveys

The records devised by H. A. Mark, county surveyor of Garden county, Nebraska, will give many suggestions as to the keeping and indexing of records of surveys, which will be of value for many others than official surveyors, tho some of the forms of record are prepared to comply as nearly as possible with the laws of Nebraska. The following description of the system is taken from a paper on the subject by Mr. Mark before the Nebraska Engineering Society.

The Official Record.

For the official record, I decided upon a loose-leaf book. To make the book suitable for retracement work as well as the subdivision of a section, as contemplated in the statutes, I found it only necessary to have two different plats.

I had a quantity of loose-leaf pages prepared as follows: First, a leaf with both pages blank except for caption and marginal ruling. Second, a leaf identical with the first, excepting the addition of a marginal column with the word "Chains" printed at its top. Third, a leaf with its first page as described for the second leaf and its second page ruled and lettered for recording latitudes, departures and closing errors. Fourth, a leaf with the first page containing a sectional one-inch-to-the-mile plat, 10 by 10 inches in size, being a township bounded with two rows of sections of each of the contiguous townships.

Below the plat is printed the legend of the different corner signs. The lines of the map are in tint, and the lines of the survey and the corner signs are to be inserted in black. The balance of the page is filled with a blank form for the recording of the final oaths of assistants. The second page of this leaf repeats the blanks for final oaths, and concludes with the surveyor's certificate. This printing required five different forms for the four leaves, and to complete the book for subdivision work one more leaf carying the plat of a section eight inches to the mile should be added. But as I have not as yet, in three years of constant work, had the opportunity of subdividing a section where retracement of, and establishment of, exterior corners was not needed, I have not felt the need of the plat. In compiling the record of a survey, I use as many of these different pages as the nature of the work requires.

The Field Memorandum.

Careful research failed to discover a field memorandum book on sale arranged for recording field memoranda as I believed they should be kept. The best I have been able to find for the work is an ordinary blank book, Demy 8va, 4¾ by ½ inches in size, semi-flexible morocco covers, containing 176 pages, put out by McClurg, of Chicago.

I use a separate field memorandum book for each township, designating them by number. The townships of Garden county number from 15 to 23 north and the ranges from 41 to 46 west. The volumes of each township are numbered from one up, consecutively. This number is followed by a dash and the unit digit of the township number, another dash and the unit digit of the number of the range. The dash is used to more easily distinguish the volume numbers from page and other figures appearing in the index without using the distinguishing prefixes. Of course, this number system could not be used in a county where the digit of the town and range number repeat.

The Index.

Realizing that any records not well indexed would be of little value, and as the statutes require indexing of both the memorandum and record, I attempted an index system that would be both simple, comprehensive and efficient, and one that would not become cumbersome as records should accumulate.

After study and experiment with different systems, I decided that for the official record index an outline map would be best. The scale of the index map I use is ⅜-in. to the mile, this being the size that will admit the area between two standard lines being placed on one page. It requires three pages for one index map of the county. The maps are in tint, with the township and range marked in tint, and the section numbers in a different tint. The page figures are inserted in black at or near the point on the map described in the record. Such an index would not class as a work of art, but it is convenient. I use three of these index maps. One for retracement and subdivision surveys, one for road surveys, and the third for miscellaneous surveys. By using different colored page figures the same map will index several volumes. In this I do not think I produced anything new, but combined the ideas of several I had seen.

Field Memorandum Index.

Since in my field memorandum I write a daily record of the survey, to devise a suitable and comprehensive index that would be both simple and efficient became a puzzling problem. After making several extended retracement surveys, some of them requiring memoranda filling more than one volume, I made a careful study and analysis of the matter recorded, and found that when a section had been completely retracted, matter had been entered concerning each of its four sides, each of its four section corners, and each of its four quarter section corners on the exterior. Beginning at the northeast corner of the section, and bounding it counter-clockwise, I found twelve general subdivisions necessary for classifying the information. I, therefore, set aside the first thirty-six pages of each field memorandum book for the index of the thirty-six sections of the township, respectively, and the thirty-seventh page for the indexing of matter that could not be grouped under the twelve subdivisions. Later, to index subdivision work, I found it necessary to add a thirteenth division.

Index Abbreviations.

I divide each page into the respective thirteen divisions and mark with abbreviations as follows:

"NE," meaning section corner at the northeast corner of the section;

"N¼," quarter-section corner on the north side of the section;

"NL," line, or boundary, on the north side of the section;

"NW," section corner at the northwest corner of the section;

"W¼," quarter-section corner on the west side of the section;

"WL," line, or boundary, on the west side of the section;

"SW," section corner at the southwest corner of the section;

"S¼," quarter-section corner on the south side of the section;

"SL," line, or boundary, on the south side of the section;

"SE," section corner at the southeast corner of the section;

"E¼," quarter-section corner on the east side of the section;

"EL," line, or boundary, on the east side of the section;

"INT," work within the section, or subdivision.

By this system, when cross-indexed, the matter pertaining to each line and exterior quarter-section corner appears on two different pages, and of each section corner on four pages. If a town or range line or corner, it appears in two volumes, and if a township corner, in the volumes of four different townships.

Should a survey, the purpose of which is to establish a line or corner in a particular township, extend into an adjoining township or on a town or range line between other townships, the record is all made in the volume pertaining to the purpose of the survey, but those parts affecting the other townships will be indexed in the volumes devoted to those townships. Until work has been initiated in all the townships, it may be that all a township volume will contain will be in its index showing where records affecting it will be found in other volumes.

I have found it advisable not only to use abbreviations for the thirteen general subdivisions of a section, but also to use abbreviations for the descriptions pertaining to these divisions. That you may better understand the index, I here reproduce the index of section 35 of township 19 north of range 46 west, as appearing in field memorandum volume numbered 1-9-6, and follow it with the index of the adjoining section to the south, or section 2 of township 18 north of range 46 west, as it appears in the second volume of this township or volume number 2-8-6.

Page 35, Vol. 1-9-6 (1st Vol. Field Memo. T. 19 N. R. 46 W.)

NE: Agreement as to corner, 46-48; LPP and LC Est-Per, 49-50 (the figures refer to pages).

N¼: Agreement, 46-48; LC Est-Per 48-49.

NL: RBch, 44.

NW: GC D-Per 44-46.

W¼: PC. Est-Per, 51-52.

WL: RBch, 42.

SW: 52-53, 1-8-6; GC. 61-64, 1-8-6; W. 156, 1-8-6. (These are page numbers in Vol. 1-8-6, or Vol. 1, T. 18 N. R. 46 W.)

S¼: PP 41, PC Est-Per 58-59.

SL: RBch, 51-52, 61, 126, 1-8-6; T1Ch, 41: E¼/¼ Est-Per 57-58: W¼/¼ Est-Per 59.

SE: PC. Est-Per 65, 1-8-6.

E¼: Agreement, 46-48; LC. Est-Per. 50-51.

EL: RBCh. 41.

INT: ¼Cor. Est-Per. 52-53. S¼/¼ Est-Per. 55-56. SW1/16 Est-Per. 56. SE1/16 Est-Per. 57. Lat ¼ Line, 52. E¼/¼ Est-Per. 53-54; W¼/¼ Est-Per. 54.

Page 2, Vol. 2-8-6 (2nd Vol. Field Memo. T. 18 N. R. 46 W.)

NE: PC. Est-Per. 65, 1-2-6.

N¼: PP. 41, 1-9-6; PC. Est-Per. 58-59, 1-9-6.

NL: RBCh. 51-52, 61, 126, 1-8-6. T1Ch. 41, 1-9-6. E¼/¼ Est-Per. 57-58.

NW: Sh. 52-53, 1-8-6; GC.D-Per. 61-64, 1-8-6. W. 156, 1-8-6.

W¼: Sh. 90, 1-8-6; PC. Est-Per. 153-155, 1-8-6.

WL: RBCh. 65-66, 1-8-6; RB, 103, 126, 1-8-6. S¼/¼, 155, 1-8-6. N¼/¼, 155-156, 1-8-6.

SW: GC.D-Per. 87-90, 1-8-6; W. 153, 1-8-6.

S¼.

SL: RBCh. 86-87, 1-8-6.

SE:

E¼:

EL:

INT:

So far I find I have used eighty-seven different abbreviations or combinations of abbreviations. The more common ones are: "R," for random line; "T1," for true line; "B," for bearing or direction; "Ch," for chained distance or length of line; "LPP," for latitude or proportional point or the proportional point on an east and west line; "MPP," or meridian proportional point or the proportional point on a north and south line; "GC," for government corner; "PC," for proportional corner, or a corner re-established according to law where a government corner is not found; "LC," for local corner, or any corner not a government corner or a corner not known to be re-established by proportional measurement according to law; "Des" or "D," for description; "Est," for established; "Per," for perpetuated or the description of the remarking of the corner or of its establishment; "Sh," for search, or the description of the search for the missing corner; "Ev," for evidence, testimony or information concerning a corner; "W," for witness or the bearing of some point in relation to the corner; "E¼/¼" and "W¼/¼," also "S¼/¼" and "N¼/¼," are, respectively, the east, west, south or north quarter-quarter section corner points when within a section, but when on the boundary their position is denoted by the particular line; "SE 1/16" or "SW 1/16" refers to the corner at the center of the southeast or southwest quarter sections of the given section. Applying these meanings to the foregoing index pages, the matter will become very plain and easy of understanding.

I find this system of indexing in the field memorandum works all right as long as not more than two volumes are used in any particular township, but when there are more than that, there should be a special index volume for the township.

Publications Received

A paper by R. E. McDonnell, Interstate building, Kansas City, Mo., on how to conduct bond campaigns, before the Kansas League of Municipalities, has been issued as a separate pamphlet and can be obtained on request.

A paper before the joint meeting of the Illinois and Iowa sections of the American Water Works Association by J. H. Dunlap of Iowa State University on "The Sanitary Drinking Fountain," has been reprinted separately for distribution.

MACHINERY AND SUPPLIES

Machine Finishing of Concrete Roads

The article on concrete road construction prepared by M. DeGlopper, county engineer, Pontiac, Mich., which appeared in the April, 1916, issue of Municipal Engineering, went into considerable detail as to the machine-finishing of concrete roads in Oakland county, Michigan. The comparisons between hand and machine methods of finishing made by Mr. DeGlopper at that time were based on practical experience resulting from his own work, but this method of machine finish has since been developed and improved in various ways.

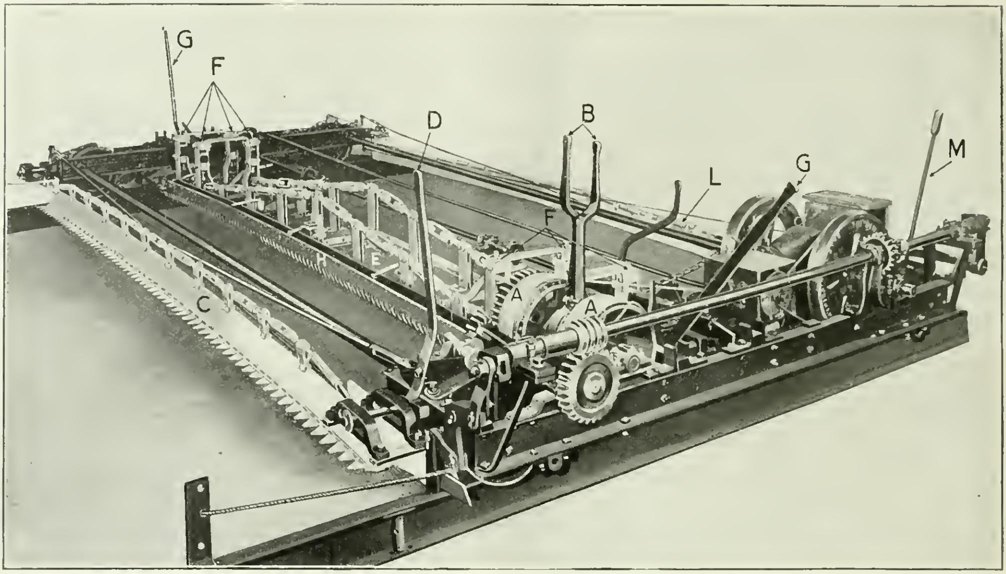
A new joint-installing device, which consists of a frame carried on two truck wheels is now drawn by the finishing machine itself.

The joints are first placed with tops 1 inch below finished surface grade, the filler between the steel plates being allowed to extend a distance of approximately 1 inch into the subgrade, banking both sides with a little earth, thus permitting the machine to pass along as tho no joint were there. This method permits of an equal density of concrete on each side of the joint, a result not obtainable by hand finish, in which case it is necessary to strike up to the joint and lift over, and then go on from the other side, leaving an excess of material at the joint. This excess usually has a preponderance of coarse aggregate and therefore makes a high joint of different quality than the concrete in the balance of the pavement.

After the finishing machine has passed over, comes the apparatus which is towed behind it, which consists of a bridge on wheels with a framework to which tongs are attached. A lever is thrust down, causing the set of tongs to catch the steel plate joint and gently lift it to grade with a slight rocking motion, which tamps the concrete around and under the plates as they are gradually brought to the surface. Stops are provided, which prevent the raising of the armor plates above the correct position, and it is stated that this method guarantees that there shall be no excess material at the joint.

By means of the above method of installation an absolutely vertical joint is assured. The installing bar holds the joint in position above, while the extending of the filler into the subgrade insures a perfect alignment. When the joint is pulled up, as previously stated, it is an easy matter for the finisher, operating from the bridge, to give the concrete a few finishing touches on each side of the joint.

The R. D. Baker Company, contractors, Detroit, Mich., have perfected the above type of finishing machine on their own work in Wayne and Oakland counties, and while the machine effects a considerable saving in labor, they do not consider its



labor-saving ability alone as its chief advantage to the contractor. "We perfected this machine," states Mr. Baker, "in order to improve the quality of our concrete as well as to render it free from waves, depressions or irregularities of any sort. The securing of a uniform, dense concrete is of more real lasting advantage to the contractor than any mere dollars and cents saving in operation, especially where a maintenance is called for, and we have proven in our work that machine-finished concrete road will not ravel.

"The machine finishing of concrete roads eliminates the personal equation in the finishing process. The machine is always on the job and ready to do its work, whereas hand labor cannot always be depended upon. The machine is automatic in its actions, while the hand finisher is not. The finishing machine does equally good work all of the time and night-outs and hot weather do not affect it."

Edward N. Hines, chairman of the board of county road commissioners, Wayne county, Michigan, in describing the machine finishing of concrete roads, puts emphasis on the same points and adds:

"Then, again, the finishing machine permits the placing of the mixed material in a drier state. The machine thoroly tamps and kneads under compression, thus not only assuring greater density to the concrete, but a uniform density thruout. For these reasons the use of the finishing machine results in a decided gain in the quality of the finished road. Water pockets and air bubbles are eliminated and a more homogeneous concrete is secured. If side forms are firmly staked to line and grade, results secured by using a finishing machine cannot be obtained in any other manner.

"The finishing machine finishes the concrete surface immediately behind the mixer before initial set takes place, whereas the initial set is apt to be under way before hand finishers can get in their work.

"The spots, filled with laitance washed in by the water, are very noticeable on account of their chalky white deposit, which can be scratched by the fingernail."

"We were the first to operate a Baker finishing machine," states George F. Key, engineer of the same board, "and this machine has been perfected to a large extent on our work.

"Thru use of the finishing machine it is not necessary to use such a wet mixture—we need use only the correct amount of water (about 27 per cent.). The machine kneads the concrete while under compression, which is better than tamping, and this kneading action at the same time eliminates the bubbles of air which get into the concrete while mixing in the drum. The machine enables us to finish the concrete close to the mixer before the initial set takes place and its kneading assures that the concrete as it is laid on the sub-grade is as uniformly mixed as when in action in the revolving drum.

"The surface of a machine-finish road is very different from that of a hand-finish road. To begin with, there is no excess water in the concrete and in finishing close to the mixer we immediately compress and seal the surface, permitting the initial set to take place undisturbed. The result is a glass-like glaze, grayish in color, while the hand-finish road is more apt to be a chalky white. Of course, the difference in color depends a great deal on the kind of cement used, but the above statement is true in the long run. The sun will glisten on a machine-finish road, whereas it will not on a hand-finish road.

"Many visiting engineers in walking over our concrete roads have detected a difference in the feel of those that were finished by hand, as compared with those finished by machine. The machine-finish road has such an even surface as compared with the projections on the surface of the hand-finish road that the difference is very noticeable. In other words, the difference between the two surfaces is noticeable to the casual observer. There is no gritty feeling to the sole of the shoe, as the machine-finished surface is uniformly even and hard.

"The Baker finishing machine which we are using consists of two trucks, each having two wheels, and the two being connected by the strike compression pan and finishing float. The two cables, extending to the left and attached to the side forms, are used to move the machine forward at a rate of approximately 90 ft. per hour. This is accomplished thru the winding of the cables around the two power-driven drums AA shown in the accompanying lettered drawing. These drums, which operate independently by the two vertical levers, B, permit one end of the machine to be moved ahead of the other when desired, so as to allow finishing around a curve.

"C, extending between the trucks, is the strike, which is adjustable vertically thru the lever, D. This strike oscillates transversely and is adjustable to different crowns by means of the turnbuckles.

"The compression pan, E, crowned with turnbuckles, can be adjusted vertically with the cap screws, FF. These screws permit the raising of the front edge of the pan higher than the rear edge and with the pan so set a large part of the weight of the machine, as it moves forward, is taken off the side forms and carried by the pan itself resting upon the green concrete, and it is this action which compresses the concrete at about 80 lbs. per sq. ft. It is this compression which squeezes out the excess air and water.

"The levers, GG, raise the pan vertically. The agitator, H, with fingers extending back under the pan, oscillates transversely, thereby kneading the concrete under the pan, and it is this kneading under compression which produces a uniform grade of dense concrete over the entire surface.

"The finishing float, L, smooths out any corrugations left by the pan. This float, which oscillates transversely, can be raised or lowered with the lever, M, and is adjustable to crown by means of turnbuckles.

"Altho this type of finishing machine weighs approximately 3,600 lbs., this weight is mostly distributed onto the green concrete along the compression pan."

Elmer G. Rice, secretary of the Wayne county road board, thinks the machine "adds at least one-third to the life of the concrete road without extra cost to the taxpayer."

William H. Ryan, contractor, Lansing, Mich., states that "one of the chief advantages of this type of finishing machine rests in the contractors' ability, thru its use, to do uniformly good work with unskilled labor. Any man, who can oil it, can run it.

"Taking it for granted that proportions of mix are right and that the material is the best and that the road has the proper thickness to support the traffic it is intended to bear, the surface of the concrete road is the most important and vital feature of its construction, as on the surface depends the success of the finished pavement. Where small depressions occur in the pavement we are apt to find one deep depression where two small ones formerly existed, as traffic so tends to aggravate them. Every point of contact marks a spot where abrasion will set in. I would therefore say, make your mortar, if possible, as dense as the coarser aggregate and thoroly bed the aggregate in the mortar. This result can only be accomplished by taking the concrete after it is thoroly mixed and knead it as it passes under the compression pan, thus eliminating the air bubbles and excess water. One of the chief advantages of the finishing machine rests in the fact that it permits the use of a concrete of jelly-like consistency, a concrete which does not run but stands up and barely settles down under its own weight. It would be impossible to strike or float such concrete by hand, yet this quality of concrete has just the proper percentage of water to give the greatest tensile strength.

"The machine does its tamping thru compression and the area of the compressing pan is so great that the concrete does not become displaced or squeezed out from beneath it, as would be the case were it feasibly practical to tamp it by hand."

One of the reasons for the success of the finishing machine in producing a superior concrete surface lies in being able to finish close to the mixer, and consequently to strike, tamp and finish the concrete before the initial set has progressed to any extent. On this subject, Chairman Hines says:

"The writer has noticed that many concrete roads lose a thin layer of surface shortly after being opened. The concrete below does not flake off like this top layer, but 'dusts' and does not seem to have the stability to resist wear, altho a strong mixture was used.

"Some time ago a contractor who has put in a large number of concrete factory floors in Detroit stated that his success in building floors that do not 'dust' is due to the fact that the concrete is finished immediately after being removed from the mixer. When asked if it wasn't hard to keep the finishers so close to the work, he stated that he considered this so important that the mixer was stopped if the finishers were getting behind, until they caught up.

"There is no question that some floors and concrete roads dust and ravel, and if immediate finishing is the solution of the former, why not of the latter?

"The writer has often seen finishers working 75 feet or more behind the mixer. Figuring that the gang lays 500 feet per day, that means the concrete has been out of the mixer 1½ hours. What is the effect when the finisher retempers the mortar in floating so long after it has been mixed? The initial set has been destroyed. Most specifications for concrete construction today call for the rejection of concrete that is not deposited in the forms within thirty minutes. The concrete road calls for more exacting specifications than building construction, for in addition to shear, tension and compression, we have abrasion. We, therefore, should not be lax in road specifications. The finishers should not be more than 25 feet

FINISHING MACHINE ON WAYNE COUNTY ROADS, DETROIT. BAKER SIDE FORMS AND ARMOUR PLATE USED.

SETTING BAKER INDESTRUCTIBLE SIDE FORMS.

MACHINE FINISHED CONCRETE ROAD. BLOOMFIELD HILLS, WOODWARD AVE., NORTH OF DETROIT.

behind the machine if initial set is to be allowed to take place uninterruptedly thirty minutes after mixing.

"Some time ago an experiment was made to obtain a more even surface. A hand strike was sawed six times over a 25-foot section of road, after which it was finished with a hand float. It looked beautiful to the eye—so even—but, shortly after traffic was turned on to it, a layer about ⅛ inch in thickness came off, exposing the pebbles beneath. The exposed concrete was hard thru the tamping caused by the excessive striking, but the top layer, which was continually disturbed by the strike, lost its initial set and the bond to the lower material.

"The chemical action of setting in the cement begins as soon as the cement comes in contact with the water. We should continue mixing the aggregates, cement and water up to a certain time, not to increase the chemical action, but to mix the ingredients thoroly so as to get an even quality of concrete. It is found if we mix longer than this time we get a weaker quality of concrete. Why? Because we had it mixed and the continual turning of the drum is interfering with the setting.

"Let us assume that we have turned it over in the mixer drum just the right length of time to get the strongest mix. We pour it out on to the grade, which is further mixing. Workingmen tramp into it, level it off and strike it, which is further mixing. Then, after it has been out of the mixer an hour, along comes the finisher with a wooden float. He slushes the mortar top around in the excess water that has come to the surface, which is further mixing.

"We have mixed the concrete in the drum until we have obtained the greatest efficiency out of the cement and then continued to mix or temper it, which, experiments prove, will decrease the efficiency. Then we come on and destroy the initial set by late floating. What is the result? Haven't you noticed the flakes that come off a concrete road soon after traffic is let on? That together with continual dusting is the result.

"Many engineers agree that the concrete should be finished close to the mixer, and in order to do this easily they make the mixture very wet. The slushing of the excess water in the mortar with the float will not produce good concrete, to say nothing of the cement that has run to the sides with this water.

"Mix your concrete dry by using the correct percentage of water. There will then be no excess water to evaporate and make voids in the concrete. It is true the striking, tamping and finishing of such concrete will cost more than the sloppy kind, but the wearing surface produced is worth ten times the cost.

"Concrete roads will last indefinitely if destroyed thru wear alone. Raveling is what destroys them and that takes place when the hardness of the mortar is not on a par with the coarser aggregate and allows it to loosen and be picked out.

"Mix your concrete the proper time, deposit it on the grade, crown and float it at the earliest possible moment, and let nature do its work uninterrupted."

Holt Company Cuts Costs With Heltzel Loaders

C. S. Kauffman of the Holt Construction Company, Denton, Md., reports a considerable saving as a result of unloading material from cars with the Heltzel lightning unloader. In reply to an inquiry regarding the exact saving effected in his work, Mr. Kauffman recently said:

"Unusually strong, light construction and low cost were the features that first interested us in the Heltzel. These things decided us after the weight and expense of the ordinary loader had kept us on the fence for some time.

"As we expected, we found that the light weight was appreciated by the men, who have no liking for such a device unless it lightens their work. A trial order of one decided us that these were the things we had been looking for.

"At present we have three Heltzels on the job all the time, and find that we are doing our work with about one-third less labor and a corresponding cut in the pay-roll. The men work faster and steadier to keep the skips full and when a wagon comes along it is loaded up in a jiffy. We are using 1½-yd. dumps and the loading time is considerably under a minute. Right there is a saving of 10 or 15 minutes for every load.

"Easy installation is a big point in favor of these loaders and we also find that they stand up wonderfully under hard usage. When we need more we will certainly buy Heltzels."

The loaders used by Mr. Kauffman are standard Heltzel loaders which consist mainly of a steel skip pivoted between two brackets. Special design of these brackets makes attachment to the side of a flat car only a matter of a few minutes and when these are attached the skip is easily slid into place.

When routing of the automobile trucks to and from the car is arranged for best results there is always a full skip waiting with its load ready to be slid off as soon as the truck pulls under it. After the load slides off the skip immediately swings back to its horizontal position ready for the shovelers. Thus there are never any idle periods either for the truck or the laborers, making an all around saving that soon pays for the set of three loaders generally used for one car.

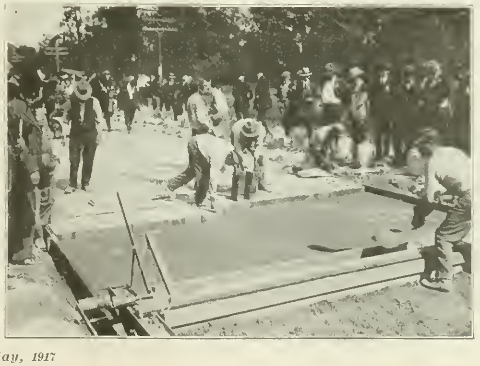
Parrish Template in Monolithic Road Construction

As a means of speeding up the construction of monolithic brick highways an ingenious template has been devised by Allan J. Parrish, who built the section of the Chicago highway near Paris, Ill. This template is simple in construction and provides the smooth bed necessary for a well built highway.

The Parrish double template consists principally of a forward cutting edge (an I-beam) and a rear cutting edge (a channel with the flanges placed outward) between which is a space to receive the luting mixture. Details of this construction may be seen in the illustration which is here reproduced. The I-beam and the channel are spaced from 2 to 3 feet apart. The bottom of the rear cutter is about 3/16 inch higher than the lower edge of the forward cutter. In use the space between the cutters is filled with a mixture of dry sand and cement so that after the template in motion has cut off the concrete surface to the proper form the luting fills all irregularities in the surface.

In working with the Parrish template the road to be paved is first covered with concrete mixed to a quaky consistency, the surface of which is roughly struck off with shovels to a depth of about 2 inches greater than the required depth of foundation. The template is then filled with a dry pre-mixture of equal parts of sand and cement and the foundation struck off and luted. Forward motion of the template is obtained either by a chain wound on a specially prepared drum on the mixer or by driving the mixer ahead on the planking.

It is found that the surface left in the rear of this template is remarkably smooth, entirely free from depressions and



ready at once to receive the brick surface. Bricks are laid in the usual manner, the dropper standing on the brick just laid, which even at this stage have sufficient rigidity to resist the formation of any depressions in the surface due to workmen moving about.

Where the Parrish template is used the brick is set immediately by rolling with a 400 to 500-pound hand roller and the surface produced in this way is found to be remarkably smooth.

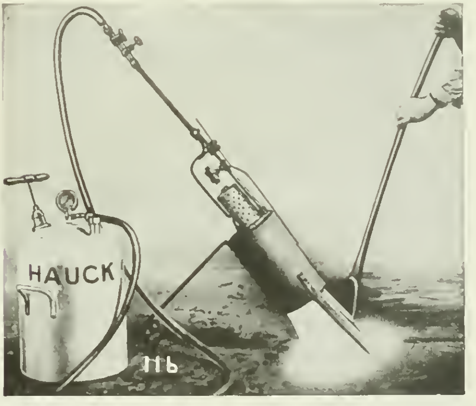
Thawing Out Frozen Ground

We are illustrating a popular type of burner for thawing frozen ground.

The distinctive features of this outfit will be found in the burner itself, it being of a patent vaporizing type which operates without compressed air. Where used in the open it is made with special housing for protecting the flame and preventing its becoming cool too quickly when shut down or starting up intermittently.

The burner has its own combustion chamber and delivers a blue-reddish flame. The oil storage tank is equipped with a quick acting 2-in. diameter heavy brass pump which forces the oil to the burner. From 30 to 60 lbs. of pressure may be obtained within 2 to 3 minutes and will last 3 or 4 hours.

The method of applying the flame for thawing out frozen ground is shown in the illustration. The burner is resting on



HAUCK HAND PUMP OIL BURNER FOR THAWING OUT FROZEN GROUND.

a stand which is made in the form of a shield for protecting the burner from the wind or draught. It helps to concentrate the flame in the manner indicated.

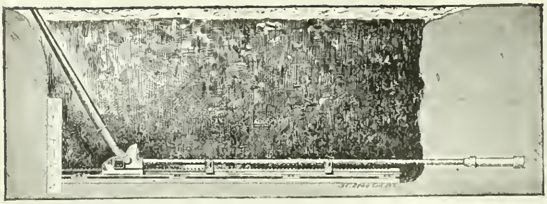
A hole 2 ft. wide and 3 ft. long into 12 in. of frozen ground was dug within 18 minutes. This was accomplished by applying the burner and loosening the frozen top surface, after which the crowbar and shovel were applied and the loosened materials removed, after which the burner was again applied.

This outfit was especially designed for digging ditches, for opening up frozen streets, for repairing gas mains, fire hydrants, etc.

Forces Pipe Under Pavement

We are illustrating a popular method of driving pipe up to 4-inch diameter under pavements.

The Barret forcing jack consists of a malleable iron cage traveling on a steel rack with machine-cut teeth and operated



by the handle. At the front of the cage is a groove and clamp for holding pipe of ¾ to 4-inch diameter. The rack is provided with foundation plates and bolts for securing a plank, and also carries two guides for holding the pipe in line. The interior working parts are of steel, heat treated. The jack will work against any resistance up to 30,000 pounds.

This jack has a travel of 7½ feet. The trench should therefore be a little longer than this, and the pipe cut in equal lengths, not over 7 feet 4 inches long. If it is desired to use longer pipe, say 14 feet lengths, the trench must be correspondingly longer, and a short piece of pipe, about 7 feet 4 inches long, to be used on every other rnn out of the jack, to force the end of the permanent service pipe its full length into the ground, making room for the next full length of pipe in the trench. The former method is usually preferred.

Air-Cleaned Roads for Asphalt Treatment

To provide an absolutely clean road surface for bituminous treatment a combination blower and asphalt spreader has been devised by S. E. Finley, of Atlanta, Ga. This system of cleaning and applying a surface of hot bitumen is known as the Finley method.

As illustrated, the machine used is a large blower mounted

FIG. I.—FINLEY METHOD SPRAY BINDER ON FRESHLY CLEANED ROADBED.

on a motor truck, this blower being chain-driven from the main shaft and capable of delivering 6,000 cu. ft. of air per minute at a pressure of from 2 to 3 ozs. Air is projected on the road surface thru a longitudinal slot at the bottom of a horizontal flue, and removes all dust by blowing it slightly ahead of the openings. At the same time the hot binder is forcibly sprayed onto the newly cleaned surface by 4 special rotating nozzles. This binder is sprayed onto the road at a pressure of about 60 lb. per square inch.

As shown in Fig. 1, the supply of binder is carried in the large tank mounted on a motor truck, thus being delivered under pressure to the distributer.

Fig. 2 shows the air blast in operation throwing up a cloud

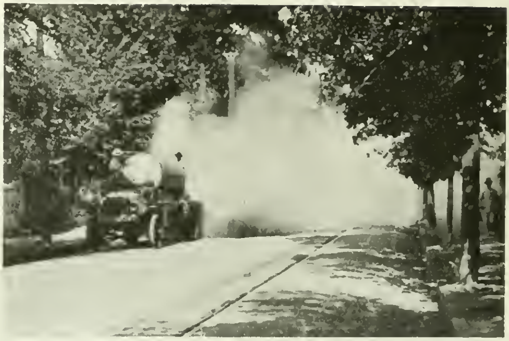


FIG. II.—BLOWER OF THE FINLEY METHOD THOROLY REMOVES ROADBED DUST.

of dust, which entirely obscures the combination blowing and asphalt-distributing device. In Fig. 3 is shown the same surface before cleaning, and it could hardly be seen from inspection of this view of an apparently clean pavement how so much free dust as is indicated by the preceding view could exist.

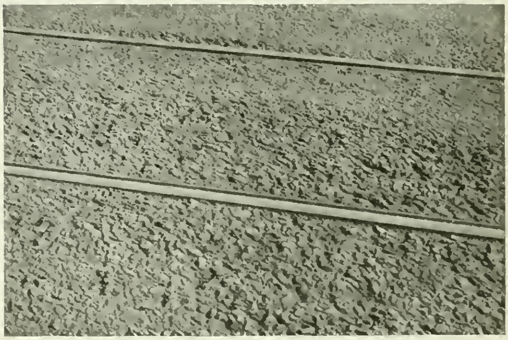


FIG. III.—APPARENTLY CLEANED ROADBED BEFORE IT WAS FINLEY CLEANED, AS SHOWN IN FIG. II.

It is claimed that these machines can be very closely regulated to distribute from one-sixth of a gallon per square yard to over two gallons, and in all cases providing a uniform layer on the roadbed.

With the Finley machines, which are not sold, but are leased under an agreement with the manufacturer, it is said that bituminous binders can be applied for a cost as low as 6c per gallon.

Shovel on Sewer Excavation

There are two reasons in particular why the Salt Lake City project, known as the West Side Outlet Sewer, is so decidedly interesting.

Reason number one is the special machinery used, whereby the constructing cost has been reduced. Number two is the fact that practically all the equipment is electrically operated.

The work consists of laying a main trunk reinforced concrete pipe sewer about 22,000 feet long, and the necessary excavation therefor. The pipe varies in diameter from 42 inches to 78 inches, inside measurement. The excavation involves about 150,000 cubic yards.

The contractors for this work are Gibbons Brothers, Reed & Roche, of Salt Lake City.

Before any of the trench has been dug, work was begun in making the reinforced concrete locked joint sections of pipe.

VIEW OF TRENCH, SHOWING THE SHEET PILING AND TWO ELECTRIC CRANES.

Instead of casting this pipe all in one yard it was made along the lines of the sewer, to save the cost of hauling and extra handling. A certain amount of seasoning is required before the pipe is put in place. The preliminary drying process was accelerated by the use of steam coils.

A section of 78-in. inside diameter pipe, 4 ft. in length, weighs about 9,100 pounds.

The depth of the trench, or ditch, varies with the contour of the ground, and the fall in the system. The greatest depth is approximately 20 ft. The width of the trench is governed by the size of the pipe, the maximum width being 10 ft. 6 in.

Considerable of the equipment used on this work was especially designed by its contractors, and the method of laying the pipe, which is said to be somewhat out of the ordinary, is as follows:

The center line of the sewer is staked out by the city engineers. An Osgood steam shovel No. 18 with a ½-yd. bucket and a special length of boom stick first digs out a ditch about 6 ft. deep and of the required width.

The shovel itself is supported by the timbers laid across the opening. This bridge is carried along by the shovel picking up sections of it from behind and placing them in front in the direction of travel.

The steam shovel is followed by a traveling pneumatic pile driver. Locked steel piles 20 ft. in length are then driven along the walls of the shallow ditch until the tops are flush with the original surface. Timber braces are next put in place to prevent the piles being forced in by the pressure of the ground on the outside. Two traveling cranes now follow, each having a ½-yd. clam-shell bucket which takes out the dirt to approximately the proper level on which the pipe is laid.

A certain portion of the ground removed is used in filling up again and the balance is carted away. The steam shovel and clam shells load directly into the carts or wagons.. The gage of the rails on which the cranes travel is wide enough to permit these wagons to travel between the outside rail and the edge of the ditch.

The third traveling crane raises and lowers the bridging timbers between the piles, sets the sections of pipe in place and afterwards pulls the steel piles. This crane is assisted by a special steel derrick for lowering the pipe.

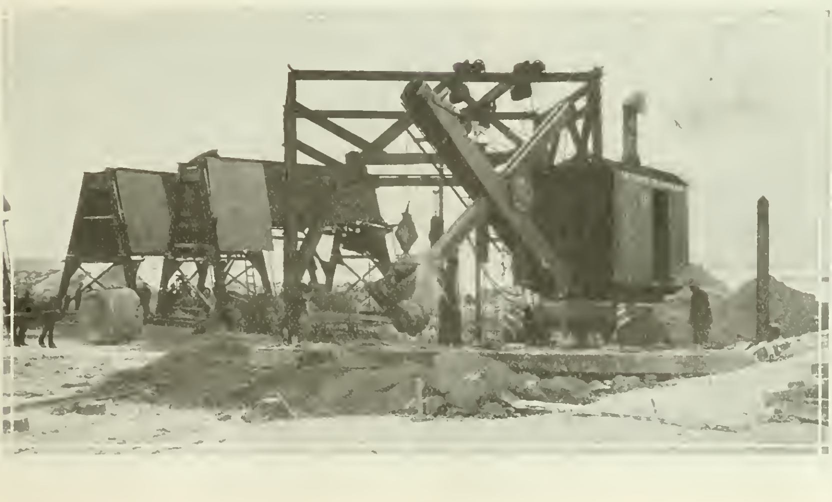
The various sections of pipe are cemented together so as to make the line continuous.

A Pawling & Harmisfeger back-filler fills up the trenches.

Wire rope was an important factor on this work and Hercules was on the job.

All the equipment with the exception of the steam shovel is electrically driven. Practically all the structural steel work is made in Salt Lake City. The hoists are supplied by the Sprague Electric Company. The air compressor that supplies the pneumatic pile driver is moved along as the work progresses.

The territory which this sewer will drain lies low so that seep water is encountered at a depth from 6 to 10 ft. and this makes it necessary to take extra precautions against cave-ins and raising of the ground in the bottom of the trench.



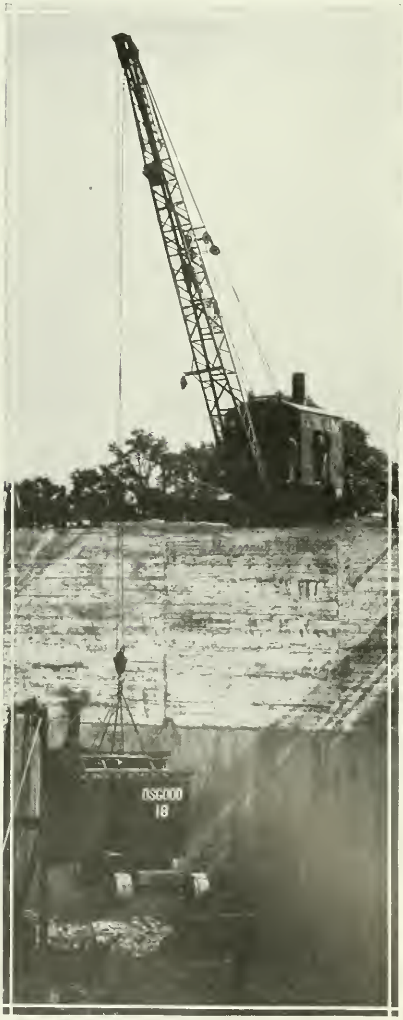
Shovel Lifted by Crane

After the 18-ton shovel that had been used by the city of Chicago for excavating to a depth of 50 ft. below the ground surface had completed its work, the question arose of how to get the shovel out of the pit with the smallest cost. A Browning locomotive crane had been used on the job for unloading sand, gravel and other construction materials.

The crane was run up to the pit on a track laid for that purpose. A ¾-inch Hercules wire rope was let down; a fastening was made in the shovel; the engine throttle was opened, and the deed was done.

The excavation in question was in connection with the construction of the Mayfair pumping station under the direction of F. Carl Martini, resident engineer, and E. S. Henry, general foreman of the engineering department of the city of Chicago.

A connection was made to the shovel by means of a chain passing around it under the truck. Before the shovel was raised its dipper and boom were removed, which made the actual weight lifted about 16 tons. The shovel was raised and swung around on the ground in less than three minutes, at a 21-ft. radius, and this performance of the crane exceeded its rated capacity by about 33 1/3 per cent.



Removable Steel Culvert Mold

By means of an ingenious knock-down steel culvert-mold, which has just been devised, it is claimed that the cost of constructing concrete culverts can be reduced by at least 50 per cent. The mold is built strongly, but of very light weight, so that it can be easily handled by one man.

As illustrated, the device consists of two side rails, each provided with a special lock or catch so that they may be joined together by arched end pieces, as shown in Fig. 1. This catch is so arranged that when it is locked with the arched members of the form upright the two arches and two side beams are rigidly held together. When unlocked by pulling the two ropes shown, the four pieces of the form at once fall apart.

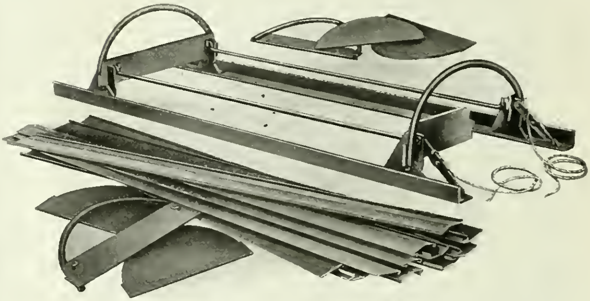


FIG. I.—PARTS OF KNOCK-DOWN CULVERT MOLD.

Interlocking steel sheets laid over the end arches complete the form.

Setting this form in place ready for use is only a matter of a few minutes. After the concrete has set the whole form is collapsed by simply pulling the two ropes, after which the steel is removed piece by piece, ready for a new job.

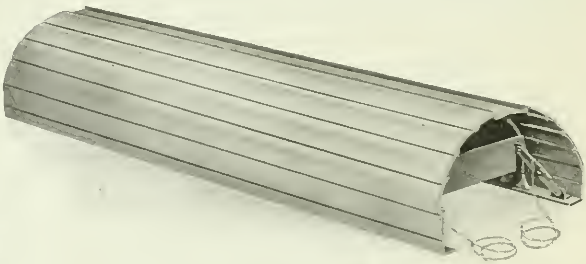


FIG. II.CULVERT MOLD ASSEMBLED READY FOR USE.

These forms are built in standard sizes for culverts 20 to 24 feet long, and with each set four pair of end arches are supplied, providing for four widths of sewers, from 20 to 48 inches wide. As the entire apparatus is made of steel and malleable castings it is good for a large number of culverts without noticeable depreciation.

Roller Cutting Attachment

A time-and-cost-saving method was used by the Stone & Webster Engineering Corporation for removing pavement in connection with a street railway job in a Texas city. The bitulithic surface to be removed was about 2,000 feet long and 8 feet wide. For the job in question two pieces of 3 by 3-inch angle-iron were fitted to one of the wheels of a 10-ton steam roller, one side of the iron being sheared for a cutting

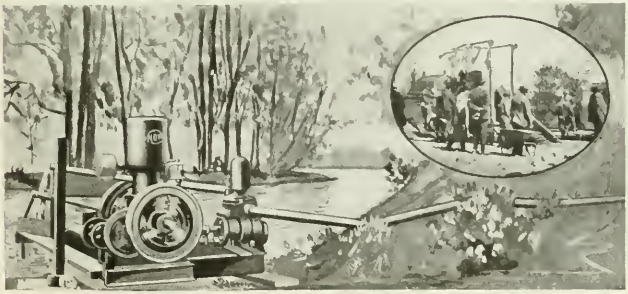
edge. Two white lines 8 feet apart were then painted on the pavement, to act as guides for the operation of the roller. As the cutter was placed on one wheel only, the steering was not difficult, and the weight of the roller drove the angle-iron thru the pavement. After two cuts had been made, each 2,000 feet in length, a gang of men rolled the pavement to one side. The device cost $10.

Pumps Water Two Miles

We are illustrating how a Novo type-U outfit solved a hard problem for contractor William H. Ryan of Lansing.

When Mr. Ryan set up his concrete mixer on west Main street, about two miles out from the city limits of Battle Creek, Mich., he found the nearest water supply was two miles away. He set up the outfit, as illustrated, on the banks of the Kalamazoo river, two miles from his mixer, started it going and left it. Until the finish of the job it supplied the mixer with more water than it could use, at about 75 pounds pressure, and without let-up or trouble of any kind.

PUMPING WATER DISTANCE OF TWO MILES TO MIXER. STEAH SHOVEL EXCAVATING TRENCH.



Concrete Tamper

The Andrews concrete tamper has projections on its face which force the coarse aggregates into the body of the concrete, and it is said that this makes it unnecessary to lay the concrete in two layers, as the operation of tamping brings the mortar to the top for a finish.

Trade Notes

The publicity bureau of the Associated Metal Lath Manufacturers has moved its offices to 901 Swetland building, Cleveland, Ohio, with Zenas W. Carter as commissioner in charge.

Anson-Byrne Company, Chicago, sales agents for various mechanical equipment, have new offices at 10 South La Salle street.

The business of August Mietz, Emma C. Rueff proprietor, has been transferred to the August Mietz Corporation, with Emma C. Rueff as president, Emil Rueff vice-president and treasurer, Otto V. Schrend, secretary; Louis C. Eitzen, general manager, and will be continued without change of policy under Mr Eitzen's personal management.

F. L. Manning has become general manager of the Peebles Paving Brick Company, Portsmouth, O., succeeding S. C. Peebles, who resigns the duties of this position, retaining those of vice president and director. John Peebles is president.

Trade Publications

The National Paving Brick Manufacturers' Association has bound in one handsome cloth-bound volume three booklets on city streets, series 1, 2 and 3 and three on country roads, series 1, 2 and 3, which are really three sets of specifications for brick pavements, with the proper modifications to adapt them to street and to road pavements respectively. Series 1 in each set is on the sand-cement super-foundation type of vitrified brick street or road pavement, with cement grout filler. Series 2 is on the green concrete foundation type. Series 3 is on the sand-cushion type.

A portable meter, for testing service meters, is described in Bulletin No. 46291A, just issued by the General Electric Company. The purpose of a meter of this kind is to save time and labor, increase efficiency ,and eliminate such inaccuracies as errors due to fluctuating voltage, load, etc.

The Austin tandem motor roller, gasoline driven, is fully shown and its advantages stated in a recent circular of the Austin-Western Road Machinery Co., in Chicago, Ill., which will be sent on request.

Meter boxes for all climates is the theme of a recent circular of H. W. Clark Co., Mattoon, Ill.

The Clay Pipe Book, published by the International Clay Products Bureau, Kansas City, Mo., is a very valuable statement of the process of manufacture of clay pipe, the tests to be applied to drain tile and sewer pipe, and many novel uses of such pipe.

"Facts About Water Power," is the title of a pamphlet issued by the Water Power Development Association, Washington, D. C., which contains the data on which the organization bases its campaign for certain legislation by Congress on this subject.

FIRE DEPARTMENT

Fire Fighting in Years Gone By

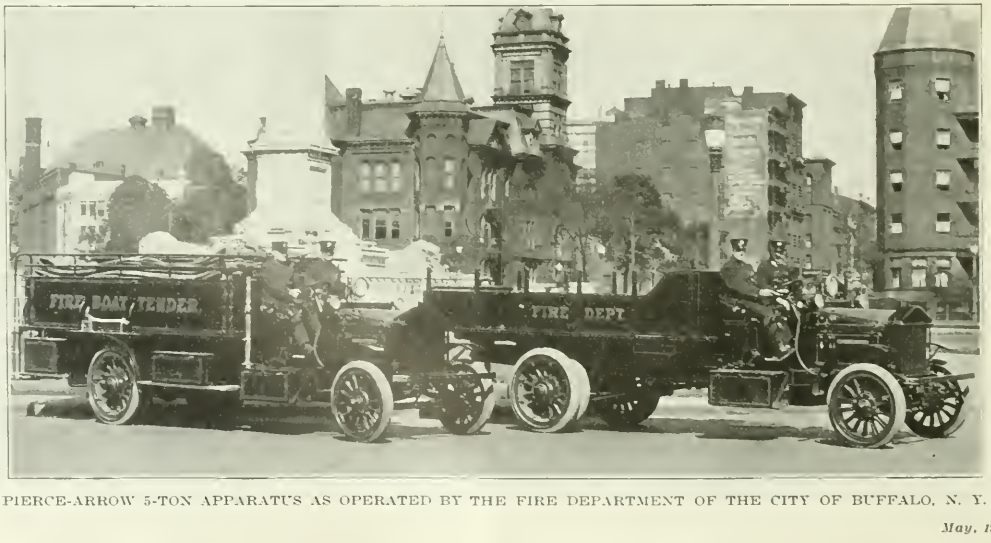
The precise origin and description of the earliest fire-fighting inventions are hard to find, altho ancient history intimates that they were devised and put to notable use in ancient Babylon.

There the problem was, how to raise water to the top of the high wall by which the city was surrounded. Herodotus tells us that the water was admitted into closed vessels or pipes, and then forcibly expelled on the principle of the bellows. Then for the first time water was forced perpendicularly up to the required height. This process, beyond doubt, suggested ultimately the fire instruments, sucking pumps, siphons, syringes; and these in turn suggested a kind of fire engine that for another long period waited on invention.

The earliest mention of fires and fire instruments in the city of London was by William Fitzstephen, who in about 1190 writes concerning them. John Stow dug up this matter, and in his survey of London, first published in 1603 made this observation: "It followeth in Fitzstephen that the plagues of the city in his time were an inordinate quaffing among fools, and oftener casualities by fire, the houses being then built all of timber and covered with thatch of straw or reed, it was long since thought good policy in our forefathers wisely to provide, namely, in the year of Christ, 1189, the first of Richard I, Henry Fitzalwine then meing mayor, that all men in this city should build their houses of stone up to a certain height, and then to cover them with slate or baked tile; since which, thanks be given to God, there has not happened the like often consuming fires as afore."

According to this authority, the only instruments then used against fires were hand squirts, syringes and axes, the like of the instruments that were used in a fire in Rome, described by Pliny. From these old times down to the great fire of London, September 2, 1666, it is certain that no considerable improvements in fire instruments were made. And from the date of the London conflagration down to the year 1834, when the first of Chicago's fires occurred, the inventive talents of all nations had produced few weapons for combating fires, and the best of them did not suggest, much less did they prophesy, the powerful steam fire engines and the accompanying paraphernalia that now are universally employed.

In the Chicago Municipal Library at the City Hall, there is a most interesting reprint, itself very old, of a remarkable pamphlet that originally bore the date, London, 1667. Some great names appear in it, names of persons who witnessed the going up of that city in flames. Among them were the diarist Pepys, who contributed a paragraph to the pamphlet, and John Ford, the poet and dramatist.



PIERCE-ARROW 5-TON APPARATUS AS OPERATED BY THE FIRE DEPARTMENT OF THE CITY OF BUFFALO, N. Y.

They had a bucket brigade in London, so much is certain, and it came into being at least two hundred and five years before Chicago's brigade of buckets appeared in 1833. And they had a pump service, which in some manner was connected with delivering instruments. What these latter were like is read in a description found in another old pamphlet in the Municipal Library, of a fire engine once employed there. "In the Guildhall Museum can be seen this fire engine (this was written twenty-one years after the fire), together with two others belonging respectively to the ward of Aldgate and the parish of St. Lionis Backchurch. These engines are brass hand squirts, the largest being three feet long, with a brass receptacle with capacity of from two to four quarts of water, to which was attached hose two and a half feet long and one inch in diameter; the base of the nozzle was one-half inch. Three men were required to work this engine—one on each side grasped the cylinder with one hand and the nozzle with the other, while the third worked the piston. Those who held the instrument plunged the nozzle into the water, the operator then drew back the piston and thus charged the cylinder; and when it was raised up to the required position he pushed the piston and forced the water on the fire, "like a fight with bayonets." China at that time had better instruments, and Germans were in advance of all other nations, and had their fire engines placed on carriages.

London had no fire bell. Alarms of fire were given by human voices, as told by one Wiseman, quoted in our pamphlet, "voices shrill, piercing, frightful. The great fire was advancing. Now the cry of fire in every street with horrid emphasis, is echoed forth; these dreadful screams disturb our midnight quiet."

A Squad Wagon of Many Uses

A squad wagon recently built by the city fire department of Los Angeles, Cal., embodies a larger number of aids in fighting fires and in saving lives than any similar apparatus in the United States, if not in the world.

Five 250-watt search lights, with lanterns 16 inches in diameter, capable of throwing a beam of light so strong that a newspaper can be easily read at 500 feet, yet so arranged with diffusing lenses that it does not blind the firemen even a few feet away, are mounted on the truck, three of them permanently and two so as to be portable, each being attached to 320 feet of heavy insulated cable on a reel which can be unrolled, permitting the lights to be carried anywhere within the limits of the cable. The lights will penetrate smoke to a surprising extent. The power for the lights is furnished by 8 batteries capable of furnishing current for the lights for 7 hours, or by a generator run by a silent chain drive from the main propeller shaft, which can be used to furnish current for the lights if necessary. As a precaution against accidentally speeding up the engine when it is driving the generator at a fire, a special protective device has been installed, consisting of a hood which can be lowered and locked in position.

A switchboard is mounted on the right side of the wagon immediately above the generator, which has a marble back in an enclosed case with a glass front. It is equipped with a master switch for the batteries and the generator, an individual switch for each light, ampere and voltmeters and a resistance cut-out, with fuses of proper capacity for each switch. An under-load and over-load switch prevents damage to the generator and acts as a governor, automatically to disengage the charging line from the generator when the rate of change gets to a dangerous height or when the rate of change is so low that this would be dangerous because of the batteries bleeding.

Each portable light can be operated on a tripod of heavy hard wood, carried in a special compartment in the rear of the wagon, which can be collapsed or extended very quickly. It is readily moved about by one man. The light may be used without the tripod, a large handle at the back of the light enabling a fireman to carry the light in one hand up a ladder. The strong rays penetrate the smoke, showing the location of obstructions or holes, openings, stairways, etc.

The three stationary lights may be elevated, lowered or swung from side to side, to illuminate the exterior of a building, fire escape, ladder or window, alley or street, to aid escape from building or collection of equipment.

Two of the latest improved smoke helmets are carried. The front of the headpiece is fitted with a heavy colored mica, which enables the wearer to see perfectly yet suffer no ill effect from the light or heat. The headpiece is heavily reinforced to protect the head from injury. A special gage indicates in minutes the capacity of the oxygen cylinder, thus giving warning of the necessity of getting a fresh cylinder of oxygen.

The operator carries a hand flash-light which allows him to make close inspection of dark places and to see the gage, to seek unconscious persons, open locked passages, close a valve from a gas main or bursted ammonia line, etc.

A strong signal line is attached by a snap to a ring on the appliance, by which signals may be transmitted in either di-

STEGEMAN 1½-TON COMBINATION CHEMICAL AS OPERATED BY THE CITY OF COLUMBUS, WIS.

rection by a pre-arranged code of jerks. It is snapped on so that it may readily be removed if it should become entangled or held fast by falling material. In case no signal is received in a reasonable length of time, men with other helmets would be dispatched to his rescue.

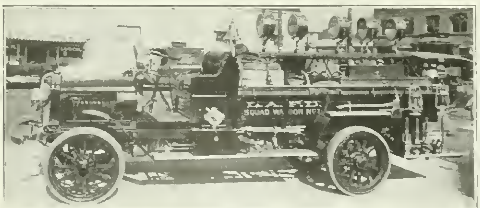
Another important piece of apparatus is a pulmotor to resuscitate persons suffocated from fumes, gas, smoke, etc., by producing artificial respiration. This works on one cylinder of oxygen for 60 minutes. Other fresh cylinders may be connected in 5 seconds. The wagon will make a special run to any point where this equipment may be needed, regardless of where the person may be. This wagon often makes runs to revive persons who become accidentally asphyxiated or partly overcome by gas fumes escaping from a gas stove. Different sized masks are carried for use on infants or adults, as the case may be.

There is hardly a fire of any consequence where some fireman or spectator is not injured, and to enable treatment to be immediately supplied, a complete first-aid outfit is carried. A trained member of the crew has charge of the outfit, which is portable, being provided with handles for carrying. It includes 25 bottles of drugs, such as iodine, antiseptic tablets, soda for burns, peroxide, etc. Also a good supply of absorbent cotton, scissors and probes, adhesive tape and a pan for bathing minor injuries.

Two portable collapsible stretchers are also carried for use in any emergency case where it may be necessary to transport an injured person from a building. Two heavy blankets are carried in connection with the first-aid outfit.

A portable oxy-acetylene cutting torch is carried on the wagon and is of such size and weight that two men can readily carry it to any point for immediate use. It is carried complete with cutter, gas tank and hose in a metal case 3 feet high by 18 inches square. It is used in cutting thru iron doors, steel columns and other kinds of metal to aid persons in escaping from burning buildings. The cutter operates on a mixture of oxygen and acetylene gas. A cylinder of each is carried equipped with the proper devices for operating the same. The strong light from this cutter makes it necessary for the operator to wear smoked glasses to protect the eyes.

An auxiliary tank of 25 gallons capacity is carried for the purpose of supplying gasoline to pumping engines. In order to eliminate the great danger of supplying a gasoline pumping engine with gasoline when a steam fire engine is near by



a hand pump with 50 feet of hose is carried. The wagon is driven about 40 feet from the engine. The hose is attached to the hand pump, which is screwed into the 25-gallon gasoline tank, the other end of the hose is attached to the gasoline tank of the pumping engine by special connections and the gasoline is delivered to the engine without coming in contact with the open air.

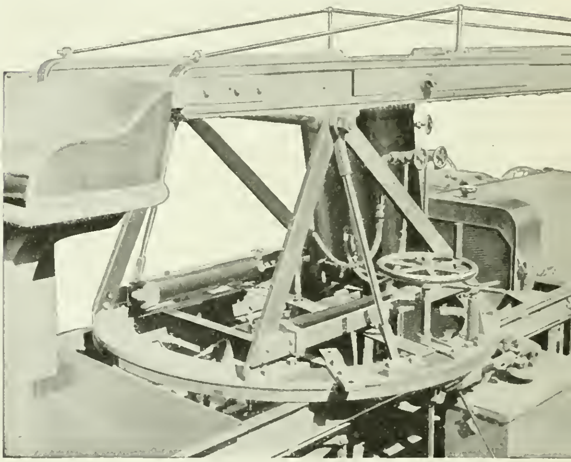
The truck is equipped with a 30-h.p. engine mounted on a 2-ton chassis and can make a speed of 30 miles an hour, which is as fast as it is safe to go with its delicate equipment. The crew is composed of four men, one of whom is a trained nurse. The wagon responds to all first alarms of fire within the downtown and business section, but is subject to special call to any point where it may be required.

The wagon was designed by E. H. Henry, mechanical engineer of the Los Angeles Fire Department, and was built by the department on a regular 1½-ton Moreland truck.

New Type of Turn-Table for Aerial Ladder Truck

The turn-table for motor fire apparatus, illustrated herewith, is of standard type, but in several respects presents a noteworthy innovation. The circles are forged and turned from high carbon steel, the upper ring being carried on ⅞-in. steel balls.

The hoist is of the Dahill compressed air type, liquid controlled, and consists of three 7-in. cylinders with pistons and rods. These cylinders are connected with trunnions with the turn-table and have free oscillating movement. The outer ends



of the piston rods are connected by trunnion to the main ladder. Opening one valve permits compressed air to flow freely into the bottom of the two outer cylinders.

The center cylinder is filled with oil and equipped with by-pass and air-chamber in combination. The opening given the valve in the by-pass piping regulates the speed at which the ladder is elevated.

The air-tank and motor-driven compressor are carried at the rear of the chassis frame. A single man with just one hand can raise and lower the ladder at will. The device is made by the Couple-Gear Freight Wheel Company, Grand Rapids, Mich.

What Worcester Is Doing

The city of Worcester, Mass., has 38 pieces of horse-drawn equipment in service, but is motorizing its complete department as rapidly as circumstances allow. During the current year 3 new pieces of motor apparatus were added, and the department is now motorized to the extent of 2 American-La France triple combination pumpers, 4 American-La France combination hose wagons and chemical engines, 2 Pope-Hartford combination hose wagons and chemical engines, 2 combination hose wagons and chemical engines, Netco chassis with superstructure built and mounted in the department shop by members of the department at headquarters, 1 Pope-Hartford hose wagon and squad car, 1 American-La France combination ladder truck and chemical engine, 5 chiefs' cars, 1 Thomas and four Buicks; 1 second-hand Locomobile for practice car.

Motor Apparatus in Fire Departments

(Continued from April number, page 199. See April number for explanatory note.)

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Oregon—													
Ashland	ch ho	Am.-La France	3	4	70	1,200	40	32	...	...	...	...	...
Astoria	ch ho	Am.-La Fr. (2)	5	4	70	1,200	70	32	...	...	...	...	...
Grants Pass	ch ho	Am.-La France	5	4	70	1,200	70	32	...	...	...	...	...
LaGrande	ch ho	Am.-La France	4	4	70	1,200	70	32	...	...	...	...	...
Marshfield	pp ho	Am.-La France	2	6	100	1,200	40	32	...	...	...	...	...
Medford	chf	Oldsmobile	2	4	40	250	70	24	1,000	78	...	...	...
	ch ho l	Pope-Hartford	5	4	70	1,250	50	82	150	...	...	...	...
Portland	ch ho	Am.-La Fr. (2)	5	...	...	...	...	...	...	...	...	...	...
	ch ho	Am.-La Fr. (6)	4	4	70	1,200	40	32	...	...	...	...	...
	pp ho	Am.-La Fr. (2)	4	6	100	1,200	6	32	...	...	...	...	...
	ae	Am.-La France	1	4	75	...	6	177	...	...	...	...	...
	tr	Am.-La Fr. (2)	1	4	70	...	...	...	...	...	...	...	...
	ae	Am.-La France	1	4	70	...	...	274	...	...	...	...	...
	ch ho	Am.-La France	½	4	70	1,200	40	32	...	...	...	...	...
Roseburg	ch ho	Brockway	1	...	...	...	...	...	...	...	...	...	...
Salem	ch ho	Am.-La France	4	4	70	1,200	40	32	...	...	...	...	...
	pp ho	Am.-La France	3	6	100	1,200	40	32	...	...	...	...	...
The Dalles	ch ho	Brockway	1	4	50	1,400	40	32	...	...	...	...	...
Pennsylvania—													
Altoona	chf	Buick	2½	4	22	...	...		...	...	51.96	118.38	160.00
	ch ho l	Knox	4	6	48	800	46	20	106	99	315.96	48.04	143.25
	ch ho l	G. M. C.	1½	...	...	800	46	20	145	112	29.96	66.70	143.25
Ambler	pp	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
Ashland	ch ho	Hale	...	...	...	...	...	...	...	...	...	...	...
Bangor	pp ho	Am.-La France	3	6	100	1,250	6	32	...	...	...	...	...
Berwick	ho	Reo-Local (2)	...	4	35	1,000	...	36	300	2	...	...	...
	ch ho	Garford-La Fr.	...	4	35	500	...	36	300	2	...	...	...
Bethlehem	pp ho	Am.-La France	1	4	75	1,200	6	32	...	...	...	...	...
Bristol	ch ho	Am.-La France	2	4	70	1,200	70	32	...	...	...	...	...
Butler	chf	Mich.	...	...	...	...	...	...	...	...	...	...	...
	ch ho l	Pope-Hartford	5	4	...	1,000	45	35	75	60	...	...	...
	ch ho l	Knox	4	4	...	1,000	60	32	50	45	...	...	...
Carbondale	ch ho	Am.-La France	½	6	100	1,200	40	32	...	...	...	...	...
Carlisle	pp ho	Am.-La France	3	6	100	1,200	6	32	...	...	...	...	...
Carnegie	ch ho	Am.-La France	2	4	72	1,100	86	44	160	50	0	22.55	...
Chambersburg	ch ho	Am.-La France	5	4	70	1,200	70	32	...	...	...	...	...
Chester	tr (2)	Am.-La France	1	4	70	...	...	...	...	...	...	...	...
Coaldale	pp ho	Hahn	0	4	60	1,200	...	32	...	...	...	...	...
Coatesville	chf	Dodge	1-3	4	35	...	P	...	...	48	...	...	...
	ladd	Am.-La France	3	4	75	...	46	279	...	...	...	...	...
	pp ho ch	Am.-La France	2-3	6	90	1,000	46	32	...	...	...	...	...
	ch ho l	Seagrave	1-6	4	75	1,200	76	32	...	...	...	...	...
	pp ch ho	Rowe	0	6	120	...	66	32	...	...	...	...	...
Connellsville	ladd	Am.-La France	¼	6	100	...	40	225	25	10	0	20.00	...
	ch ho	Pope-Hartford	¼	4	50	600	70	...	120	20	...	20.00	...
	ch ho l	Pope-Hartford	4	4	60	1,000	70	48	50	60	10.00	25.00	...
Conshohocken	pp ho	Am.-La France	2	6	100	1,200	6	32	...	...	...	...	...
Charleroi	ch ho	Am.-La France	2	6	100	1,200	70	32	...	...	...	...	...
Donora	pp ch ho	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
DuQuesne	ch ho	Am.-La France	2	6	100	1,200	70	32	...	...	...	...	...
Duryea	pp ch ho	Am.-La France	½	6	100	1,400	40	32	...	...	...	...	...
Easton	chf	Saxon	½	4	18	...	...	...	4,000	88	0	94.00	...
	ho ch	Seagrave	2	6	80	1,000	70	30	100	...	0	69.80	...
	ho ch	Seagrave	1	6	80	1,000	40	30	400	...	0	71.60	...
	pp ch	U. S.	4	6	7	1,000	35	30	250	...	60.00	52.20	...
	pp ch ho	Seagrave	1	6	80	1,000	40	42	250	88	0	65.00	...
	pp ch ho	Seagrave	0	...	...	...	...	...	...	...	...	...	...
E. Stroudsburg	pp ho	Am.-La France	½	6	100	1,200	6	32	...	...	...	...	...
E. Washington	ch ho	Am.-La France	2	4	70	1,200	40	32	...	...	...	...	...
Edwardsville	pp	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
Erie	ae	Am.-La France	2	4	72	...	6	403	300	...	30.00	31.00	540.00
	pp ho ch	Am.-La France	1-3	6	105	1,000	35	36	375	...	12.00	40.00	120.00
Franklin	pp	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
	ch ho	Knox	2	4	48	1,200	70	36	224	46	...	...	...
	pp ho ch	Thomas	0	6	60	1,000	40	40	...	...	...	...	...
Ford City	pp ch ho	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
Freedom	ch ho	Am.-La France	1	4	70	1,200	70	32	...	...	...	...	...
Greensburg	ch	(2)	...	...	...	...	35	...	...	...	...	...	...
Hanover	pp ho	Am.-La France	2	6	100	1,200	6	32	...	...	...	...	...
Harrisburg	ch ho	Am.-La France	2	6	100	1,200	40	32	...	...	...	...	...
	tr	Am.-La France	1	4	70	...	...	...	...	...	...	...	...
	ch ho	Brockway	1	4	50	1,400	40	32	...	...	...	...	...
Hazleton	mot	Indian	...	...	...	...	...	...	...	...	...	...	...
Homestead	ch ho	Studebaker	0	4	45	600	160	40	...	...	...	...	...
	ch ho l	Seagrave	3	6	85	1,200	52	110	50	89	20.00	35.00	...
Jeannette	ch ho	Am.-La France	2	6	107	1,200	60	72	32	34	5.00	64.00	...
Johnstown	pp ho	Am.-La France	5	...	...	...	...	...	...	...	...	...	...
	pp ch	Am.-La France	4	6	100	1,200	6	32	...	...	...	...	...
	pp	Am.-La France	1	6	135	1,700	40	32	...	...	...	...	...
	pp ch ho	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
Kennett*	pp ch ho	Am.-La France	½	...	...	...	...	...	...	...	...	...	...
Kingston	pp ho	Am.-La France	3	6	100	1,200	6	32	...	...	...	...	...
Kittanning	ch ho	Brockway	1	...	...	...	...	...	...	...	...	...	...
Lancaster	ch ho	Am.-La Fr. (3)	1	...	...	...	...	...	...	...	...	...	...
	tr	Am.-la France	1	6	100	...	6	177	...	...	...	...	...
	tr	Am.-La Fr. (3)	1	4	70	...	...	...	...	...	...	...	...
Lansdowne	pp ho	Am.-La France	3	4	75	1,200	6	32	...	...	...	...	...
Lansford	ch ho	Am.-La France	½	6	100	1,200	40	32	...	...	...	...	...
Latrobe		Has no motor apparatus.											
Lebanon	ae	Am.-La France	3	6	100	...	6	177	...	...	...	...	...
	pp ho	Am.-La France	½	6	100	1,200	6	32	...	...	...	...	...
Leechburg	ch ho	Brockway	1	4	50	1,400	6	32	...	...	...	...	...
Lewistown	ch ho l	Thomas	2	6	60	800	60	75	...	...	...	...	...
		Morton (2)	1-12	8	80	800	40	75	...	1	...	...	...
Meadville	pp ho	Am.-La France	4	6	105	1,400	40	36	583	62	39.00	97.00	...
	ch ho l	Am.-La France	2	4	75	1,000	40	32	392	40	0	27.30	...
	ladd	Am.-La France	2	4	75	...	...	225	360	33	0	21.80	...
Minersville	ladd	Am.-La France	2	4	70	...	...	235	...	...	...	...	...
Morrisville	ch ho	Brockway	1	4	42	1,400	40	32	...	...	...	...	...

(To be continued in the June number.)

Contracting News

AUTOMOBILES, MOTOR TRUCKS AND FIRE APPARATUS.

Alameda, Cal.—The city council last night authorized the police and fire commission to purchase a combination auto and fire combination auto, chemical and hose wagon with booster pump, for the department, at an estimated cost of $5,500.

Boonton, N. J.—Board of aldermen considering purchase of new motor-driven hose wagon for South Boonton fire companies.

Cass Lake, Minn.—The fire department is endeavoring to join with the village council in purchasing an automobile chemical engine.

Cherokee, Ia.—Chief Nelson, of the fire department, has presented a petition to the city council asking that a new auto fire truck be purchased.

Columbia City, Ind.—The city council is acting on its plan to motorize the city fire department and has purchased a $5,500 truck, fully equipped.

Duluth, Minn.—Station No. 2 of the Duluth fire department, at 17th ave., West, and 1st st., will be equipped with modern fire apparatus after May 1.

Elmira, N. Y.—The board of public works has purchased two motor tractors to use on dirt street work and other general hauling. They are made by the Moline Plow Co., and each one is valued at about $700.

Elgin, Tex.—At a regular meeting of the city council it was decided by a [illegible] vote to purchase a motor fire truck for the city.

Grand Rapids, Mich.—The board of health has determined on including in its next year's appropriation a sum sufficient to purchase motor trucks for the garbage department.

Harrisburg, Pa.—City commissioners are considering petition for new fire engine for the Thirteenth ward district and new chemical wagon for the Paxton fire co. Commissioner E. Z. Gross in charge.

Jersey City, N. J.—City commissioners will build new triple fire house in Hudson City district, to cost about $50,000.

Keasbey, N. J.—Township commissioners planning for erection of new fire house and purchase of new equipment for fire district No. 4. Board of fire commissioners in charge; Wm. D. Hoy, secretary.

Kendallville, Ind.—Kendallville will take steps to motorize its fire department at once. Such was the decision of the city council.

Muskegon, Mich.—Tractors for the hook and ladder trucks of the Muskegon fire department, the second step in motorizing all vehicles of the department, are soon to be purchased by this city. Fire Chief Napoleon Belfy, advising the change to motor-driven apparatus, gained the approval of the council immediately.

Oneida, N. Y.—The common council is contemplating the purchase of motor-driven fire apparatus at an estimated cost of about $8,000.

Pawtucket, R. I.—City contemplates the purchase of a motor truck at an estimated cost of $6,200.

Pitman, N. J.—Report submitted to boro council by its public safety committee, recommending purchase of new motor-driven fire equipment to cost about $6,000.

Red Wing, Minn.—The city council again considers the purchase of a street flusher.

Red Bank, N. J.—City council has authorized special election to vote bonds for the purchase of new motor-driven fire equipment, including pumping engine, hook and ladder truck, 2,500 ft. hose and other apparatus.

Salt Lake City, Utah—At a meeting of the commissioners the purchase of a fire truck was authorized. The truck will carry the fire engineer, together with 70 gallons of chemicals. The truck purchased last fall carries 240 gallons of chemicals, together with the hose and ladders.

Stevens Point, Wis.—The city council is planning to purchase a motor fire truck.

Steelton, Pa.—City council planning for the purchase of two new garbage trucks for municipal service, to cost about $5,000.

Terre Haute, Ind.—City is to have $40,000 worth of new fire equipment, which will include six new motor fire trucks. At the regular monthly meeting the common council passed an ordinance appropriating the sum to the fire force account, to be used by the department of safety in purchasing motor fire equipment.

Wauwatosa, Wis.—City is advertising for bids for the furnishing of a motor truck for the fire department.

BRIDGES.

BIDS REQUESTED.

Corydon, Ind.—Until May 10 (2 p. m.), for the construction of a bridge across Blue river, on line Harrison and Crawford counties. Sam C. Mauck, auditor.

Lawrenceburg, Ind.—Until May 8 (11 a. m.), for the construction of bridges in Clay, Kelso, Manchester and Jackson townships, six in all. Harry E. Lutherbeck, auditor.

Monticello, Ind.—Until May 8 (10 a. m.), for the construction of a bridge in White county. A. G. Fisher, auditor.

Mt. Vernon, Wash.—Until May 8, for constructing bridge over Skagit river, within city limits, 220 ft. fixed steel span, 18 ft. roadway. Estimated cost, $33,000. W. E. Costello, engineer, Mt. Vernon.

Plymouth, Ind.—Until May 8 (1:30 p. m.), for the construction of four bridges in Walnut township, one in Green township and repairs to bridges in Tippecanoe township. O. H. Weber, auditor.

Stronghurst, Ill.—Until May 27 (10 a. m.), for the construction of two reinforced concrete bridges in Raritan township, Henderson county, known as the John Simonson and John Vorhees bridges. Spans, 18 and 6 ft., roadways 20 ft. Est. of cost, $1,320 and $440, respectively. Add. Clifford Older for plans and specifications.

Visalia, Cal.—Until May 8, for the construction of nine reinforced concrete bridges, on state highway between Visalia and south county line, 96, 140, 40, 60, 32, 30, 160 and 80 ft. long. B. O. Lovelace, co. surveyor.

Wahpeton, N. D.—Until May 10 (2 p. m.), for the construction of ten or more steel bridges, according to plans and specifications on file in the office of the county auditor, F. A. Burton.

Wahpeton, N. D.—Until May 10 (3 p. m.), for the construction of two steel bridges. One across the Bois de Sioux river on section line between sections 16 and 21, and one bridge across the Red river near the section line between sections 21 and 16. Plans and specifications on file at the county auditors of Richland county, North Dakota, and Wilkin county, Minnesota. F. A. Burton, auditor Richland county, North Dakota; P. E. Truae, auditor of Wilkin county, Minnesota.

CONTRACTS AWARDED.

Beemer, Neb.—The Standard Pipe Co., of Omaha, was awarded the contract for the construction of steel bridges, steel repair work wood bridges, wood bridges repair work and concrete work.

Centralia, Wash.—Charles G. Huber, Central Bldg., Seattle, awarded contract for construction of bridge across Skookumchuck river at $14,730.

Carroll, Iowa—The Omaha Structural Steel Bridge Co., Omaha, Neb., was awarded the contract for the construction of a 270-ft. concrete deck girder, requiring about 2,300 lin. ft. piling at $15,922.

Devils Lake, N. D.—Contract for constructing eight reinforced concrete bridges was awarded to Minneapolis Bridge Co., 1129 Metropolitan Life Bldg., Minneapolis, Minn., at $8,445.

Des Moines, Iowa—The Iowa Bridge Co., Des Moines, was awarded the contract for the construction of six bridges in Black Hawk county at a contract price of $22,865.

Eureka Springs, Ark.—The International Steel & Iron Co., Evansville, Ind., awarded contract for 500-ft. steel bridge over White river and 160-ft. small steel bridge at $20,000.

Fairmont, W. Va.—The Concrete Engineering Co., New York City, awarded contract for construction of two concrete bridges here to cost about $550,000.

Macedonia, Iowa—Wickham Bridge and Pipe Co., Council Bluffs, Iowa, and Illinois Bridge and Steel Co., Jacksonville, Ill., awarded contract for bridge over the Nishnabotna river here at $12,670.

Marshalltown, Iowa—The following contracts were awarded for bridges: T. J. Wagner, Swea City, 22 bridges, $20,410; Cole Bros., Ames, Iowa, 13 bridges, $21,920; Ingersoll-Stoufer Const. Co., Marshalltown, 22 bridges, $28,665; M. O. Burnett, Marengo, Iowa, 38 bridges, $30,710.

McKenna, Wash.—Contract awarded to C. G. Huber, Central Bldg., Seattle, Wash., at $27,987 to construct concrete bridge here.

Muskegon, Mich.—N. P. Nelson, Muskepile substructure and concrete superstructure, north revetment, Ludington Harbor, Mich., at $19,499. A. M. Warner, St. Joseph, Mich., contract for similar work on north revetment of St. Joseph Harbor at $16,245.

Nevada—Contract awarded by Salt Lake & Los Angeles Ry. (J. Richards, secy. and gen. traf. mgr.) to Houghton Constr. Co., 503 Market st., San Francisco, Cal., at $90,000, to construct several reinforced concrete bridges and concrete abutments for steel bridges on its lines in this State.

Newark, N. J.—Board of Freeholders has awarded contract for bridge work as follows: Linde & Griffith Co., foot of Fourth ave., Newark, Clay st. bridge (fenders, etc.) at $18,300; Allen N. Spooner & Sons, Pier 11, North river, New York City, Paterson Plank Road bridge (new fender, etc.) at $14,650.

Olyphant, Pa.—Boland Bros., Carbondale, Pa., were low bidders for bridge over the Lackawanna river connecting Olyphant and Blakeley at $34,200.

Olympia, Wash.—Contract awarded by comrs. Piers and Thurston counties to C. C. Huber, Central Bldg., Seattle, at $27,987, to construct the McKenna bridge, of concrete; other bidders, R. E. Meith, Olympia, at $27,960, for steel; H. C. Malott, Seattle, at $28,310 for concrete; C. Barnette, Olympia, at $28,590, for steel. Anna Gaston, aud. Thurston county.

Somerset, Ky.—The Virginia Bridge and Iron Co., Roanoke, Va., has been awarded the contract for the superstructures of two steel bridges over Pitman creek and substructures have been awarded to the Builders' Supply Co., Lexington, at $14,450 and $13,035, respectively.

Sheldon, Iowa—Contract for twelve new steel bridges in the county have been awarded to the Hey-Keeler Construction Co., of Waterloo.

Seattle, Wash.—Booker, Kiehl & Whipple, Central Bldg., Seattle, awarded contract for construction of substructure for the Eastlake ave. bridge over the Lake Washington canal, at $213,000.

Washington, D. C.—Charles H. Tompkins, 1883 3rd st., N. W., Washington, D. C., awarded contract for constructing concrete bridge in the line of 16th st., northwest, crossing Military road, at $32,000.

Washington, Ia.—Contract for constructing 38 concrete box culverts was awarded by bd. of supvrs. of Washington Co., to R. H. Waugh, Clarksville, at $35,206.

Waterloo, Ia.—To the Iowa Bridge Co., Des Moines, was awarded the contract for the construction of six bridges in Blackhawk Co., at a contract price of $22,865, and to the Waterloo Construction Co., Waterloo, was awarded the contract for the construction of a foot bridge over the Cedar river, at Gilbertville.

White Plains, N. Y.—To Fagnani Bros., Tuckahoe, was awarded the contract for the construction of a stone bridge over Bronx river, between Yonkers and Tuckahoe, at their bid of $16,500.

Yonkers, N. Y.—To Fagnani Bros., Tuckahoe, for the construction of reinforced con. bridge over Bronx river, at $16,355.

CONTEMPLATED WORK.

Asheville, N. C.—Acting on the recommendation of the commissioner of public works, the city board of commissioners decided to have the city engineer prepare specifications for the construction of concrete bridges across the Cripple creek at the intersection of South French Board ave. and South Sice ave. and the intersection of Gaston st. The purchasing agent was advised to advertise for bids for this work.

Birmingham, Ala.—Bids will be called for constructing a new wooden trestle on Dervy st., in the industrial district. The bridge will be 20 ft. wide, the timbers treated and the deck covered with asphaltic concrete or something similar. It will be about a $20,000 job.

Cedar Falls, Ia.—T. Michaelson, contractor, is preparing plans and specifications for the construction of the proposed concrete bridge that will be built across Dry

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run, as soon as practical, to replace the present structure.

Dayton, O.—Plans for the paving of Keowee st., from Webster st. to the corporation limits, have been completed by the county commissioners, who instructed Clerk W. H. Aszling to advertise for bids. The cost of the improvement, to be paid by both the city and county, is estimated at more than $56,000.

Des Moines, Ia.—The city council ordered plans prepared and bids received for a bridge across the Des Moines river at University ave. Estimated cost, $300,000.

Fort Smith, Ark.—City plans construction of a bridge over Arkansas river, at foot of Garrison ave. For further information address bridge comm.

Harrisburg, Pa.—Board of pub. grounds and buildings will be empowered by state legislature to plan and erect bridge over the Delaware river, between Philadelphia and Camden.

Hillsboro, N. D.—Ingwald Pedweson and Carl Arnegard, members of the board of supervisors of Bloomfield twp., appeared before the board in regard to bridge work needed in Bloomfield twp., and filed an application for such needs. Gerhard D. Olson, county auditor.

Jacksonville, Fla.—Harrington, Howard & Ash, Kansas City, are preparing plans for the construction of new concrete and steel bridges over McGirt's creek, at Ortega, and Trout creek, at Panama. The cost of the Panama and Ortega bridge is estimated at $200,000, and the bridge south of Jacksonville at about $1,000,000.

Jersey City, N. J.—Hudson and Union county boards of freeholders planning for erection of bridge over Newark bay, between Bayonne and Elizabethport. Hudson board of freeholders has voted appropriation of $5,000 for surveys.

LIGHTING.

Akron, N. Y.—State legislature passed bill authorizing $19,000 bond issue to install electric light plant and street lighting system.

Farmingdale, N. J.—Board of public utility commissioners granted permission to West Monmouth Water Co. to install and operate a system here.

Greensport, L. I.—At a special election in Deering Harbor the voters approved a bond issue in the sum of $8,500 for the lighting system.

Irving, Kans.—City plans election to vote on $7,000 bonds for distribution and lighting system and transmission line to Blue Rapids.

Jersey City, N. J.—Board of freeholders planning for installation of electric flood light projectors on bridges over Passaic and Hackensack rivers.

Quakertown, Pa.—City has purchased site for power plant and will install engine, generators, boilers, etc. G. E. Willard, supt.

Reading, Pa.—Metropolitan Electric Co. contemplates the constr. of a new transmission line from its West Reading power station to Leesport and Temple.

St. Louis, Mo.—The Central Trades and Labor Union went on record at their meeting as in favor of a municipal electric lighting plant.

Trenton, N. J.—John A. Roebling's Sons Co. will build a new power plant at its wire and wire rope factory on Canal st.

Trenton, N. J.—Stone & Webster Engineering Co. awarded contract for erection of one-story brick and concrete power plant and stack for the Westinghouse Lamp Co., at its new plant, Pennington ave., at $45,000.

Waterville, O.—Citizens want their streets lighted and contemplate the installation of street lights. A bond issue of $10,000 for the purpose will be voted on April 25.

Warsaw, Ind.—The city council of Warsaw is planning to install an ornamental street lighting system.

MUNICIPAL BONDS.

Ada, Okla.—The city will call an election soon to vote $60,000 for the purpose of improving its water supply and system. This will include constructing a new reinforced concrete flume for the water power plant and the 500,000 gallon elevated tank in the city. Benham Eginr. Co., consulting engineers; E. S. Ratliff, mayor.

Akron, O.—Ordinance No. 5403 passed for the issuance of bonds in the sum of $2,000,000 for the purpose of paying the corporation's part of improving water courses, to wit: Wolf Ledge run and tributaries thereto by constructing conduits therein. A. Cole, clerk.

Akron, O.—Ordinance No. 5391 passed to issue bonds to pay the corporation's part of improving sundry streets and to repeal ord. No. 5102 to issue bonds in the sum of $122,150 to pay the city's portion of improving sundry streets. S. J. Cole, clerk.

Bartlesville, Okla.—Washington county will shortly vote upon the question of a bond issue for the construction of a comprehensive system of hard-surfaced highways to be built in all sections of the county. It is planned to construct 121 miles of improved highways at a cost of $600,000. The proposed roads will be 16 ft. in width.

Dallas, Tex.—Finance Commissioner Manning B. Shannon announced that he will recommend to the board of city commissioners at an early date the issuance of $300,000 worth of sewer bonds voted a year ago.

Dandridge, Tenn.—The county court authorized the issuance of $200,000 road bonds; $50,000 of this will be expended in repairing old roads and $150,000 in building new roads. Archie Holsinger is a member of the road commission.

Hamlin, W. Va.—Plans have been completed by which the eight districts of the county of Lincoln will submit a road bond issue the latter part of April. The proposed issue will be $650,000, approx., and the county will be the unit in the election.

Johnson City, Tenn.—Election will be held to vote on $75,000 city hall and market house bonds. Address the mayor.

Logan, O.—An ordinance was passed to issue bonds for the purpose of improving High st. from the alley immediately north of Hunter st. to the north side of Second st., by grading, curbing and paving same with brick, in the aggregate sum of $3,400. Fred Allen, clerk.

Macon, Ga.—Members of the Bibb county road board and the county commissioners will ask the next session of the legislature to grant a special registration for a $1,000,000 bond issue proposed by the commissioners to improve the roads, build a new courthouse and to enlarge the school system.

Okemah, Okla.—The city will call an election soon for the purpose of voting $65,000 for constructing a sewer system and $20,000 for improving the electric light plant. Benham Engineering Co., consulting engr. J. B. Poynter, mayor.

Pleasant Hill, La.—Until April 24 bids will be received by W. R. Ross, secretary of board of district supervisors, Sabine parish, for $30,000 of 5 per cent. bonds, road district No. 6.

Salem, N. J.—Appropriation of $50,000 secured for new road between Sharpstown and Woodstown, on Pensgrove-Malaga section. County Engineer Keasbey in charge.

Steubenville, O.—In the county system of roads financed by the $800,000 bond issue which Brooke county approved some time ago, a road will be built from Follansbee to Eldersville, Washington county, Pa.

Union, N. J.—Town council passed ordinance providing for immediate sale of bonds for $23,000 for a fire and police signal system.

ROADS AND PAVEMENTS.

BIDS REQUESTED.

Brazil, Ind.—Until May 8 (10 a. m.), for the improvement of a highway in Washington township, in Clay county, by grading, paving with crushed stone, and draining. Add. Wm. O. Graeser, auditor.

Lewisville, O.—Until May 14, for the paving of the principal streets of the village of Lewisville. Add. Village Council.

Monticello, Ind.—Until May 8 (10 a. m.), for the improvement of two highways in White county, one in Union township and the other in Honey Creek township, by grading, draining and paving with crushed stone. Add. A. G. Fisher, auditor of White county.

Rollette, N. D.—Until May 8 (6 p. m.), for the construction of cement sidewalks and crossings on Main st. and 2nd ave. Cert. check, $100. T. W. McMilan, village clerk.

Wyndmere, N. D.—Until May 8 (2 p. m.), for the grading and construction of 10 mi. of road in said township, according to plans and specifications on file in the clerk's office. Cert. check, $100. John McDougall, clerk.

Woodsfield, O.—Until May 14, for grading, sewering, curbing and paving with hard-burned vitrified brick, Black st., in that village, Woodsfield st., Maaga st. and Railroad st. Plans and specifications at office of Ed Keylor, clerk of the village of Lewisville.

CONTRACTS AWARDED.

Battle Creek, Mich.—The Stoddard Construction Co., of Grand Rapids, have been awarded the contract for the construction of 5¾ miles of brick pavement, 18 ft. wide, at their bid of $135,297.70.

Baltimore, Md.—Paving contracts have been awarded as follows: Asphalt Block and Tile Co., for sheet asphalt paving, at its bid of $112,831.35; Lawson Construction Co., Norfolk, two annex paving contracts, at its bids of $98,689 and $57,859.50, and to P. F. Reddington, for paving with hillside blocks the hills on Mulberry and Pleasant sts., from Calvert to Courtland st., at his bid of $11,248.96.

Chillicothe, O.—Brewer, Tomlinson & Brewer, city, have the contract for the Iderea road at their bid of $73,000.

Chicago, Ill.—To John A. McGarry & Co., Security Bldg., Chicago, was awarded the contract for the paving of 95th st., from Western ave. to Keane ave., at their bid of $175,693.72.

Dayton, O.—The city of Dayton has entered into contracts with the following contractors for road improvements: Ed Ryan, for paving Jefferson st. with wood block, covering 15,524 sq. yds., at his bid of $60,572.60; E. D. Murray, for the paving of Manhattan ave., 4,675 sq. yds., at a cost of $17,233.40; Ed Ryan, for paving Grafton ave. with wood block, at a total bid of $37,079.40; W. J. Kernan, for the paving of Oxford ave. with wood block, at a bid of $11,823.85.

Forest, O.—The Forest Construction Co., of Forest, O., have the contract for building the Tenman road at their bid of $40,000.

Hamilton, O.—The Andrews Asphalt Paving Co. is the low bidder for paving the Hamilton pike in Hamilton county, at their bid of $160,000.

Lima, O.—The Andrews Asphalt Paving Co., Hamilton, which bid for seven streets of this city approximately $70,000, will be awarded the contract. They are now constructing a portable asphalt plant here preliminary to beginning the work.

Lincoln, Ill.—The Rhoades Co., city, was awarded the contract for the construction of thirteen blocks of pavement, representing a public improvement to cost $47,000.

Mercer, Cal.—J. H. Shafer, Los Angeles, was awarded the contract for the paving of K, J, O and 22nd sts., and also a number of alleys, at his bid of $56,039.

Newark, N. J.—To the Standard Bitulithic Co., 31 Clinton st., Newark, for paving the following streets, at $54,399.90: Chadwick ave., Edwin Place, Stengel ave., Norwood st., Columbia ave., Mapes Place and Telford st.

Portland, Ore.—The Warren Construction Co., Portland, for the paving of St. Helena road from Linnton to the Columbia county line, a distance of 10 mi., at their bid of $180,922.18.

Sapulpa, Okla.—John E. Nolan, paving contractor, was awarded contracts totaling $68,727.10, for 19 blocks of paving.

Sherman, Tex.—The Kaw Paving Co., Kansas City, was awarded the contract for the paving work on North and South Montgomery, West Pecan, East King and East Brocket sts. The work will cost approximately $50,000.

CONTEMPLATED WORK.

Atlantic City, N. J.—Board of freeholders planning for the opening and paving of Atlantic ave., through lower Margate and upper Longport, to form improved boulevard 100 ft. wide.

Atlanta, Ga.—Chief of Construction Henry L. Collier is making plans to supervise the improvement of Bellwood ave. and

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of North Jackson st., both improvements being made possible by the county commission's offer of financial aid to the city.

Atlanta, Ga.—Ordinances for the paving of Willingham, from Gordon to West Hunter, of West Ontario, from Ontario to Gordon, and of 7th st., from Myrtle ave. to Penn ave., were passed on by the committee.

Bay City, Mich.—The council has been asked to arrange for the paving of 26th st. Plans and specifications are to be prepared at once and bids advertised.

Camden, N. J.—State highway commission will build road from Camden to Atlantic City, with continuation to Trenton, as part of new state road system.

Cleveland, O.—County Engineer Stinchcomb states that plans for the completion of the county park blvd. will be pushed as rapidly as possible.

Fresno, Cal.—Petition for the paving of White's Bridge road from Trinity to Tohama, a distance of three blocks, was filed with the city clerk yesterday.

Garfield, Wash.—The city council has passed legislation calling for the grading of the ungraded streets in the principal part of the town and the laying of concrete sidewalks. It is estimated that the improvements will cost about $20,000, to be paid for by 10-year bonds.

Hackensack, N. J.—Board of freeholders planning for improvement with permanent paving of Ridgewood ave., from Kinderkermack road to Paramus road. Roscoe P. McClave, county engineer.

Lambertville, N. J.—Council considering plans for improvement of Coryell street with vitrified brick paving. Movement also started for construction of undergrade crossing at Ferry street and railroad tracks at estimated cost of about $130,000.

Lorain, O.—Mayor Moore is soon to appoint a city planning commission to supervise the laying out of streets, parks and allotments in order that the future development of this city may be carried out in a uniform and systematic manner.

Lincoln, Neb.—Asphalt will be used for paving Lake from 22d to Sheridan blvd., and 22d from South to Lake. Cost, $18,000. Asphaltic concrete will be used for paving 13th street from Van Dorn to High. Cost, $12,000.

Mingo, O.—Engineer Flayd is preparing plans and specifications for the paving of Union, Madison, Murdock and McLister avenues. The sidewalks on Garfield avenue are to be graded, and the sidewalk, curb and gutters are to be constructed on Western avenue. These improvements have been decided upon by council, and the ordinances are being prepared.

Newton, N. J.—Board of Freeholders planning for following paving: Construction of road from Ross' Corner to Sussex, concrete; estimated cost, $73,000. Road from Sparta to Ogdensburg, Tarvia; estimated cost, $40,000.

Newark, N. J.—Board of Works has passed ordinance providing for paving of Stuyvesant avenue and White terrace with asphalt on 6-in. concrete foundation; Division lane with oblong granite blocks, on 6-in. concrete foundation. A. L. Swain, clerk.

Newark, N. J.—Board of Works has passed ordinance for paving of Broad street, from Clay to Harvey street, with asphalt. Morris R. Sherrerd, chief engineer.

Omaha, Neb.—An ordinance has been passed by city council directing the city clerk to advertise for bids upon asphalt, stone, vitrified brick, artificial stone, macadam, creosoted wood block and asphaltic concrete for paving a number of streets. James C. Dahlman, mayor. T. J. O'Connor, city clerk.

Oakland, Cal.—Accepting the recommendation of Commission of Street William J. Baccus, the Board of Supervisors has unanimously adopted a resolution pledging the co-operation in the improvement of East Fourteenth street between Fiftieth avenue and Stanley avenue at a cost not to exceed $100,000.

Riverside, Cal.—It is proposed to pave Magnolia avenue from Jurupa avenue, where the paving now ends, to the intersection of Arlington and Palm avenues, where the other portion of the street begins. This will be done under the Vrooman act. The paving will be similar to that already completed on New Magnolia avenue.

San Diego, Cal.—City Engineer Cromwell announced that eight districts have been created for convenience in assessment in the paving of the $200,000 highway line from India street to Torrey Pines via Ocean Beach.

Sioux City, Iowa—Sixteen blocks of streets in the downtown district were ordered repaved by the city council. The council will call for bids on the work April 7th.

Springfield, Mo.—City council has been petitioned to pave 25,000 square yards on various streets with asphaltic concrete and intends constructing five miles of stone or concrete curb and gutters. O. D. Chrisman, city engineer.

Steelton, Pa.—Street Dept. planning for immediate improvement of Front street with permanent type surfacing. Jacob Meshy, street commissioner.
for the Ferry street improvement, including paving, will be about $40,000. Plans and specifications are to be prepared at once and bids advertised.

PARKS.

Akron, O.—D. K. Page announces that over $100,000 has been subscribed for developing Silver Lake and adds that the directors are going to make the park one of the most novel and beautiful parks in the State.

Cleveland, O.—City will spend $141,000 for its parks during the summer, according to Service Director Bernstein.

Grand Forks, N. D.—Charles Frederick Weller, recreational expert, Minneapolis, Minn., will have charge of construction of playgrounds in 49 communities in Grand Forks.

Newark, N. J.—Appropriation of $326,000 for Essex County Park Commission planned by Board of Freeholders. Funds to be used for road and park construction and maintenance work.

Reading, Pa.—Council planning for purchase of Pendora Park, to be improved and equipped for a public playground.

Urbana, O.—The State Legislature has appropriated $30,000 for repairs at Indian Lake Park. The improvement to be started this spring.

SEWERS.

CONTRACTS AWARDED.

Chicago, Ill.—N. D. Heiny, Gary, Ind., was awarded the contract for the construction of the big sewer at his bid of $249,-222.70.

Cincinnati, O.—Two contracts for sections of Mill Creek intercepter sewer were awarded by the Board of Control. Contract No. 4, covering that portion between Mitchell and Spring Grove avenue, was awarded to D. P. Foley at his bid of $168,637.95. Welling & Franz were awarded contract No. 2, between Harrison and Marshall avenues, at $154,759.

Decatur, Ill.—To Arthur Birt was awarded the contract for the construction of the Staley-Wabash sewer at a contract price of $41,920.

Fairbury, Neb.—The Roberts Construction Co., of Lincoln, was awarded the contract for the construction of a sewer in storm and drainage district No. 1 at their bid of $11,947.50.

Gibson City, Ill.—Arthur Birt, Decatur, Ill., awarded constr. of sewer at $25,860. Contract calls for 800 ft. 20-in. tile; 1,800 ft. 18-in., 3,300 ft. 15-in., 700 ft. 14-in., 6,600 ft. 12-in., 10,000 ft. 10-in. and 9,900 ft. 8-in.

Hopkins, Minn.—To William Danforth, contractor, Germania Life Building, St. Paul, was awarded a $36,500 contract for the construction of a sewage system and disposal tank in Hopkins.

Murray, Utah—Park Bros., Salt Lake City, were awarded contract for the construction of a new sewer system at their bid of $27,000.

Newton, Iowa—The Newton city council awarded the contract for the laying of 7 miles of sewer to the Turner Co. of Des Moines. The contract for two disposal plants was awarded to Ward & Weighton, Sioux City.

CONTEMPLATED WORK.

Aberdeen, S. D.—The trunk line storm sewer system and laterals proposed is estimated to cost about $200,000.

Boonton, N. J.—Board of Aldermen negotiating with officials of Jersey City for construction of trunk sewer line. Plan proposed for city to pay $86,000 towards improvement and build a local sewerage disposal plant.

La Porte City, Iowa—The street and alley committee were authorized to construct a storm sewer on Fourth street from Walnut to Commercial street. G. E. Stebbins, clerk.

Passaic, N. J.—Board of Freeholders planning for construction of drainage system at Wesel Brook, Acquackanonck township, near the Passaic city line, including culvert and other work. Estimated cost, about $40,000.

Rhinelander, Wis.—Plans and specifications for the sewer to be built on Thayer street and Phillip street are on file with the city clerk. R. G. Robertson, city clerk.

Syracuse, N. Y.—Common council considering the installation of a sewer in Grand avenue. Estimated cost, $20,000.

SEWAGE DISPOSAL.

Chicago, Ill.—Until May 12 sealed proposals will be received by quartermaster, Fort Benjamin Harrison, Indiana, for the construction of an addition to the sewage disposal plant at said post. Information furnished on application here or to Q. M. post.

Trenton, N. J.—Colored Municipal Training School planning for installation of sewage disposal system to cost $25,000. Appropriation being arranged by Legislature.

Summit, N. J.—Board of Health arranging for the establishment of a municipal garbage collection and disposal system.

New Rochelle, N. Y.—Board of Estimate and Apportionment authorized the issuance of $15,000 in construction certificates for the purpose of constructing the first unit of the new sewage disposal works.

WATERWORKS.

Ann Arbor, Mich.—Gessner Co., Toledo, O., was awarded the contract for the laying of 16-inch cast iron water main in the city of Ann Arbor at its bid of $25,917.5.

East Troy, Wis.—City awarded the contract for putting in waterworks to J. P. Chafin for $10,000.

Greenwood, Ark.—Coal District Power Co., Lawrence, Kas., will construct waterworks system at Greenwood, Booneville, Hartford, Huntington and Mansfield, Ark.

Lancaster, O.—Service Director Geo. Larman has received a report from J. King, supt. of the city waterworks, on the proposed extension of water lines to a number of sections of the city. The total cost of the improvement contemplated will be $20,000.

Lawrenceburg, Ind.—The city council has decided to grant the Newtown Water Co. a franchise to construct a water plant in Newtown. The water company contemplates the expenditure of $32,000 on the plant

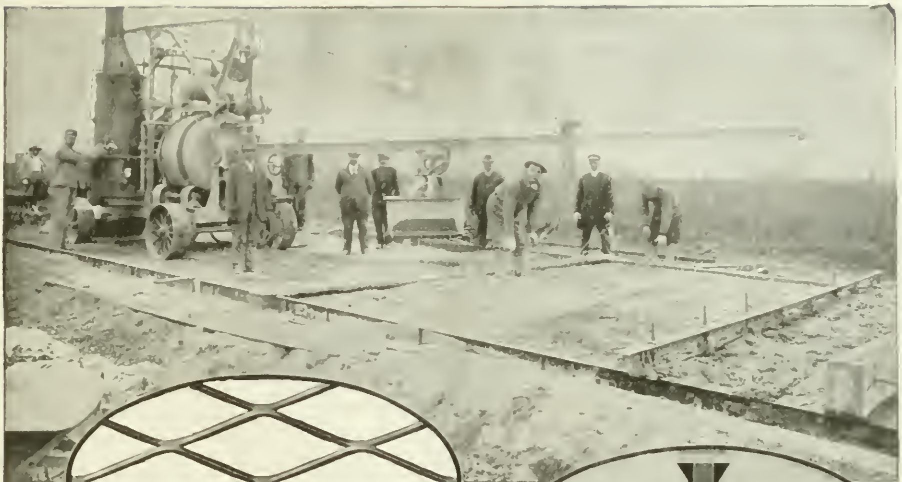
Manganese, Minn.—Bonds will be issued in sum of $10,000 for the purpose of constructing a public waterworks system in and for the village. George Phelps, village clerk.

Marshall, Mo.—The question whether Odessa shall spend $6,000 to locate water for a water plant was decided favorably last election.

Okmulgee, Okla.—The Benham Engineering Co., Colcord Bldg., Oklahoma City, will prepare plans and supervise construction of improvements to water and sewer system. Bonds for $300,000 will be voted on.

South Amboy, N. J.—Common council planning for the construction of a municipal water pumping plant for water system.

Thief River Falls, Minn.—City Engineer George Walker submitted his estimate on the cost of a new waterworks system; approximate cost, $13,000. The city clerk was ordered to advertise for bids on the contract, these to be opened at a meeting on May 8.



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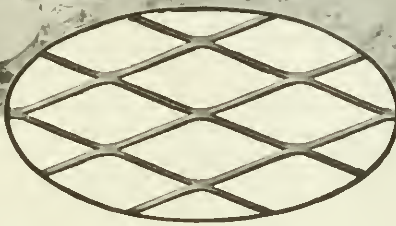
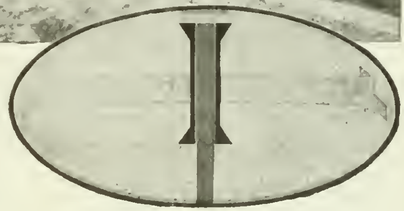
—Kahn Road Mesh
—Kahn Armor Plate
—Kahn Installing Device
All were used on this road.



KAHN ROAD MESH



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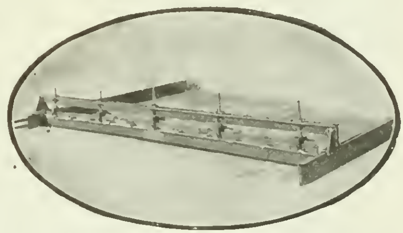
Means maximum road strength. Its steel web resists contraction and expansion in every direction. Cold-drawn from a thick sheet of steel, Kahn Mesh is shipped flat in one piece—easy to install—no tying in place necessary.

KAHN INSTALLING DEVICE

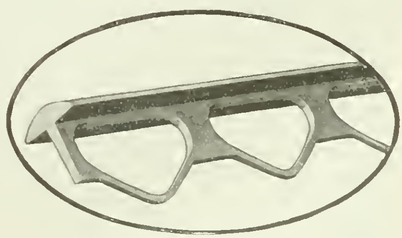
Insures proper placing of Kahn Armor Plates. This new improved device makes certain that the pavement is floated evenly with the top of the Armor Plates, and an accurate crown is insured.

KAHN CURB BARS

Are perfect protection for concrete curbs, in addition to providing a thorough reinforcement for the curb itself. These Curb Bars furnish a steel protection of 1⅝ inches, and are furnished either straight or bent. We also manufacture Kahn Edge Protectors, which follow the same principle of design as the Kahn Curb Bars except that they provide only a 1-inch protection and are generally used for the protection of columns, stairs, plastered corners, etc.



KAHN INSTALLING DEVICE



KAHN CURB BAR

Let us tell you more about Kahn-built roads and **Kahn Highway Products.** Many interest facts and illustrations in our booklet. Write for it now.

KAHN Building Products TRUSSED CONCRETE STEEL CO.

Trussed Concrete Steel Co.

Dept. A-65. YOUNGSTOWN, OHIO

Representatives in Principal Cities

KAHN Building Products TRUSSED CONCRETE STEEL CO.

Classified Dept

POSITION WANTED AS EASTERN REPRESENTATIVE.

Civil engineer, now selling all kinds of contractors' supplies. Owing to lack of protection, desires position as salesman. Can handle Eastern business, New York territory. Address,

H——, Municipal Engineering.

WANTED—Credit for two months' subscription to MUNICIPAL ENGINEERING or 20 cents in cash will be given to any one sending copy of any of the following back numbers to the publication office, Indianapolis, Ind., plainly marked so that the sender's name can be found:

July, 1907	September, 1911
April, 1910	October, 1911
October, 1910	October, 1912
December, 1910	December, 1915
January, 1911	April, 1916
May, 1911	

Bids received until May 14, 1917.

NOTICE TO DRAINAGE CONTRACTORS AND CONCRETE CONTRACTORS.

Notice is hereby given that Alfred Riske, engineer for the drainage district near Defiance, Mo., known as Drainage District No. 4 of St. Charles County, Missouri, will offer for sale at public outcry and receive bids, at the west door of the court house, in the city of St. Charles, Mo., at 2 o'clock p. m., on Monday, May 14, 1917, the work of clearing the right-of-way, excavating the ditch and constructing the culverts, according to plans and specifications on file in the office of the engineer, for said drainage district. The length of the ditch is 11,367.7 feet and the quantities embraced in the work are as follows:

Clearing, 1 acre.
Excavation, 9,080 cu. yds.
Culvert pipe, 18 ft. 24 in. Armco Corrugated.
Concrete, 52 cu. yds.
Steel, 5,605 lbs.
Lumber, 3,027 ft. white oak.

Bids will be taken separately for clearing and excavation and for the culvert work. All work to be completed on or before the first day of December, 1917. A bond, payable to the State of Missouri, of 20 per cent. of the amount of the bid will be required, signed either by two local qualified bondsmen or by a surety company authorized to transact business in the State of Missouri.

For further information apply at the office of the engineer, Room 6, First National Bank Building, St. Charles, Mo.

H. C. SANDFORT.
Clerk of the County Court of St. Charles County, Missouri.

Bids received until May 26, 1917.

NOTICE TO CONTRACTORS.

The board of supervisors of Road District No. 8 of Rapides Parish, Louisiana, will receive sealed bids up to 12 m. of Saturday, May 26, 1917, for the grading, bridging, culverts and drains; for the hauling, placing and rolling of the gravel surface; for the gravel, sand, stone, reinforcement and bridge material, required for the construction of Units 1, 2 and 3 of the highways to be improved in Road District No. 8, aggregating approximately 15 miles; all in accordance with certain plans and specifications on file in the office of Ira W. Sylvester, engineer, Alexandria, La.

Bids will be accompanied by certified check in the amount of 5 per cent. of the price bid, made payable to J. W. Texada, president board of supervisors, Road District No. 8.

The right to reject any and all bids is reserved.

All bids will be opened and considered in the police jury room of the parish court house, Alexandria, La., at 12 m. of Saturday, May 26, 1917.

For further information address J. W. TEXADA, Pres. Bd. of Supervisors, Road Dist. No. 8, Boyce, La.

IRA W. SYLVESTER, Engr.,
Alexandria, La.

Bids received until May 16, 1917.

STREET PAVING.

Sealed bids will be received by the city clerk of the city of Eldon, Ia., up to 7:00 o'clock p. m., Wednesday, May 16, for grading, curbing and paving nine blocks or approximately 13,000 sq. yds. of pavement, 1,500 yds. extra excavation and 6,700 ft. of concrete curb.

Bids will be received on vitrified brick and brick block, concrete, asphaltic concrete and Warren Bros. bitulithic, laid on concrete foundation.

Certified check to the amount of 5 per cent. of bid must accompany proposal in separate envelope, which will be returned to unsuccessful bidders. Successful bidder must enter into contract within ten days after award of contract and must furnish bond to the amount of 50 per cent. of contract price for the faithful performance of the work, and to guarantee the pavement for a period of five years after acceptance.

The bids must be on blanks furnished by the city, and the right is reserved to reject any or all bids.

Plans and specifications may be seen at the office of the city clerk, Eldon, Ia.

H. E. RITZ, City Clerk.

MOTOR FIRE APPARATUS.
BORO OF CLIFFSIDE PARK, BERGEN COUNTY, N. J.

Bids open May 14, 1917.

Notice is hereby given that the mayor and council of the boro of Cliffside Park, Bergen County, New Jersey, will receive sealed bids at a regular meeting to be held at the Boro Hall, corner of Palisade anl Jersey avenues, on Monday evening, May 14, 1917, at 8 o'clock, for the following fire apparatus, detailed specifications of which are now on file in the office of the boro clerk:

To convert a horse-drawn hose wagon, now at the Grantwood hose company's fire station, to a motor-driven combination hose and chemical truck.

Bids for a complete new equipment, with due allowance for the above-mentioned horse-drawn hose wagon will also be considered.

No bids will be received before the hour of 8 p. m. and none after 8:30 p. m.

The mayor and council reserve the right to reject any or all bids.

Dated April 17, 1917.

LOUIS J. RENTLER, Boro Clerk.

MOTOR FIRE APPARATUS.
BORO OF CLIFFSIDE PARK, BERGEN COUNTY, N. J.

Bids open May 14, 1917.

NOTICE TO BUILDERS OF MOTOR FIRE APPARATUS.

Notice is hereby given that the mayor and council of the boro of Cliffside Park, Bergen County, New Jersey, will receive sealed bids at a regular meeting to be held at the Boro Hall, corner of Palisade and Jersey avenues, on Monday evening, May 14, 1917, at 8 o'clock, for the following fire apparatus:

One quadruple combination motor fire apparatus, together with all necessary attachments, according to detailed specifications now on file in the office of the boro clerk.

Equipment to consist of a pumping engine with a capacity of at least 500 gallons at 120 pounds net pressure, chemical tank, hose body, and approximately 140 ft. of ladders.

Motor to be 75-h.p., A. L. A. M. formula. Wheels to be Sewell cushion wheels.

Bids from manufacturers of motor fire apparatus only will be accepted.

No bids will be received before the hour of 8 p. m. and none after 8:30 p. m.

The mayor and council reserve the right to reject any and all bids.

Dated April 17, 1917.

LOUIS J. RENTLER, Boro Clerk.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912,

Of MUNICIPAL ENGINEERING, published monthly at Indianapolis, Indiana, for April 1, 1917.

State of Indiana, County of Marion, ss:

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Charles C. Brown, who, having been duly sworn according to law, deposes and says that he is the Editor and Manager of the MUNICIPAL ENGINEERING, and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor and business managers are: Publisher, Engineering Publishing Company, Inc., Indianapolis, Indiana; Editor, Charles C. Brown, Chicago, Illinois; Managing Editor, Charles C. Brown, Chicago, Illinois; Business Manager, Charles C. Brown, Chicago, Illinois.

2. That the owners are: (Give names and addresses of individual owners, or, if a corporation, give its name and the names and addresses of stockholders owning or holding 1 per cent. or more of the total amount of stock): Engineering Publishing Company, Inc., Indianapolis, Indiana; A. P. Fox, Indianapolis, Indiana; Charles C. Brown, Chicago, Illinois; C. S. Sale, Urbana, Illinois.

3. That the known bondholders, mortgagees and other security holders owning or holding 1 per cent. or more of total amount of bonds, mortgages or other securities are: (If there are none, so state.) Frank S. Stalnaker, trustee, Indianapolis, Indiana, for A. P. Fox, Indianapolis, Indiana, and Charles C. Brown, Chicago, Illinois.

4. That the two paragraphs next above, giving the names of the owners, stockholders and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association or corporation has any interest direct or indirect in the said stock, bonds or other securities than as so stated by him.

CHAS. C. BROWN,
Editor and Manager.

Sworn to and subscribed before me this 30th day of March, 1917.

(SEAL) VIOLA HEDRICK.

(My commission expires March 1, 1920.)

MOTOR TRUCKS

Printed as insert to MUNICIPAL ENGINEERING, May 1917.

MOTOR TRUCK OPERATION AND ACCOUNTING XXI.

By Charles A. Dickens.

Because they can be kept constantly on the move and can be operated at almost any speed desired, the motor truck is especially well adapted to the work of street sweeping and flushing. The fact that the power of the engine can also be applied to the pumps or other necessary machinery is also a decided point in their favor. So many are the marked advantages of the motor truck in this work over horse-drawn apparatus that their use is rapidly extending thruout the live municipalities of the United States.

In many cases the chassis is used for different purposes at different seasons of the year, making the truck more than ever always on the go, an all-year proposition. Witness the changeable body truck in use by the city of Boston, Mass.

"Old Versatile" Does Varied Work.

"Old Versatile" is the name of the Peerless 5-ton motor snow plow that has earned its price many times over during the five years it has been in operation over the streets of Boston. During its career it has performed a wide variety of useful purposes. In fact, in behalf of "Old Versatile" we are prepared to issue a challenge to any other truck in municipal service to excel this Bostonian record.

Originally employed as a regular carrier of stone and road-building material, its removable body was displaced by a tank. This tank, in connection with a power pump, was used during the spring and summer season as a tree-sprayer, water sprinkler and to spray oil on dust-covered highways. It was also pressed into service as an auxiliary to the fire department. The force of the pump is sufficient to throw a stream to extinguish small brush fires along the road.

Again, as a refuse truck with a dump body, it can transport with ease 100 barrels of waste. (Four double teams would originally have been necessary.) It has been used as a refuse collector and a snow plow. The boards in front were so connected on this latter device that it was but the work of an instant to elevate them and send the truck to do duty in any section of the city.

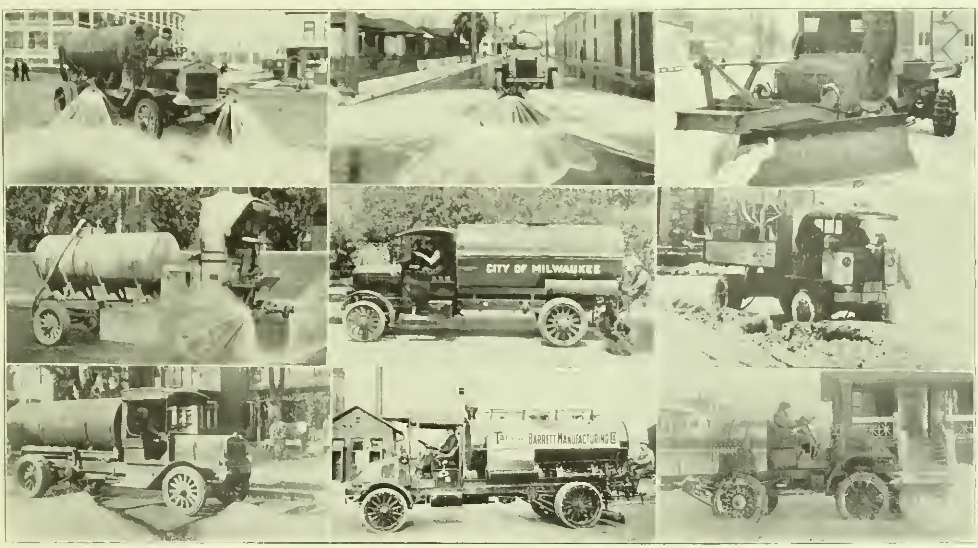
Portland Cuts Sprinkling Costs.

In Portland, Ore., a motor-driven sprinkler has cut in two the cost of street cleaning. This truck, a 5-ton Locomobile, carries a 1,300-gallon tank. Water is forced onto the pavement under a pressure of 50 pounds, by a centrifugal pump driven from the automobile engine.

Portland has 370 miles of paved streets, with 20,800 square yards to the mile. This motor sprinkler will cover 6 miles a day at a cost of $17.27 as against a daily cost of $38.60 recorded for the old horse sweepers which covered the same area. This saving in cost for a year of 300 days totals $6,426, or the approximate initial cost of the truck.

Street Flushing In Niagara Falls.

The city of Niagara Falls is very successfully operating a 1,200-gallon motor-driven tank in the work of street flushing.



G M C 5-TON FLUSHER AS OPERATED BY THE BARRETT CO., FALLS, N. Y.

G. V. 3½-TON FLUSHER AS OPERATED BY CITY OF BOSTON, MASS.

GRAMM-BERNSTEIN 5-TON FLUSHER AS OPERATED BY CITY OF YOUNGSTOWN, O.

MORELAND 5-TON FLUSHER AS OPERATED BY CITY OF LOS ANGELES, CAL.

STERLING 5-TON OILER AS OPERATED BY CITY OF MIWAUKEE, WIS.

KELLY 3½-TON OILER AS OPERATED BY BARRETT MFG. CO., CHICAGO, ILL.

MENOMINEE 3½-TON SNOW PLOW AS OPERATED BY SUPERIOR, WIS.

GARFORD 5-TON SNOW PLOW AS OPERATED BY WASHINGTON BULKLEY, INC., BROOKLYN, N. Y.

KELLY 3½-TON SNOW PLOW AS OPERATED BY SOUTH PARK COMMISSIONERS, CHICAGO.

This piece of equipment is illustrated in these pages. The tank is mounted on a 5-ton G. M. C. chassis and four flushing nozzles controlled by levers in convenient reach of the driver project the water onto the roadway.

Power for flushing is supplied by a centrifugal pump driven by a silent chain from the power-take-off shaft extending thru the rear-end transmission case. This flusher will supply water at the rate of about 350 gallons per minute at 35 pounds pressure.

Garbage Collection In New York City.

"Different from the street cleaning equipment used by any other city," states the *Scientific American*, "the twelve motor tractor-and-trailer units now employed in the model street-cleaning district of New York City, under the supervision of Commissioner Fetherston, are designed to do all the work in that district, including the collection of garbage, ashes and paper refuse in the day, the sweeping and flushing of the streets at night, and the cleaning off of snow in winter. Aside from the multifarious work which they are designed to do and the elimination of all horse-drawn vehicles in the area in which they work, the tractors are featured by the use of gas-electric drive and by the fact that they haul huge 20-ton detachable trailers."

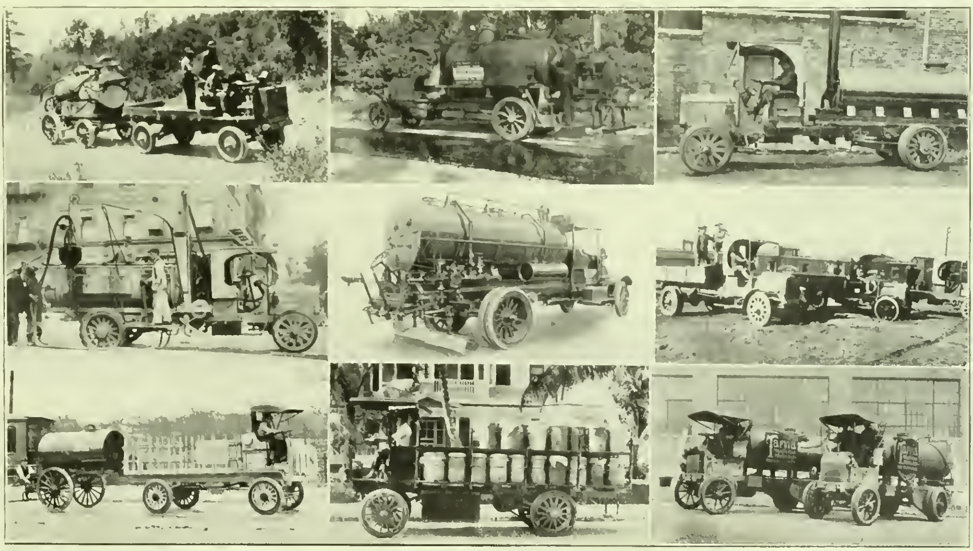
REASONS FOR GAS-ELECTRIC TYPE.

The selection of the gas-electric type of drive on the tractors was made for cheapness and operating simplicity. While the electric tractor was highly desirable from the standpoint of ease of operation, the fact that each unit has to work 16 out of the 24 hours every day made its use impossible except by the employment of two sets of batteries, because of the mileage limitations imposed upon it by the storage battery equipment. On the other hand, the gasoline tractor with gear transmission, clutch and spark and throttle controls, was impracticable because of the great number of stops in collection work, averaging from 60 to 100 per hour, and the subsequent slow acceleration between stops, the comparatively large consumption of gasoline during these periods, and the resulting necessity for drivers of a higher class.

The gas-electric type of drive, comprising a gasoline motor directly connected to an electric generator whose output is used in motors driving the rear wheels, combines the desirable qualities of both the purely gasoline and the purely electric tractor. The mileage limitation of the latter is overcome thru the generation of the current by means of a gasoline motor instead of being taken from the storage battery. The simplicity of the electric is retained thru the elimination of the gear shift and the conventional controls of the gasoline tractor, while the comparatively large gasoline consumption of the latter, when the motor is run at normal speed during the many short stops, is eliminated by the use of a special device which automatically cuts the speed of the motor in half when there is no load on the generator.

DESIGN OF TRACTORS AND TRAILERS.

The governor device consists of a solenoid of the plunger type, which is connected in the throttle lever of the gasoline motor by linkage. It is wired in multiple across the generator terminal thru a contactor on the driver's controller shaft, which in turn is so arranged that a slight movement of the controller handle from neutral position in either direction will close the circuit, automatically speeding up the gasoline engine before the driving motors at the rear wheels begin to draw current. Conversely, throwing the controller to neutral automatically reduces the gasoline motor speed to half that when there is a load on the generator.



JEFFERY QUAD TAR DISTRIBUTOR AS OPERATED BY CALIFORNIA STATE HIGHWAY COMMISSION.

PACKARD 5-TON CATCH BASIN CLEANER OPERATED BY BORO OF MANHATTAN, NEW YORK.

F. W. D. 3½-TON TRUCK PULLING OILER AS OPERATED BY LA CROSSE COUNTY, WIS.

G. V. 6-TON MERCEDES TAR DISTRIBUTOR AS OPERATED BY HAHESY BROS., CHELSEA, MASS.

KELLY 3½-TON ROAD OILER AS OPERATED BY CITY OF OMAHA, NEB.

G. V. 2-TON ELECTRIC GARBAGE TRUCK AS OPERATED BY CITY OF MIAMI, FLA.

PACKARD 5-TON TAR DISTRIBUTOR AS OPERATED BY BARRETT MFG. CO., CINCINNATI, O.

U. S. 5-TON TRUCKS AS OPERATED BY KENTUCKY STATE MILITIA.

LOCOMOBILE 5-TON TAR DISTRIBUTOR AS OPERATED BY BARRETT MFG. CO., NEW YORK CITY.

FEDERAL MOTOR TRUCK COMPANY

FEDERAL
MOTOR TRUCKS

DETROIT MICHIGAN U.S.A. May 1, 1917.

M. L. Pulcher

Federal Motor Truck Company,
Newark, N. J.

Attention: Mr. George Ludlum.

Dear George:

Everything comes to him who waits. You've been looking forward to the complete FEDERAL line. Now it's ready - FEDERAL quality in every needed capacity.

We are going to make announcement of all five models in May - One Ton, One and a Half Ton, Two, Three and a Half, and Five Ton models.

The photo prints I enclose will give you a good idea of the jobs themselves. I think they're corkers. How do they look to you?

Remember -- these are not "new" models in the sense of being revolutionary departures from past FEDERALS. All the stamina and reliability of the good old FEDERAL has gone into these models -

- in addition, they have everything that motor truck experience has taught us right down to May 1st, 1917.

This line of FEDERAL trucks is, in essence, the outgrowth of seven years spent in studying the haulage needs of Business.

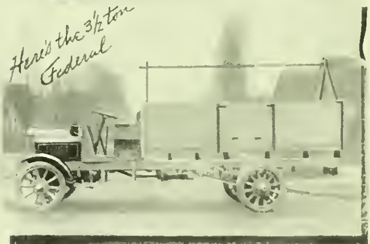
Features? Every point of FEDERAL construction is a "feature" in the sense that it was designed solely with haulage service in mind.

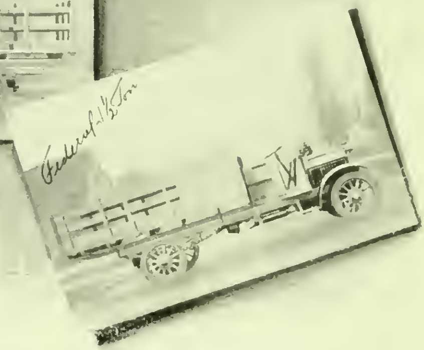
The engine is a truck engine exclusively -- "full of pep". The oiling system, by means of pump pressure, increases lubrication as heavy duty or increased speed make it necessary - and so on -

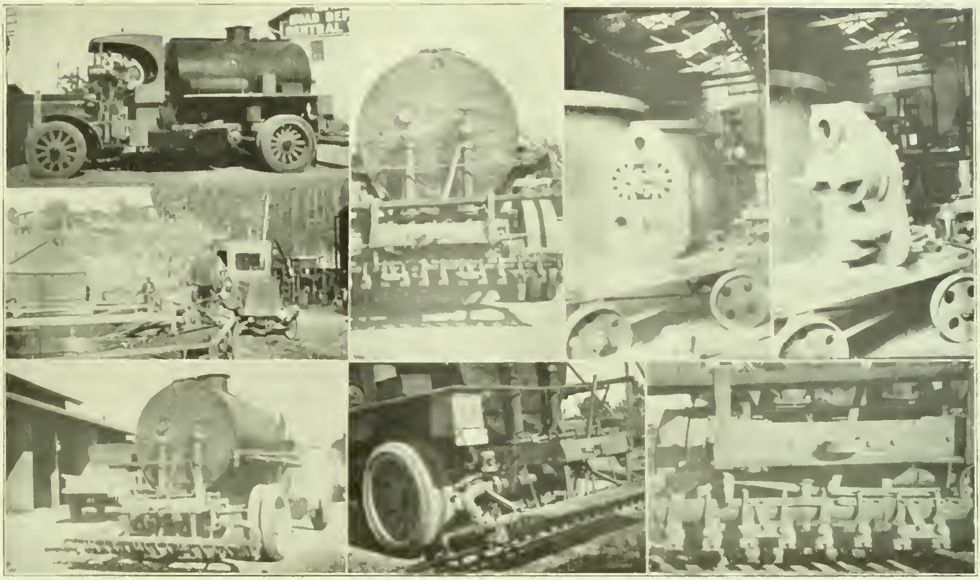
I can't hope to cover all the points here, of course. You have them all in the "Blue Print Book". We are receiving quite a number of inquiries for these. Do not fail to get a supply for distribution.

Now then, here's hoping for the best year yet! I know that this FEDERAL family is going to prove well worthy of its name.

Yours with best wishes,
M. L. Pulcher
Vice President
FEDERAL MOTOR TRUCK COMPANY







PEERLESS 5-TON ROAD OILER AS OPERATED BY LOS ANGELES COUNTY, CAL. VIEWS SHOWING OIL TANK LOADING WITH OWN POWER FROM TANK IN GROUND. REAR VIEW SHOWING EXTENSION, VALVES AND GAGES. FRONT VIEW OF PUMP CASTING SHOWING ROLLERS. REAR VIEW OF PUMP CASTING. VIEW SHOWING EXTENSION AND STEP FOR OPERATOR. DETAIL OF HEADER.

The solenoid device is locked to be tamper-proof. From the moment the gasoline motor is started at the beginning of the day's work, it is kept running without any attention on the part of the driver, its speed being regulated by the solenoid apparatus. All the driver has to do is to steer the vehicle and operate the controller, which gives five speeds forward and two reverse.

Perhaps of equal importance with the design of the tractors is that of the trailers for the collection of garbage, ashes and paper refuse at the same time. The trailers make use of eight double-decked steel buckets. The lower buckets are arranged in two longitudinal rows of four each, set into the trailer frame. On top of these are two other buckets with V-shaped bottoms and side dors. The latter are opened to permit the men to dump the cans of garbage or ashes into the eight buckets on the lower deck, the paper and other refuse collected being thrown directly into the upper buckets from the sidewalk.

In unloading at the disposal pier the upper buckets are lifted off first, dumped into scows and then set down on the pier floor. Then each of the lower buckets is hoisted out and dumped in a similar manner. They are then loaded onto the trailer in the reverse manner, when the unit is ready to return to its next point of collection.

The sweeping and flushing on the streets and the plowing of snow in the winter is to be done by special trailers. The tractors were used to plow snow after last winter's heavy snowstorms, however, by uncoupling the trailers and applying the conventional front-end plows.

Largest Motor-Driven Flusher.

What is probably the largest motor-driven flusher of its kind has been put in service by Mr. F. H. Clark, Superintendent of Streets and Engineering, of Springfield, Mass. The equipment consists of a Knox Model-35 Tractor, used in connection with a Hvass street-flushing trailer.

The pump, which is mounted on the tractor, is capable of discharging 350 gallons of water per minute at 35 lb. pressure. This pump is part of the flushing equipment and is driven by a special power-take-off. Flusher nozzles are all placed on the tractor, one in front of each wheel. Sprinkler-heads immediately in front of the front wheels are fed from the same line of pipe as the flusher-nozzles and controlled by a three-way cock so as to permit the water to flow either to the sprinkler-heads or flusher-heads, as may be desired.

The four flusher-nozzles and two sprinkler-heads are all controlled from the driver's seat with snap levers, all immediately in front of the operator. One operator works the entire outfit, altho the probabilities are in some instances two may be preferred.

The pump is of the centrifugal type of special design. The tank contains 1,700 gallons. It is 48 inches in diameter, 18 feet long and made of 3 16-in. shell and ¼-in. heads. The tank contains swash plates. The frame is of 8-in. channel with 8-in. I-beam cross members. The connection from tank to pump is of special construction allowing sufficient flexibility for control to turn in any direction. Special fitting, of course, is required for pump connection. There is plenty of clearance between trailer and tractor. The trailer is mounted on silicon manganese steel springs with patented Archibald bronzed bushed axles. Wheels have 10 by 1¼-in. steel tires, dual type. Axles are 4-in. size.

Great economy is claimed for this method of street flushing, inasmuch as by having the increased capacity of the tank too frequent stops are eliminated. Owing to the short turning radius of the tractor and trailer, it may readily be turned around in the narrowest of streets, thus eliminating the lost time necessitated by the conventional type of motor truck being forced to go to the end of the street for turning purposes. The bulk of the load is also being carried on the steel-shod tires of the trailer wheels. One of the great advantages claimed for this method of street flushing is that when winter sets in the tractor may be detached from the street-

Gilroy's Halls Haul on Schedule!

Right on the *dot* at the *job* with the *stuff!* In and out of the Broadway traffic tangles—through hindering tie-ups, with a short stop and a quick pickup that makes much of every minute! That's the reputation the HALL has gained with the Gilroy Contracting Co., of New York City. And with Gilroy *minutes* mean *dollars!!*

When they get to the job Gilroy's HALLS hardly stop to unload. In less than a minute the engine-driven automatic hoist-tilted body slides the load off in *one clean sweep.* Body returns of itself to a horizontal position.

Just one case, but it illustrates the *special* adaptability of the giant HALL to *contracting* work. HALLS speed up results and cuts down contracting load-carrying costs because they are built for *emergencies* and walk off easily with the unusual demand.

Built according to Russian army specifications! To stand up under abuse that would put any *ordinary* truck on the scrap heap! Has the brawn to deliver the service, and it delivers *unfailingly!*

The new pamphlet *"Speeding Up"* tells the story of lowered ton-mile haulage costs in actual service. Send for ***your*** copy ***today!***

LEWIS-HALL IRON WORKS

MANUFACTURERS OF THE HALL TRUCK

Ferry Ave. and Grand Trunk Ry. DETROIT, MICH.

"Haul it in a Hall"

FOUR F. W. D TRUCKS AS OPERATED TO MOVE NATIONAL GUARD COMPANY HOUSE DISTANCE OF $7\frac{1}{2}$ MILES AT CAMP STEWART ON MEXICAN BORDER.

ONE OF SEVEN 1-TON MORELAND TRUCKS AS OPERATED ON ROAD MAINTENANCE BY LOS ANGELES COUNTY, CAL.

flushing trailer and used in connection with dump trailers, if desired, or for hauling garbage. By this means, the tractor can be kept constantly busy earning money for the city. The tractor which is illustrated in this issue has brought considerably increased economy to the department it serves, having replaced five horse-drawn vehicles.

Electrics Flush Boston's Streets.

In this issue is illustrated one of five $3\frac{1}{2}$ ton G. V. Electric combination flushers and sprinklers operated by a contractor for the city of Boston, Mass. The tanks carried on these trucks have a capacity of 800 gallons each. In winter these electrics are put to work at waste removal. A time-saving feature of these machines is their patent battery cradle which lowers the batteries when needed for a big day's work. Fresh battery can be installed in about five minutes.

Motor Truck Costs In Seattle.

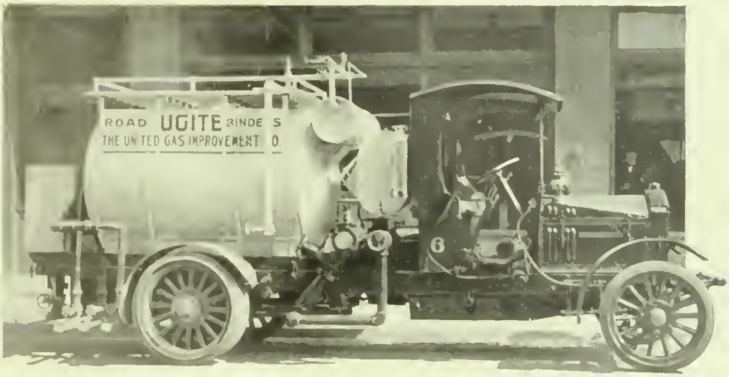
Figures compiled by the Department of Streets and Sewers, Seattle, Wash., show that a considerable saving was made over the cost of doing an equal amount of work with horse-drawn wagons. A 1-ton Velie and three 3-ton Gramms were used in the work. Each one of the three-ton trucks regularly did the work of three or four teams, carrying on the average a load of 26 tons a distance of 30 miles. For this work the cost per truck was $7.90. The cost per day for the 1-ton truck was $7.80 and its cost per mile slightly under 26 cents. Cost per mile for the 3-ton trucks averaged 29 cents.

Oiling and Utility Truck.

A special oil-truck design has been worked out by Los Angeles County, California, for use in both road oiling and road maintenance work. It is so arranged that the oil tank and header may be removed, and a flat body or dump body

KNOX MODEL NO. 35 FOUR-WHEEL TRACTOR (PULLING HVASS STREET FLUSHING TRAILER) AS OPERATED BY THE CITY OF SPRINGFIELD, MASS. AUTOCAR TAR DISTRIBUTOR AS OPERATED BY THE BARRETT CO., PHILADELPHIA, PA. KELLY ROAD OILER AS OPERATED BY DEPARTMENT OF PARKS, CITY OF OMAHA, NEB. AUTOCAR OILER AS OPERATED BY DANIELS ROAD OILING CO., PROVIDENCE, R. I.

PIERCE-ARROW AS OPERATED BY THE UNITED GAS IMPROVEMENT CO., PHILADELPHIA, PA., IN DISTRIBUTION OF ROAD OILS.



be put on in place of it, thus keeping the truck busy all the time. The truck, which is illustrated in this issue, will handle any material up to asphaltic cement, retaining its heat all day, and be ready at any moment to cover a patch from 6 inches square to 8 feet wide (12 feet with extensions on header) of any length, and of any amount up to about $1\frac{1}{2}$ gallons per square yard.

In order to make the heat of the entire body of oil available to keep everything hot right down to the nozzles which spray the oil on the road, the pump was placed in the front head of the tank, and all the piping outside the tank is arranged so that oil can be circulated thru it until it is at a working temperature.

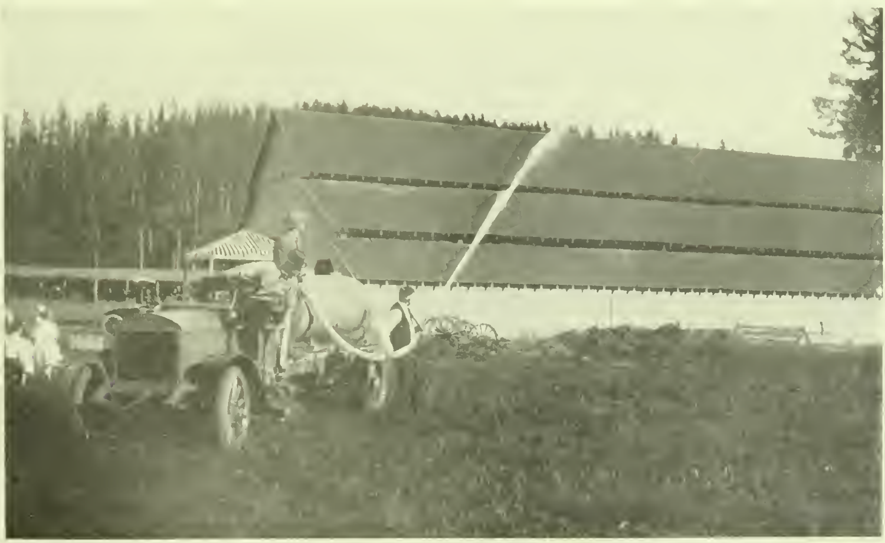
The pump is driven by chain from a shaft extending thru the front of the transmission. By building a three-way cock into the body of the pump casting just underneath the runners, the pump can be shut off and taken apart with the tank full of oil, and at the same time the cock makes available a side outlet in the suction that can be connected either to the pump or to the tank, so that the tank can be emptied by another pump, or the pump can be connected to an outside supply.

In spreading the oil goes from the pump back thru the tank and comes out thru the back head, down and to the left end of the distributing header across and up thru a spring-loaded relief valve, and back into the tank.

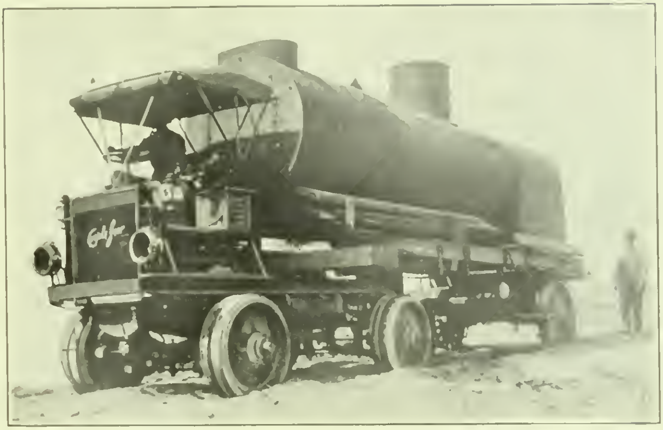
As the hot oil goes across the header it heats the upper end of the spray cocks, which is screwed into the header, and by convection heats the whole cock. The header swings around a packed joint at each end and can be raised and lowered.

The cocks are not operated by a fixed connection, but by pins in a bar which are placed about 3 inches apart, which allows each lever on a cock to be operated independently if desired, thus giving the operator, who stands on a step across the back at the level of the cocks, entire control over the width and position of the strip that is to be covered with oil.

In order to get a large spreading range without using excessive pressure, the cocks have two outlets with large and



G. M. C. 2-TON TRUCK AS OPERATED IN ROAD SPRINKLING, TREE SPRAYING AND FIRE FIGHTING. CAPACITY 3 BARRELS PER MINUTE.



COUPLE-GEAR SIX-WHEELER AS OPERATED BY THE TENNESSEE NATURAL DEVELOPMENT CO., GREENVILLE, TENN HAULING 100 H. P. BOILER INTO INTERIOR OF MOUNTAINOUS DISTRICT.

small nozzles and a 30-degree movement of the handle to the right or left opens either one.

In cases there are places where it is impracticable to get the truck, a ¾-inch metallic hose is attached to the header and the oil distributed by hand. The tank itself is covered with asbestos and a sheet steel jacket placed around the asbestos. Large tool boxes and running boards are put on so that equipment can be carried to tackle any kind of a job.

At the back of the tank there is a gage with a hand that makes one revolution from tank full to tank empty, so that the operator knows how much oil he has left at any time.

Los Angeles Road Maintenance Equipment.

The maintenance of the paved road system of Los Angeles County, California, is handled by seven 4-ton motor trucks and crews, the average crew consisting of foreman, driver and eight laborers. As the county is divided into four road districts with a district engineer in charge of each, it was found advisable to put the trucks and crews under the direct supervision of the district engineers.

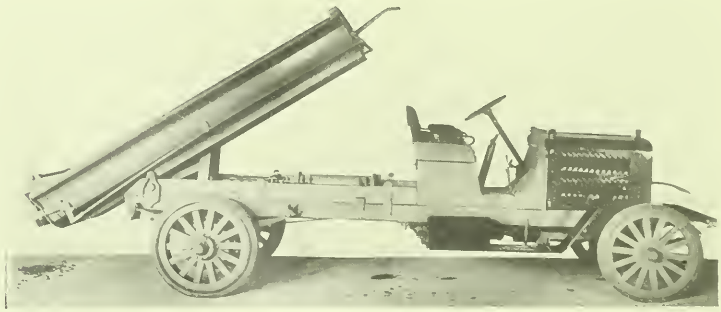
In the first road district there are two trucks in use. A one-ton truck is also used at times for emergency patching jobs. This district includes about 125 miles of paved roads. In one of the small towns in the center of the district a warehouse is maintained which is used as headquarters for the trucks. In the fourth road district there are four trucks in service. Two of these operate from a warehouse located in the central part of the district and two from the central warehouse in the city of Los Angeles. There are about 185 miles of paved roads in this district. One motor patrol truck handles all the work in the third and fifth districts which includes about 100 miles of paved roads.

At the central warehouse in Los Angeles an oil pit and heating plant is maintained to supply oil to the two district warehouses and to the trucks operating from the central warehouse. Oil is transported in tank trucks and placed in 5-gallon buckets for storage at the district warehouses. At convenient places along the highways piles of rock and screenings are located for use of the motor-truck crews. Stone for the stock piles is shipped via rail to the nearest siding and hauled in wagons to the piles.

FULL EQUIPMENT FOR ROAD WORK.

Each patrol truck is equipped with a portable road-oil heater and distributer and an oil-bucket heater. (Described in the November, 1916, issue of MUNICIPAL ENGINEERING.) One wheelbarrow, shovels, picks, street brooms and lanterns are also part of the equipment. The amount of oil carried de-

A JEFFERY QUAD WITH A "SNOW SCOOT" CLEARING AWAY A WEEK-OLD SNOW.



FEDERAL TRUCK, WITH 3-YD. LOAD OF GRAVEL, AFTER 8-FT. DROP THRU BRIDGE. NO INJURIES EXCEPT A BROKEN TAIL LIGHT. IN SERVICE OF ARTHUR O'KEEFE (CONTRACTOR), PLYMOUTH, IND.

pends on the character of the work to be performed. The amount varies from 60 to 150 five-gallon buckets.

The work handled by the patrol crews consists of: Sealing road surface, constructing shoulders, patching holes or places which have settled, cleaning gutters and shoulders, cutting down high places in the road surface and at times reconstructing wornout sections of the pavement. In all kinds of work where hauling is necessary the truck is used. Usually a patrol crew goes straight thru from one end of a road to the other. In this way it is often possible to keep a small tandem roller on the job. By using the roller a much better class of work is turned out than could be with hand tamping. The oil heater and unused buckets of oil can also be left along the roadside overnight, thus saving considerable time.

AVERAGE COST OF WORK IS LOW.

The average cost per month of operating a truck and crew is as follows:

Labor	$500
Foreman	100
Driver	90
Rock	150
Oil	150
Supplies for truck	30

There are often other items, such as roller, hauling rocks to stock piles, hauling oil, etc.

SPECIAL EQUIPMENT FOR EMERGENCY DEVICE.

The patrol crews have proven exceedingly valuable during stormy weather in protecting bridges and pavements from flood water. The character of the rivers in Southern California is such that they are liable to frequent change in course. The banks are low and subject to overflow. On account of the frequent changes in course many pile trestles have been erected in the past, both by the railroads and the county. During high water periods brush and driftwood lodge against the pile bridges. In this way the bridges are soon turned into dams, water is backed onto adjacent property and often the bridges give way, resulting in great damage caused by the sudden discharge of the accumulated water.

In order to guard against this trouble it has been the practice to assign truck crews to duty at the various threatened bridges. For this work a special equipment is necessary .

The equipment carried for flood-protection work consists of two or three hundred empty sacks, steel blocks and tackle, pike poles, lanterns, axes, saws, shovels, picks, etc. Some of the trucks have been equipped with a small boom derrick which is mounted in the center of the truck bed. This der-

SIGNAL VACUUM STREET CLEANER AS OPERATED BY THE CITY OF LOS ANGELES, CAL.

ACME
THE TRUCK OF PROVED UNITS

THE TRUCK THAT PAYS BIGGEST DIVIDENDS

The truck that stands up—the truck that's "on the job" every day—the truck you can depend upon—is the motor truck that pays the biggest dividends.

And Such a Truck is the ACME!

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The **Acme** truck represents the combined engineering skill and wisdom of the acknowledged leaders of the motor truck field.

It is built to meet the tough requirements of contracting and municipal haulage.

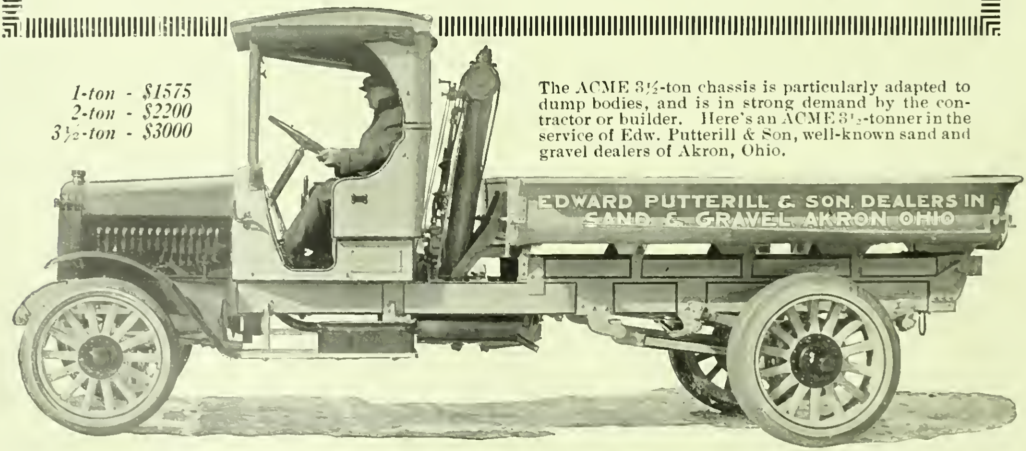
Write for our New Truck Book—It's Free!

Our valuable new book—*"A Pointer to Profits"*—contains vital facts for the truck user or prospective buyer. Write today for your copy. Read the experience record of hundreds—many in your own business. Know how and why the **Acme** cuts delivery costs 30 to 50 per cent as compared to old methods. Write today, using space below for your request.

Cadillac Auto Truck Co.

144 Mitchell Street **CADILLAC, MICH.**

1-ton - \$1575
2-ton - \$2200
3½-ton - \$3000



The ACME 3½-ton chassis is particularly adapted to dump bodies, and is in strong demand by the contractor or builder. Here's an ACME 3½-tonner in the service of Edw. Putterill & Son, well-known sand and gravel dealers of Akron, Ohio.

Write Your Reply Here—Tear Off and Mail Today

CADILLAC AUTO TRUCK CO.
144 Mitchell Street, Cadillac, Mich.

GRAMM COMBINATION HOSE AND CHEMICAL AS OPERATED BY WILDWOOD CREST F. D.

rick when used for lifting driftwood away from a bridge has proved very satisfactory. During rainy weather all trucks are equipped with canvas coverings over pipe frames.

Cuts Oiling Costs In Two.

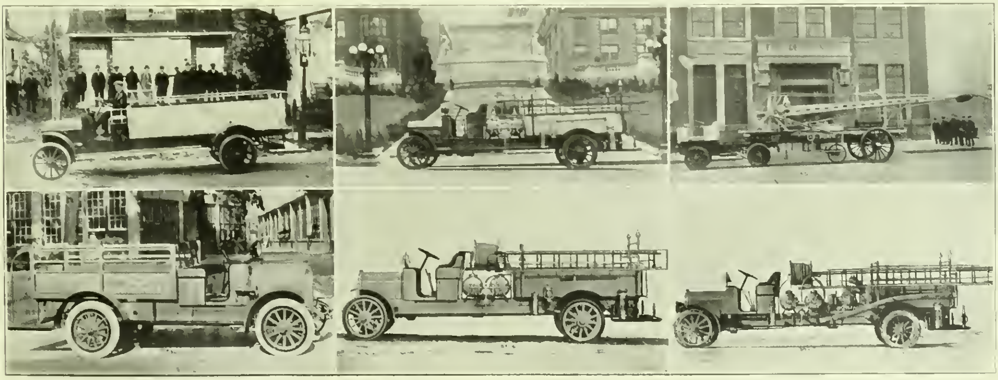
A 2-ton Jeffrey Quad purchased last summer by the Kenosha, Wis., County Board has made a very considerable reduction possible in the road work of that county. This truck was originally purchased with the idea of trailing a 600-gallon road oiler, hauling stone, gravel and the like for the construction and maintenance of Kenosha County roads.

"Maintenance on this truck," said Russel H. Jones, County Clerk of that county, "has been practically nothing. In fact, the entire expense for the past season's driving, outside of gasoline, oil, driver's wages and the like, have been less than $10.00.

"We normally haul a 2-ton load on the truck itself, with a trailer load of from 2 to 3½ tons, depending on the condition of the roads. By putting in a very slight amount of overtime now and then, we have been able to haul as much road material in a day as could be hauled with 4 teams in the same day.

"We average about 52 miles per day, trailing either the road-oiler or the dump-wagon as above mentioned, consuming not to exceed 15 gallons of gasoline per day so that our gasoline consumption, even with the use of the trailer, is on the basis of approximately 4 miles per gallon."

Prior to using the Quad for this particular work, it required four horses to handle this road-oiler on the same job and at the end of one round trip of 14 miles these horses had to be replaced with fresh horses, particularly in the hot



GARFORD HOSE AND SQUAD TRUCK AS OPERATED BY THE CITY OF PORT WASHINGTON, L. I., N. Y.

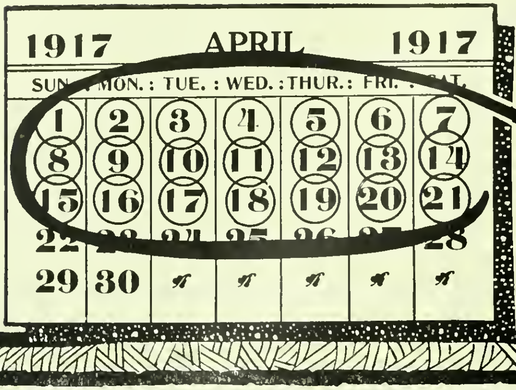
GARFORD HOSE AND SQUAD WAGON AS OPERATED BY THE CITY OF DINUBA, CAL.

GARFORD TRIPLE COMBINATION AS OPERATED BY THE CITY OF ROSLYN, L. I., N. Y.

GARFORD COMBINATION CHEMICAL AS OPERATED BY TWO WESTERN OHIO MUNICIPALITIES.

GARFORD AERIAL TRUCK AS OPERATED BY SEVERAL NEW YORK MUNICIPALITIES.

GARFORD TRIPLE COMBINATION AS OPERATED BY THREE PENNSYLVANIA MUNICIPALITIES.



3 WEEKS
Steady Grind
20 hours
out of every 24

Stegeman
SIX CYLINDER
TRUCKS

"*Some Pace!* But my **Stegeman** hung on without missing a shot! *Overloaded*, too; almost every trip. And *not a penny* paid out for repairs."
That's what John Peters, Waterford, Wis., says of his **Stegeman** Truck.

Characteristic **Stegeman** performance! The six-cylinder steady pull *conquers* long hours of continuous, hard work just as it does rough roads and hindering hills.

At all speeds! All times! The **Stegeman** pull is a smooth *even* power flow! Every **Stegeman** governor is set so that the *big pull* comes before limit speed is reached.

That avoids the clattering rack of the *over-speeded engine* that follows when a governor is taken off to make the truck *deliver!* Adds years to **Stegeman** life.

Every **Stegeman** a self-starter—and the *only* ***self starting truck*** on the market. This feature alone saves as high as 40 per cent on engine wear! Cuts down waste of gas that accompanies the idled engine.

Standard! Every unit in the **Stegeman** is approved. Their combination make a truck fitted especially for *severe service;* not made for easy selling. Compare **Stegeman** specifications with *any other!* They're the *basis* of **Stegeman** superiority.

Stegeman Motor Car Company MILWAUKEE WISCONSIN

weather. The Quad handles this same work with remarkable ease, having repeatedly made 4 round trips per day even in the extreme heat of the summer, and with one or two exceptions on extremely hot days, even the motor has not heated up beyond a point of maximum efficiency.

Distributes Cold Oils at Low Cost.

An efficient type of road oiler is in use by the Daniels Road Oiling Co., of Providence, R. I. The outfit, which is illustrated in this issue, consists of an Autocar on which is mounted a 550-gallon tank, with a Goulds rotary pump. This pump is driven by the truck engine. The pipes and sprayers used will handle any cold road oil that is 15 per cent asphalt or less.

In practice the oil is usually applied to city streets in so small a quantity that closing the street or covering the oiled surface with sand are both unnecessary. The range of the machine is from 4 yards to 30 yards per gallon, 8 yards being usually approximated. Four to six treatments are given in a season.

The truck illustrated had an output that ran on many days as high as 3,300 gallons. Costs per gallon, considering only gasoline and lubricating oil, were as follows:

Gas at 23c.	.00105
Oil and grease	.00008
	.00113

Daily average output of oil, 2,422 gallons. With a $3\frac{1}{2}$-ton truck operated in the same service this truck carrying a 940-gallon tank costs were as follows:

Gas at 23c.	.00112
Oil and grease	.00028
	.00140

Daily average output, 2,138 gallons.

More Work at Less Cost.

The economy of a good motor truck in the work of a street department has been demonstrated by the record of a 2-ton Armleder in the employ of the city of Franklin, Pa.

This truck went into service July 3, 1916, and worked steadily every day after its initial installation. Aside from the time for inspection and the time consumed in making minor adjustments, it has been shown conclusively that loss of time with this truck is a negligible quantity, especially when compared to the inability to use their horses at all times and under identical conditions.

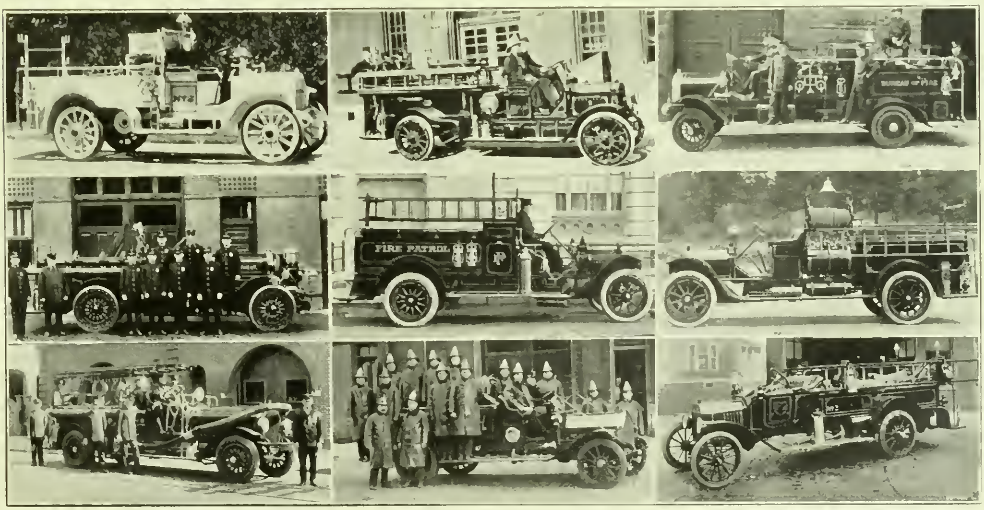
The truck worked at hauling a street sweeper and at gathering up sweepings. It also hauled a scraper in grading dirt streets. The work required much running in low gear and a great many stops with the engine running.

But in spite of these conditions, tending to increase the consumption of gasoline, the cost of operation for 3,296 miles figured out at 9 cents a mile. Truck costs amounted to $265, and depreciation and interest of $200 were added, making total truck expense $465. With this expenditure the truck did a great deal more work than had been accomplished by two teams the previous year at an expense of $614.92.

St. Louis Oils at Less than Sprinkling Cost.

The economy effected by a motor truck equipped with a road-oiling apparatus in the service of the city of St. Louis, Mo., during the year of 1915, resulted in the purchase of a second similar truck by that municipality. J. L. Laxton, engineer in charge of bituminous roads and streets in the department of streets and sewers, reports that the first White combination truck applied 130,000 gallons of oil at one-seventh of the cost of using horses and wagons, without considering the limitations and inferior work of the latter equipment.

The amount regularly paid for team hire was $4.40 per



FEDERAL COMBINATION HOSE, CHEMICAL AND SQUAD WAGON, CITY OF LITTLETON, COL.

AHRENS-FOX PUMPER, MILWAUKEE, WIS., EQUIPPED WITH SEWELL CUSHION WHEELS.

SEAGRAVE TRIPLE-COMBINATION CENTRIFUGAL PUMPER, CITY OF CHARLESTON, S. C., EQUIPPED WITH SEWELL CUSHION WHEELS.

G. M. C. COMBINATION HOSE, CHEMICAL AND LADDER TRUCK, CITY OF ALMEDA, CAL.

WHITE FIRE PATROL, CITY OF NEW YORK, N. Y.

STEGEMAN COMBINATION HOSE, CHEMICAL AND LADDER TRUCK, CITY OF MILWAUKEE, WIS.

MACK COMBINATION HOSE AND CHEMICAL, CITY OF PHILADELPHIA, PA., EQUIPPED WITH SEWELL CUSHION WHEELS.

WHITE COMBINATION CHEMICAL AND HOSE TRUCK, CITY OF CHICO, CAL.

SMITH FORM-A-TRUK COMBINATION CHEMICAL AND HOSE TRUCK, FORD CHASSIS, CITY OF ELKHART, IND.

day of 8 hours. Eighty-seven miles of soft-paved streets were oiled, using ¼ gallon of oil to the square yard. This was put down at a cost of ½ cent a yard. St. Louis has 540 miles of soft-paved streets, and the city plans eventually to oil all of these thorofares.

By applying the oil as early in the season as weather conditions will permit, repeating the operation a week or ten days later, and then making a third application about two weeks after the second, the surface becomes dustless and almost water-proof. The truck and two men are able to distribute from 3 to 6 tank loads in 8 hours, depending on the length of the haul from the loading station. With oil at 2½ cents per gallon, the cost of oiling soft-paved streets from curb to curb, 36 feet wide, amounted to $313 a mile.

SAVED $72 PER MILE.

Previous to the installation of the motor distributer the average cost of sprinkling streets was $385 per season-mile. Sprinkling was unsatisfactory because the streets soon became dusty and the water left no permanent result, whereas the distributer rendered the streets permanently dustless and tended largely to prevent the surface from wearing out under constant traffic. The truck therefore showed a saving of $72 per mile and gave a treatment that was immeasurably better.

Fayette County Spreads 80,000 Gallons of Liquid Asphalt.

Motor truck facilities and equipment developed especially for this work enabled Fayette county, Kentucky, to distribute 80,000 gallons of liquid asphalt in treating 25 miles of macadam road during the 1915 season.

The county's new highway supply station is designed with two 12,000-gallon storage tanks resting on concrete cradles, with a railroad siding above the tanks and a driveway for the distributer below them. When a carload of asphalt arrives it is spotted above the storage tanks and connected to a steam heating system. As soon as the asphalt is heated to a state of fluidity it is discharged by gravity into the storage tanks. These tanks have interior steam coils to maintain the asphalt in liquid form and facilitate its transfer to the combination truck.

Exploding the Short-Haul Fallacy.

In the early days of the motor truck the term "short-haul" was a bugbear to the business man who had not thoroly investigated the possibilities of the motor-driven commercial vehicle. Some one had told him the truck was all right for long-distance work, but that it was a liability where the distance the goods were to be transported was short. Now he is facing instances every day in which the short-haul fallacy is being exploded. He is learning that, given proper loading and unloading facilities in connection with volume of business, the truck is as profitable on ¼-mile as on 4 or 5-mile hauls.

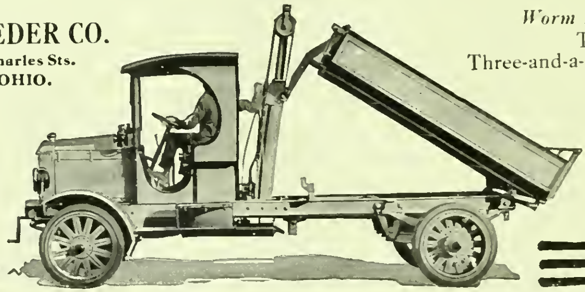
C. R. Norton, truck sales manager of the Packard Motor Car Company, cites an instance of this in the record made by a 6-ton Packard coal truck in the service of the Jurgen-Rathjen Company, Long Island City. In one day recently, this truck, working from 8:30 a. m. till 4:30 p. m., and with an hour off at noon, hauled 180 tons of coal over a delivery route of ⅜ mile, the round trip being only ¾ mile. The total truck cost of this typical day's work, including interest on the investment, depreciation, insurance, fuel, lubricant, wages of driver and helpers and all other items, was only $15.35.

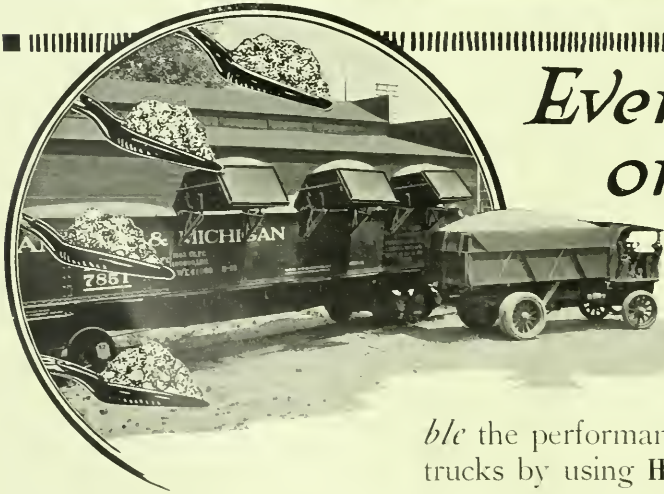
"The performance of the Rathjen truck was not extraordinary," Mr. Norton says. "Every day we hear of like records being made by Packard owners in a wide variety of lines. The short-haul scare of the timid business man who hesitates over the introduction of modern delivery equipment is a thing of the past."

TEN PACKARDS AT PLATTSBURG.

Ten Packard chainless motor trucks have been assisting Uncle Sam in the development of his citizen soldiery at the Plattsburg, N. Y., training camp. The trucks are of 1½ tons capacity, and are painted a neutral adobe-tan color. They have tarpaulin-covered army transport bodies and are exactly like the 122 Packards which are carrying supplies to General Pershing's army in Mexico. Eleven employes of the Packard Motor Car Company accompanied the trucks, having enlisted for service during the several months' duration of the Plattsburg camp. The men are all expert mechanics of long experience in the Packard shops and will act as instructors to those volunteers who desire to take special training in motor transport work.

The complete machine weighs 9,052 pounds.

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Vol. LII. — No. 6. Municipal Engineering June, 1917.

The World's Leading Municipal Publication

MONEY FOR MUNICIPAL CONSTRUCTION

States and cities which have much work to do have been having some difficulty in letting contracts this spring because, first, they are not willing to pay the increased interest on money needed to pay for the work, and second, because they are not willing to pay the increased cost of the work. These conditions are both of them temporary and will shortly be overcome, mainly, it must be confessed, by overcoming the inertia of the governing bodies who will soon fall into line and pay the increased prices, but also in part because the present unsettled conditions will improve and prices will find their proper levels in part in obedience to the law of supply and demand, in part because illegitimate control of prices forcing them to abnormal heights will be prevented, and in part because the unsettled feeling of the moment will be changed as the new conditions are recognized and allowed for in our daily life.

State and municipal bonds are not subject to income tax, and this fact in itself will make them popular to investors beyond most other bonds except the national loans. Just now the Liberty loan must first be taken up and we are all patriotic enough to put our money there first. But for many months almost every cent of money raised by this loan will be expended in this country and it will be back immediately into the channels of trade, ready for new investment. And "municipals" will keep their advance position as the favorites for safe investment, good for long time or readily salable on the market when the need comes. Notwithstanding the plentiful supply of money, the influence of the interest rates on government loans and the chances for making (or losing) large sums on projects made necessary or fostered by the war will keep the rates of interest on municipal bonds at a somewhat higher level than in the past, and we must accept this along with all the other increases in price which are due primarily to the greater abundance of money in all its forms and its consequent shrinkage in value as compared with the really stable general average of values of the staple commodities.

Contractors have had to raise their prices to meet increased cost of materials and labor, but there is no prospect of any material reduction in the general run of uncontrolled prices, and the work must be done, so that the governing bodies will find it necessary, as stated above, to make up their minds to pay the increased cost. Nor can they be accused of improvidence in doing this, because they can see no reasonable prospect of a reduction in cost of work until long after the structures have been put into use and possibly until they have been worn out.

To be sure there are some abnormal conditions which make certain materials and apparatus too high in price in some localities, and it may be necessary in such cases to control the situation by refusing to invest until either lack of business or official control of such illegitimate ways of making profits brings the prices down to the proper level. But this will be done and the work will go on.

Notwithstanding the great expansion in many lines of manufacturing, due to the war and to the trade arising from the present conditions, it is therefore certain that the municipal field, including state, county, city and town improvement, is a most promising field for investment and for work, and it will be but a few months until the tide of municipal improvement will reach a height heretofore undreamt of. Now is the time to take advantage of this certain prospect and make ready to take care of the great business which will soon be overtaxing all the facilities for it now in existence.

POSTAL ZONES FOR PUBLICATIONS

The zone system for paying postage should make Indianapolis, the railroad center nearest the center of population in the United States, the greatest publishing center in the world for magazines and papers of national circulation, for it will be able to mail its publications at a much lower cost than any other city under the plan which, at the time this is written, has passed one House of Congress. But Indianapolis is not selfish and is joining in the protest against this discrimination in favor of local publications, this penalizing of subscribers at a distance from the point of publication. For the increases in rates for long distances are so great that the magazines must in self-defense pass on the increase to the subscribers. Otherwise, with the increases in mail rates added to the enormous increases in cost of paper and of labor, many of them must go out of business.

There is less reason (except as to volume of business) for applying the zone system to second class mail matter than to first class matter.

Protest may still be effective in stopping the passage of this feature thru the other House. If not, the full rates do not go into effect for a year, and there is another chance with the next session of Congress. The friends of the free and equal dissemination of knowledge, all of whom are directly interested, must get busy or this injustice will be perpetrated. It certainly cannot be perpetuated. The evil results will show too plainly. Meanwhile many of the best mediums, and therefore not the most popular, will be forced out of existence.

STREET AND ROAD PAVEMENTS

THEIR DESIGN, CONSTRUCTION AND MAINTENANCE

EDITED BY CHARLES CARROLL BROWN, M. AM. SOC. C. E.

The Maintenance of Bituminous Pavements

By the Editor.

This article opens with some descriptions of special forms of bituminous road construction crowded out of last month's article, which is followed by a brief discussion of the subject of oiling roads.

The principles of ideal asphalt pavement repair work are developed and some practical hints are given regarding the nearest possible approach to these ideals in the work on the street.

Little attention has been given as yet to the technical specifications for repair work of any kind, and a few brief suggestions are made concerning the repair of bituminous pavements other than asphalt.

THE following descriptions of two special forms of bituminous surfaces used to some extent in Massachusetts are from a paper by Wm. D. Sohier, chairman of the Massachusetts State Highway Commission. The first is a mixture of sand and tar for a wearing surface, adapted from the practice of City Engineer Brodie, of Liverpool, England.

Sand and Tar Surface.

We have heated our sand and tar on the roadside, using tar kettles and a sand heater to heat the sand. We built a box on wheels, sloping to the end, and had a flexible pipe with a flat nozzle from which the tar and sand mixture was poured into the road.

In Natick, where some work of this character was done in 1914, the old macadam road was scarified, about 2 inches of 2½-in. stone was spread and rolled; this was grouted with the tar and sand mixture, finer stone rolled in, etc., and the cost was about 75 cents a sq. yd.

The road has been most satisfactory, and it certainly looks now as if it would last for ten years at least, on a road with about 50 trucks a day and over 700 motor vehicles.

We have used this method of construction on quite a number of stretches of road, especially on grades, as it seems to be less slippery for horses than any other type of bituminous surface, especially if the surface coat is left off and the stones are allowed to project a little.

The tar and sand seems to stiffen and strengthen the whole road, and we believe the use of the sand prevents the tar from oxidizing for many years, and thereby adds to the life of the road.

We developed this year a very good contrivance for securing an even distribution of the mixture. Two plank bridges were made that bridged the road. They were 2-in. plank supported in the middle on a 2-in. plank on the crown of the road and built up on the sides. Another 2-in. plank running lengthwise of the road was supported on these, and the man pouring the mixture walked along this plank, held his bucket right against the plank and walked at a rate of speed that just emptied the bucket in the length of the plank. A flat-nosed bucket was used, with a nozzle about 8 inches in width.

By placing the bridges the right distance apart, one bucket covered just the proper area, and we poured about 2 gallons to each sq. yd. of surface.

Keeping the bucket against the edge of the plank secured a straight edge on the road. The plank was then moved along on the bridges across the road, and the process repeated until the whole width was done. There were practically no spaces left where the voids were not filled, and the bitumen did not lap.

By keeping the same men on the pouring and having the hot mixture brought to them, uniform results were insured and the work progressed rapidly.

In England, in several instances, I think in all where they were rolling either a sand-pitch grouted road, or grouting with tar a stone road, they were wetting the wheels of their roller. In one or two cases they had a man on each side constantly pouring water on the roller wheels. This was to prevent the tar from picking up on the wheels of the roller.

In Liverpool, they make a little ordinary water box and place it over the wheel of each roller. In the bottom of the box they leave a little opening on one side, and put in a piece of crash or linen toweling, which hangs down over the roller wheel and keeps it just moist, the roller man filling the box from time to time with water. They say it does not need much water but merely enough to keep the wheels of the roller damp, and when they tried other methods they got too much water and it interfered with the hot tar surface, pitting it. The box is just the width of the roller wheel, about a foot to 14 inches square. When they used too much water, they got blowholes in the tar.

Gravel and Asphalt Surface.

The second special form of construction used in Massachusetts is a mixture of gravel and asphalt for wearing surface which Mr. Sohier describes as follows:

In Shirley, Mass., a road, 18 feet in width with 3-ft. shoulders, was built, the curves being banked and widened to 21 ft. A gravel foundation was put in wherever the bottom was bad, and about 4 inches of local crushed stone was spread and well rolled.

On this was spread, as evenly as possible, about 3 inches of a bituminous mixture, made of gravel that had been run thru the crusher, and sand or stone dust, mixed with a heavy asphaltic product.

The gravel and sand and the asphalt were thoroly heated and were mixed in a hot mixer, and then carted onto the road and spread. The surface was rolled down to about 2 inches in thickness, when the mixture was sufficiently cool not to crawl under the roller.

Great care is necessary to insure a uniform product, uniformly heated, mixed and spread, and that sufficient asphalt is used and no more than sufficient to bind the mixture properly.

The quantity of asphalt has to vary somewhat, according to the amount of voids in the mineral aggregate. The varia-

DISTRIBUTING TARVIA ON WEARING SURFACE.

DELIVERING TARVIA X HOT FROM CENTRAL PLANT BY MOTOR TRUCK.

SPRAYING TARVIA B ON ROAD SURFACE.

tion is usually from 18 to 22 gallons of the cold asphalt to the cubic yard of gravel. When the mixture is right it has about the consistency of brown sugar, and compacts under the roller, tho when it is first spread and rolled it sometimes has a few hair cracks which the traffic soon rolls out. The asphaltic product used in this work has a penetration of from 80 to 120 with a Dow penetrometer.

Roads constructed of sand and asphaltic oil were first tried by my Commission in 1905, and that road is still in existence, tho it has required a considerable expenditure each year, to keep it up, renew and widen it.

The gravel and asphalt mixture was first tried by me in 1907, and that piece of road is still in reasonably good condition.

Such mixed asphalt gravel roads certainly look as if they would last for a considerable period of time. Several quite long stretches have had already five years' wear. A few, but not many, weak places occur, and these have to be patched, but the expense is very slight.

With the higher wages, the higher cost of all materials, etc., the cost of all road construction has increased.

I am giving below a few of the costs of roads of this character. These costs are all for the 4-in. broken stone base, rolled, with a 3-in. mixture spread on top and rolled to 2 inches. The grading, foundation, if any, drainage, etc., were all additional.

Cost—Gravel-Asphalt Mixture.

Shirley	(1914)	$0.81 a sq. yd.
(Residuum asphalt, 8 cents a gallon.)		
Sterling	(1914)	$1.01 a sq. yd.
Gloucester	(1916)	$1.29 a sq. yd.
Andover	(1916)	$1.20 a sq. yd.
Reading	(1916)	$1.08 a sq. yd.

The asphalt used was a residuum asphalt, usually one with some lake asphalt in it. It cost 9½ cents a gallon to 12½ cents a gallon, depending on the quality.

We used a penetration of about 85 for this character of road.

Bitustone.

Bitustone double bond pavement is a Warren Brothers Company product which is different from asphaltic concrete on cement concrete base or the thin bituminous layer on cement concrete base in that the cement concrete base is left somewhat open in texture, particularly in its upper portion, so that the double bond cement, a mixture of hot bituminous cement and fine sand, fills the voids in the cement concrete and flushes to the surface to receive a thin layer of fine stone chips to form a slight mat wearing surface.

Experimental Bituminous Pavements.

A road which is neither a concrete road nor a bituminous concrete road is the so-called concrete road with bituminous wearing surface, the first development of which was the dolarway pavement, patent on which was not obtainable. It is a concrete pavement with a very thin bituminous top and has appeared in various parts of the country, the most successful development being that on state highways in California. But even there, where conditions are most favorable, the thin bituminous coat, not over ¾-in. thick, wears off or breaks off in large areas and the concrete on some roads is soon bare. A thickness of bituminous top of about 1½ inches seems to be necessary to reasonable permanence of the bituminous top.

The National pavement is a mixture of asphalt with clay for a wearing surface which has been under trial for two or three years. Reports of its success are not yet definite enough to warrant full description of the methods of construction at this time.

One patent on an asphalt pavement mixture starts with crusher run stone with 1½ inches maximum size, to which is added enough fine sand, if any is necessary, to bring the proportion of fine material up to 6 to 10 per cent. To this mineral aggregate is added from 25 to 40 per cent. in volume of sawdust, which is intended to reduce the voids still further by means of a fine material which is compressible. Ten per cent. of hot asphalt cement completes the mixture. This is the product of a practical asphalt contractor of long experience, but as the pavement is scarcely two years old its value is not yet demonstrated.

Fibered asphalt pavement is made by mixing a treated wood fiber with asphalt and some stone dust to produce a wearing surface which has some good points. No cushion coat is necessary, as the fiber in the mixture prevents creeping or rolling. Cracks are not frequent for the same reason. This pavement is now three or more years old and while the pavements laid have not all of them been successful on account of the lack of careful study of the methods and materials for mixing and laying, and the possible absorption of moisture if chips are used instead of fine fiber, the pavement gives promise of success if it can be properly developed under scientific study and experiment.

Oiling Roads.

The oiling of roads is not for the purpose of making a pavement, but simply to suppress dust and make the surface of the road waterproof. There is much difference in the detail of operation with difference in the material and some materials, such as sand, require the mixture of clay or loam to give the road material more stability before the oil can be used successfully.

A mixture of water and oil makes a mush which is very objectionable and it is necessary, therefore, to drain and grade the road so that water can not get in to mix with the oil or with the oiled road material. This means a thoro grading and shaping of the road surface so that water falling on it will run off readily, and adequate ditching so that water will not stand in the sub-grade. Also any ruts or holes formed by traffic in the surface must be filled and oiled so that rain water will not be worked by traffic into the oiled mixture.

While the oil is used mainly as a prevention of dust, it should not be applied on a dusty road. After the surface has been made smooth and uniform, it should be compacted by rolling and the oil then applied. If the surface is uniform enough and will shed water easily and promptly, any slight depressions should be filled, and then the loose dust should be well swept off, leaving a clean earth surface on which to apply the oil. The mending of the road should be carefully done, scarifying the spot where new material is to be added if necessary to bind the new with the old, and then tamping or rolling the soft spot down until it is as hard as the rest and makes a smooth uniform surface. The Illinois state highway engineers prefer a sprinkling of sand over the surface of the freshly oiled road to take up any surplus oil and prevent sticking to wheels or hoofs, believing that the extra cost is well repaid. Many engineers, however, use the sweepings from the road for a top dressing. About 1 cu. yd. of sand for 100 to 150 sq. yd. of surface will be required.

Application of the heavier oils on a dusty road is likely to form a mat which does not adhere to the road surface beneath and rolls up on wheels or creeps or breaks up, destroying the value of the treatment. Putting the road dust back as a top dressing may have the same effect to a less extent. These effects are not so pronounced with the lighter oils, until their lighter ingredients have evaporated.

The oil should be applied for a first treatment at the rate of about ½ gallon per sq. yd., and it is much better to put on this amount in two applications with a few hours between them that the oil may have an opportunity to soak in and therefore less tendency to gather in pools, making the oiling irregular and softening the road so that holes will form in the soft spots under traffic.

The oil can be applied by an ordinary sprinkling cart, but much better results as to penetration and uniformity can be obtained by the use of a pressure distributer which drives the oil straight down against and into the surface with a pressure of 15 lbs. in the tank. The distributer is supplied with a pump to give the required pressure, either an oil pump to give the pressure direct or an air pump to keep the oil in the tank under constant pressure. It should also be provided with a heater so that it can be used in cold weather or with heavy oils when they are required. If an automobile truck is used the power for pumping is at hand.

In applying the oil it is specified that great care must be taken not to overlap the strips on which the oil must be applied in order to cover the whole width of the road, and extreme care in getting the oil uniformly distributed. Any spots not covered by the first application must be covered by hand-pouring cans following immediately behind the distributer.

After the first treatment, double as described, later treatments may be with ¼ to 1/3 gallon per sq. yd. if they are not too many months apart. Treatments with ¼ gallon twice a year are much more satisfactory than one with ½ gallon once a year. Indeed, the one treatment very often does not last over the year. If a road has been properly oiled and with sufficient frequency for several years, a single small application per year may be sufficient.

The time for applying the oil varies according to the character of the season. The road should be dry when the oil is applied. April and September are the months preferred if the

OILING A MACADAM ROAD IN PHILADELPHIA.

FIRST: SPRINKLING AND SWEEPING WITH HORSE-DRAWN SWEEPER.

SECOND: HORSE-DRAWN SPRINKLER AND SWEEPER FOLLOWED BY HAND BROOMS.

THIRD: PRESSURE DISTRIBUTER APPLYING OIL.

FOURTH: SPREADING STONE SCREENINGS OVER THE FRESH OIL.

weather permits, northern climates making some difference in the date on account of late springs.

For oiling roads paraffine base oils have been largely used. When the oil is reduced by weathering no adhesive material is left and there is no permanent effect produced on the road. Oils with asphaltic base are better because the residuum after weathering still has some beneficial effect upon the road.

There is no very definite line between road oiling and road treatment by the penetration method, one shading off into the other. However, the asphaltic oils and tar are used almost wholly for the bituminous macadam pavements, penetration method, while paraffine base oils and light asphaltic oils are used for oiling roads. The bituminous macadam treatment is applied to gravel or broken stone roads only, whereas, road oiling may be applied to any road surface from the highest class of old macadam road to the earth road which has merely been graded and drained. Even a sand road can be oiled if a heavy asphaltic oil is used first and mixed with the upper 4 or 5 inches of the road under some such program as the following used in Illinois: Apply ¾ gallon per sq. yd. of the heavy oil, cover this with 1 inch of the sandy soil, apply ½ gallon of oil, add another layer of sand, and continue until a sufficient thickness of solid oil and sand crust is formed to carry light traffic.

It must be definitely understood that no oiled road will carry any heavier traffic than the original material of which it is composed.

Hard tire traffic with heavy loads will rut the road if of earth or poor gravel the same as tho the road had not received the oil treatment. The only function of the oil is to prevent dust and to keep the water out of the road so that it will not be softened by the rains as much as the untreated road would be. The first purpose is attained by oilings as frequently as the formation of dust requires; the second by keeping the surface of the road always smooth and solid by careful and prompt repair of ruts and holes and application of oil to small areas in which the oil disappears more rapidly than in the road generally.

The following quotations from W. Huber, Assistant Engineer in the Ontario Department of Public Highways, sum up the principles of road oiling a very clearly and concisely.

The different materials used for the prevention of dust and for the preservation of the road surface have been classified as non-asphaltic oils, asphaltic oils and refined tars. If the material to be selected is expected to contribute in any degree to the binding of the road surface the choice will lie between asphaltic oils and the refined tars. The non-asphaltic oils may serve the purpose of dust layers, and, if applied with sufficient frequency, may do much to protect the surface, but their effects are at best only temporary and except for the protection which the road has received in the meantime, it is no better at the end of a period of treatment than at the beginning. Therefore the non-asphaltic oils must be considered only as dust preventives.

On the other hand, the asphaltic oils, i. e., those oils having as a base a certain amount of pure asphalt, are more than dust layers, and each application leaves, on the evaporation of its volatile constituents, a certain amount of asphalt in the road surface to act as an aid to the binder. The greater the asphalt content in the original oil, provided it has been properly applied, the greater will be the permanent benefit derived from its application.

As between the true asphaltic oils and the refined tars of corresponding grades there appears to be little choice, excellent results having been observed from the careful application of either material. Satisfactory results would, therefore, appear to be due not so much to the choice between oil or tar as to the selection of the most suitable grade and to the methods of application.

Summing up, success in oiling and tarring roads will depend on many factors, principal of which are the original condition of the road, the care with which it is cleaned prior to treatment, the selection of the most suitable grade of material, the weather in which the work is done, the temperature to which the oil or tar is heated, the quantity in which it is applied, the protection from traffic of the freshly treated surface, the proper covering with suitable material to take the wear, and finally on the careful maintenance of the treated road. The fulfillment of these requirements demands no special technical knowledge, but it does demand extreme care in the preparation of the road surface, the selection and handling of the materials, and the maintenance of the road after treatment.

When a city or county has much road oiling it is worth while to put up a 10,000 or 12,000 gallon oil tank with heating coils and manholes. If it can be located near a city power plant or a factory from which steam can be obtained when needed, this will be most convenient and economical. But if such a location is not available, a boiler, stationary or portable, can be purchased also, or a tractor or roller can be run up to the tank to furnish the required steam heat to make the oil light enough to pump readily. A rotary pump will give good service. An ordinary pump for a water tank can be used, and if power is not available an ordinary hand lift pump can be used for oils light enough to be pumped cold or at low temperatures.

Steam heat will raise the temperature of the oil up to 150 or 175 deg., sufficient to make any road oil easy to pump.

Repairs of Bituminous Pavements.

The subject of repair of bituminous pavements has never been treated fully in publications or specifications. When repairs are made by contract the result is specified and occasionally the kinds of apparatus permissible and not permissible are defined. When made with a municipal plant the methods of doing the work are prescribed by the superintendent of the asphalt repair plant or the foreman of asphalt street repairs, who may or may not be an experienced and competent man. The consequence is that asphalt repairs are too often failures and the lives of good pavements are shortened by ignorant efforts to replace breaks and cuts, which produce elevations or hollows, soft spots or hard spots, doing little toward stopping the disintegrating action of traffic upon the good asphalt surrounding the original break and holding their own surfaces for but a brief time.

The original system of guaranteeing asphalt pavements for a series of years is still continued in most cities and where the amount of work is sufficient to warrant close attention results in reasonably good repairs made by the contractor during the period of the guaranty.

High cost and frequent poor quality of repairs made by contract after guaranties had expired led to the establishment of municipal asphalt plants for repair purposes in cities having yardage of asphalt pavements sufficient to warrant them. The number of such plants is increasing each year, and some of them have developed into construction plants also. The first of such plants were standard stationary plants, such plants being considered necessary for good work.

The demands of the smaller cities for asphalt pavements, and the impossibility of establishing stationary plants in such cities, led to the design and construction by manufacturers of portable plants which began with a plant constructed on two railroad cars with some additional construction alongside for use with the plant when in operation. The sizes of plants have been gradually reduced, sometimes without reduction in capacity, thru two-car plants, practically self contained, and one-car plants of like nature, to the modern road asphalt plant, which, while of less capacity, can turn out one kind of mixture at a time at a very satisfactory rate.

These improvements in the adaptability of asphalt plants to small amounts of work have materially extended the use of asphalt and related bituminous pavements in the smaller cities and have made possible the establishment of small private and municipal repair plants to take care of repairs promptly and efficiently, provided they are in charge of competent men.

Besides these regular plants there are several outfits for preparing asphalt pavements for the new material required for repair which, when supplemented by some apparatus for supplying the new mixture required, are doing quite satisfactory work. Some of these also supply the mixture. Some of these will be mentioned more in detail later.

The repairs necessary on asphalt pavements may be placed in a general way in two classes. One class includes surfaces

RESURFACING OLD BRICK PAVEMENT WITH ASPHALT. AUSTIN MOTOR ROLLER IN BACKGROUND.

which have become irregular by wear or minor movements of the material in the wearing surface. The other class includes breaks, cracks, areas in which rolls or shoves have taken place affecting the whole asphalt surface, and depressions caused by settlement of the foundation.

If irregularities of the first class can be corrected without taking up the whole pavement, material is saved and probably, also, labor and time. The obvious way of doing this is to heat up the asphalt surface until it is soft and fluid enough to be raked up, supplied with the necessary amount of new material to fill any depressions, smoothed off and rolled down into place. The Perkins heater was invented early in the history of asphalt pavements to perform this service. It consists of a series of gasoline burners under a hood which directs the hot flame and gases of combustion against the asphalt surface. When carefully operated this machine does very good work. The flame sets the surface asphalt on fire and burns it, and if the flame is made hot very quickly the asphalt below does not absorb the necessary heat before the surface is burned off. Experience with the operation of the machine and expertness in determining from observation when the asphalt is properly heated and how much of it must be raked off to be sure to get down to the uninjured mixture below are essential to good work with the machine. Many more yards of pavement than are actually repaired may be injured or put in the way of rapid injury by traffic by putting the operation of the machine under a foreman with poor judgment and little or no experience. This accounts for the prejudice against the direct heat process which exists in some places.

Several attempts have been made to devise a machine which would discharge hot air and combustion gases against the surface of the asphalt, thus simply heating the asphalt without danger of burning it. This requires a larger machine because large quantities of air must be heated very hot and discharged under some pressure against the asphalt surface. The Lutz asphalt repair plant is the ultimate development along this line, and is doing very satisfactory work at costs reported as quite low, not only for this class of repairs but for those of the second class described farther on. A portable plant for supplying the mixtures, called the Equitable, having one drum, or having two drums so that both binder and surface mixtures can be turned out at the same time, is supplied to accompany the surface-heater, or to operate alone. The Hooke asphalt repair plant is a small asphalt kettle plant of special design used in a number of cites. The manufacturers of asphalt paving machinery also supply such small plants for small asphalt repairs.

In repairing defects of the second class it is economy to go as far as may be necessary to reach the seat of the trouble. If it was due to settlement of the foundation, cut entirely thru the concrete and remove enough material to determine whether any additional settlement is possible. Compact the sub-grade thoroly by flushing or tamping, and put in new material which will compact well to take the place of any unsatisfactory material removed. Use concrete for the filling if the cavity is not too large. If the settlement is in an old trench or excavation, carry the cut along its length far enough to reach well solidified material, then widen the cut in the concrete so that the new concrete, when placed, will bridge the trench and form a sort of arch over it, being supported by and against the solid ground on each side of the trench. Place the new concrete and tamp it well into place, leaving the top surface even with the surface of the old concrete around the edges of the excavation and uniform so that the asphalt top will be of uniform thickness.

After the concrete has set and is ready to receive the wearing surface, or if it has not been necessary to cut into the concrete, sweep out the opening thoroly and clean up the edges of the asphalt, cutting them so that the sides of the opening will be vertical. Cut back until the edge shows good material and the top shows that there is plenty of good material behind it. The cuts should be rectangular, not rounded, and the sides fairly straight. A sharp cutting instrument which will not shatter the adjoining surface is necessary. It is quite common to cut the edges sloping, but this leaves a feather edge of the new material which may make an outline of the patch, whereas if the edges are cut vertical and the patching is well done the patch can hardly be distinguished from the original surface after a few days under traffic. Carefully paint the edges of the cut with asphalt cement so that the old surface is all covered with a thin coat, thick enough to cement the old and new together but not thick enough to make an appreciable joint between the two.

The opening should then be filled, first with the cushion coat, well tamped into place, and then covered with enough surface mixture so that when thoroly rolled the patch will have a surface uniform with the old surface surrounding it; neither depressed so as to be pounded by heavy traffic nor elevated so that the traffic will pound the old pavement on the sides of the patch and thus form new holes.

To produce the best results the mixture used in the old pavement should be known and the new mixture should be

STREET REPAIR GANG OF GARY, INDIANA, REPAIRING CONCRETE STREET BY FILLING CRACKS WITH ASPHALT. ASPHALT IN BARRELS ON WAGON AT LEFT. AUSTIN MOTOR ROLLER. ASPHALT HEATING TANK AT RIGHT. HOT WAGON FOR TOOLS IN REAR.

PROPER METHOD OF PREPARING ASPHALT STREET FOR PATCHING. PAINTING EDGES WITH ASPHALT CEMENT IN MIDDLE GROUND. AUSTIN MOTOR ROLLER IN REAR.

the same, except that the old pavement is probably harder than when laid and so somewhat stiffer asphalt cement should be used so as to make the new mixture when compressed conform with the hardness of the old pavement.

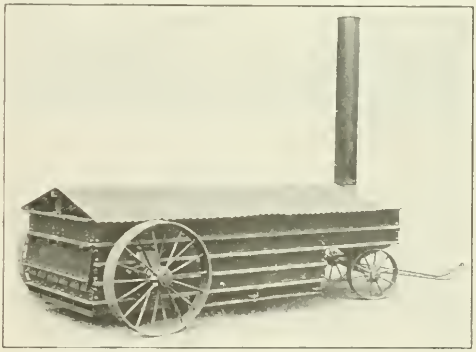
No repair work should be done in wet weather or in weather so cold that the old surfaces of heater patches will get cold before the new material is applied or the new material will get cold before it can be thoroly rolled.

The above gives the ideal conditions under which good patching can be insured. When a city has laid pavements for many years under the variations which have been made in specifications and with the variations in materials used by different contractors and at different times, it will not be possible to vary the mixtures sent out from a central plant to suit exactly the variations in conditions met in a single day's work, or even in the work covered by a single load. For this reason a good portable plant can sometimes do better work on account of the possibility of varying the mixture in each batch, to suit the conditions immediately before the gang.

Again, old pavements may be so worn down that it will be impossible to use the two layers and a single layer may be better to use. Too frequently surface mixture only is used in patching and this is almost as frequently the reason why the next patching of the street is largely the replacing of the previous patches with enlargements due to the deterioration of the old pavement next adjoining them.

Cracks are sometimes patched by filling with a fine soft mixture instead of by cutting out and replacing completely. This practice is liable to result in a larger and wider patch the next time instead of a patch which will last for a reasonable length of time. Nothing is more exasperating to traffic than a series of transverse cracks imperfectly repaired so as to give a series of thin ridges to pound over.

While the ideal conditions of repair work are seldom attainable, an expert foreman can and will approximate them closely by varying his treatment and thus make patches of fairly long life, if they are not equal to the original pavement. Sometimes foremen pride themselves on making patches which are better than the original pavement. While this is better than patches much poorer than the original, they are liable to increase the rate deterioration in the old pavement and thus shorten the period until the next patching. When a pavement is very old and patches are large, an entirely new surface is thus obtained in the course of two or three years at the expense of the repair fund and to the relief of the construction fund or of the property owners who would pay for a new pavement. The result is a pavement more irregular and less durable than a new pavement and more or less economical according to the relative costs of patching and of new surfacing.



IROQUOIS ASPHALT REPAIR WAGON.

Saving Expense in Garbage Collection

A STUDY OF ACTUAL CONDITIONS IN BILLINGS, MONTANA

By John N. Edy, County Surveyor, Billings, Montana

Billings, Mont., is apparently an average city as regards its methods of garbage and refuse collection. The author of this paper reports the results of an investigation which showed that the cost could be cut in two by the adoption of proper methods and apparatus. Nearly every one of the smaller cities in this country can do almost or quite as well. This article is therefore of great interest to them all, and it goes into the practical details so that they can learn just how to go about it. Billings collects by means of city teams. Where collections are made by contract the saving would probably be still greater.

THE city of Billings, Mont., has provided five garbage collectors who use two-horse, tight-bottom, box-like wagons, having capacities of about three cubic yards. Some of these wagons have low, and others high, wheels. The five drivers cover different routes, collecting from the residential districts once each week, from the rooming-house districts twice each week, and from the business district daily. Manure is collected with the garbage. The accumulations are hauled to the city dump, which is located inside the city limits and within a half mile of the business district. This dump is less than 200 feet from the main line of the Southern Pacific Ry. and is in plain view of passing trains. A dump man is provided to assist in unloading the wagons, burn all combustible materials, guard against danger from fire, etc.

Sometimes the drivers are assisted by prisoners from the city jail. At times it is necessary to use extra garbage teams, the regular collectors not being able to keep up with the work. The drivers collect everything, accepting all kinds of refuse, no matter where or how stored.

The entire cost of this garbage handling is paid out of the general fund. In one year this cost, including extra teams, was approximately $12,000.00. Of this amount regular teams cost $9,400.00, dump man $1,000.00 and extra teams $1,600.00. The city has very little co-operation on the part of the taxpayers.

The Local Study.

By the definition set out in the ordinance, "garbage" includes all forms of waste matter, such as kitchen refuse, ashes, cans, crockery, paper, boxes, grass, weeds, manure, etc. Small dead animals are also included. Any article or substance (except night-soil), that the householder or business man wants to be rid of is placed in, or more often near, the garbage receptacle and removed by the city. Our investigation was therefore directed against the methods and cost of present methods of handling these many individual accumulations.

The conditions are such that only by the hardest work are the drivers able to keep their routes in good condition; and every man in the department is plainly anxious to assist in placing it on a basis of economy as well as efficiency.

There are three subdivisions of this general subject; viz., collection, hauling, or removal, and final disposal. We undertook to ascertain,

1. The weight of garbage handled, by collection districts.
2. The methods of storing individual accumulations.
3. The cost of collection, removal and disposal.

From the information thus obtained we expected to determine whether or not the present method is satisfactory and economical. Also, as particularly regards the removal of manure, we wished to know how many head of stock contribute to the general bulk of refuse enjoying the free haul provided by the city.

Weight of Garbage.

As collections in residential districts are completed in six days and in other districts in a shorter time, we had but to weigh each load for a period of six days to ascertain the total weight handled in one week. The first weighing began on Sept. 30, with results shown in accompanying table:

WEIGHT OF GARBAGE HANDLED SEPT. 30-OCT. 6.

	Driver No. 1.		No. 2		No. 3		No. 4		No. 5	
Date	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.
9-30	3	10930	3	10135	4	6120	4	9976	4	7705
10-1	3	8715	3	10035	4	7715	3	7655	4	8190
10-2	3	8810	3	10645	4	7100	4	7180	4	5955
10-3	2	8135	3	8880	4	5965	4	9770	4	7470
10-5	3	9445	3	10450	4	8420	4	12010	4	9530
10-6	2	8845	3	8860	4	8125	3	7555	4	10645
Totals	16	54880	18	59005	24	43445	22	54145	24	49495
Average Wgt. per load....		3430		3275		1810		2460		2050

Total loads, 104; grand total weight, 260,970 lbs. (130.5 tons).

Average weight per load, all loads considered, 2,510 lbs.

Weather good; condition of streets good. All weights net, in pounds.

It must be remembered that garbage accumulations of early fall are not likely to represent a fair average for the entire year. The weights above noted are somewhat below the actual of summer, the vegetable season, and of winter, the season of ashes. Perhaps this applies more to the residential districts. Although we may expect the business districts to show some difference, that difference may not be so marked.

It happened that on October 10th Billings celebrated its annual "clean-up" day, when the community made an extra effort to clean yards and adjacent public property. While but one day was officially designated for this clean-up, the process covered a period of several days. In fact, the Street Commissioner had extra teams engaged for the whole week ending October 17th: and by that time we thought the city was pretty clean. It is therefore interesting to compare the results of the first weighing with those given in the second table showing the weights hauled in the week following the clean-up week.

WEIGHT OF GARBAGE HANDLED, OCTOBER 19-24.

	Driver No. 1		No. 2		No. 3		No 4		No. 5	
Date	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.	Lds.	Wgt.
10-19	2	6230	3	8880	4	8230	4	9040	4	7645
10-20	2	8515	3	10075	4	6945	3	7495	4	8965
10-21	3	10545	4	9765	4	7465	4	9520	4	9065
10-22	2	6825	3	8375	4	7000	3	7615	4	7435
10-23	2	8125	3	9090	4	7315	3	8000	4	7810
10-24	3	8000	3	9590	4	8280	4	8625	4	8560
Totals	14	48240	19	55775	24	45235	21	50295	24	49480
Average Wgt. per load....		3445		2935		1880		2395		2060

Total loads, 102; grand total weight, 249.025 lbs. (124.5 tons).

Average weight per load, 2,440 lbs.

Weather good; condition of streets good. All weights net, in pounds.

It seems quite reasonable to assume that this table represents the weight of garbage under the most favorable conditions. And yet there is so little difference in the totals for the two weighings that we may conclude that the clean-up days did not affect the weight of garbage handled.

The figures given are the net total of all waste matter hauled to the dump.

One must wonder at the the great variation indicated in the average load weights. For instance, the second table shows that driver No. 1 average 3,445 lb. per load, while driver No. 3 averaged but 1,880 lbs.; the average of all loads being 2,440 lbs. No. 1 hauls from a residential district and collects ordinary garbage, refuse and manure. No. 3 serves a portion of the business district only, and his collections include a large proportion of light stuff such as boxes, waste paper, packing, etc. This seems to indicate a greater relative cost of collection and removal in the business district than in the residential districts, and so it does. But the fact that driver No. 3 collects light stuff is not a legitimate excuse for this excessive cost. It is largely a matter of storing and preparation by the storekeeper.

The average load-weight of garbage (2,440 lbs.) is less than one-half the average load-weight of coal hauled over Billings streets under unfavorable conditions, as indicated by reports from six local coal dealers. This condition is chargeable partly to the nature of the material handled and partly to the methods of storing by the householder, but the efficiency of our garbage hauling is at best but 50 per cent., and in one district is as low as 40 per cent.

The minimum weight of all forms of refuse is approximately 18 tons per day.

If manure is not handled with the garbage it is probable that the average weight will not exceed 20 tons per day.

Methods of Storing Garbage by the Householder.

An inspection trip disclosed the fact that, contrary to the provisions of the ordinance, garbage is being kept in the following receptacles: lard cans, water buckets, coal buckets, wash tubs, wooden boxes (varying in size from 1 to 80 cu. ft.), paper boxes, baskets, sacks; and in many instances no receptacle whatever is provided, the refuse being deposited on the ground or thrown broadcast into the alley. No effort is made to separate the several kinds of refuse except that manure is usually kept apart from other materials. We found concrete garbage retainers so built that it is almost impossible to clean them thoroly. Manure boxes are of all kinds and sizes, most of them having no provision for emptying except from the top with a fork. Usually such boxes have no lids. We found that there are but 430 satisfactory garbage cans in use, although the population of Billings must be near 14,500. We found 135 head of stock, privately owned, and about 100 manure boxes contributing to the bulk of handled material. We may say:

1. Only about 20 per cent. of the householders provide satisfactory garbage cans.

2. Of the other types of receptacles provided none is satisfactory and practically all are in violation of the existing ordinance; and it may safely be said that all are more expensive to maintain.

3. Manure is stored in open boxes that are hard to clean; and according to the provisions of the ordinance, manure is being removed by the city at general expense.

Cost of Collecting, Hauling and Dumping.

We come now to the question of actual costs.

First, as to collection: The total loads and weight of garbage vary but little from week to week at one time of year; and as the teams all work eight hours per day, we may assume that a record of one day's performance is a fair average of the time spent in doing the different parts of the

ABOVE: A BILLINGS GARBAGE COLLECTION WAGON ON LOW WHEELS, WITH A LOAD OF LIGHT RUBBISH.

BELOW: THE GARBAGE AND REFUSE DUMP. RAILROAD IN MIDDLE GROUND.

work. The following form of report was furnished the drivers and kept by them for one day:

Driver........................... Date.....................

		—Loads—			
		1.	2.	3.	4.
Began Collection:	Time.				
	St. Number.				
Finished Collection:	Time.				
	St. Number.				
Arrived at Dump:	Time.				
Left Dump:	Time.				

The reports were tabulated in the third of the accompanying tables:

REPORTS OF GARBAGE COLLECTORS, OCT. 8.

Time in Hours and Minutes

Driver No.	Load	Collecting	Hauling	Returning	Dumping
1	1	1:10	0:35	0:25	0:45
	2	0:55	(est.) 0:30		0:45
	3	1:20	0:30	0:30	0:35
2	1	1:30	0:30	0:30	0:45
	2	1:00	(est.) 0:30		0:40
	3	1:05	0:30	0:35	0:35
3	1	1:30	0:20	0:15	0:20
	2	1:05	0:20		0:20
	3	1:25	0:20	0:25	0:30
	4	0:45	0:10		0:40
4	1	1:00	0:20	0:10	0:30
	2	1:05	0:20		0:25
	3	1:20	0:30	0:10	0:25
	4	0:40	0:10		0:40
5	1	1:00	0:40	0:20	0:25
	2	0:50	0:20		0:35
	3	1:00	0:30	0:15	0:40
	4	0:45	0:15		0:30
Totals		19:25	7:20	3:35	10:05

5 teams, at 8 hours..............................		40:00
Collection	19:25	
Dumping	10:05	
	29:30	29:30
To be paid for as hauling..............................		10:30

Note that the table shows: Hauling plus Returning equals.....10:55

All the above is regular garbage; no clean-up.

PERMITTED VIOLATIONS OF GARBAGE ORDINANCE. UPPER REASONABLY CLEAN. OTHERS BOTH UNSANITARY AND CAUSING UNNECESSARY EXPENSE IN REMOVAL. TYPICAL OF CONDITIONS IN MOST SMALL CITIES. THEY CAN CLEAN UP AND SAVE MONEY AT THE SAME TIME.

In this table one is quite likely to note two important and unexpected conditions:

1. The time of collection is nearly 50 per cent. of the total time.

2. The time spent at the dump approximately equals the entire time spent in hauling.

These findings were so startling that we undertook to obtain a few short time records of the time spent in collection, so that we might locate the cause of this apparent excessive cost or prove the figures in error. A competent observer was sent out with two different garbage wagons, with instructions to time the drivers in all their operations. Twenty-one blocks were covered in different parts of the city, the reports reading as follows:

SHORT TIME RECORD OF GARBAGE COLLECTION.

I.	Time required to clean block	14 min.
	No. of cans emptied	4
	No. of piles refuse picked up	2
	Total time to empty and clean 4 cans	2 min. 10 sec.
	Total time to clean up 1 pile rubbish	8 min. 30 sec.
	Total time to clean up 1 pile ashes	1 min. 10 sec.
		11 min. 50 sec.
II.	Time required to cover block	7 min. 00 sec.
	No. of cans, 1; time required	0 min. 05 sec.
	No. of boxes, 1; time required	0 min. 20 sec.
	No. of piles, 1; time required	1 min. 00 sec.
	Manure boxes, 1; time required	2 min. 30 sec.
	Clean up around 1 can, time required	0 min. 50 sec.
III.	Time required to cover block	30 min. 30 sec.
	2 men clean one manure box	5 min. 30 sec.
	1 can required	0 min. 30 sec.
	1 can ashes required	0 min. 30 sec.
	1 can, 10 sec; clean up around can	0 min. 50 sec.
	1 pile rubbish picked up	1 min. 30 sec.
	2 men dump box of wet stuff	0 min. 40 sec.
	Pick up small limbs of trees	4 min. 00 sec.
	2 men clean out 4 wooden boxes too heavy to lift	14 min.
IV.	Time required to cover block	15 min. 00 sec.
	Empty 2 cans	0 min. 30 sec.
	Shovel wet stuff from old box	0 min. 40 sec.
	2 men load pile leaves	6 min. 00 sec.
	Empty 6 cans and 2 tubs	1 min. 45 sec.
	Clean up pile ashes (canful)	1 min. 30 sec.
	Clean up pile ashes (canful)	1 min. 40 sec.

Without quoting further from these records it is readily seen that the time occupied in cleaning up around overfull garbage cans, picking up loose piles of rubbish and emptying boxes that are too large to handle is several times as great as the time required to dump and clean the cans.

The total time required to cover 15 of the 21 individual blocks during the progress of the experiment was 203 minutes, or an average of about 13½ min. per block 300 ft. long. Eliminating the manure and allowing 2 cans per residence or 24 cans per block, and assuming that each can may be emptied in 15 seconds,—and this is believed to be a reasonable assumption,—we have 6 min. as the time actually required to empty the cans; and if we allow 2 minutes for the team to walk 300 ft. we have a total time per block of 8 min., as against the present apparent average of 13½ min.

In other words, if the existing ordinance were rigidly enforced as to cans, and manure excluded from free haul, the cost of collection should be about 40 per cent. less than it now is. And the 24 cans will provide for accumulations of ashes and vegetable refuse not being handled at this season of the year. As to the item of collection cost, then, we may conclude:

1. The number and type of garbage receptacles has a great bearing on the cost of collection.

2. It costs at least five times as much to shovel a can of refuse from the ground as it does to dump the contents from the can into the wagon.

3. If the can system for garbage is adopted and strictly enforced, manure and light refuse being collected separately and hauled in a proper wagon, the cost of collection should be decreased at least 40 per cent.

Hauling.

Very little will be said on the subject of hauling; certainly there can be no criticism offered as to the horses engaged in the work. The city teams are all fine specimens of horseflesh and they are admirably well trained. In fact, were it not for the fact that the teams are so well trained, the drivers would have difficulty in covering even less territory.

It has been pointed out, however, that our hauling is only about 50 per cent. efficient, due to the light loads hauled. This is simply another expensive result of collecting all forms of refuse in the same wagon, and, too, of improper preparation of the light stuff by the householder.

In this connection it has been suggested that motor trucks might haul the garbage more economically than teams. This might be true under certain conditions and for some communities: and this feature may be investigated in the future. But for the present I believe team hauling to be more satisfactory locally for the following reasons:

1. There appears to be no advantage, and considerable disadvantage, in using motor vehicles for collection.

2. It would be necessary to provide some central transfer station where the wagons could deliver garbage to the trucks for transporting to the point of final disposal.

3. Rather than provide such transfer station, a, garbage disposal plant seems to be more desirable, both as to economical operation and from the sanitary standpoint.

Dumping.

As to the final disposition of local garbage accumulations, it has previously been stated that all refuse is hauled to the city dump where it is burned. It had never occurred to me, however, that any great time was required to empty the wagons, some of which have been in use about four years. Quite naturally, therefore, we decided to check the results as to dumping time shown in the third table. This was done by providing the dump man with a note book ruled as follows:

Date ....

Name of Driver.	Arrived at Dump.	Left Dump.
	....Time....	...Time...

This record was kept for four days and covered a total of 70 regular garbage loads. All the drivers knew that the record was being kept, tho they did not know for what purpose. The tabulated results of this record are shown in the last of the tables.

DUMP MAN'S REPORT ON UNLOADING TIME. OCT. 12 TO 15.
Total Dumping Time in Minutes.

Date.	Driver 1.	No. 2.	No. 3.	No. 4.	No. 5
10-12	35	40	25	35	30
	15	35	20	35	22
	25	20	15	25	20
	..	..	25	20	20
10-13	50	50	25	25	20
	40	25	15	25	25
	..	35	26	20	25
	..	..	35	15	20
10-14	45	35	15	30	30
	35	25	25	25	30
	..	35	20	20	15
	..	..	25	20	25
10-15	20	45	35	25	30
	25	30	25	25	20
	25	40	20	20	25
	..	..	20	20	40
Totals.............	5hr.15m.	6hr.55m.	6hr.10m.	6hr.25m.	6hr.37m.

Total dumping time, 4 days, 70 loads....................31 hr. 22 m.
Average dumping time per day...........................7 hr. 50 m.

At the dump is offered the only opportunity for the drivers to loaf. There is no necessity for allowing the teams to rest, as they are never heavily loaded and always return light. The writer believes, however, that the time indicated as occupied in unloading the wagons was actually so spent. In order to appreciate this unusual condition one must watch the performance of this unpleasant and expensive task. The wagons arrive loaded to capacity. The driver first throws off such light material as may be on top of the load: he then uses his fork, his shovel and at times his hands to unload the mass of garbage, crockery, tin cans, ashes, clothing, waste paper and rubbish of all kinds. After observing the accomplishment of this duty one is inclined to the belief that the workmen do pretty well to get the wagon unloaded at all. So there is every reason to believe that the daily time required in dumping garbage is approximately as stated.

It will be noted that the total dumping time shown by the dump-man's report is considerably less than that shown in the table. This is explained by the Street Commissioner as being due to the fact that the drivers were picking up much light and easily unloaded stuff, resulting from the clean-up campaign then in progress, and which the extra teams did not get. The explanation seems entirely reasonable, altho the fact that the time was being recorded may have had something to do with it. At any rate, if we average the two total dumping times we should arrive at a result entirely fair to present methods. We find, therefore, that the average dumping time is 9 hours per day. The rate of pay for garbage teams being 75 cents per hour, this is equivalent to $6.75 per day, not including the time of the dump man. And it follows that for 313 days we have $2,112.75 as the *annual minimum cost of unloading regular garbage teams at the dump.* As no extra teams are here considered, the total actual cost must be greater.

To us this was the most startling discovery of the study; perhaps because it was most unexpected. It is quite evident that the cost of handling garbage does not stop with delivery at the dump. The cost of unloading must be considered.

As to the remedy for this costly and unnecessary condition, it is suggested that a satisfactory type of bottom-dump garbage wagon will solve the problem. These wagons will cost about $175 or $200, and but three or four will be required. In using dump wagons, however, it must be noted that provision should be made for the proper preparation of light, bulky material, such as boxes, waste paper, etc.

It is a simple matter to form conclusions as to the cost of handling garbage at the dump:

1. The present cost is unreasonably excessive.

2. This excessive cost is due partly to the nature of the material handled, partly to unsatisfactory means of storing and lack of preparation by the householder, and largely to the type of wagon used.

3. Under proper regulations as to the points just mentioned and by using suitable wagons, the city can effect a net saving of not less than $2,000 a year on this item alone.

Conclusions and Recommendations.

In viewing as a whole this brief study of conditions affecting the collection and disposal of garbage in Billings, we must conclude that our present system is not only unsatisfactory from the health standpoint, but unnecessarily costly as well. We have seen that:

1. Our collection cost is excessive because proper receptacles are not provided by the householder and because we are handling free of charge a great deal of material that should be cared for at individual expense.

2. Our hauling cost is excessive due to the light loads hauled, which in turn is due to the conditions listed above.

3. Our dumping cost is excessive, due largely to the type of wagon used, and also to the condition listed in (1).

It is entirely proper to ask, What are we going to do about it? I have therefore taken the liberty of offering the following recommendations:

First, Billings needs a new garbage ordinance, one that will be more in accord with progressive methods; and needs to enforce that ordinance without any compunction whatever. I am quite ready to admit my unpreparedness to offer a model. However, the following features should be included:

The can system should be enforced, every householder being required to provide *as many cans as necessary* for the proper storing of all garbage and house refuse. Paper should be baled or tied in bundles so as to be handled quickly and easily. All boxes to be removed, whether wood or paper, should be broken and tied flat. Loose paper had better be tied in paper bundles than placed in sacks, unless the sacks are not to be returned. Manure should be kept in boxes of *approved* design, and removed by the city at the expense of the owner.

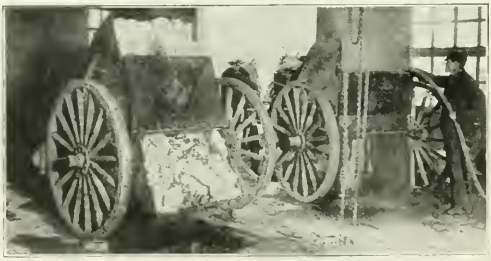
There is certainly nothing very harsh about these provisions. The principal objection will attend their enforcement rather than their adoption, as is to be expected. But the cans will cost little; and if purchased by the city and distributed to the householder at cost, such expense will be very slight indeed. The idea of baling or bundling paper and boxes is not new: such a plan will work no hardship on the householder, while it will aid materially in reducing collection and hauling costs. As to the handling of manure, there can be no legitimate objection to charging the individual for special service rendered. Certainly there is a valid objection to paying for such special service out of the general fund. It naturally follows that if the stock-owner pays cash for the removal of manure he will willingly provide such a box as will be most readily emptied and consequently less expensive to maintain.

What has been said of the can system applies primarily to residential districts. There should be some provision that, where the garbage or refuse from any one building exceeds a certain stated quantity, a receptacle or receptacles of special, approved design shall be provided by the householder or proprietor. In some cases the city might be justified in making a special charge for removing this excess refuse: as, for instance, from large hotels operating heating plants, from printing and publishing establishments, manufacturing concerns, etc. In fact, these large establishments receive special service just as the stock-owner does at present.

Kitchen garbage should be reasonably free from water before being placed in the can.

I believe that except for a few weeks each year, weeds, grass, tree cuttings, etc., can be economically handled with the manure, using a special wagon, one very much like a hayrack but with more nearly tight sides and ends. It might be possible to arrange flaring sideboards for a dump wagon; altho I am not sure that a dump wagon would prove economical for such hauling.

As to the enforcement of a garbage ordinance. Certainly there should be some severe penalty for non-compliance, because the offense is indeed a grave one. A sanitary inspector reporting to the Health Officer all persons guilty of neglect in this respect, would have the most authority and this garbage question deserves the entire time of one man.



A SANITARY GARBAGE CART SUCH AS SHOULD BE USED, WHETHER TWO OR FOUR-WHEELED. GARBAGE WRAPPED IN PAPER, AS SHOWN HERE, IMPROVES SANITARY CONDITION IN GARBAGE CAN AND IN COLLECTION. AT THE RIGHT A CART IS BEING WASHED BY STEAM BEFORE STARTING FOR ANOTHER LOAD.

If efforts along this line are to meet with success, we must secure the co-operation of the individual. A campaign of publicity thru kodak pictures of decidedly unsanitary garbage collections, similar views shown on the movie screen, should tend to waken the public conscience.

Finally, I want to suggest that the garbage be weighed at regular intervals and that some system of reports be exacted from the drivers. It must be remembered that if this policy had been followed in the past this study would have been uncalled for; neither would we be forced to acknowledge the gross waste herein shown.

Final Disposal.

I want to say further that this investigation has been carried on with the assurance that the existing city dump must go. I feel sure that in a short time Billings must and will adopt a more satisfactory and sanitary method of final disposal. The conclusions and recommendations offered in this report apply with equal force to the handling of garbage and refuse in connection with any modern disposal plant. And, the desirability of and real necessity for such a final disposal plant having appeared, the local study has indicated such opportunities for reducing costs that the suggested plant can be installed and paid for in a few years from the savings effected.

In conclusion let me sum up the apparent cash value of the garbage study herein outlined. We know that the annual cost of handling all forms of garbage and refuse, including the hire of extra teams, was $12,000, and exclusive of the dumpman's time was $11,000. Of this amount the regular teams cost $9,400 and extra teams $1,600. Based on the second table we may assume that this regular cost is divided approximately as follows:

Collection	$4,700
Hauling	2,600
Dumping	2,100
	$9,400

If then, as has been outlined, we adopt improved methods, we may reasonably expect the following net saving:

Collection, 40 per cent. of $4,700	$1,880
Hauling, 50 per cent. of $2,600	1,300
Dumping, 90 per cent. of $2,100	1,890
Extra teams, 50 per cent of $1,600	800
Total annual net saving estimated	$5,870

In other words, I believe it is possible for Billings to cut in half its cost of collecting and disposing of accumulations of garbage and refuse.

ORNAMENTAL GAS STREET LIGHTING.

System in a City Engineer's Office

By Manley Osgood, City Engineer, Ann Arbor, Mich.

The office record system and the field system described in this paper before the Michigan Engineers' Society are not as elaborate as some which have been established, but are quite full enough for the purposes of the city engineer's office in the ordinary small city, and are therefore of practical value to many of the engineers among our readers.

THE routine work of our office consists of the engineering for and inspection of sewer and pavement construction, the setting of stakes for contractors building sidewalks on street curbing under either municipal or private contract, the locating of street lines and setting of stakes for grading streets which in years past have been accepted by the city without meeting the present requirements of grading improvement, the cleaning and maintenance of sanitary and storm sewers, the inspecting of plumbing, the numbering of houses, and other miscellaneous work.

Due to the location of the University at Ann Arbor, our organization for this routine work can, during all that part of the year when elasticity is needed, be made quite elastic. One full time man is given charge of all of this routine work, except the sewer cleaning and maintenance and the inspection of construction work, and during the University session as many senior and junior engineering students are employed part time for rodmen and chainmen as are necessary to handle the current volume of work. It is perhaps needless to say that no such part-time help is used in less than half-day units. During the summer months the volume of this routine work is sufficient to keep very busy a full time party of four men. Effort is made to complete all plans for contemplated sewer and pavement construction during the winter months in such shape that only the setting of stakes for this construction work will be required of the routine work organization during the busier session.

An inspector, full time only, is placed upon each contract construction job, whose duty it is to see that the contract is faithfully carried out and to make a record of such happenings or details of construction as may be of later interest.

Cleaning, flushing and repairing of sewers is assigned to one full-time experienced and somewhat skilled laborer who has one helper most of the time and as many more laborers as are necessary for any particular task that may arise.

One Ford machine is provided for all the conveyance needs of the Department.

No work of any kind is undertaken without the issuing of a regular departmental work-order covering same. These work-orders, in all but minor cases of the most routine work, come to the desk of the engineer and are signed by him. On the form is provided space for a report upon the work at its completion, and this report is returned to the engineer's desk for his inspection before filing. In the interim between the issuing of the order and the completion of and report on the work, these orders are kept, by the employee to whom they are issued in a place provided, where they are readily accessible to the engineer or his clerk in case it is desired to check up the condition of the work or to obtain information from one of them. In issuing these work-orders an attempt is made to designate a definite date by which the work should be completed and to give as fully as possible all general or special information relating thereto.

Forms are provided for ordering any extra work in connection with contract construction or for authorizing any change whatever in the plans or specifications for such work, even tho they involve no extra cost. Inspectors have the most rigid instructions to insist upon the contractor obtaining these respective orders for each individual case which may arise. Such orders must be signed by the city engineer or, in case of his absence, by his principal assistant.

Much work of a special nature has arisen in Ann Arbor within the past few years. Each task has been separately considered and provided for altho much of it has been handled by the routine work organization without interfering with regular duties. Special organizations have, in some cases, lapped over from one special task to another. In work of this nature Ann Arbor is again particularly fortunate, for much of the detail work of such a special job can be assigned to the more advanced engineering students and advice is often gratuitously given by the experts in the various departments of the Engineering College thru their interest in Ann Arbor and their good citizenship.

The filing of the mass of accumulated data in convenient and easily accessible form has received considerable attention. Field note books, permanently bound, are indexed under subject divisions according to street or other location. Thus notes relating to the sanitary sewer in a certain street are indexed in the sanitary sewer division on a card reserved for that certain street. The notes are described by limiting streets, and key information, date of taking, book number and page are given in the description. Notes pertaining to more than one general division are indexed under all the divisions to which they pertain.

A standard size for drawings has been adopted which produces a trimmed blue-print twenty-two inches by thirty-four inches so that it may be neatly folded to an 8½x11 size, that of an ordinary letter sheet. If occasion demands a smaller size, these sheets are halved or quartered or further divided, always maintaining a sheet which will be or fold to the 8½-inch by 11-inch size.

At the time of starting our present filing system, drawings on hand to be filed were of all shapes and sizes. They were accommodated by dividing into eight sizes designated by letters from "A" to "H" inclusive. On account of the equipment in our filing vault, envelopes to accommodate each of these eight sizes were prepared from a heavy Manila paper, each envelope holding not to exceed ten drawings. The subject matter in the files was divided for purpose of indexing and convenience in filing into seven divisions as follows:

I. Sanitary sewer and storm sewer maps and details of sewer standards.
II. Pavement maps and details of pavement standards.
III. Maps of city and large city divisions, such as sections and wards, parks, boulevards, cemeteries, etc.; county, state, and national maps.
V. Plats of small city divisions, additions and subdivisions, and standards.
IV. Railroad, railway and public service corporation maps and maps showing streets, lot divisions, etc.
VI. Public buildings, bridges, and culverts.
VII. Water works and water supply.

Each division was assigned a shelf in the vault and a separate section in the Reference Index. The drawings under any one division and of any one size are given continuous sub-numbers and the envelopes containing these drawings show on the outside the sub-numbers therein contained. Furthermore all drawings are given a designating number. Upon completion of any drawing this designating number is assigned and a card, bearing this number and a complete description of the drawing, is made. These cards are filed numerically and known as the Numerical Index. A second index known as the "Reference Index" has been prepared and divided into sections according to subject matter as heretofore related.

If now, it is desired to find a drawing of a certain section of storm sewer, Section 1 of the Reference Index is referred to, where on a card reserved for the particular street in question the maps pertaining thereto are described by limiting streets. This Reference Index refers to the index numbers in the Numerical Index and, by turning in the Numerical Index to the numerical numbers referred to, full description of each of the drawings may be had and the one desired selected without extracting more than this one from the envelopes. The cards in the Numerical Index bear the filing data by which each drawing is found. If a drawing has information belonging in more than one of the above divisions it is filed under the major one and indexed under all to which it pertains.

Profiles are on muslin-backed profile paper with a scale of 40 feet to the inch horizontal and 4 feet to the inch vertical. They are made on sheets about five feet long and rolled with about four or five sheets in each roll, arranged, of course, alphabetically. A title in the corner of each sheet indicates clearly what is to be found on such sheet and, due to the shortness of and the uniform size of the sheets, the profile desired can be very quickly and easily separated from the other profiles in the roll. If the profile to be plotted is longer than the standard sheet, the profile is broken and plotted with one section above the other on the same sheet or on as many sheets as necessary. In some cases the profiles of two or three different streets are shown on one sheet, but in all such cases the first two letters in the street name are the same. The 40-foot horizontal scale of these profiles corresponds with the standard scale for plans and drawings of public improvements. This scale was chosen after considerable deliberation and altho it is larger than necessary for some purposes, it has proven a very effective scale for other purposes and quite convenient for general use. It is our rule and practice to have a continuous profile thruout the block and establish a grade thereon before setting stakes for even a short improvement in any block.

Two vertical files are maintained in the office, one the usual correspondence file and the other the so-called "job file." When any work is ordered or started, a folder in this job file is made for it and in this folder are placed all papers, computation sheets, inspectors' daily reports, orders for extra work, or changes in plans, together with the engineers' copy of the specifications and contract covering the work. There is also a cross-index card referring to any correspondence pertaining to this particular job which may be found in the correspondence file. The entire history and departmental record of any one job is thus readily accessible.

We have attempted to simplify our cost account system as much as possible because our help for work of this nature is not sufficient to allow anything elaborate. The time of each man in the department, including the engineer, is kept on time sheets, which allow proper distribution of such time, and the cost of same is posted from these time sheets to the proper account cards. All bills are received in duplicate and from the copy kept in this office the costs of material and supplies are also posted to this same cost-account system. Material and supplies taken from the city storage yards are charged and carried thru as bills for material. We have found that this system kept up to date gives us at all times an accurate record of the cost of any part of the work of any particular job.

Following are some of the forms used, giving the size of card or sheet and the wording, without reference to manner of spacing on card.

MONUMENT

Character ....
Depth .... Condition ....
Witnesses: ....
Remarks: .... Signed ....
Date ....
....
....
Card 3 by 5 in.

BENCH MARK

Location: ....
....
Description: ....
....
Elevation: .... U. S. G. S. datum ....
.... Signed ....
Date
Card 3 by 5 in.

HOUSE NUMBER

.... Block ....
(Between) ....
Name of Owner ....
Addition or Subdivision ....
Lot No. ....
to house from .... line of ....
House No. given ....
Remarks ....
.... Signed ....
Date ....
Card 3 by 5 in.

COST ACCOUNT CARD

Headings of columns:
Date Bill.
Date of Council.
Name.
For.
Amount.
Card 5 by 8 in.

ORDER TO DO WORK

Job No. .... 191....
Ann Arbor, Mich. .... $..................
To ....

Dear Sir:
You will please do the following work and report in the space provided below when same is completed.

....
....
....
....
....
....
.... *City Engineer.*

Attached: ....
The above work was commenced on .... 191....
The above work was completed on .... 191....
Remarks: ....
....
....
....
....
(Under remarks give any special or unusual features of the work and any cause for delay)
Signed ....

Size of sheet about 11 by 8¼ in.

ORDER FOR EXTRA OR SPECIAL WORK

Ann Arbor, Mich., 191....
To ....
Sirs:
You will please perform the following extra or special work, for which no price has been set in the proposal, in connection with the building of ....
.... *work which you are performing in and for the City of Ann Arbor, Mich.* ....
....
....
....
....
For this extra or special work it is hereby agreed that you shall receive ....
....
Very truly,
.... *City Engineer.*
The above extra or special work and price for same is hereby accepted.
.... *Contractors.*
By ....

Original sheet on white paper to contractor; signed duplicate in pink to City Engineer; size about 8¼ by 11 in., left half occupied by above order and right half ruled in ⅛-in. faint blue squares.

CHANGE OF PLANS OR SPECIFICATIONS

Job No. ....
Ann Arbor, Mich., ...191....
To ....
Sirs:
You will please conform to the following changes in the plan profile specifications for the building of ....
........*work which you are doing for the City of Ann Arbor, Mich.*
....
....
....
....
....

For this work you will receive no extra or special compensation, same being fully covered in the specifications and proposal.
Very truly,
....
City Engineer.

Received and accepted:
....
Contractors
By.....................

Original sheet on white paper to contractor, signed duplicate in blue to City Engineer, size about 11 by $8\frac{1}{2}$ in. Bottom 3 inches of sheet ruled in faint blue $\frac{1}{8}$-in. squares for making sketches or profiles.

INSTRUCTIONS FOR SEWER EXCAVATION

Job No..........
Depth Sheet for.... ....Sewer
Date...................
Note Book......Page....

Headings of columns:
Station.
Depth in Feet and Hundredths.
Height of Bar Above Pin.
Remarks.
Size of sheet about 11 by 8½ in.

DAILY REPORT OF GENERAL OR SPECIAL WORK

Job No. ....
Date ....191....
Description of work.....................................
....
Location of work..
....
Progress of work..
....
....
....
....
Contractor ....
Labor... *man days at*........ ....*man hours at*......
...... " " "........ ...... " " "......
...... " " "........ ...... " " "......
...... " " "........ ...... " " "......
Material ....
....
....
Streets opened or closed.................................
....
Remarks ....
....
....

Under remarks give time and causes for all delays and of extra or unnecessary work.
(Signed) ....
Title....................

Size of sheet about 11 by 8½ in.

LOS ANGELES POWER DEVELOPMENT

UTILIZATION OF SURPLUS POWER FROM THE LOS ANGELES AQUEDUCT

California is prompt in adopting new methods and apparatus which are of value and has taken up the motor truck in particular. Some idea of the various ways in which automobiles are used and of the provisions made for taking care of them will be gained from this article.

ALL obstacles have been removed from the path of municipal ownership by bringing to a final conclusion the long-drawn out negotiations between the city of Los Angeles and the Southern California Edison Company, which now includes the Pacific Light and Power Corporation, by a contract for the purchase by the city of the private distributing system which has finally rounded into shape.

This agreement was finally conceded by the power corporations, who have been holding out against distributing the city's power, or paying the city for any power distributed, until the purchase price, $8,270,000, had been paid for the plants by the city.

The companies now agree to distribute the city's power from the San Francisco power house No. 1, and will surrender full title to the distributing systems upon the payment of the purchase price by the city. This power house is capable of developing 37,000 horsepower at Los Angeles. Part of this power is now being distributed by the city in some of the outlying districts thru the distributing system built by the city. It is estimated that the city will have about 25,000 horsepower to dispose of, and the distributing of this by the two companies will bring an income of $100,000 a month to the city.

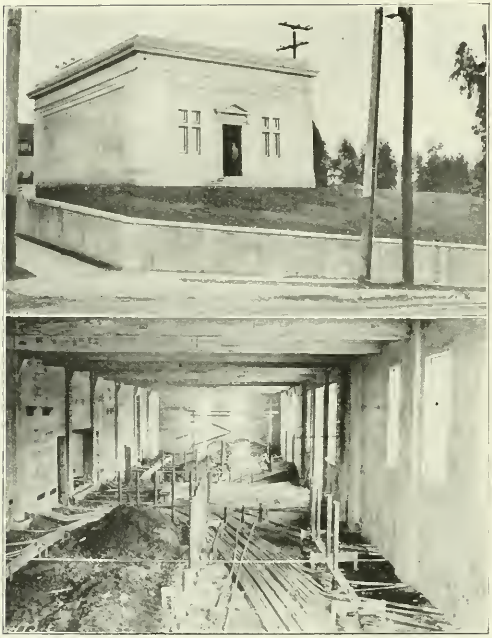
It will take some time undoubtedly to get the bonds voted and the money therefrom ready in hand to pay for the systems, but during this time the companies will be distributing the electrical energy generated at the municipal plant and not distributed by the municipal system, paying as previously stated $100,000 a month for the city's power. They are also to provide any extra electrical energy that the city may need or that may be needed to supply the demands of the city consumers.

This contract between the city and the two companies is for a period of three months, from May 1 to August 1 of this year. The city has the privilege of extending this contract until July 1, 1919, provided that at least ten days before the expiration of the three-month contract written notices of such desire from the public service commission, approved by the city council, shall be given to the companies.

The city is to pay the companies a rate of 8 per cent., per annum on the purchase valuation of the companies' distributing system, $8,270,000. The companies are to retain from their collections the cost of maintenance of the distributing systems, and the proper proportion of the 8 per cent. annual payment, and are to turn into the city treasury daily the balance on their collections from the sale of city power. Exact settlements are to be made with the city treasurer on the 10th day of each month.

There is to be no paralleling of any portion of the distributing systems of the two companies during the life of this contract.

A board of supervisors is appointed, composed of two members from the city and two from the companies, to supervise the maintenance, extension and conduct of the business per-



ABOVE: GARVANZA DISTRIBUTING STATION AT 61ST AND MONTE VISTA, THE FIRST ONE BUILT.
BELOW: CONDUIT INSTALLATION IN LOW-TENSION GALLERY OF CENTRAL RECEIVING SUB-STATION NO. 1.

formed under the contract. In case disagreement arises then a fifth member may be selected, or, if the matter is of sufficient importance, it may be placed directly before the State Railroad Commission.

In the event of extension of the contract the city may cancel the same at any time by giving three months' notice, under the same provisions as outlined above, or it may be cancelled by a majority vote of the people, or by the payment to the companies of the purchase price of their distributing plants, the city taking possession of the distributing systems.

The opportunity for the development of large quantities of hydro-electric power along the line of the Los Angeles aqueduct and on certain natural streams tributary to the aqueduct water supply has at all times been contemplated as a feature of the Los Angeles Aqueduct project which in addition to supplying the motive force for industry has a water capacity sufficient for the needs of 2,000,000 people. This is destined to be of immense value as a reliable source of hydro-electric power, which may be developed and supplied at very low cost, thus assuring low rates to electricity consumers and serving an important part in the encouragement of industry.

Opportunities for power development along the line of the aqueduct itself result from differences of elevation in excess of that which is required as a gradient for producing and sustaining a gravity flow of the water in the aqueduct. Such excess differences in elevation occur at four points along the duct; one just below the Haiwee reservoir, 162 miles from Los Angeles, where the difference of elevation equals approximately 190 feet; the second in the San Francisquito Canyon, 47 miles from the city, equaling approximately 940 feet. This is the plant that is now developing power for the city. The third point is in the San Francisquito Canyon, 40 miles from the city, equaling 530 feet, and the fourth between the end of the aqueduct and the lower San Fernando reservoir, 25 miles from Los Angeles, equaling 300 feet. This will give a total gross head of 1,960 feet available for power development with an assured constant flow of water of between 400 and 430 second-feet.

Altogether the power development thru these and other projects will be sufficient to deliver 200,000 h. p. to the city of Los Angeles.

The power is transmitted over two separate steel-tower transmission lines of an unusually reliable design and fitting, supporting two electric circuits each, thus providing such duplication as to make complete interruption practically impossible, and affording a degree of reliability far in excess of the reliability of the average power system of the present day.

One of the drawbacks of large hydro-electric power plants is that they are usually at such a great distance from the point of use. The loss of power in such a case of long distance transmission is very great, but this is eliminated in this plant because of the nearness of the point of use, the two largest plants being approximately 47 miles from the point of use.

The reliability of water for the power plants is assured thru the acquisition of the Fairmont storage and regulating reservoir and the Dry Canyon reservoir above and below the power plants. This will assure development of capacities sufficient to take care of peak demands approximately two and a quarter times greater than the average.

These storage and regulating reservoirs together with the Haiwee reservoir, the Long Valley reservoir and proposed reservoirs on the Cottonwood and other creeks above the power plants will thus not only provide assurance against any emergency along the line of the aqueduct affecting the power supply and against the shortage of water during dry periods, but also make possible variation in the flow of the water during the day so as to take care of peak loads without the necessity of providing for the great cost of installing and maintaining auxiliary steam plants either for emergency use or for carrying peak loads.

SAN FRANCISQUITO POWER HOUSE NO. 1, SHOWING ALSO THE PENSTOCK LINE AND THE SURGE TANK. THREE OF THE SIX UNITS HAVE BEEN INSTALLED AND FURNISH 37,500 HORSE POWER, PEAK LOAD.

LEGAL DECISIONS

Decisions of the Higher Courts of Interest to Municipalities

Sufficiency of Guaranty—Payment for Repairs on Guaranteed Pavement—In the case of Steele v. City of Duluth, Minn., (161 N. W., 593) the supreme court states that altho the pavement was a failure, there was sufficient evidence that the repairs ordered became necessary from causes not due to defective material or workmanship to warrant the decision that they should be paid for at the rate stated in the contract, $2.50 a sq. yd.

Arbitration Clause in Contract—In the case of the City of San Antonio, Tex., v. Reed, et al., (192 S. W. 549) the Court of Civil Appeals states that where the city empowered the mayor to enter into a contract for street paving, the work to be controlled by the city engineer, it was beyond the mayor's powers to include in the contract an arbitration agreement, and the city was not bound thereby; the principle that those dealing with an agent are bound to ascertain the nature of his authority being more strictly applied in regard to municipal corporations than private corporations.

Payment for Reconstructed Street—In the case of Louisville, Ky., v. Tyler, some years ago, it was decided by the Kentucky Court of Appeals that abutting property could not be assessed with the cost of reconstructing a street altho the original construction had not been made by ordinance or at the cost of the abutting property owners, thus putting much expense on cities for reconstructing streets which had originally been constructed as roads before they were included within the city limits. This decision was disapproved by the same court later in the case of Catlettsburg, Ky., v. Self, in which it was held that a street is not orignally constructed in the sense intended by the law until it has been constructed at the cost of the adjoining property owners; also it was overruled specifically in the case of Louisville, Ky., v. Stoll. This decision is again confirmed in the case of Curran v. City of Ludlow, Ky., (192 S. W., 526) covering a case where three adjoining towns had improved a road thru them at common expense, which was then turned over to the three towns to take care of their own sections respectively. A subsequent reconstruction of the section in Ludlow at the expense of the abutting property owners is held to be legal and valid.

Payment for Improvement of Street Intersections—The Court of Appeals of Kentucky in the case of Tapp v. Johnson, Mayor of Henderson (192 S. W., 504) decides that the law governing third-class cities providing that a city may pay for improvement of street intersections or assess the cost on the abutting property means that when a city has decided upon one of the two methods it must continue to follow it until a change is made by an act of the legislature.

Two Water Pipes in a Street—An ordinance requiring two water mains in a wide street cannot be said to be so unreasonable as to constitute an abuse of discretion by the council or an arbitrary imposition of an unjust burden upon the owners of property.

Responsibility for Damage Caused by Projecting Manhole Cover—A manhole at the intersection of two very lightly traveled streets in Grinnell, Ia., projected 17 inches above the roadway surface and it was concealed by weeds and grass, and there was no light at the corner. An automobile backed into the projection in attempting to turn round and its transmission and crank case were badly damaged. If there were no contributory negligence the city would be liable for the damage altho the automobilist had not obeyed the law regarding registration of his vehicle. Wolford v. City of Grinnell (Iowa) 161 N. W. 686.

Damages for Change of Grade of Sidewalk—City officers ordered a sidewalk constructed on a new grade higher than the old one and the property owner so constructed the walk. He could not collect damages for the consequent raising of his house, because the proceeding was not under authority of a city ordinance and a city is not liable for the unauthorized acts of its officials and still less for consequential damages because of obedience to unauthorized orders of such city officials. Johnson v. City of Granville, N. D., 161 N. W., 721.

Separate Water Meters for Building Tenants—A municipal regulation that there should be but one connection and one meter to supply a building with water from the city's plant is held to be unreasonable and void as it makes a discrimination between lessors and lessees as to water service and separate meters and connections should be furnished the several tenants. City of Galveston (Tex.) et al., v. Kenner, 193 S. W., 208.

Construction of Municipal Sewage Disposal Plant Enjoined—In the case of the City of Marlin (Tex.) et al. v. Holloway et al., 192 S. W., 623, the supreme court sustains the lower court, in granting an injunction preventing the city constructing a sewage disposal plant near a residence district and inside the city limits because, among other reasons, "the evidence (shows) that offensive odors emanate from all types or systems of sewage disposal plants except possibly that known as the activated sludge system, which is not the kind designed for the City of Marlin, and which the evidence indicates would not be practicable for a city the size of Marlin."

Fees for Structures Under Streets—A city, in the regulation and supervision of a street, may require an abutting owner, though the owner of the fee, to obtain a permit and pay a fee for the privilege of constructing vaults under its surface. Appleton et al. v. City of New York, 114 N. E., 73.

Protecting Fence at Bridge—The duty of a municipality to maintain a railing or barrier upon its streets is not absolute and is not required unless the dangers are unusual. The street was reasonably safe for ordinary uses if the city maintained a board fence at the side of a bridge, even if an automobile, on account of defective steering gear, went thru it and a person was injured. Swain et al. v. City of Spokane (Wash.), 162 Pac., 991.

ROADS AND PAVEMENTS

Hauling Gravel by Team and Tractor and Comparative Costs

By Orrin J. Kipp, before the Minnesota Surveyors' and Engineers' Society.

The data that I will present and the conclusions that I may suggest are derived from the gravel checkers' records on five team hauling jobs totaling 22 miles of road graveled and one tractor hauling job covering 3.6 miles of road graveled, the gravel being placed at the rate of 15 cu. yds. per 100-ft. station on each job.

Gravel hauling by team is familiar to all, and no description of outfit or method is necessary other than the statement that ordinary dump planks were used and 1½-cu. yds. per load were hauled uniformly. The team wagons were loaded by hand shoveling. The number of shovelers in addition to the teamsters shoveling varied from none for a portion of the time on job No. 1 to a maximum of two on all of the jobs.

The data obtained from the checkers, together with percentages and averages derived therefrom, I have compiled in the following table, in which are shown from each job and each haul length on each job, the following data:

GRAVEL HAULING COST DATA

Length of Haul	0-½ Mi			½-1 Mi			1-1½ Mi					1½-2 Mi				2.2 Mi	2.3 Mi	2.95 Mi
Job No.	1	2	5	1	2	5		2	3	4	5	1	3	4	5	3	3	1
Total No. loads hauled	407	575	452	[illegible]	[illegible]	[illegible]	506	525	598	[illegible]	[illegible]	312	573	434	98	337	[illegible]	[illegible]
Av. No. teams hauling	72	52	45	96	70	90	65	76	70	60	87	64	75	52	46	80	72	97
Av. No. loads per team per day	[illegible]	40	945	935	[illegible]	735	70	91	755	733	60	54	693	673	535	46	40	39
Load Miles per team day	422	462	283	731	875	551	875	138	944	916	750	945	[illegible]	1178	936	1035	[illegible]	151
% Time dumping 5 Min per load	00	109	78	8	97	6	58	76	63	61	50	45	58	56	44	38	33	32
Av. actual time in pit per load	306	250	460	266	65	467	307	110	[illegible]	225	250	360	15	42	372	340	35.	309
% actual time in pit per load	617	583	733	432	320	572	359	67	307	329	450	325	133	59	332	272	234	201
% of time required for loading—12 m per load	242	280	189	95	233	167	40	82	151	47	20	108	139	35	107	92	80	78
% of time actually lost in pit	375	303	544	237	87	425	219		56	62	330	217		74	225	40	54	23
Av. No. of teams at pit	45	30	33	41	22	51	23	13	22	20	39	20	10	08	15	22	7	38
Hauling cost per cu. yd. in cents	[illegible]	92	283	273	229	363	381	294	353	364	[illegible]	294	384	400	500	580	667	670
Total cost per cu. yd. in cts.—loading & hauling	299	280	363	323	309	453	[illegible]	385	573	[illegible]	563	[illegible]	[illegible]	600	750	750	897	760
Contract price per cu. yd. in cents	250	390	350	500	500	450	700	650	650	600	650	850	800	750	800	1075	775	[illegible]
Spreading cost per cu. yd. in cents	200	225	375	75	200	250	375	250	300	375	300	500	325	500	625	450	575	225
Hauling cost per cu. yd. mile in cts.—actual	730	576	963	364	305	484	305	235	283	[illegible]	355	292	220	228	285	255	263	[illegible]
with 12 min. for loading	430	430	430	278	278	278	238	235	238	238	238	220	220	220	220	212	206	212
with 6 min. for loading			34	245			217											
Hauling cost per cu. yd. in cts. 12 min. for loading		135			205		298						385					
with 6 min. for loading																		

The above figures based on 25¢ per hour for man alone and 40¢ for man & team

From the above table we find that providing the time of loading were reduced to 12 minutes per load the hauling cost per cu. yd. mile would be as follows: 0 to ½ mile haul, 43 cents; ½ to 1 mile haul, 27.8 cents; 1 to 1½ mile, 23.8 cents; 1½ to 2 mile haul, 22 cents; 2 mile haul and over, 21.5 cents. If the loading time could be reduced to 6 minutes per load the hauling cost per cu. yd. mile would be further reduced as follows: 0 to ½ mile haul, 34.1 cents; ½ to 1 mile, 24.5 cents; 1 to 1½ mile, 21.7 cents, and above 21.5 cents per cu. yd. mile. Also, on a 12-minute loading basis the cost per yard for the hauls would be as follows: 0 to ½ mile, 13.5 cents; ½ to 1 mile, 20.5 cents; 1 to 1½ miles, 29.8 cents; 1½ to 2 miles, 38.5 cents.

The data in the foregoing table warrant these conclusions, for we find in Job No. 2 on the ½ to 1 mile haul the cost was 22.9 cents with an 8.7 per cent. loss of time at the pit; on the 1 to 1½ mile haul the cost was 29.4 cents as compared with 29.8 cents as estimated, while on the 1½ to 2 mile haul of Job No. 3 the cost was 38.4 as compared with the estimated cost of 38.5 cents and on a 2.95 mile haul the cost was 67 cents with a 12.3 per cent. loss of time as compared with the estimated cost of 65 cents.

It would thus appear that efficiency in team hauling and consequent low cost is largely dependent upon efficiency in loading. The total loading and hauling cost on the various jobs provides for the shovelers actually employed and $5.00 per day additional for the general superintendence of a foreman or the contractor. The resulting loading costs varying from 7 cents to 25 cents per yard, the lower figures being too low on account of the teamsters acting as shovelers while waiting to get into the pit and the highest figures being boosted on account of an excessive amount of frost and firewater, and poor supervision. The lowest job average was secured on Job. No. 2, it being 9 cents per yard. Favorable conditions were a large factor in producing this low figure. It would appear that for average Redwood County pits 10 to 15 cents per cu. yd. should cover the item of loading by hand. Whether or not some mechanical loader would be able to reduce this item I am unable to state.

The tractor hauling outfit used in Redwood County consisted of a 30-60 Holt caterpillar gas tractor and a train of seven Troy 3½-yd. reversible spread wagons, a 50-yd. storage bin and a belt conveyor loader.

Difficulties were encountered from the very start. Considerable time was consumed in erecting the storage bin and loader. When the first train was finally loaded ready to start it was found that the tractor would not pull more than two cars over a short sharp pitch at the railway crossing on the most direct route. After some investigating and experimenting it was found that four cars could be hauled across private fields to the top of a short pitch about ¾ of a mile from the pit and that by doubling back for the remaining three cars a train of five cars could be made up and hauled the remaining distance of 2¼ miles. Thirteen hundred sixty-five cu. yds. were hauled in this way over an average haul of 3 miles or a total of 4,125 cu. yd. miles, at the average rate of 129 cu. yd. miles per day, which on a basis of $20.00 per day to cover the cost of operation, interest and depreciation was at the rate of 15.4 cents per cu. yd. mile for the hauling.

From the next pit they hauled a total of 1,584 cu. yds. onto a stretch from 1 to 3.6 miles distant, making a total of 3,422 cu. yd. miles. There were no grades greater than 2 per cent. on this stretch and they made an average of 142 cu. yd. miles per day on this work, the cost being 14.1 cents per cu. yd. mile. Several days they were able to make as high as 216 cu. yd. miles, which would be at the rate of 9.2 cents per cu. yd. mile.

From the foregoing it would appear that the cost of hauling by tractor was considerably less than by teams. The advantage in favor of the tractor would have been even greater, in my opinion, had there been more power available. A 40-80 tractor would have made a much better showing. Another factor cutting down the capacity of the train was the inability of the loading equipment to supply gravel fast enough. With ample power to pull six cars and a train load of gravel always ready when the train arrived at the pit there is no doubt that the record of 9.2 cents per cu. yd. mile made on a few days could have been maintained thruout the job. It is essential to have a bin full of gravel ready to dump into the cars quickly when the train arrives at the pit, for the outfit cannot make any money while waiting to be loaded. A bin of from 25 to 30 cu. yds. capacity must be provided. The bin must be easily transported from pit to pit, the loading apparatus also. A belt conveyor and a non-portable bin is not practical, for I've seen them tried and the cost of tearing down, moving and re-erecting the bin alone amounted to fully 10 cents per yard of gravel handled. The belt conveyor may be successful on a level grade or a very slight incline, but when it comes to raising the gravel about 30 feet vertically you have gone beyond the practical range of a belt conveyor. I have no definite data as to the cost of loading with this apparatus, but as nearly as I can estimate it was between 25 and 30 cents per yard, which, together with the cost of moving the bin, makes a total loading cost of 35 to 40 cents per yard.

It would seem that with the proper equipment the total loading cost should not exceed 10 cents per cubic yard. If this is possible the comparison between tractor and team hauling is very much in favor of the tractor.

Besides the cost there are other features in favor of tractor hauling which I wish to point out briefly. First: By applying the gravel in two courses with a tractor you get your gravel rolled without additional cost and the road is ready for travel as soon as the gravel is applied instead of a month or more later as with teams. Second: By loading into a bin, thence to the wagons and thence to the road you obtain an efficient mix of the materials so that instead of having one load with good gravel with a fair amount of binder followed by a load of sand with no binder and the resulting hard bump and chuck hole a few weeks later, you have a gravel of uniform consistency which does not tend to develop waves or chuck holes.

Proposed Wagon Road Tunnel Under Hudson River from Jersey City to New York

The Public Service Corporation of New Jersey, operating city and interurban electric railways in Jersey City, Newark and other places, has been considering plans for extending its interests across the Hudson river to New York city by means of a tunnel; and, according to Thomas N. McCarter, president of the corporation, in a statement made before the Newark Board of Trade, such a project has elements of reasonableness. The thing contemplated is a tunnel for motor trucks.

Mr. McCarter estimates that a tunnel, from near Twelfth street in Jersey City to Canal street, Manhattan, could be built for about $10,000,000. Such a tunnel would be about two miles long, and about one mile of it would be beneath the river. The ruling grades would be less than three per cent. The statement says that last year the ferries between Manhattan and New Jersey points carried 6,130,945 vehicles, of which about one-half were on the ferries of the Pennsylvania, the Erie and the Lackawanna railroads. The average fare paid by these vehicles on the boats was 27¾ cents each. It is estimated that by 1920 the railroad ferries referred to will be called upon to carry about 4,000,000 vehicles yearly; and as a tunnel would save for them considerable time, it is calculated that a charge of 35 cents a trip could be made. It is estimated that by 1920 not less than 60 per cent. of the freight wagons in use in this territory will be motor driven.

Mr. McCarter's statement is based on the results of studies made by William H. Burr, Ralph Modjeski and Daniel E. Moran. They calculated that motor vehicles would run at ten miles an hour and go thru the tunnel in about eleven minutes, and it is estimated that 2,000,000 of them would use the tunnel the first year. At this rate, and calculating the hourly fluctuations according to the actual present traffic over the five principal ferries, the average distance between vehicles following one another thru the tunnel would be in the busiest hour of the day (8 to 9 a. m.), 189 feet.

The officers of the Public Service Corporation hope that a tunnel will be built by the states or counties, or at least with public money; but if that should not come to pass they might, at some later date, consider construction by the Public Service Corporation.

Good Roads Notes

The North Platte Valley Highway Association has been formed to promote a connecting highway thru the North Platte Valley from North Platte, Neb., on the Lincoln Highway to the Yellowstone Park Road. H. A. Mark, secretary of the Community Club of Oshkosh, Neb., is the secretary of the association.

Connecticut is finding that the construction of its original good roads of waterbound macadam was not economical and is resulting in bills for maintenance which have been increasing each year, the road surfaces not being sufficient for the traffic over them. Recently the state adopted the policy of renewing the roads most heavily traveled with harder surfaces and, as a result, has reduced the rate of increase of maintenance charges and in some districts has actually reduced the annual cost of maintenance. Bad frost conditions and heavy trucking traffic are responsible for the damage and light foundations come in for some responsibilty on the thru routes of heavy vehicles.

Expenditures for good roads in the Southern States were 2½ times as much in 1914 as they were in 1904, showing a real awakening to the necessities of the case. Nine per cent. of the roads now have modern surfaces, as against 6 per cent. in 1909. In Kentucky over 21 per cent. of the roads were surfaced by 1914, and at the other end was Oklahoma with only 0.11 of 1 per cent. That these roads are not up to modern standards is shown by the statement that of the 73,600 miles of surfaced roads about 40 per cent. are sand-clay, 29 per cent. macadam, 24 per cent. gravel and only about 7 per cent. of the harder surfacing such as bituminous macadam, brick, concrete, etc.

One of the first bridges designed by a certain state highway department was at a small railway station miles from the county seat, where, to the people and the commissioners, the requirement that the structure should be able to carry a load of 6 tons seemed excessive. Scarcely a year later road bonds were issued by the county in which this bridge is located, and the bridge had to be strengthened to carry a 12-ton road roller. The more general use of traction engines and motor trucks tends to put all roads in the "important" class, so far as their bridges are concerned. Agricultural tractors with shipping weights of 17½ tons, motor trucks carrying loads of 10 tons in addition to their own weight, and trailers carrying loads of 15 tons are in use. In order that such loads can be carried safely and bridges may be strong and durable enough to have ultimate economy, all structures with roadways of 18 feet width or less, except those near cities, should be designed to carry a load of 15 tons on two axles 10 feet apart, the rear axle carrying 10 tons and the front axle 5 tons. Near cities it is better to design structures for a 20-ton load.

Bituminous Macadam Pavements Laid in 1916 and Proposed for 1917

Descriptions of Pavements as laid, cost per square yard and total cost.

Design, Cost and Quantity are shown.

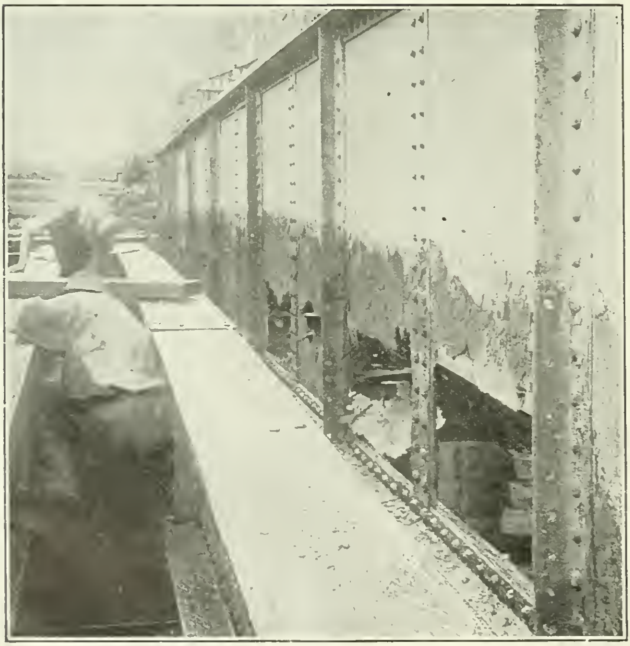
State and City	Sq. yds. laid 1916	Base Thick	Base Kind and Propor.	Top Thick	Top Kind and Amt.	Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of Bitumen	Proposed yardage in 1917
Arizona—									
Phoenix	32.089	...	.....	.....	....	1.24	63,850	....	......
California—									
Alhambra	3,480	...	.....	.....	....	....	.....	....	......
Glendale	37,600	...	.....	5	....	0.72	.....	....	......
Long Beach	5,094	...	.....	5½	....	1.42	.....	....	......
Los Angeles	20,098	...	.....	.....	....	0.90	18.088	....	......
Pasadena	32,423	...	.....	1-6	....	0.517	24,039	....	......
Pomona	1,872	...	.....	.....	....	0.08¼	1,668	California	......
Redondo Beach	64,500	...	.....	2½	....	0.40	.....	....	......
Richmond	64,071	6[27]	.....	1½	....[49]	0.72	.....	....	5,000
Santa Ana	85,598	2	.....	.....	....	0.36	.....	92% Asph.	......
Santa Monica	42,415	2	.....[50]	.....	....	0.24	11,768	....	......
Sausalito	8,000	...	.....	2	....	1.03	.....	....	......
Vallejo	2,000	...	.....	¾	1 gal.[1]	0.45	.....	Oil	......
Connecticut—									
Ansonia	4,850	5	.....	.....	2½	1.36(1)	.....	Bermudez	......
Danbury	8,000	4	.....	2	....	0.90-1.10	.....	Tarvia-Berm.	......
Enfield	10,500	...	.....	2¼ gal. sq. yd.	....	1.37-1.77	.....	Tarvia X	......
New Haven	18,824	4	.....	2	2 1-3 g.[1]	1.02	1.13	....	14,000
New London	4,820	...	.....	.....	....	0.61	2,937	Tar	6,500
Putnam	6,000	4	.....	2	....	0.80	5,000	Mex.-S. O. B.	1,000
Wallingford	6,500	7½	.....	.....	....	1.30	.....	....	3,500
Florida—									
Tampa	18,203	4	.....	2	....	1.22	.....	....	......
Georgia—									
Atlanta	63,433	...	.....	.....	....	....	63,433	....	......
Brunswick	7,500	...	.....	.....	....	....	.....	Tarvia	......
Illinois—									
Ardmore	......	...	.....	.....	....	....	.....	....	20,600
Chicago	480.000	...	.....	.....	....	1.33	2.447	....	......
Cicero	......	...	.....	.....	....	....	.....	....	31,920
Evanston	21,166	5	1:3:6	3¼	....[117]	1.28	34.668	Bermudez	36,676
Evanston	3,970	...[41]	.....	3¼	....[117]	0.79	3,288	Bermudez	......[9]
Hinsdale	5,952	...	.....	2	....	1.19	11,343	Tarvia	5,600
Joliet	37,900	...	.....	.....	....	1.50	76,935	....	......
LaGrange Park	32,000	...	.....	3	....	.355	12,280	Tarvia	......
Lake Forest	22,500	...	.....	2	....	.465	.....	....	......
Lyons	......	...	.....	.....	....	....	.....	....	5,000
Marion	28,733	...	.....	6-9	....	1.48	.....	....	......
Peoria	6,044	...	.....	2	....	1.18	8,969	....	31,500
Wheaton	13,344	...	.....	.....	....	1.73	(1)(2)(3)	....	......
Indiana—									
Crawfordsville	4,116	...	.....	.....	....	....	.....	....	......
Crown Point	13.000	...	.....	.....	....	0.85	.....	....	......
Ft. Wayne	27.218	...	.....	....	2½ gal.[1]	0.95	35,581	Standard C	......
Gary	6,500	...	.....	3	....	0.90	.....	....	......
Marion	208	...	.....	.....	....	0.88	.....	....	......
South Bend	7,054	...	.....	.....	....	1.045	12,847	....	......
Iowa—									
Keokuk	......	...	.....	.....	....	....	.....	....	4,128
Kansas—									
Leavenworth	......	...	.....	.....	....	....	.....	....	45,000
Pittsburg	34,826	4	1:2:5	2[89]	18%[12]	1.35	66,367	Stanolind	......
Rosedale	......	...	.....	.....	....	....	.....	....	2,000
Wichita	......	...	.....	.....	....	....	.....	....	15,000
Kentucky—									
Louisville	5,962	...[41]	.....	2	....	1.10	.....	Tar	0
Middlesboro	20,540	...	.....	6	....	0.85	.....	....	......
Maine—									
Bangor	18,296	...	.....	6	....	1.23	.....	....	......
Portland	3,034	2 gal.	per sq. yd.	.....	....	1.398	4,243	Texaco 130	......
S. Portland	10,935	8	macadam	.....	3 gal.	0.78	8,514	Tarvia	......
Maryland—									
Frederick	4.095	...	.....	.....	....	....	3,800	....	11,370
Westminster	8.533	...	.....	10	....	4.00	.....	....	......
Massachusetts—									
Arlington	14,160	...	.....	.....	....	....	.....	....	......
Boston	119,198	...	.....	6	....	0.93-1.00	.....	....	......
Brookline	38,600	...	.....	.....	....	0.55	21,132	....	40,000
Cambridge	59,050	...	.....	.....	....	....	.....	....	......
Concord	19,190	...	.....	.....	....	1.70	.....	....	......
Fitchburg	19,265	6	.....	2 gal.[1]	....	1.20	23,118	Bermudez	......
Greenfield	2,800	...	.....	.....	....	....	.....	....	5,000
Haverhill	46,850	4	.....	2	....	1.20	.....	Indian	45,000
Lawrence	2,430	...	.....	.....	....	....	.....	....	......
Leominster	8,500	...	.....	7	....	1.41	.....	....	......

June, 1917.

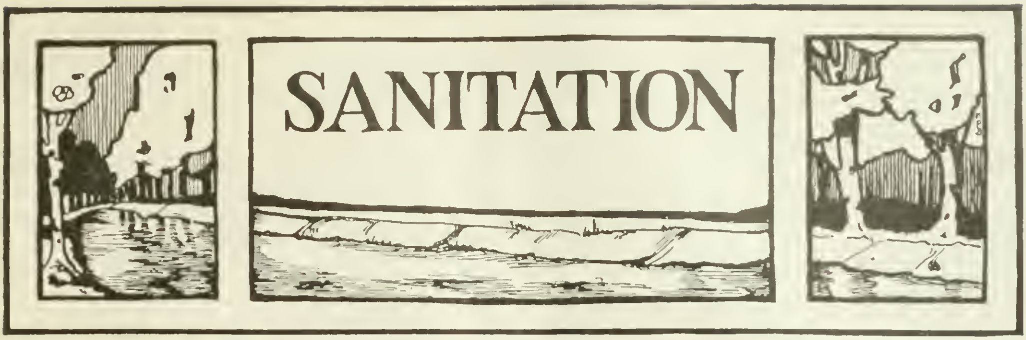
State and City	Sq. yds. laid 1916	Base Thick	Base Kind and Propor.	Top Thick	Top Kind and Amt.	Cost per sq. yd. pave. and foundation	Total cost of pave., inc. (1) (2) (3) (4)	Kind of Bitumen	Proposed yardage in 1917
Lowell	35,184	..	....	4	....	1 25			......
Lynn	10,566	4	....	½	....	0.63			10,000
Medford	24,817	...	....	4-6	....	1.00-1.25		....	......
Methuen	10,560	...			..	0.50		Tarvia X	.....
Middleboro	15,810	...			....	....	18,[illegible]	....	12,000
New Bedford	76,768	6	....	2	....	....	.....	Tarvia	......
Newton	60,000	...	....	2½	....	0.65	.....	Tarv. Tarite	..
N. Adams	......	...	.....	.....	....	.....		....	8,000
Norwood	21,000	...		6	.		17,050	......	....
Peabody	3,899	..	.....	2	.	1.02	.....	......	.....
Quincy	25,000	..	...	.....	....	1.00	.....	....	.....
Revere	15,681	..		2-3	....		1 05	Tarv. X-Berm	20,000
Saugus	1,000	...		4	....	0.50	0.50	Tarvia X	6,000
Southbridge	8,000	...	....	4	..	....	8,000	Tarvia X	10,000
Wakefield	5,000	4	...	2	2 gal.		1.25	Tarvia	10,000
Walpole	7,755	...	..	.....	....		.....	....	......
Waltham	14,950	...	..	5	....		1.16	....	......
Watertown	18,000	...	..	.....	...		24,000	.....	18,000
Webster	400	8	.....	.....	....		0.62	..	......
Westfield	4,232	.	....	.....	....		0.49	....	......
Weymouth	1,948	...	....	....	....	....	2,077	......	5,000
Worcester	26,026	...	.....	.....	....	....	0.91	....	......
Michigan—									
Adrian	4,950	..	...	7½	....	1.23	.....	....	......
Benton Harbor	......	..	....	....	....	......	.....	....	15,000
Holland	9,500	..	.....	2	...	1.20	20,415	Bermudez	14,000
Marquette	5,110	3	1½ gal.[1]	½	½ gal.[1]	0.912	....	Bermudez	......
Muskegon	15,706	..	....	.....	...	0.43	.....	....	......
Negaunee	13 900	..	.....	.	.	0.91	14,996	Stanolind C	13,000
Minnesota—									
Duluth	73,839	.	.	..	..	....	.....	.. ..	......
Rochester	24,753	5	1:3:5	2½		1.52	29,221 (1) (3) (4)	Tarvia	.....
Missouri—									
Carthage	......	..	....	.....	....	....	.....	....	25,000
Columbia	19,717	6	....[111]	2½	1.7-½[1]	0.83	26,913	Tarvia X	......
Fulton	3,188	...	....	2½	2 gal.[1]	1.19	(1)	Tarvia X	......
Jefferson City	12,000	...	...	2	3 gal.[1]	0.90	26,000	Stanolind	0
St. Louis	40,600	6[34]	3	.....	....	1.35-1.50	58,220	....	25,000
Springfield	63,153	4-6	.	2	2 gal.[1]	0.83-1.10	0.96-1.28	Tex.-Tarv. X	10,000
Nebraska—									
Norfolk	29.576	..	....	..	....	....	.....	....	......
New Hampshire—									
Franklin	4,817	...	.....	.....	....	0.80	.....	....	......
Laconia	15,914	...	...	6	2½ gal.[1]	0.86-1.40	24,441	Tarvia X	10,000
Nashua	25,000	...	..	4	....	0.80	.....	....	......
New Jersey—									
Bloomfield	9,511	...	.....	.....	....	1.37	.....	....	20,000
Montclair	7,500	5	1:3:6	2½	...[80]	1.42	11,900	Bermudez	10,000
Passaic	4,228	7	.....	.....	....	0.92	1.18	....	13,600
Rutherford	9,000	6	.....	.....	....	1.15	....	....	......
Summit	2,660	...	....	2	....	0.63	.....	....	3,000
W. Orange	......	...	.....	.....	....	....	....	....	10,000
New York—									
Amsterdam	5,860	...	.....	3	....	3,500	..	Tarvia X	......
Auburn	7,000	...	.....	.....	....	1.20	..	....	7,000
Bronxville	17,500	11	....	.....	....	0.70-1.00	..	....	......
Dolgeville	6,500	...	.....	3	....	1.32	. .	....	......
Elmira	......	...	....	.....	....	....	.....	....	12,000
Fulton	5,300	...	.....	.....	....	1.05	8,420	Bit. A.	9,300
Geneva	12,600	...	.....	3	....	0.90	.....	Montezuma	......
Hudson	30,000	...[41]	...	3	....	0.90	1.30	Standard	......
Johnstown	300	5	....	3	....	1.40(1)	.....	Bermudez	......
Kingston	42,062	...	....	6	....	......	35,332	Trinidad	......
Little Falls	2,962	3	.....	3	2 1-3 gal.[1]	1.30	2.00	Tarvia X	......
Middletown	15,333	7	.....	.....	....	0.85	.....	....	......
New Rochelle	55,532	4[55]	1:3:5	2½	....	1.485[51]	30,613	Tarvia X	......
New York—									
Queens	45,600	...	.....	.....	....	....	.....	....	......
Richmond	14,261	6½	.....	.....	....	0.84	.....	....	......
Norwich	3,360	5-9	.....	6	....	1.93	8,514	Bermudez	......
Ogdensburg	6,021	...	.....	.....	....	0.60	.....	....	......
Oswego	1,425	5	1:3:6	3	....	1.65	2,778	Barber	0
Poughkeepsie	1,269	6	.....	3	....	0.79	1,000	Aztec	......
Syracuse	37,325	...	.....	.....	....	....	.....	....	......
Tuckahoe	24,000	7½	.....	.....	....	1.00	.....	....	......
North Carolina—									
Durham	2,000	...	.....	6	....	1.00	3,800	....	......
Greensboro	10.000	...	.....	.....	....	....	.....	Oil Asph.	......
Wilmington	1,400	8	2 gal.[1]	2	....[53]	1.25	.....	S. O.	......
Ohio—									
Bowling Green	6,548	...	.....	.....	....	0.85-0.95	9,852	Bermudez	2,500
Cincinnati	6,593	6	.....	3	2 gal.[1]	1.16	22,092	....	......
Cleveland	2,500	...	.....	.....	....	1.20	.....	....	......
Columbus	3,785	...	.....	.....	....	0.92	.....	....	......
Mansfield	1,821	...	.....	.....	....	1.80	....	....	......
Middletown	5,302	...	.....	2½	....	1.36	.....	....	......
New Boston	24,594	...	.....	.....	....	....	.....	....	......
Piqua	16,600	6	.....	2½	....	1.35	27,026	Bermudez	......
Van Wert	7,061	8	.....	.....	2½ gal.[1]	1.15	.....	....	......
Oklahoma—									
Durant	15,730	4	.....	2	....	1.24	28,700	Natural Rock	32,000

June, 1917.

State and City	Sq. yds. laid 1916	Base		Top		Cost per sq. yd.	Total cost, inc. (1) (2) (3) (4)	Kind of Bitumen	Estimated constr. for 1917
		Thick	Kind and Propor.	Thick	Kind and Amt.				
Pennsylvania—									
Carbondale	6,000	6	...		....	1.39	.....	Tarvia	.....
Chambersburg	2,100	..	....		....	....	.....	....	......
Chester	50,000	...	....		....	2.15	.....	Fibertine	......
Norristown	5,930	4½		2½-3	....	0.60-0.78	.....	Tarvia	6,000
Northampton	2,240	...	....	.....	....	....	.....	Pioneer	1,200
Reading	260	...	.....	.....	....	1.25	.....	....	......
Waynesboro	7,292	...[41]	.....	3	....	0.40	.....	....	......
Waynesboro	1,170	6	.....	.....	....	0.85(1)	.....	....	......
Rhode Island—									
Providence	2,954	...	.....	2½	....	....	1.50	....	......
Westerly	40,000	6	.....	.....	...	1.05	.....	....	......
Woonsocket	15,000	6	.....	.....	....	1.00	.....	....	......
South Carolina—									
Florence	......	...	.....	.....	....	....	.....	....	21,000
Greenville	12,000	...	.....	.....	....	....	.....	Tarvia	......
Texas—									
Austin	37,000	...	.....	.....	....	....	.....	Tarvia	......
Clarksville	2,400	...	.....	.....	....	....	.....	....	......
Corsicana	3,938	6	.....	.....	....	0.85	5,162	Oil	......
Corpus Christi	4,000	5	.....	.....	....	0.75	.....	....	......
Denison	14,222	...[41]	.....	.....	....	0.60	.....	....	......
Ft. Worth	11,384	...	.....	.....	....	....	1.25	Tex.-Mag.	......
Houston	5,504	...	G	1	surf.	0.56	3,100	Tarvia	......
San Antonio	8,275	...[41]	.....	2½	....	1.00	1.00	Mexican	60,000[9]
Vermont—									
Montpelier	4,170	...	.....	.....	....	....	.....	S. O. A.	5,000
Virginia—									
Clifton Forge	3,000	5	.....	3	2 gal.[1]	0.80	1.00	Berm.-Aztec	5,000
Danville	1,160	...	.....	.....	....	0.885	.....	....	......
Staunton	2,500	6	.....	.....	....	0.51	.....	Tex.-Aztec	......
Washington—									
Pullman	12,445	6½	.....	.....	....	0.95	.....	....	......
West Virginia—									
Bluefield	4,926	4	1:3:6	2½	2½ gal.[1]	1.44-1.53	10,531	Bermudez	......
Wisconsin—									
Baraboo	7,500	10	.....	.....	....	....	9,000	....	0
Eau Claire	6,150	...	.....	.....	....	1.08	2,004[54]	Sarco	......
Janesville	14,388	4-7	.....	2	....	1.05	.....	Bermudez	46,000
Jefferson	25,000	...	.....	.....	....	0.90	.....	....	......
Oshkosh	4,120	...	.....	.....	....	0.96	5,445	....	......
Racine	......	...	.....	.....	....	....	.....	....	5,537
Two Rivers	6,600	8	.....	.....	....	1.075	.....	....	......
Waukesha	11,013	6	.....	2½	....	0.92	16,448	Stanolind C	......
Wausau	6,214	...	.....	.....	....	0.73	6,580	Sarco & Tar	3,000



SHOWING CORROSION OF WROUGHT IRON GIRDERS IN WASHINGTON ST. BRIDGE OVER BOSTON AND ALBANY RAILROAD, BOSTON, MASSACHUSETTS.



Rochester's Sewage Disposal Plant in Operation

On March 29 the East Side trunk sewer of the Rochester, N. Y., sewerage system was connected with the newly completed intercepting sewer and sewage disposal plant, and on April 27 the West Side trunk sewer was connected, so that now practically all the sewage of the city has been removed from the Genesee river, the lower portion of which has heretofore acted as a settling basin for the city's sewage.

Some parts of the system have been completed for a year or two, and there remain a number of accessories to complete, but the plant is ready to perform the major part of its functions and is now in operation.

Consulting Engineer E. A. Fisher of the city gives the following brief history of the development of the system, the entire cost of which will approximate $2,500,000:

"The main sewage disposal plant has been gradually put in operation since the East Side trunk sewer was turned into the system on March 29 until today, when the West Side trunk sewer was turned in, completing the interception of all sewers now emptying into the river except the small Lake avenue outlet sewer near the northerly boundary of the city on the west side of the river.

History of New System.

"Thirty years ago, in 1887, the Common Council appointed a special committee to investigate and report upon an East Side belt line sewer. Emil Kuichling made the necessary surveys and submitted a report in April, 1889. This was the first investigation relative to any treatment of the sewage of which we have a record.

"Mr. Kuichling's report briefly outlined several methods of disposal in use at that time, and as sewage farming with cultivation, filtration thru land without cultivation, chemical precipitation and the discharge of crude sewage into the lake.

"No further steps were taken in this matter until 1904, when Mr. Kuichling was again called upon to investigate and report upon a method of sewage disposal for the entire city.

"In 1907 George H. Benzenberg, of Milwaukee, and Rudolph Hering, of New York City, were associated with Mr. Kuichling, and in February presented a report concurring in Mr. Kuichling's report of the same year. No immediate action was taken, due to the fact that the extensive improvements in the waterworks system had brought the city close to the constitutional limit of indebtedness.

"Further studies were made by Mr. Kuichling and a supplemental report was made in March, 1910. The original plan made by Mr. Kuichling provided for a city of 275,000 population. This plan was revised, and the present installation provides for a future population of about 450,000, including the Brighton system.

Intercepting Sewer Plan.

"The intercepting sewer begins at the intersection of Central avenue and North Water street, taking in at that point the Central avenue sewer and the North Water street sewer and its tributaries east of the Genesee river. From this point the intercepter passes under the Genesee river in a tunnel 8 feet in diameter. The sewage is confined in a semi-circular invert channel 3 feet wide. On each side of this invert are bench walls 2.5 feet wide, on one of which is laid a 20-in. water main and on the other a 17-in. Holly main, connecting the water systems on both sides of the Genesee river.

"From Front street the intercepting sewer is still in tunnel, and follows Central avenue to Mill street, thence in Mill street to Brown street, thence across the R., W. & O. R. R. lines to a short distance north of the R., W. & O. R. R. bridge, intercepting on its way the Front street sewer, the Platt street sewer and the Spencer street sewer. At the last named point, north of the R., W. & O. R. R., there is constructed a detritus tank, in which all heavy material, such as gravel and small stones, will be deposited before the sewage enters the cast-iron mains extending from this detritus tank along the bank of the river, crossing under the river opposite the Flower City Brewery, and thence running along the foot of the bank to a point opposite Avenue B, on the east side of the river, where the pipe ends in a tunnel intercepting at this point the Avenue B sewer.

West Side Sewer Enters.

"At this point the West Side trunk sewer enters the intercepter after crossing the river in a double cast-iron pipe inverted siphon, with a grit chamber on top of the bank at the extension of Glenwood avenue similar to that described near the R., W. & O. R. R. on the main line.

"From the intersection of the Avenue B sewer the intercepting sewer is still in tunnel to a point about 300 feet south of Norton street. From this last named point the sewer is in open cut to the Ridge road. At Norton street the East Side trunk line sewer is intercepted.

"From the Ridge road to the disposal plant the sewer is called an outfall sewer. At a point near the city line a sanitary sewer from Clinton avenue, north of Norton street, is taken in, and from this point to the disposal plant, a distance of four miles, there are no sewers intercepted excepting the sanitary sewage from some of the residences along the East Side boulevard.

"At the different points of interception of the existing outlet sewers regulating devices have been installed which can be adjusted to take into the intercepting sewer the dry-weather flow and a certain proportion of the stormwater flow. The existing sewers beyond the point of interception become overflow sewers for the surplus stormwater.

"The regulating devices are controlled by means of a float which rises as the stormwater in the sewer increases and closes the inlet to the intercepting sewer, so as to prevent a greater quantity being taken into the intercepter than contemplated.

"The plant is located in Irondequoit, about midway between Summerville and Sea Breeze, and about one-half mile south of the lake shore. At this place the city has acquired about 310 acres of land, which is adjacent to and west of the Durand-Eastman Park.

"The first structure at the entrance to the plant is a Venturi meter, which makes a continuous record of the quantity of sewage reaching the plant. The sewage then passed thru coarse racks of 2-in. openings, and enters the detritus tanks or grit chambers, of which there are six. These grit chambers are about 90 feet long, 10 feet wide and 3 feet in depth, for the retention of grit. These tanks are designed to retain only the heavier solids of the sewage, such as sand and gravel.

"From these tanks the sewage passes thru fine screens which remove floating and other suspended matter that would interefere with the operation of the tanks. These screens are known as of the Riensch-Wurl type, and have been extensively used in Germany. There are two screens 12 feet in diameter having openings ⅜-in. by 2 inches, and also two screens having openings of 1/16-in. by 2 inches. These screens are automaticaly cleaned, and the screenings are deposited in a small car, taken out and dumped on low ground. They will either be covered with earth or used as a fertilizer.

From Screens to Imhoff Tanks.

"From the screens the sewage enters the main distributing channel to the Imhoff tanks thru channels controlled by automatic regulators similar to those used in the intercepting sewers. The tank units are ten in number and are 115 feet long and 37 feet wide, and of a total depth of about 40 feet.

"The design of the tank provides for the separation of the old sewage from the new, and are what are commonly known as double-story tanks. The upper compartment or flowing-thru channel, is separated from the lower or sludge compartment by inclined slabs at the bottom of which is a 6-in. opening or slot thru which the sedimented matter from the upper chamber passes into the lower. These slabs are arranged in such a way that the escaping gases from the decomposing sludge will not enter the fresh sewage, but will escape thru gas vents at the side of the tanks.

"The sludge is retained in the tanks for a period of six months, and is removed thru 8-in. pipes, the discharge of which is below the water surface in the tanks, the hydrostatic head being sufficient to force the sludge out of the pipe.

Sludge Not Offensive.

"The sludge is discharged onto drying beds. The area of the present bed is about one and three-quarters acres. From these beds the dry sludge is removed in small cars and dumped on low ground. This sludge is without appreciable odor and can be disposed of on any part of the ground without offense.

"After passing thru the tanks the sewage discharges into the outlet pipe into the lake. This pipe is 66 inches in diameter and discharges at a point about 7,000 feet from the shore in 50 feet of water. The effluent will be used to develop power more than sufficient to operate and light the plant.

"The system has been designed for a future population of 450,000. The intercepting sewer, detritus tanks and screen buildings have been constructed for this future population, but only one-half of the Imhoff tanks have been built at present. These ten tanks, operating in connection with the Riensch-Wurl screen installation, have a capacity sufficient to take care of more than the present population of the city."

Modern Methods of Refuse and Garbage Disposal

Recent developments in garbage and refuse disposal have demonstrated the soundness of the reasoning in articles heretofore published in MUNICIPAL ENGINEERING, and the statements in this article, derived from reports of recent court decisions and from a recent paper by G. R. Tuska, consulting engineer, New York, before the American Association for the Advancement of Science, present the latest advances in the two directions in which success has been greatest in the larger cities.

The recovery of the values in the refuse and garbage is the point of greatest interest in modern methods, developed mainly since the subject has been made one for consideration by engineers rather than by physicians, and the possibility has been demonstrated that collection and disposal can be made without nuisance and in a perfectly sanitary manner.

There are two ways in which these values are now recovered. One is by using the steam power developed and the clinker produced in destructor plants and the other is by removing the valuable grease from garbage and reducing the remainder to a form usable in the manufacture of fertilizer.

The difference between the two methods begins with the collection system.

In the former system the best results are attained when all refuse except incombustible metals and mineral substances and including ashes, is collected together. But one receptacle is required for this collection unless the amount produced in a building is greater than a single can of convenient size for handling will hold. The refuse is comparatively dry and requires less care to prevent nuisance in handling and in transportation.

In the latter system the garbage must be separately stored and collected, and in it should be included only the decomposable wastes and the materials which will add to the value of the products of the garbage reduction plant. Combustible refuse must be destroyed in an incinerating plant of some sort, utilizing the resulting heat in producing steam or otherwise if possible, and the incombustible refuse, including ashes, can be used as filling for low lands, if decomposable materials other than manure and like substances are carefully excluded. This requires a triple collection, one of which must be carefully made in tight cans or wagons to prevent nuisance from odors and dripping of liquids, and a second must be made so that the light ash dust will not be blown about the neighborhood in emptying cans or hauling wagons. Three receptacles are required instead of one, and the regulations regarding careful separation of the three kinds of refuse must be thoroly enforced.

It is evident, therefore, that in estimating the sanitary value and the economic value of the methods under discussion for a certain city the cost and sanitary possibilities of the collection system must be considered as carefully as those of the disposal system; and that collection and disposal must be considered together as equally important parts of the problem, inseparable because each system of disposal has its own most suitable system of collection and cannot be served with full satisfaction by any other.

The high-temperature system of refuse destruction has been under a cloud for some time in this country because of two suits based on claims of municipal officials that the plants built for their cities did not fulfill their guaranties. The first decisions in both these cases have been rendered in favor of the constructors of the plants, their practical compliance with the terms of the contracts having been demonstrated to the courts and the extraneous and irrelevant source of the objections being quite clearly demonstrated.

There are twelve installations of one general design now in successful use in North America, ranging in size from 60-ton units at Montgomery, Paterson and West New Brighton to four 25-ton units at Havana, Cuba, besides the plant at San Francisco, which is not yet in regular operation.

There are many smaller installations of incinerating plants operating with lower temperatures which are lower in first cost and of various degrees of success, in disposing of garbage or mixed refuse as to odors and smoke nuisance with or without additional fuel, all of which are installed in the smaller cities or to serve restricted districts in the larger cities.

Garbage reduction plants have been operated in the past by private corporations until Cleveland and Columbus demonstrated the possibility of operating such plants under municipal ownership successfully as regards financial returns and with fair success as regards nuisances created. Plants in other cities are increasing in number and Mr. Tuska's paper describes in some detail the plans for a plant for the boro of Manhattan, New York City, which seems to have some points of advantage, at least in the matter of freedom from nuisance, over its predecessors in the field.

The following is abstracted from Mr. Tuska's paper:

In the methods of reduction for the handling of garbage great improvements have been made in the last few years. Formerly, where successful reduction processes were used, they were only of two types, one where the garbage was mechanically dried in hot-air furnaces and the grease then extracted by means of a chemical solvent and the material then redried so as to produce a commercial product; the second where the garbage was digested, pressed and mechanically dried, the grease being extracted partly by pressing and partly by degreasing with chemical solvents.

The main objections to these plants have arisen from the gases produced in the destruction of the garbage and from the gases discharged in the drying processes.

To obviate these objections a new reduction process has lately been evolved. The operation of this process is as follows:

The raw garbage is placed in a closed tank, which is sealed air-tight. This tank or reducer is constructed with jacketed walls and jacketed bottom. Into these jackets the steam which is used in the reduction of the garbage is delivered, the jackets being so designed that it is impossible under proper operation for the steam to enter the tank or come in contact with the garbage. In the interior of this tank there is an agitating device operated by power from the exterior. When the proper charge of garbage has been placed in the reducer and the covers are placed thereon the tanks are sealed and the solvent is pumped into the reducer and steam is admitted to the jacketed walls. The heat from the steam, which is transmitted to the garbage thru the walls of the reducer, causes the evaporation of the solvent and the water in the garbage.

Garbage is usually composed of over seventy-five per cent. by weight of water. The steam heat vaporizes the solvent and the water from the garbage and these mixed vapors are drawn off from the reducer to the condenser. The economy in this method of evaporation rests on the fact that water is vaporized at a lower temperature when evaporated with a solvent having a low boiling point than when evaporated without such a solvent.

The mixed vapors of the solvent and the water while in the condenser are there condensed to a liquid state and the water and solvent together are conveyed to a closed tank. Owing to the solvent being of lighter specific gravity than the water, the solvent and the water are separated by gravity, the solvent rising to the top, from where it is drawn back to the storage tanks and then pumped back to the reducers and used over and over. The condensed water, which has been largely diluted owing to the jet condensers used, is discharged into sewers or waterways.

When the garbage has been thoroly dried by this method the solvent is pumped into the reducer and dissolves the grease. The solvent with the grease is drawn off into a closed tank or evaporator, where the same is heated by steam pipes, where the steam is kept separated from the grease. The solvent therein is vaporized and carried to a condenser, where the same is again liquified and carried to the storage tanks to be used again.

After the grease has been extracted from the garbage in the reducer it is further dried by means of the steam in the jacketed walls and is now in the form of de-greased garbage tankage, which is used for fertilizer purposes after being ground and screened.

It will be seen that it is to the financial interest of the owner of the plant to see that there are no leaks or vents thru which the solvent can be lost. The garbage is at no time brought in contact with the atmosphere, from its original entrance into the reducer until after over twelve hours of cooking it is finally discharged, dried, sterile and practically odorless as grease and tankage.

The process is one of straight de-hydration. No process of digestion occurs and the odors and gases incidental to such a process are not created.

The water condensed contains all the gases evolved and has when fresh a slight odor of the mixed essential oils. Some traces of alcohol are detected in the effluent aand a very small quantity of fixed oils is carried over. Any ammonia evolved, if it has escaped the acid in the garbage is neutralized by acid carried over in the vapor. Whatever albuminoid ammonia exists in the effluent is carried over by mechanical entrainment as dust particles during the steaming out of the solvent.

The effluent from this process consists of almost pure water, this water being the condensed moisture drawn from the reducer while the garbage is being treated and from which the solvent has been extracted as completely as possible. The effluent is cold and gives forth no steam or vapor and is practically odorless, and as a result can have no undesirable effects when run into a large body of water.

The only other possible source of odor during the entire reducing operation would be in the air and gases mechanically included in the green garbage prior to its entrance into the reducer, so small that no objectionable condition can be created by their discharge.

The tankage when taken out from the reducer is in a dry condition and quite warm, and when it is first exposed to the atmospherer has momentarily a slight odor of dried material best described as a smell of stale gingerbread, due to the essential oils rising from the material when hot. No gases are generated and this odor lasts only during the period of emptying of the reducer, and is not offensive nor perceptible outside the building.

Heretofore gasoline has been used as the solvent in the degreasing process, but it has been proven that a more economical operation and an elimination of the danger of explosions is obtained by the use of a kerosene distillate obtained by the treatment of ordinary kerosene in a vacuum still.

The cost of a plant operating on the above system is from twenty to fifty per cent. greater than one on the digester system. The cost of operation per ton of garbage by this system is also considerably higher than by the digester system; the labor cost being about the same, but the cost for fuel and solvent being considerably greater.

As against this increased cost we have superior sanitary advantages and a considerably greater value of recovered products, more grease and a more valuable tankage, the potash contained in the vegetable fibre remaining in the tankage from this process amounting to over one per cent. by weight in the dried product.

The practical operation of this system has been demonstrated by the plants handling the garbage for the cities of Los Angeles, Cal., and New Bedford, Mass. The New York City plant now under construction will have a capacity of over two thousand tons of garbage per day and will therefore be the largest of its kind in the world.

MISCELLANEOUS

Meeting of Organizations

June 6-13, at Pittsburg, Pa. National Conference of Charities and Corrections. Wm. T. Cross, sec'y, 315 Plymouth Court, Chicago, Ill.

June 12-14, at Hotel Iroquois, Buffalo, N. Y. New York State Conference of Mayors and other City Officials. W. P. Capes, sec'y, 25 Washington Ave., Albany, N. Y.

June 20-22, at Buffalo, N. Y. American Institute of Chemical Engineers. J.C. Olsen, sec'y, Cooper Union, New York.

June 26-30, at Atlantic City, N. J. American Society for Testing Materials. Edgar Marburg, sec'y, University of Pennsylvania, Philadelphia, Pa.

September 24-29, at Santa Rosa, Cal. League of California Municipalities and Annual Public Welfare Exposition of municipal supplies, street and road-making machinery. F. J. Erb, director of exhibits, Pacific Bldg., San Francisco. H. A. Mason, sec'y, 1120 Crocker Bldg., San Francisco.

September 27 to 29, at Chicago Norske Klub, 2346 North Kedzie Boulevard, Logan Square, Chicago, Ill. Informal Congress and Reunion of American and Canadian Engineers and Architects of Norwegian Birth or Descent. Joachim G. Giaver, chairman of local Chicago committee on arrangements.

October 17-18, at St. Cloud, Minn. League of Minnesota Municipalities. Richard R. Price, sec'y, University of Minnesota, Minneapolis.

November 12-16, at New Orleans, La. American Society of Municipal Improvements. Chas. C. Brown, sec'y, 702 Wulsin Bldg., Indianapolis, Ind.

Civil Service Examinations

The U. S. Civil Service Commission will hold examinations at the usual places as follows: Electrical engineer, also metallurgist, in Springfield Armory, Ordnance Department at large, each at $3,000 a year, at any time application is made in due form. Also expert radio aid in Department of Steam Engineering, Navy Yard, Washington, D. C., at $6 a day.

Mechanical draftsman in Ordnance Department at large, at $1,320 a year.

June 5: Radio engineer at Ft. Huachuca, Ariz., and Ft. McIntosh, Tex., in Signal Service at Large, War Dept., at $1,800 a year.

June 6-7: Aid in Coast and Geodetic Survey, at $1,000 a year to begin.

June 12: Sub-inspector, aeronautical engines, in Department of Steam Engineering, Navy Yard, Washington, D. C., at $4.48 to $6.40 per day.

Technical Schools

A neat circular about the Engineering Schools of Purdue University, Lafayette, Ind., has been issued.

Municipal Reports

Report of Board of Water Commissioners of Westfield, Mass., for 1916, 24 pp. Henry W. Sanderson, Supt.

Report of Department of Public Works, Woburn, Mass., for 1916, 38 pp. H. V. Macksey, C. E., Supt. Pub. Works.

Report submitted to the Board of Estimate and Appointment by the chief engineer of the board on behalf of the Board of Consulting Engineers recommending the adoption of certain general rules governing the design of outlet sewers and sewer outlets, which report was approved and which rules were adopted by the Board of Estimate and Apportionment at a meeting held on Feb. 23, 1917. Paper, 11 pp. Nelson P. Lewis, chief engineer.

Reports of engineering department of Hartford, Conn., for 1914 and 1915. Paper, 41 and 45 pp. R. N. Clark, city engineer.

Report of the water board of Auburn, N. Y., for 1916. J. Walter Ackerman, chief engineer and superintendent.

Annual reports of the city of Prahran, Victoria, Australia, for 1915 and 1916. John Romanis, town clerk.

A Book on the Automobile

Dyke's Automobile Encyclopedia, fifth edition, is a practical automobile book from which one can learn about automobiles, trucks, also engines, etc. This book is the resultant of the first practical automobile book published in America. It contains 825 pages, 6¾x9¾ inches. There are 2,370 illustrations. In addition to the 50 instructions there is a supplement on the Ford and Packard, part of which is printed in two colors. There are 350 pages and 976 illustrations on electric subjects.

There are 74 pages and 254 illustrations on testing electric systems; 74 pages and 75 illustrations on the Delco system alone; 534 illustrations on repairing, and there are 4,000 lines to the index, which adds to its value as a ready reference.

In 1900 Mr. Dyke published "Dr. Dyke's Diseases of a Gasoline Automobile and How to Cure Them." This book was the first practical automobile book published in America. Although Mr. Dyke was engaged in the automobile supply business from 1898 to 1908, which by the way was the first automobile supply business in America, he did not lose sight of the fact that some day a good practical book would be in demand, therefore, he revised the book year after year. In 1908 he rewrote the book and changed the title to "Dyke's Automobile Encyclopedia."

Mr. Dyke's books are distinctively different from other books and evidently giving satisfaction as he claims that from a sale of 150,000 books not one has been returned. Mr. Dyke's books are not only used as a reference and guide to the thousands of automobile owners, but are in the hands of every practical automobile repairman in the country. They are used by many of the aviation posts and truck divisions of the

War Department, and fifty-six automobile schools, including a great number of the leading Y. M. C. A. schools from New York to San Francisco.

The publisher's address is A. L. Dyke, St. Louis, Mo.

Personal Notes

Rudolph Hering continues his practice as consulting engineer in New York City, since dissolution of his recent partnership.

E. B. Bradbury has been appointed sanitary engineer of Franklin county, at Columbus, O.

B. J. T. Jeup, city engineer, ex-officio, Jay A. Craven of the Terre Haute Water Company and C. H. Hurd of the Indianapolis Water Company, form the new Board of Sanitary Commissioners of Indianapolis, whose duties are to design and construct sewage and garbage and refuse disposal plants.

Gaylord C. Cummin has been appointed city manager of Grand Rapids, Mich., at a salary of $10,000 a year, having been promoted from a similar position at Jackson, Mich.

W. E. Baldry is the new city engineer of Topeka, Kan.

John H. Gregory, formerly of the firm of Hering & Gregory, continues his practice as consulting hydraulic engineer and sanitary expert at 170 Broadway, giving special attention to water supply and purification, sewerage and sewage disposal, garbage and refuse disposal.

Ralph W. Whitaker is city engineer of Bakersfield, Cal., in place of R. B. Ray.

F. S. Benson has been appointed city manager of Bakersfield, Cal.

Charles E. Hewes has left Alhambra to become city manager of Alameda, Cal.

Herbert Nunn is the new chief engineer of the Oregon State Highway Commission.

Daniel S. Miller has been promoted to city engineer of Long Beach, Cal.

A. T. Thompson is the new city engineer and superintendent of public works of Grand Rapids, Wis.

W. A. Powell has been promoted to city engineer of Rensselaer, N. Y.

W. D. Howren is the new city engineer of Amarillo, Tex., and A. D. Armstrong is city manager.

S. D. Newton is the new city engineer of Cleveland, Tenn.

Professor C. R. Richards, since 1911 at the head of the department of Mechanical Engineering of Illinois University, has been appointed Dean of the College of Engineering and Director of the Engineering Experiment Station of the University.

By a series of promotions W. J. Fulton becomes president of the board of public works of Gary, Ind., W. P. Cottingham, city engineer, and H. E. Jordan superintendent of parks.

J. L. Jacobs & Co., Monadnock Bldg., Chicago, engineers, cost accountants, and statisticians, announce an enlargement of their organization to furnish advice on revenue and expenditure, budgets, appraisals, civil service, salary and cost accounting standardization and allied services.

Mr. Guy Robert Ramsey, Assoc. M. Am. Soc. C. E., of Orlando, Florida, has joined the engineering staff of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio, and will be Division Engineer for the Southern States, with headquarters at Atlanta, Ga. He has had railroad, city engineering and highway experience and has a high standing among members of his profession. The Dunn Wire-Cut Brick Company now has eight engineers on its regular staff.

Charles H. Moore, president of the New Jersey Dock & Bridge Building Co., Elizabeth, N. J., died on May 1.

W. R. Caldwell is the new city engineer at Ypsilanti, Mich.

Frederick T. Elwood, city engineer, and former commissioner of public works of Rochester, N. Y., died on April 22.

Publications Received

Report of E. A. Stevens, New Jersey Commissioner of Public Roads, for 1916.

Report of Duluth, Minn., Water and Light Department for 1916. D. A. Reed, manager.

Military Preparedness and the Engineer, by Ernest F. Robinson, Assoc. M. Am. Soc. C. E., Captain Corps of Engineers, N. G., N. Y. Cloth, 224 pp., $1.50. Clark Book Co., 27 William street, New York City.

Dictionary of Altitudes in the Dominion of Canada, by James White, F. R. S. C., F. R. G. S., deputy head and assistant to chairman of the Commission of Conservation of Canada, Ottawa, Can.

The Industrial Arts Index, published by The H. W. Wilson Company, of White Plains, N. Y., is a cumulative index to engineering and trade periodicals. It is published in February, April, June, October and December. The list of periodicals makes the index well worth while and covers almost everything imaginable in the arts and sciences. There are large numbers of people to whom the Industrial Arts Index will prove a very valuable addition indeed to their book shelves of practical literature to be kept always at hand for reference purposes.

Public service rates in Texas cities have been compiled by Edward T. Paxton, secretary of the Bureau of Municipal Research and Reference of the University of Texas, at Austin, and published in Municipal Research Series No. 10. Water, sewer, light, gas, telephone and traction rates are given, with statement that there are none, or there is no report, so that every city is covered. Texas is the only state in which cities have the custom of charging or allowing charges for use of sewer systems. There are twenty-nine private companies and twenty-eight cities which charge rates for sewer service and twenty-eight cities which have free service in the manner in vogue in other states in the Union.

A new periodical is *The Modern City*, 32 pp. and cover, published at Hammond, Ind., J. E. Cowgill, Board of Trade, editor and manager.

Practical Street Construction is the subject of a book by A. P. Folwell, recently issued, which is excellent from the standpoint of design of a practical street. Municipal Journal Co., New York.

Bulletin 390 of the U. S. Office of Public Roads gives the public road mileage and revenues in totals for each state for the year 1914.

Report of Board of County Road Commissioners of Wayne County, Mich., for 1916. Edward N. Hines, Chairman.

"Highway Laws of the United States," is a topical discussion by A. N. Johnson issued by the Bureau of Municipal Research, 261 Broadway, New York. Paper, 163 pp., $1,00.

The Municipal Year Book of the City of New York, issued by the Municipal Reference Library, 512 Municipal building, for 20 cents postpaid, gives brief but clear descriptions of the duties and activities of the many departments, boards, commissions, bureaus, etc., in the city and a few statistics of revenues, public improvements, etc.

Raymond W. Parlin's paper before the American Society of Municipal Improvements on "Flushing; Its Place in the Street Cleaning Field," can be obtained in separate pamphlet form from the New York Bureau of Municipal Research.

Water Survey, Series No. 13, of the University of Illinois Bulletins, contains the report for 1915 of the Chemical and Biological Survey of the Waters of Illinois. Edward Bartow, Urbana, Ill. The book of 381 pp. contains also a number of papers and reports of investigations made on chemical and bacterial contents of water and their treatment, pollution of streams and the effects on fish, typhoid fever, methods and materials for treating water, experiments on activated sludge, sewage treatment and use of the sludge, etc.

MACHINERY AND SUPPLIES

South Bend Hose Wagons

The fire department of New York City reports the delivery of 5 South Bend double-duty type H-70 hose wagons as well as 3 South Bend double-duty type C-H-70 combination hose and chemical trucks.

The first two high-pressure motor hose trucks as well as the first combination hose and chemical wagons delivered were immediately placed in service in the high-value district covered by the high-pressure system. The high-pressure cars carry 1,200 feet of 3-in. hose, while the combination (aside from the chemical equipment) carries 1,200 feet of 2½-in. hose.

These South Bend double-duty outfits recorded a perfect score after their twenty mile run over the hilly portion (15 per cent. grade) of Manhattan. They averaged thirty miles per hour in the congested districts, thus making this average an enviable record when we consider the many turns and twistings and the grade crossings which had to be negotiated.

The combination hose and chemical, which carries two 40-gallon chemical tanks, is equipped with 36 by 5 solid front and 36 by 4 dual solid rear tires. These outfits are equipped with hub-odometers instead of speedometers.

One of the noteworthy features as noticed in the equipment consists of the two independent ignition systems. The one system is operated in conjunction with two storage batteries and the lighting outfit, there being a switch for the cutting in on either battery with the ignition system while using the other battery for the lights. Either ignition system may be operated alone or both systems may be operated at the same time.

The high-pressure hose wagons carry high-pressure turret nozzles with two 2-way 3-in. siamese connections, one on either side of the body. These wagons have extra long hose bodies with the center partitions thus enabling the department to run out two lines of hose at the same time.

The first three delivered were installed in Station No. 17 which is ranked as the fastest station in the city.

Heltzel Skips Find General Use

A considerable amount of favorable comment relative to the economies effected by unloading cars with Heltzel skips instead of the old "gondola to truck" method, has been heard recently. As these comments originate in widely separated parts of the country, the indication is that contractors have been thinking hard on efficiency methods.

When asked recently relative to the saving made by the Heltzel skips he had installed, Wm. Tonkel of Fort Wayne, Ind., said: "We firmly believe that real efficiency methods are coming, and that is just what we have applied in unloading our cars. The two Heltzels we put in, have just saved us the price of a motor truck, as the two we now have are doing about as much as three would otherwise, as they are constantly on the move.

"We have just about cut in two the items of salary time and money. The two 2½-ton trucks that we use are filled in an average time of 2 minutes to a load. As far as our experience goes, there seems to be no wear out to these skips."

Frank McInenery, of Easton, Pa., has also had considerable experience with Heltzels and is strongly for anything that reduces unloading time or speeds up the truck. "Our 3-tonners are just about 30 per cent more efficient with two loading skips to help them out," remarked Mr. McInenery, "as we now load one in 2 minutes instead of 15 minutes, which we figure with hand unloading from the gondola. The two Heltzels we have, have been steadily on the job for the past five months, so we have had a good opportunity to size them up."

Another Pennsylvania contractor, J. P. Eyre Price, of Price & Baker, Chester, Pa., brought out still another feature when questioned as to his views of unloading efficiency. "While we are using the same number of shovelers," said Mr. Price, "we are getting the loads out much faster, as the Heltzels have entirely cut out the time loss that was a necessary feature of direct shovel unloading. The shovelers work much more steadily, and the unloading process is over so quickly that our demurrage charges have been practically eliminated."

Much the same opinion was voiced by James Wilson, president of the Warren General Construction Company, Warren, Ohio. "Quite aside from our direct saving in unloading cost," writes Mr. Wilson, "we have been enabled thru the use of our two Heltzel lightning-loader skips to make a considerable saving thru the elimination of demurrage charges. These skips are genuine efficiency aids, and are about the best that we have ever seen."

Tilghman H. Moyer, of Allentown, Pa., is another contractor who has worked out the problems of quick unloading. Mr. Moyer used two Heltzels for transferring material from the car to his 3-ton trucks. "This operation," says Mr. Moyer, "takes us hardly more than two minutes, which seems to us to be quite an item of saving when compared to the nine or ten minutes' loading time which we always used to figure on.

"In our experience we have found that the skips can, if necessary, be fastened to the car by two men, but can be very easily put on by three. We find that our skips are giving us that much-needed quality—ability to stand punishment of hard usage."

Savings even more marked have been made by large industrial companies which have made a study of the loading problem. At the Ohio Works plant of the Carnegie Steel Company 8 Heltzels are in constant operation, working in connection with 30-cu. ft. cars. These cars run on an industrial track, taking material to concrete mixers.

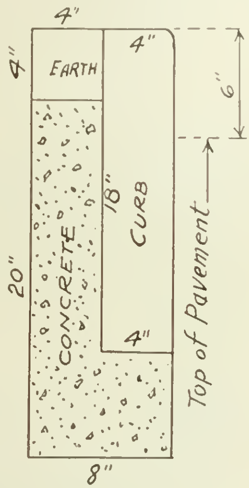
"All our material," said Mr. J. H. Grose, general superintendent of the plant, "is handled from the railroad cars into the Heltzels, and from there discharged into the small dump cars, which take it to the mixer. It is impossible for us to state how many men we eliminate, due to the use of the loader skips, inasmuch as they are part of our whole system for handling our material. It is only by working the whole system together that we make each unit of it successful. This type of skip is handling our concrete aggregate (slag and sand) and gives equal satisfaction on any of these products. They give a clean discharge, do not leak and are fairly easy to handle. They seem to stand up very well under rather hard usage and are giving very good satisfaction."

Sandstone Curbing in Detroit

"Berea natural sandstone curbing, when placed in accordance with our specifications," states Mr. J. G. Hutzel, superintendent of new paving, Detroit, Mich., "would last for at least fifty years.

"We have used Buckeye Berea sandstone for curbing on residence streets particularly, and this grade of stone, altho first placed 25 years ago, is today in excellent condition.

"So far we have not made a very extensive use of sandstone curbing on streets which are subjected to heavy tra..c, nor for circles at intersections of streets and alleys. For circles and retaining stone we have been using granite.



Scale 1/8" = 1"

"We now have over 500 miles of natural sandstone curbing on our streets and will this year lay approximately 35 more miles. Our specifications call for the curb to be 18 in. high, 4 in. thick, no stone to be less than 3 ft. long, top and breast to be neatly dressed with tooth chisel and bullnose 1¼ in. by 1¼ in. on the street side to be neatly dressed off.

"The curb is set on a 6-in. concrete bed and is backed up with a 4-in. concrete wall to within 4 in. of the top. The line adjoining the earth or sidewalk is pitched off at 4 in. The concrete for this work consists of 1 part cement, 3 parts of sharp, clean sand, and 6 parts of ½-in. crushed stone. This concrete adds a great deal of strength to the curb and prevents the frost heaving it up or down or pushing it out of line."

Away with the Wheelbarrow!

As a means of bringing brick up to the setters on a paving job, the wheelbarrow seems to have outlived its usefulness. At least that is what a number of prominent contractors have decided as a result of their search for more efficient methods.

"There is a new era in the paving business," is the way Roehl Brothers, contractors, of Cleveland, Ohio, express it. "We have long since wiped out the old practice of using wheelbarrows to place brick for the pavers, and are using gravity carriers (Mathews type) exclusively. We would not think of going back to the wheelbarrows.

"In our operations we use two sections of carriers. By using four men to each section (two men placing brick on the carriers and two men taking brick off and placing them for the setter), it is no trouble to handle 40,000 brick in an 8-hour day. If we were to handle the same amount of brick by the old wheelbarrow method, we would have to use four men in addition to the number required to operate with the carriers, thus necessitating twelve men where we now do the same amount of work with eight. As far as adroitness is concerned, we find it is impossible to do good work without skilled help. The men who are taking off the brick and setting them must be good brick handlers, which we consider skillful. The men who are putting the brick on the rollers must also be good brick handlers. We find it takes good men to do good work.

"It also can be noticed that the carriers have helped to reduce the number of culls, such as broken and chipped brick, which always happens when dumping the brick from the wheelbarrows, thus saving a number of good brick that would otherwise be culled out because they are chipped. The men also appreciate the carriers in the fact that setting brick with the carriers is less tiresome by far than the old wheelbarrow method.

"With the labor troubles that contractors are experiencing at the present time and without any relief in sight, a saving of four men is a big item, and with the very wide margin that the price of labor has, one can easily see if the price of labor keeps on advancing, the saving in the use of gravity carriers will keep increasing. Our data as to saving are shown below, figured on an 8-hour basis, in which we handled 40,000 brick."

With Mathews Gravity Carriers.

Two men putting brick on rollers at $2.75 per day	$ 5.50	
Two men taking brick off and setting at $3.00 per day	6.00	
	11.50	
Two sections	11.50	$23.00

With Wheelbarrows.

Nine men wheeling at $2.75 per day	$24.75	
Three men setting brick at $3.00 per day	9.00	$33.75
Wheeling cost	$33.75	
Carrier Cost	23.00	
Saving per day	$10.75	

According to John R. Kennedy, of C. Kennedy & Son, Parkersburg, W. Va., this same gravity conveyor not only reduces labor cost, but actually cuts down the percentage of chipped and broken brick.

"We can handle brick much more economically with the Mathews than was possible by the old wheelbarrow method," says Mr. Kennedy, "as it requires only about one-half the number of laborers.

"In using the wheelbarrows it was necessary to have two gangs, one wheeling and one setting up the brick to the brick layers. With the use of the Mathews carrier the wheelbarrow gang is eliminated and the brick is delivered to the layers in better condition, that is, not chipped or broken. With two good bricklayers and 10 or 12 laborers we can lay 50,000 brick per day by handling the brick over the Mathews carriers.

If the opinion of a large user is of any greater weight than that of any other experienced person, the testimony of the Stamey-Mackey Construction Co., should be important. This concern has been handling a large quantity of brick with the gravity system, having in use eight or ten sections of Mathews gravity carriers.

"Our carriers," said Mr. Stamey, in speaking of the efficiency methods he employed, "are all in the 8-ft. length so that they will fit various widths of streets.

"Unless the street is exceptionally wide we use one set of conveyers to each man setting. We find that better time is made by having the brick setters divided up, using several gangs of this kind, than is made with more than one setter or layer to each conveyer. Of course, if the street is 40 feet or more in width then we use two setters. For a narrower street where we are using two or three sections 8 feet long, we use one setter, two men taking brick off the conveyer and setting them in place for the setter and two men taking them from the pile along the curb and putting them on the conveyer.

"A gang of this size will set 600 yards of 3-in. vertical fiber brick or about 20,000 brick in 8 hours. Before using the conveyers, we had 7 men with wheelbarrows for each setter. The chief disadvantages with wheelbarrows were in chipping brick and displacing the ones already laid. If I were a brick manufacturer, I would insist that the contractors use these conveyers as they save many a brick on a year's work."

A slightly different method of using the conveyers is carried out by Stipes & Pilcher, of Champaign, Ill. "We do not handle brick off the parking," writes Mr. Edw. S. Pilcher, of that company, "but take them off the wagons instead and lay them directly into the street. We commence laying brick at the end of a street or intersection and then place 2 by 12 boards for a track to run our loaded wagons on so as to bring them at all times up to the brick laying. In this way, we only handle our brick once.

"On each side of the wagons we use a 16-ft. carrier and have two men putting the brick on each carrier and two at the other end, stacking them for the brick setters. Our average is 35,000 brick laid in a day, all of which are handled with the carrier and it takes eight men to put them on and take them off. We are not compelled to handle the brick so many times and in muddy weather the brick come to the setters clean and the men are not tracking mud in on the new brick before the filler is poured. We always have the right number of brick at hand where if they are stacked on the parking in some places you are a few short or have some left to pick up when the job is finished."

The Mathews gravity brick conveyers referred to by these contractors are all-steel ways provided with rollers over which the brick are carried by their own weight to the setters. They are easily moved on casters which are provided, and are built very strongly to stand the hard usage they are sure to encounter.

Cummer Plants on Large Yardage Jobs

Proof of the ability of the Cummer portable road asphalt plant to handle the biggest sort of a paving job speedily and with uniformity was given by the work that one of these plants did for the city of Elizabeth, N. J., last year. During the year, the Continental Public Works Co., of New York, put down in Elizabeth approximately 40,000 yards of sheet asphalt all prepared with the Cummer machine.

All of this asphalt was laid on a 6-in. concrete foundation. This was a 1-3-6 mix, and was prepared with Koehring mixers, a No. 14 and a No. 16 being used in the work.

On account of the large quantity of asphalt used the entire supply was delivered in tank cars. After being heated by steam coils it was pumped direct into the kettles for further heating. For this work, coal fires instead of steam were used, the heated material then being either pumped or ladled into the measuring boxes. The asphalt then went to the mixer.

The 1,250-yd. Cummer plant which the Continental Co. used on this job is one especially adapted to road work. A sand drum 54 inches in diameter and 13 feet long gives it a capacity of 12 tons of dry sand per hour. The sand bin is divded into two compartments having $6\frac{1}{2}$ tons total capacity. This double bin is provided with rotary screen. In order that each ingredient may be weighed separately the measuring box is put on a 2-beam scale. The mixer is steam jacketed and has a capacity of 7 cu. ft. The asphalt bucket is hung on a 125-lb. capacity double-beam scale.

Sand for the Cummer plant is carried up by a chain bucket elevator, and the hot asphalt is taken up by a similar one. The power plant of the whole machine is a 30-h.p. steam engine.

Even a larger job than the one above was handled by the same plant in the Province of Quebec, Canada. On this work, which Quinlan & Robertson put down, 350,000 sq. yds. of sheet asphalt and 200,000 sq. yds. of Topeka were laid. Two plants were used on this work, the 2,000-sq. yd. railroad plant and the 1,000-sq. yd. portable. Both were worked considerably above capacity.

Quinlan & Robertson in telling of the performance of their portable plant said recently: "Our 1,000-yd. Cummer portable road asphalt paving plant turned out as high as 1,500 yards per day and there were no delays worth mentioning in all of the work. Asphalt for the jobs was heated by standard steam and air process before being delivered to the mixer. Our dryer was the standard Cummer dryer."

Vibrolithic System of Laying Pavement

By R. C. Stubbs, Dallas, Texas.

More than thirty years constant use and study of portland cement and its products has not convinced me that plain concrete is the full answer for municipal and highway pavements, believing that more of the operation should be intrusted to special machines, eliminating as far as possible the unsteady human hand with its personal equation.

The simple method of applying vibration and pressure, used in the placing of vibrolithic, is extremely efficient, flexible, and foolproof, following the mixer and raker over any width of street of any crown, including any combination of intersection formation without change or the slightest variation of efficiency.

KOEHRING PAVER AND PATENTED GASOLINE ENGINE VIBRATOR AS USED IN CONSTRUCTING A VIBROLITHIC PAVEMENT AT WHITE LAINS, NEW YORK.

I recognize the importance of uniform abrasive value in the surface of the slab under traffic, and know that mortar and coarse aggregate would vary in this value, and that it was impossible to secure a surface with uniform amount of either, even with the most carefully compounded and mixed concrete spread and leveled to grade in the street. The vibrolithic system meets this demand by spreading upon the surface of the placed concrete a casting of hard stone immediately ahead of the vibrators that send it down into the surface constituting it a part of the mass, leaving an effectually armored slab behind.

Experience taught me that no concrete is better than its curing, because the period of hydration can be no longer than the moisture state of the mass. I knew that concrete could be forced to retain its moisture in but two ways: One by surrounding the mass with moisture; the other by insulation to prevent evaporation. I was not convinced that it was practical to undertake to keep slabs of large area moist by sprinkling under high temperatures, too much chance for neglect, and in case of sudden drop of temperature below freezing point the water would be no barrier to frost. The vibrolithic system provides an effectual insulation while original moisture is yet in the mass, forcing same to remain for a long period of hydration, shutting out frost in the meantime. The insulating property is in an effectually stuck tar carpet that remains to shield the surfacing stone from actual contact with traffic until the cement bond has sufficient age to resist the shock, since concrete is not concrete until it has an age of several months or even years, for that matter.

I would not have you believe that I claim vibrolithic to be perfect, but the system recognizes laws of nature and traffic not admitted to exist by others, but that are believed to be important by the engineer who knows concrete.

The pavement is laid without expansion joints at the curbs, but with transverse and longitudinal joints of ½ by 3-in. boards left in the bottom half of the pavement. These divide the pavement into slabs 30 feet long by half the width of the pavement. The upper 3 inches of the pavement, however, is monolithic, the joints merely being designed to form vertical planes of weakness where the slabs will crack uniformly instead of irregularly, if they crack at all.

After the concrete is a day or two old a high-speed revolving broom is passed over the surface, and any laitance and surplus mortar is removed, leaving a clean hard stony surface. On this surface is immediately spread a hot tar carpet, covered with pea stone or grit.

The object of the tar carpet is chiefly to protect the concrete during the curing process. It is designed to retain the moisture in the concrete until a complete set has occurred and to save the green concrete from the abrasion of traffic. The tar carpet is claimed to make it unnecessary to keep the concrete dampened or covered with water or earth, as in ordinary practice.

The distinguishing feature of construction, the use of a vibrator, unquestionably produces a very dense concrete. Pieces broken out of old pavements show the stones in close proximity to each other and a smooth, flinty plane of cleavage characteristic of a dense and thoroly hydrated concrete. Both the vibrator and the process involving its use are patented. The machine itself is merely a 4-h.p. motorcycle engine mounted on a steel frame with steel roller wheels. The pulsations of this unbalanced engine are about 1,000 per minute.

The developer of this method of construction sums up its advantages as follows: The vibrations produce density in the entire mass, permit the economical addition of broken stone in the upper portion of the slab and bring to the surface a rich dense mortar to bind the added stone, while the stones being at or near the surface form the ultimate wearing surface. The seal coat of tar covered with pea stone, chats or torpedo sand forms the temporary wearing surface, improves the looks of the pavement, makes it noiseless, gives it a non-skid surface and aids in the uniform curing of the concrete.

Trenching Machine Work

By William W. Brush, Deputy Chief Engineer, Bureau of Water Supply, Department of Water Supply, Gas and Electricity, New York, before the American Water Works Association.

In 1909-1910, the City of New York installed between Valley Stream and Amityville, Long Island, (a distance of 83,800 feet) a 72-in. lock bar 7 16-in. steel pipe as a portion of its Brooklyn conduit system. The contract which was dated November 6, 1908, was awarded to the T. A. Gillespie Co., and the total estimated cost for all the work which included culverts, valve chambers, valves, and other appurtenances, was $1,879,390.

That portion of Long Island traversed by the pipe, is an almost level sandy plain, there being only a few feet difference in elevation between the small valleys and the low intervening ridges. The material to be excavated was sand with some gravel and a light sandy top soil. A right of way, in general 200 feet in width, with few cross roads gave opportunity for the use of any excavating system.

The contractors used practically every known method in excavating the trench, including hand, horse and scraper, clam shell buckets, steam shovels, and the Austin trenching machine. The trenching machine was used for the greater part of the work. It could be and was operated from the shallowest trench section up to a maximum depth of about ten feet, the limiting depth being determined by the resultant width of trench, it being necessary to have a secure track foundation on each side of the trench on which the machine travelled, and by which it was supported. Where the depth of the trench was greater than 10 feet, the contractor removed a portion of the material by other methods and then used the trenching machine.

In a section where the average depth of cut was 8 feet, and the work was performed during a period of one month, data are available on which accurate determination of the cost of excavation by this method can be worked out.

Two machines were regularly employed, working in tandem, one machine removing approximately half the material and the other machine completing the trench. This method was considered to give maximum rate of progress. The contractors were desirous of completing the work as rapidly as possible and the methods adopted were based first on progress and second on unit cost.

The two machines used were not owned by the T. A. Gillespie Co., but were rented from the F. C. Austin Drainage Excavator Co. at a yearly rental of $8,500 and $9,300, respectively. This rental was based on the total yardage excavated by either machine being 100,000 cu. yds. or less, all over and above 100,000 cu. yds. being paid for at the rate of $0.055 per cu. yd. The machines were worked in tandem for the greater part of the work and in many cases for the 24 hours in each day.

To determine the cost per cu. yd. for excavating the trench by use of the trenching machine, a length of trench was taken extending from Sta. 96,952 to Sta. 109,092 or a total of 12,140 feet. The machines were worked in this section three shifts per 24 hours for one month from May 15 to June 16, 1909. An accurate force account was kept by the department for this period.

The total cost of excavating per cu. yd. was subdivided under the following:

(1) Rental of machines
(2) Repairs and coal for machines
(3) Labor force.

The total amount of excavation made by the two machines was approximately 400,000 cu. yds. or 200,000 cu. yds. for each machine. The cost for rental per cu. yd. would therefore be for

Machine No. 1, the first 100,000 cu. yds.......$0.085 per cu. yd.
the second 100,000 cu. yds.... .055 per cu. yd.
Machine No. 2, the first 100,000 cu. yds...... .093 per cu. yd.
the second 100,000 cu. yds.... .055 per cu. yd.
The average for both machines would be $0.072 per cu. yd.

The trenching machine excavated the trench with side slopes of 1 on 1 and the bottom of the trench rounded to conform with the curve of the pipe. The average depth of the trench for the 12,140 feet excavated was approximately 8.0 feet. This gave a total of 48,500 cu. yds. or 4 cu. yds. per linear foot of trench. The repairs on the two machines for the first six months, including the cost of setting up, amounted to $6,000 and the cost of coal for the same period was $2,000. The cost for repairs, coal, etc., for one month would be $1,334 or $0.0275 per cu. yd.

The force included:

(a) The men who operated the machines,
(b) The gang laying and shifting the track and moving machines,
(c) The gang who trimmed the trench to grade after the machine had passed.

This force was as follows:

General foreman, 2 months at $125	$ 250.00
Foreman, 143.5 days at $2.50	358.75
Laborers, 2,368 days at $1.40	3,315.20
Teams, 266 days at $5.00	1,330.00
Boys, 45 days at $0.75	33.75
Engineman, 176 days at $4.00	704.00
Foreman, 171 days at $3.00	513.00
Foreman, 171 days at $3.00	513.00
Skilled laborers, 15 days at $2.00	30.00
	$6,534.70

This cost of labor shows a cost per linear foot of trench of $0.5382 and a cost per cu. yd. of excavation of $0.1345.

The total cost for excavation would be:

Rental of machine	$0.072	per cu. yd.
Repairs and coal for machine	0.0275	per cu. yd.
Labor	0.1345	per cu. yd.
	$0.2340	per cu. yd.

This cost per cu. yd. is equivalent to $0.936 per linear foot of trench.

The following summary of cost of laying the pipe will enable a comparison to be made between the excavation cost and that of other factors in the work:

Clearing and grubbing	$0.037	per lin. ft.
Excavating	.928	per lin. ft.
Unloading and distributing	.1911	per lin. ft.
Laying	.2166	per lin. ft.
Digging bell holes	.084	per lin. ft.
Riveting	.345	per lin. ft.
Calking	.288	per lin. ft.
Testing	.24	per lin. ft.
Backfilling	1.061	per lin. ft.
Cleaning up, etc.	.0994	per lin. ft.
	$3.49	per lin. ft.

It is interesting to note that on this job, the backfilling cost 15 per cent. more than the excavation. The usual experience warrants an estimate to backfill at a materially lower cost than the excavation.

New Kahn Built Bridge

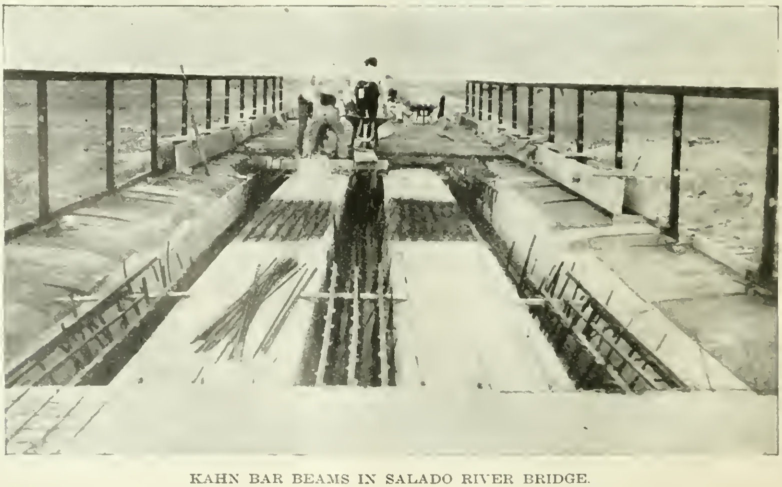
That South America is keeping well abreast of the times in the matter of concrete bridge construction is evidenced by the Kahn system bridge which was recently constructed as a highway bridge across the Salado or Salt river. This bridge is approximately 145 feet long, and is of a clear Kahn type, similar to other structures that the company has erected in other parts of Argentina.

Fully two months of the work were carried forward under extremely trying conditions owing to the heavy February and March floods. The Salado river carries drainage from a large territory, taking the water into a wide expanse of marsh. It is across this marsh at the town of Tintina that the new bridge is constructed.

In every place that concerned mud and high water, the construction problem was a difficult one. While the marsh at low water was only a series of disconnected pools, at high water it covered three miles or more of the flat valley. At bottom was a white clay, very soft in consistency, which could not be crossed with safety except in the dry season.

Owing to the soft bottom it was decided to construct the foundation by sinking piles to a great depth to form a solid foundation. With the possibilities of Kahn beams which are so light, and which have at the same time such an exceedingly great sustaining capacity, the contract was accepted, and a good profit was made.

The superstructure of the bridge is of Kahn standard type with inclined supports. The abutments and the retaining walls for earth show an idea of Messrs. Malmquist which was very little known there, which consists of supporting the sides upon the foundations under the beams, in this way form-



KAHN BAR BEAMS IN SALADO RIVER BRIDGE.

LOADING TESTS ON KAHN SYSTEM BRIDGE.

ing a monolithic construction of light weight, perfectly safeguarding the embankments against the waters rushing underneath.

The principal beams are provided with the famous Kahn bars, and as these bars are rigidly connected with the abutments, they stay in their place once they have been placed, and it is impossible for the workmen to make mistakes on account of carelessness, for which reason the Kahn bars have received the nickname of "fool-proof bars."

The covering of the bridge is of the Kahn reinforced type, with rib metal, which is furnished in large sheets and can be easily handled, so that it is not necessary to bind it with wire, and the uniformity of all sections is assured.

Credit for the successful completion should be divided between Malmquist y Cia., who had complete charge of construction work, and the Trussed Concrete Steel Co., which manufactured the reinforcing and structural steel material.

The Merriman 2,000-yd. Railroad Asphalt Plant

The Merriman asphalt plant made by the East Iron and Machine Co., Lima, O., consists primarily of a heavy steel frame mounted on heavy trucks, on which are mounted the boiler, drying drum, asphalt kettles, mixer, sand-storage and weigh-box, screens and hot and cold elevators, ready for the preparation of asphalt binder and asphalt topping.

The cold sand or stone is fed by elevator into one end of the drum for thoro drying and is conveyed to discharge by internal spiral flights. By the hot elevator it is conveyed to the screen which removes any oversized material and discharges into the hot material bin and drawn as needed thru gates operated by levers into the weigh-box and thence into the mixer.

The melting kettle has two compartments, each with agitators, valves and manholes, for convenience and economy in charging with cold and drawing hot asphalt. The barrels are usually stripped, the asphalt cut up and weighed on the ground and raised by a rotary steam hoist and crane to the kettles which have large manholes in the top. The flux is pumped into the kettles by an oil pump. After charging manhole is fastened on, and steam is turned into the coils within the kettles, thus obviating any burning of the asphalt, a danger with direct fire heat.

The agitator systems are equipped with valves to allow either steam or air agitation. The melted asphalt is conveyed from either kettle thru a steam-jacketed line to the asphalt weigh-box, and then dumped into the mixer. The dust is kept in storage on the mixer platform convenient to the mixer. A dust elevator can be furnished altho not a part of the regular equipment. After mixing, the batch is dumped direct into the wagon, the mixer platform being high enough to permit driving under.

Particular attention is called to the completely steam-jacketed asphalt pipes and fittings, which save valuable working hours thawing out A. C. lines. Attention is also called to the separate power units, making a smooth-running plant and eliminating complete shut-downs as may occur with one engine only.

This plant is 9 feet wide, 14 feet high, and 65 feet long as shipped, being increased in operation 8 feet 6 inches by the extension of the mixer platform. The end of the cab, which drops to form a firing platform for the boiler also adds about 9 feet of length.

Air brake equipment and automatic couplers at each end meet the M. C. B. and Interstate Commerce Commission rulings.

The true shape of the drying drum is insured even after excessive firing, by heavy cast-iron spiders and channel reenforcement. By means of spill plates and cascading a constant and thoro agitation is obtained by this method which will dry material very promptly. All moisture is carried out thru the stack by the hot furnace gases. The drum revolves 8 r. p. m. and it takes about three minutes for material to pass thru it. One contractor took his sand from the lake bed with a scraper and ran it directly thru the drum and kept his plant up to its full capacity, showing the efficiency of the system.

The kettles are well stiffened with angle irons and tie rods. Clean-outs are placed in the bottom of the long leg and also just above the false bottom of the kettle. Safety valves prevent excessive pressure. Agitators are provided and electrically welded pipe coils in each kettle, all condensation being returned to the boiler by the feed pump, thus saving water. Kettles hold 1,265 cu. ft. of asphalt allowing 8-in. space at top.

The tubular marine boiler has about 931 sq. ft. of heating surface. The boiler, 15-h.p. drum engine and gearing for cold stone and sand elevators, throwing either one out of gear, are in the same steel cab, also the air compressor with which to agitate asphalt in kettles and force liquid asphalt to the weigh-bucket.

The hot material storage bin, of about 3 cu. yds. capacity, is sometimes doubled on special order by increasing height on the bin. Enclosed angles are placed inside the bin for placing of partitions if it is desired to screen material into two or more sizes. Special bins containing more gates and partitions can be supplied for making asphaltic concrete and bitulithic.

The mixer is driven by a direct-connected 25-h.p. horizontal engine. The hot sand elevator is driven by an independent 5-h.p. horizontal engine.

The mixer engine, hot elevator engine, and the rotary engine for the hoist are placed on the movable mixer platform, which rests directly on the plant frame when packed and is extended 8½ feet by heavy screws running in babbitted nuts, when set up for operation.

The hot-sand or hot-material bin is raised to its working height by heavy screws working in babbitted nuts. All exposed machinery on the mixer platform is covered with a sheet iron housing.

Low Cost of Handling Water by Gas-Engine-Driven Centrifugal Pumps

The cost of pumping water is made up of two principal elements, viz., first, the fixed charges consisting of interest, repairs, maintenance and depreciation, and second, the cost of fuel. The fuel cost varies inversely as the duty of the engine, but on the other hand reciprocating engines showing the highest duties may also be the most costly, so that what is gained on fuel consumption may be lost in interest and depreciation charges.

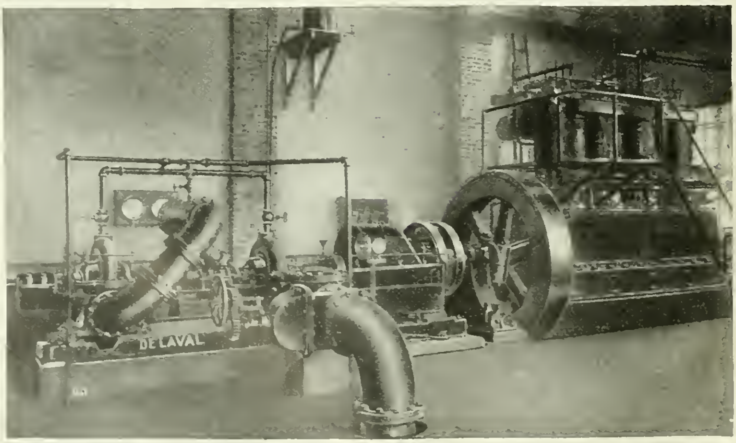
For example, a comparison of the 1,100-h.p. triple-expansion pumping engine at the Bissels Point Station, St. Louis, which upon test showed a duty of nearly 203,000,000 feet pound per 1,000 pounds of steam, with the 1,200-h.p. steam-turbine-driven pump at the Kirtland Station of the City of Cleveland, which showed a duty of slightly over 152,000,000 feet pounds per 1,000 pounds of steam, developed the fact that the unit showing the lower duty was the more economical. The total cost of the reciprocating equipment, including buildings, foundations, boilers and boiler plant complete, was about $195,000, while for the steam-turbine-driven centrifugal pump, it was about $84,000. Assuming both stations to use coal costing 1.70 per ton, the total cost of pumping with the centrifugal pump was $23.08 per water-horse-power year of 365 days of 24 hours each, as against $27.60 for the reciprocating pump. Of these amounts, approximately $17.50 for the centrifugal pump and $13.50 for the reciprocating pump represented fuel.

In some localities natural gas of high heat value can be obtained at remarkably low cost. Taking advantage of this fact and of the superior efficiency of the gas engine as compared with the steam engine, the City of Clarksburg, W. Va., has been able to reduce the fuel cost of pumping to about $7.00 per water-horse-power per year.

The pumping equipment recently put in service at Clarksburg consists of a 50-h.p. gas engine driving thru speed increasing gears a 4,000,000-gal. per day De Laval centrifugal pump, which delivers water against 35 feet head to the filter bed, and a 350-h.p. gas engine running at 200 r. p. m., driving thru double-helical speed-increasing gears a De Laval two-stage centrifugal pump, delivering 4,000,000 gallons per day against 350 feet head to the city reservoir. The latter unit is illustrated herewith.

The gas engine was guaranteed by the maker to deliver a brake horse-power on 10 cu. ft. per hour of gas of a heating value of 1,000 B. t. u. per cu. ft. During a ten days' continuous run the total consumption of the high-service and low-service pumps together was found to average 82,200 c. ft. of gas per day. During this run the capacity was kept up to 4,100,000 gallons per day, the high service pump delivering against about 330 feet head, and the low service pump against 30 feet head, a total of about 258.5 water-horse-power. The gas is received from wells near by belonging to the city and is charged for at 6 cents per 1,000 cu. ft., altho the commercial power rate in that locality is about 8 cents. The fuel cost of a water-horse-power would be $6.96 per year at 6 cents and $9.27 at 8 cents.

Formerly water was supplied by engine-driven centrifugal low-service pumps and duplex direct-acting high-service pumps, receiving steam from gas-fired boilers. With this equipment the gas consumption was about 350,000 cu. ft. per day, at a pumpage rate of approximately 3,000,000 gallons. When additional capacity and new equipment became necessary, the Clarksburg Water and Sewerage Board, and their engineer, Geo. W. Fuller, made a careful investigation of the



HIGH PRESSURE GAS-ENGINE-DRIVEN CENTRIFUGAL PUMP OF THE CITY OF CLARKSEBURG, W. VA.; CAPACITY 4,000,000 GAL. PER DAY AGAINST 350 FT. HEAD; ENGINE SPEED 200 R. P. M.; PUMP SPEED 1,385 R. P. M.

following: steam-driven centrifugal pumps, steam-driven crank-and-fly-wheel pumping engines, gas-engine-driven direct-acting pumps and gas-engine-driven centrifugal pumps.

The preliminary estimates showed that the best gas consumption with steam-driven pumps would be about three times that of gas-engine-driven pumps and, in view of the rapid depletion of the natural gas supply in the neighborhood, it was deemed advisable to put in the more economical, altho more expensive, equipment in order that the city's gas wells might last as long as possible.

Bids were finally requested on gas-engine-driven direct-acting pumps and gas-engine-driven centrifugal pumps. The units offered by the Dravo-Doyle Co., of Pittsburg, involving the use of double-helical speed-increasing gears driving high-efficiency, high-speed centrifugal pumps were accepted because of the high over-all economy and the greater simplicity and lower expense for maintenance of the centrifugal type of pump, together with saving in floor space and a very material reduction in the first cost of the equipment.

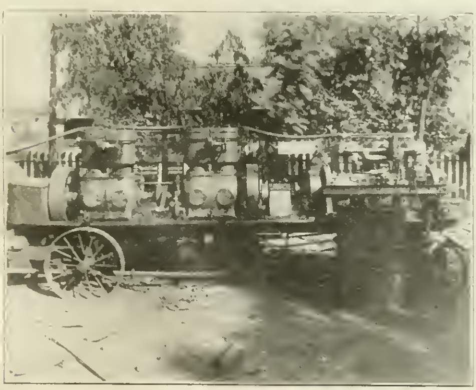
The complete cost of the pumping equipment, was approximately \$17,500. The cost of the substructure, superstructure, crane, piping and appurtenances complete was \$13,905, or a total of \$31,405. The annual interest, depreciation and upkeep charges upon this amount at 8 per cent. would be \$2,512.40 per year, or \$9.71 per water-horse-power, giving a total cost of pumping, exclusive of attendance and supplies, of \$16.67 per water-horse-power year of 365 days of 24 hours each. For 16 hours operation the cost would be \$14.35. These figures compare favorably with those previously cited for much larger steam-driven pumping units.

New Asphalt Repair Wagon

To meet the demand for an asphalt repair outfit of low cost and available for the use of municipalities where no asphalt plants are located, the Iroquois Works of The Barber Asphalt Paving Company have devised an asphalt repair wagon capable of supplying material for from 50 to 75 sq. yds. of patching per day. The total weight of the outfit is only two tons. It can be used to remelt old asphalt paving or cakes of new mixture made at a larger plant and stored, for heating sand and stone with asphalt cement to make new mixtures, and as a sand, gravel or stone drier or substitute for a melting kettle. The wagon is supplied with a full outfit of paving tools.

Interesting Compressed-Air Outfit

The accompanying photograph shows an interesting installation of a Wisconsin motor in Los Angeles, Cal. The motor is shown driving two double 8 by 6 Rix-Gardner air



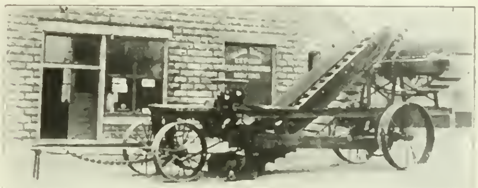
compressors, with a capacity of 280 cu. ft. of air per minute, against 125 pounds working pressure.

This motor has 5 cylinders with a 5¼-in. bore and a stroke of 7 inches. The speed of the motor is 800 r. p. m., and of the compressors 400 r. p. m. The Los Angeles job has a 10-hour operating day, furnishing aid for pneumatic hammers and drills.

The motor is that of the Wisconsin Motor Manufacturing Co., Milwaukee, Wis. The Gardner Governor Co., Quincy, Ill., and the Rix Compressed Air & Drill Co., San Francisco, Cal., are responsible for the air compressors.

Combination Grader and Loader

The combination grading and loading machine here illustrated has been devised and perfected to reduce the cost of all grading operations. It consists of a plow and scraper with a conveyor and cross-conveyor which carries the material shoveled from the roadbed directly into a wagon which follows the machine.

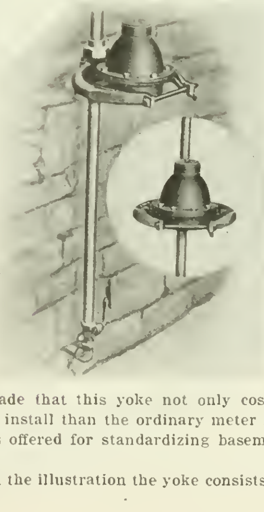


It is claimed that the only limit of this machine is the power of the tractor attached to haul it, or of the teams hitched to it. With a 24-h.p. road tractor the inventor states that it will load 2,000 yards in 10 hours and that it will handle any and all kinds of material that a wheeled scraper can take care of.

The machine was devised and will be manufactured by Harry L. Barton, of Gary, Ind.

A New Vertical Pipe Meter Frame

To meet the demand for a cheap practical device for setting meters on basement pipes the Ford ram's horn meter yoke has recently been perfected.



Claim is made that this yoke not only costs less, but is much easier to install than the ordinary meter fitting. By its use a means is offered for standardizing basement meter settings.

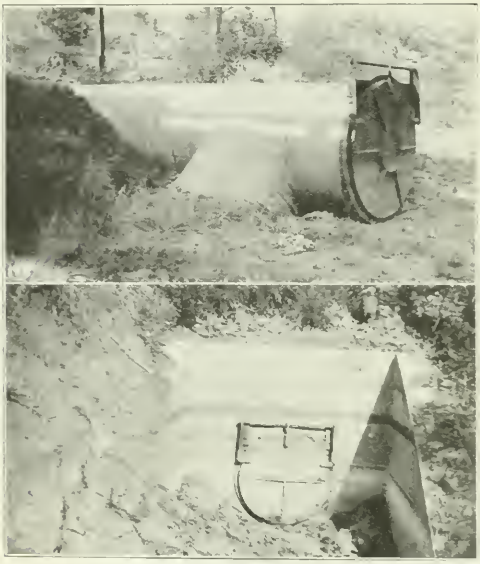
As shown in the illustration the yoke consists of two hollow pivoted members, thru one of which the water flows to the meter, the other carrying it to the house service pipes. A single nut clamps the meter between the two members of the ram's-horn setting and sealing the meter is thus made easy.

The ram's-horn yoke has the special advantage of offering a very direct path to and from the meter, with extremely little resistance to flow at any point. Each meter is tested to 200 pounds pressure.

Regular meter connections are unnecessary, and the device will take any standard $^5/_8$-inch meter or $^5/_8$-inch meter with $^3/_4$-inch spuds.

Automatic Drainage Gates

The accompanying photographs show, one an automatic drainage gate mounted on the end of a corrugated iron drainage culvert where it serves to prevent the back flow of water when the stream into which the culvert discharges rises above the cutout; and the other a similar gate installed on the concrete end wall of a similar culvert.



These drainage gates are automatic, remaining closed unless the pressure of water behind them is enough to open them, and so remaining closed whenever the water in front of them rises above the gate to any extent.

They are used also for discharging drainage water from streets into irrigating or other canals which at times are full enough of water to back up on the streets if the outlets are left open.

Trade Notes

The Road-Maker, heretofore published at Moline, Ill., is now published by the International Trade Press, 515 Monadnock Block, Chicago, Ill. Joe L. Long continues as editor and manager and H. E. Hopkins as managing editor. This organization recently took over the *Cement World* and its latest accession is the *Electrical Review and Western Electrician*.

The Copeland-Inglis Shale Brick Company, Birmingham, Ala., has become a licensee of the Dunn Wire-Cut Lug Brick Company of Conneaut, Ohio, and will henceforth make wire-cut lug paving brick. This is one of the largest and most important paving brick companies in the South.

A. F. Ehrbar is now the general manager of the Duplex Mfg. and Foundry Co., and their office has been removed to Elyria, O.

Grangers Lime Co., West Stockbridge, Mass., is distributing small samples of finely ground limestone dust, suitable for use as asphalt filler and the like.

Trade Publications

The Lehigh Portland Cement Co. has issued the standard specifications and tests for portland cement adopted by the American Society for Testing Materials in handsome board binding. Another publication of the company gives forty-one reasons why concrete should be selected for modern construction, by D. V. Moore, C. E.

Studebakers, South Bend, Ind., have issued a municipal portfolio of handsome reproductions in color of photographs of their various street sprinklers and sweepers, garbage and refuse collection wagons and carts and road oilers.

The Spray Engineering Co., 93 Federal St., Boston, Mass., issue a general catalog, No. 501, briefly illustrating their lines of sprinklers for cooling water, sprinkling lawns and parks, spraying trees, applying bitumen to roads, etc. .

Pioneer expansion joints are fully described in a booklet of the Pioneer Asphalt Co., Lawrenceville, Ill., including filler asphalt, premolded joints ready for insertion in the pavement, for concrete, brick and block pavements, with full specifications for the same.

The Sewer Pipe Manufacturers' Association, Akron, O., has issued a pamphlet "About Culverts," giving much valuable information about the use of vitrified clay pipe for culverts and side drains.

Bulletin A-5 of the Hydrated Lime Bureau, Pittsburg, Pa., is entitled "Modern Methods in Concrete Construction."

The Huber Mfg. Co., Marion, O., in a circular on new roads from old materials, describes the process of scarifying a macadam or gravel road, smoothing it and rolling it back into place, using their machinery in the processes.

The Galion Iron Works & Mfg. Co., Galion, O., are distributing an illustrated circular entitled "Galion Ideas Save Your Dollars," in which their cast iron and corrugated iron culverts, gravel screening plants, road drags, grading machines and scarifiers are shown.

Cressy Contracting Co. have a small circular illustrating their asphalt and oil sprayers for pressure distribution in road treatment of hot or cold bitumens of all grades.

About a year ago there appeared in several of the technical journals, an account of a test on a centrifugal pump installed at the Low Level Pumping Station of the City of Montreal, showing a duty considerably above any previously recorded for steam-turbine-driven centrifugal pumps. In answer to certain criticisms as to the method of figuring the duty, which was based upon the total heat taken by the turbine from the boiler, rather than the amount of steam used, and also regarding the omission of certain data from the test report, an article was prepared by A. Peterson, an engineer of the De Laval Steam Turbine Co., of Trenton, N. J., which the latter company has reprinted and is distributing in booklet form. The use of net B. t. u.'s as the basis upon which to calculate duty is defended upon the grounds that the user is interested in obtaining the most foot pounds from a given amount of heat, rather than the smallest weight of steam. It is shown that a heat cycle which may appear more efficient upon the basis of steam used, may at the same time be the less efficient upon the basis of heat used. Users of steam turbines will be interested in the detailed analysis of the turbine performance.

FIRE DEPARTMENT

Traction and Non-Skid Devices for Motor Fire Apparatus

Most fire chiefs have given the problem of securing traction on bad roads considerable thought and have personally tested or developed devices for overcoming their local difficulties. Conditions and ways of meeting them are, of course, largely governed by the geographical location of the city, but Olaf Johnson, fire chief for the city of Superior, Wis., has made some observations which should interest fellow chiefs wherever they may be.

"The Superior fire department," says Chief Johnson, "has to cover a territory of 47 sq. mi., much of which consists of clay streets that get into boggy condition after the heavy rains. Oftentimes these streets become practically impassable for heavy apparatus and the mud gets so deep as to make tractor for motor apparatus impossible.

"Under such conditions as these we have hesitated to add extra weight to our equipment. At the present time we have four pieces of motor apparatus in service, namely: one triple combination pumper, chemical and hose, in service nine months; one tractor for aerial truck, in service 2½ years; one auxiliary squad, in service nearly 5 years; and one chief's car, in service over 5 years. The only traction device we have used during these years is what is generally known as the Weed tire chains. We use these chains on all wheels during the winter, as we find it much easier to steer the apparatus when using chains on the front wheels. On the aerial truck we use heavy chains on the driving wheels, with cross chains reaching across the solid dual tires and a light center chain attached to each cross chain with a light ring and cold-shut. The function of the light center chain is to hold in place any cross chain which may break during a run so as to keep it

KISSEL KAR COMBINATION CHEMICAL AND SQUAD WAGON AS OPERATED BY MANY MIDDLE WESTERN MUNICIPALITIES.

from getting into the sprocket wheel or damaging the truck in any way. On the front wheels we use lighter chains, as they are not subjected to any strain.

"On our triple combination we use heavy chains on the outside units of the dual tires on the rear wheels for traction and lighter chains on the front wheels. The rear chains are kept on at all times, summer and winter, as we have to get off the pavements at times with this rig and must be prepared for it.

"However, I am satisfied that we cannot get along successfully and get traction under all conditions without chains reaching clear across the dual tires, and for that reason I have adopted the device gotten up by Chief Aungst of East Liverpool for use in addition to our other chains when road conditions are very bad. This device was introduced last year. It consists of several short chains, each long enough to go around the rim and tires of the wheels. A short piece of chemical hose is pulled over the chain to protect the rim and the ends of the chain are connected by a patent link, making it easy to put on and take off. If necessary, one of these chains may be put on for every spoke in the wheel.

"Our auxiliary squad is a comparatively light car with pneumatic tires, dual on rear wheels, and we use the same system or traction device on this car as we do on the triple combination, except that we use a lighter chain. On my own car the common Weed chains are used, both front and rear, when necessary. We inspect the chains frequently and replace the cross chains when they become worn so that they are apt to break.

"We buy a good grade of chain in bulk, cut them the right length and insert them ourselves when needed. For very bad road conditions I believe that the Aungst device is the best that has been brought to my attention.

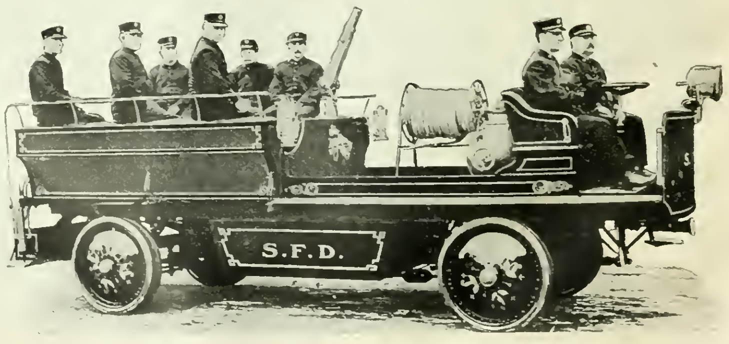
"There have been other devices introduced and placed upon the market, but I have had no experience with them personally. Some of these devices are widely advertised as possessing great merit, which in many cases is testified to from seemingly reliable sources. We must not lose sight of this fact, that a device which might give satisfaction in your town may fail in mine, and a system which would answer the purposes in Ohio might not work successfully in Manitoba. Our city is perfectly level and our sister city, Duluth, is extremely hilly, so there you see my friend, Chief Randall, has a worse problem to solve than I have, tho the climatic conditions in both cities are the same. In summing up I might express my experience, as far as it goes, in this way: it takes chains under the tires to secure traction in snow and mud, and the deeper the snow and mud, the more chains it takes.

"It is safe to say that the builders of motor apparatus are furnishing plenty of power to take their machines thru all kinds of roads, if traction can be obtained, but they do not always furnish the best traction devices. I have seen some of the finest and most powerful apparatus sent out to places where road conditions are of the worst kind with driving wheels running so close that chains could not be used. The best machine is useless if it cannot be brought where it is needed, and manufacturers should give more thought to this important feature in developing the efficiency of their product.

"In connection with this subject I want to bring to your attention a device for raising the weight of the heavy apparatus off the tires. I believe we all feel that the constant pressure exerted upon the rubber by the heavy apparatus causes rapid deterioration and that this pressure should be relieved if possible.

"This contrivance is my own invention and you can have it made in your own repair shop for less than $3.00 for each set of wheels. It consists of a common jackscrew with a T-iron crossbar swinging free on a plate on the top of the jack and held in place by a link connection. The crossbar catches the axle at two points near the springs and by turning the screw the axle may be raised to release the pressure on the tires. With the brake set, it will stay in position, but as soon as the brake is released it will trip. It will not need to be removed, as the rear wheels cannot strike it and it requires little effort to operate. It can be used under front and rear wheels alike, as it can be made to fit any axle and conform to any height."

COUPLE-GEAR 3½ TON HOSE AND CHEMICAL (BATTERY-DRIVEN), AS OPERATED BY THE CITY OF SPRINGFIELD, MASS.



Motor Apparatus in Fire Departments

(Continued from May number, page 265. See April number for explanatory note.)

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Pennsylvania—													
Mt. Carmel	ch ho	Am.-La France	2	4	70	1,200	40	32					
	pp ho	Am.-La France	1	4	70	1,200	6	32					
Mt. Pleasant	ch ho	Am.-La France	1	4	70	1,200	40	32					
Munhall	ch ho l	White	6	4	30	750	60	180	100	31			
Nanticoke	ladd	Am.-La France	1	4	70			235					
New Castle	chf	Ford	3½	4	22		6	0	18,000	289	125.00	96.35	
	ch hc	White (2)	3½	4	45	1,200	40	36	291a	83a	75.50a	44.50a	540.00a
	pp ch ho	Knox	5	6	64	1,000	40	36	165	128	66.50	55.00	270.00
	pp ch hc	White	0										
New Kensington	ch ho	Hale											
Newville	pp ch hc	Am.-La France	½										
Norristown	ch	Am.-La France	3	4	70	200	120	32					
Old Forge	pp ho	Am.-La Fr. (2)	2	6	100	1,200	6	32					
	pp	Am.-La France	½					244		3879a			
Philadelphia	ladd	Webb	4	4	50			244e					
	ladd	Boyd (8)	½	4	67			244e					
	ladd	Seagrave (2)	2	4	80								
	chf	White	4	6	60								
	chf	Cole (6)	4	4	45								
	chf	Ford (9)	1	4	22								
	ho ch	Alco	4	4	40	2,300e							
	ho ch	Mack (11)	5	4	60	2,300e							
	ho ch	Boyd (4)	5	4	50	2,300e							
	ho ch	Commer. (4)	2	L	13	2,300e							
	tr	Commer. (2)	3	L	13	1,250e							
	tr la	Webb	4	4	50	2,300							
	tr la	Knox-Martin	4	4	60	2,300							
	tr la	Commercial	2	L	13	2,300							
	tr la	Christie (4)	2	4	50	2,300e							
	tr la	Couple-Gear (2)	4	4	60								
	tr st	Webb	3	L	13								
	tr st	Boyd (11)	2	4	50								
	tr st	Commer. (3)	2	L	13								
	tr st	Couple-Gear	3	4	60								
	sup	Mack	3	4	50								
	sup	Peerless	10	4	40								
	sup	Knox-Martin	1	4	40								
Pittsburg	chf	Chalmers	1	4									
	chf	Overland (9)	2	4	29								
	ch ho	Am.-La Fr (13)	4	4	70	1,200	70						
	tr	Am.-La Fr. (7)	1	4	70								
	tr st	Am.-La Fr (8)	1	4	70								
	tr	Various (7)	2	4	90								
	ch ho	Hale	0										
	ch ho	Various (14)	4	4	48	1,000	40	36					
	ladd	Various (8)	4	4	48								
Port Carbon	ch ho	Waterous											
Pottstown	pp ho	Am.-La France	2	6	100	1,200	6	32					
Pottsville	chf	Stutz	3	4	90		35		100	11	200.00	5.00	
	pp ch ho	Robinson	6	6		1,250		80					
	ch ho	Knox				1,000	35	71					
	ch ho	Boyd				1,000	35	71					
	ch ho	White (2)				1,000	35	71					
	ch ho	Wonders				800	35	31					
Punxsutawney	pp ho	Am.-La France	2	6	100	1,200	6	32					
Rankin	ch ho l	Stegeman	1-12	6	50	1,200	40	36	33	41			
Reading	ch ho	Am.-La France	5										
	pp ho	Am.-La Fr. (2)	3	6	200	1,200	6	32					
	ae	Am.-La Rrance	½	4	70								
	ch ho	Am.-La France	½										
	st tr	Am.-La France	½	4	70								
	tr	Am.-La France	½	6	73								
Renovo	ch ho	Am.-La France	3	6	55	1,400	40	32					
Ridley Park	ch ho	Waterous											
Sayre	pp ho	Am.-La France	½	4	70	1,200	6	32					
Scranton	ch ho	Am.-La Fr. (3)	4	4	70	1,200	70	32					
	ae	Am.-La France	1	6	100		6	177					
	ladd	Am.-La France	1	4	70			235					
	ch ho	Am.-La France	1										
Sellersville	ch ho	Brockway	1										
Shamokin	ch ho	Am.-La France	2	6	100	1,200	70	32					
Shenandoah	ch ho	Am.-La France	½	4	75	1,000	75	45					
	pp ho ch	Boyd	2	6	90	1,200	120	45		12			
Somerset	ch ho	Am.-La France	2	4	70	1,200	70	32					
Spring City	pp ch ho	Am.-La France	½	6	100	1,200	40	32					
Susquehanna	ch ho	Brockway	1	4	42	1,400	40	32					
Swarthmore	ppg ho	Am.-La France	3	6	100	1,200	6	32					
Taylor	ch ho l	Brockway	2	4	40	1,000	50	16	30	15	0		
Trainer	pp ch ho	Am.-La France	½										
Uniontown	ch ho	Knox	1	4	70	2,000	70	72	80	72	25.00	90.00	730.00
Warren	ch ho	Am.-La France	4	4	70	1,200	70	32					
Waynesboro	ladd	Am.-La France	½	4	70			235					
West Chester	pp ho	Am.-La France	3	6	100	1,200	6	32					
Wilkes-Barre	chf	Stutz	1	4	36		6		2,000	250			
	pp ho	Am.-La France	3	6	82	1,200		48	800				
	ch ho	(8)	8	4	50	1,200	35	50	4,000				
	pp st	(2)	3	4	90				500				
	tr	(4)	3	4	90				1,000				
Wilkinsburg	ch ho	Am.-La France	4	4	70	1,200	70	32					
Williamsport	pp ho	Am.-La France	2	6	100	1,200	6	32					
Williamstown	ch ho	Am.-La France	1										
Windber	ch ho	Seagrave	3	6	90	1,400	75	32	100	30	250.00		
	ladd	Mitchell	16	6	70			130	100	30	75.00		
Woodlawn	ch ho	Am.-La France	½										
Rhode Island—													
Central Falls		Has no motor apparatus at present.											
East Providence	ch ho l	Alco	5	6	60	1,000	50	54	253	96	526.15	35.00	
Newport	chf	Overland											
	ch ho	Am.-La Fr. (4)	3	4	70	1,200	40	32					
	pp ho	Am.-La Fr. (3)	1	6	100	1,200	6	32					
	ladd	Am.-La Fr. (2)	1	4	70			235					
	st	Two in reserve drawn by motor.											

	Kind	Maker	Years Service	Cyl.	H.p.	Ft. Hose Carried	Gal. Chem. Carried	Ft. Ladder Carried	Mi. Trav. Last 12 Mo.	Alarms Last 12 Mo.	Cost of Repairs Last 12 Mo.	Cost Gas. and Oil Last 12 Mo.	Cost Maintenance Same Horse Equip.
Providence	ch ho	Am.-La France	2	4	70	1,200	40	32	....	....	....	....	....
	sal	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La Fr. (5)	½	6	100	1,200	6	32	....	....	....	....	....
	ae	Am.-La France	½	4	70	....	...	...	....	....	....	....	....
	ladd	Am.-La Fr. (2)	½	4	70	....	...	235	....	....	....	....	....
	tr	Am.-La France	½	6	73	....	...	...	....	....	....	....	....
Warren	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Woonsocket	chf	Rambler	3½	4	32	....	6	...	5,500	312	....	....	....
	ch ho	Pope-Hart. (2)	3	4	50	1,000	46	32	....	....	....	....	....
		Knox (1)	3	4	50	1,000	46	32	....	....	....	....	....
	ladd	Seagrave	3	4	90	....	...	350	....	....	....	....	....
South Carolina—													
Aiken	ch ho	Am.-La France	3	4	70	1,200	40	32	....	....	....	....	....
Anderson	ch ho	Am.-La France	4	4	70	1,200	40	32	....	....	....	....	....
Columbia	chf	White	5-6	4	35	....	40	...	....	200	28.00	16.00	....
	ch ho	Am.-La France	5	4	70	1,000	46	30	485	425	84.40	33.90	....
	pp ho	Am.-La France	2	6	120	1,200	6	32	363	221	134.10	92.00	....
	ae	Seagrave	2	6	80	....	6	255	347	225	187.60	40.80	....
	pp ho	Robinson	2	6	110	1,750	6	30	236	200	143.25	80.80	....
	pp ho	Webb	..	6	72	1,750	6	30	247	142	127.00	79.50	....
Gaffney	ch ho	Am.-La France	4	4	70	1,200	40	32	....	....	....	....	....
Georgetown	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Greenville	ch ho	Am.-La France	1	6	100	1,400	40	32	....	....	....	....	....
Laurens	pp ho	Am.-La France	1	4	70	1,200	6	32	....	....	....	....	....
Manning	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
Orangeburg	ch ho	Am.-La France	4	4	70	1,200	40	32	....	....	....	....	....
Rock Hill	pp ch ho	Am.-La France	4	6	95	1,000	46	36	199	....	6.00	100.83	489.40
Spartanburg	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
Union	ch ho	Am.-La France	3	4	70	1,200	40	32	....	....	....	....	....
South Dakota—													
Aberdeen	chf	Studebaker	1-12	6	40	350	25	...	100	1	....	10.00	....
	ch ho	White	2	6	80	1,200	40	40	200	66	23.00	60.00	264.00
Sioux Falls	ladd	Am.-La France	1	4	70	....	...	235	....	....	....	....	....
	ch ho	Am.-La France	1	6	100	1,200	6	32	....	....	....	....	....
Tennessee—													
Bristol	ch ho	Am.-La France	3	4	75	1,200	40	32	....	....	....	....	....
Chattanooga	ho	Am.-La France	1	6	75	1,000	6	32	289	92	6.00	41.80	....
	tr st	Am.-La France	1	6	75	....	...	...	165	43	1.45	27.33	....
	pp ho l	Am.-La France	2-3	6	70	1,000	40	32	193	91	14.91	66.25	....
	pp ho l	Am.-La France	1	6	70	1,000	40	32	244	119	77.84	51.41	....
	pp ho l	Am.-La France	¾	6	70	1,000	40	32	306	65	2.50	76.54	....
	pp ho l	Webb	..	..	...	....	...	...	158	27	394.28	32.95	....
	pp ho l	Am.-La France	..	6	70	1,000	40	32	46	181	25.50	89.07	....
	pp ho l	Am.-La France	..	6	70	1,000	40	32	594	175	5.56	140.42	....
	pp ho l	Am.-La France	..	6	70	1,000	40	32	692	91	22.05	85.20	....
	ch	Am.-La France	..	4	45	....	105	32	1,398	333	98.05	97.30	....
	ae	Am.-La France	..	6	100	....	6	...	351	124	6.55	64.07	....
	sup	(1)	..	..	...	....	...	...	....	....	....	....	....
	chf	(3)	..	..	...	....	...	...	....	....	....	....	....
Clarksville	pp ho	Am.-La France	3	6	100	1,200	45	40	900	35	10.00	....	....
Cleveland	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Columbia	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Humboldt	ch ho	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Jackson	pp ho	Am.-La France	4	6	100	1,200	6	32	....	....	....	....	....
Johnson City	pp ho ch	Am.-La France	2½	4	110	1,000	54	24	154	63	3.50	74.00	....
Knoxville	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
	pp	Am.-La France	1	..	...	....	...	...	....	....	....	....	....
Memphis	sal	Am.-La France	5	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La Fr. (2)	4	6	100	1,200	6	32	....	....	....	....	....
	ladd	Am.-La France	3	4	70	....	...	235	....	....	....	....	....
	sal	Am.-La France	2	4	70	....	...	...	....	....	....	....	....
	pp	Am.-La Fr. (2)	½	..	...	....	...	...	....	....	....	....	....
Morristown	pp	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Mt. Pleasant	ch ho	Am.-La France	1	6	100	1,200	40	32	....	....	....	....	....
Murfreesboro	ch ho	Am.-La France	½	6	100	1,200	40	32	....	....	....	....	....
Nashville	chf	Marathon	6	..	35	....	4	...	....	....	....	120.00	....
	pp ho	Am.-La Fr. (6)	4	6	100	900	35	30	705	137	210.00	51.91	597.32
	tr	Am.-La France	2	6	100	....	6	200	231	150	3.00	43.00	450.00
Paris	ch ho	Am.-La France	2	4	70	1,200	40	32	....	....	....	....	....
Park City	pp ho	Am.-La France	4	4	70	1,200	6	32	....	....	....	....	....
Shelbyville	pp ch ho	Am.-La France	½	6	55	1,400	40	32	....	....	....	....	....
Union City	ch ho	Am.-La France	½	4	70	1,200	40	32	....	....	....	....	....
Texas—													
Abilene	pp ho ch	Am.-La France	3	4	75	1,200	35	32	....	94	3.40	100.25	396.00
Amarillo	chf	Staver	1	4	60	....	...	...	879	....	0	26.00	....
	ch ho l	Am.-La France	5	4	76	1,200	35	28	24	79	0	....	....
	pp ho	Am.-La France	2	6	105	1,200	...	32	232	79	0	....	....
	ch ho l	Cadillac	3½	4	40	850	35	28	315	79	0	101.00a	....
Austin	chf	Ford	..	..	...	....	...	...	5,000	....	....	....	....
Ballinger	pp ho	Am.-La France	½	4	70	1,000	6	32	....	....	....	....	....
Bastrop	ch ho	Brockway	1	4	30	200	30	26	....	....	....	....	....
Beaumont	chf	White	3	..	40	....	...	...	....	198	2.25	....	....
	ch ho	Am.-La France	3	..	72	1,200	35	32	....	198	1,785.00	....	....
	pp ho	Ahrens-Fox	2	..	80	1,200	...	34	....	104	....	....	....
Belton	ch ho	Am.-La France	3	4	70	1,200	40	32	....	....	....	....	....
Bonham	ch ho	Am.-La France	3	4	70	1,200	46	32	....	....	....	....	....
Brady	pp ho	Am.-La France	2	6	100	1,200	6	32	....	....	....	....	....
Bryan	ch ho	Am.-La France	4	4	70	1,200	40	32	....	....	....	....	....
Cameron	pp ho	Am.-La France	½	4	70	1,000	6	32	....	....	....	....	....
Cisco	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Cleburn	ch ho	Am.-La France	1	6	55	1,400	40	32	....	....	....	....	....
	ladd	Am.-La France	1	6	55	....	...	235	....	....	....	....	....
Coleman	pp ch ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....
Colorado	ch ho	Brockway	1	4	42	1,400	40	32	....	....	....	....	....
Cooper	pp ho	Am.-La France	3	4	70	1,000	6	32	....	....	....	....	....
Corpus Christi	pp ho	Am.-La Fr. (2)	3	6	100	1,200	6	32	....	....	....	....	....
Corsicana	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
Dallas	chf	Cadillac	1	..	...	....	...	6	....	....	....	....	....
	chf	Cadillac	½	..	...	....	...	40	....	....	....	....	....
	chf	Stud., Garford	5	..	...	....	...	40	....	....	....	....	....
	chf	Studebaker	5	..	...	....	...	40	....	....	....	....	....
	pp ho	Am.-La France	3	6	100	1,200	6	32	....	....	....	....	....
	pp ho	Am.-La France	2	6	100	1,400	40	32	....	....	....	....	....
	ch ho	Am.-La Fr. (2)	3	6	200	1,200	6	32	....	....	....	....	....
	pp ho	Webb (3)	5	..	...	....	...	...	....	....	....	....	....
	ladd	Webb	4	..	...	....	...	...	....	....	....	....	....
	pp ho	Am.-La France	½	..	...	....	...	...	....	....	....	....	....

Contracting News

AUTOMOBILES, FIRE APPARATUS AND MOTOR EQUIPMENT.

Bristol, Conn.—Board of Fire Commissioners will commence negotiations at once for purpose of securing prices and providing demonstrations of fire engine.

Chamberlin, S. D.—Residents of Pukwana Township, Brule County, voted to purchase traction engines and graders for purpose maintaining good roads.

Cincinnati, O.—Planning for purchase of 15 units of automobile fire fighting apparatus. Purchase made available thru receipt of $127,000. Fire Chief Houston. Three tractors, two service trucks, one aerial truck, one combination hose wagon, chemical and life saving apparatus, four 1,000-gal. combination pumpers, 4 800-gal. combination pumpers.

Columbus, O.—Ordinance appropriating $1,000 for purchase auto truck to supplant service of two horses and wagons in waterworks department. Will have favorable report at council meeting.

Cleveland, O.—City Board of Control authorized purchase steam roller and two trucks to be used in road improvement.

Greenfield, O.—Ordinance passed to issue $7,000 bonds for purpose paying cost and expenses of purchase motor fire truck and necessary equipments. E. M. Conner, Village Clerk.

Louisville, O.—Agitation for purchase of light auto fire engine is being made by the business men of town.

Mt. Gilead, O.—County Commissioners negotiating for purchase another automobile truck of 5 tons to assist in road construction work.

New York, N. Y.—Resolved that Fire Commissioner is authorized and empowered to purchase five gasoline pumping engines, five hook and ladder trucks, fifteen tractors and ten hose wagons. Total cost not to exceed $194,500.

Schuylkill, Pa.—Boyerstown Council passed an ordinance for purchase $9,000 auto apparatus for Friendship Hook & Ladder Co.

Stevens Point, Wis.—City Council authorized purchase fire automobile truck, $5,600.

Weehawken, N. J.—West New York Town Council authorized bond issue of $30,000 for purchase of motor-driven fire equipment, including two combination pumping engines, 1,000-gal. capacity, and one hose tender. Bids will soon be asked.

BRIDGES.

BIDS REQUESTED.

Bedford, Ind.—June 23, 1 p. m., Lawrence County Commissioners, for unfinished work on Salt Creek bridge in Shawswick Township. E. W. Edwards, Auditor.

Crookston, Minn.—June 12, 10 a. m., County Board of Polk County, bridge steel and concrete 23-ft. span, section 34-35, Russia Township; bridge steel and concrete 23-ft. span, section 30-31, Argus Township; bridge steel and concrete 30-ft. span, section 27-28, Tabor Township; bridge steel and concrete 18-ft. span, section 4-9, Tabor Township. Plans and specifications on file office County Auditor and office E. H. Harding, City Engineer. H. J. Welte, County Auditor.

Ellendale, N. D.—June 20, 2 p. m., Board of County Commissioners of Lamoure and Dickie Counties for furnishing materials and building bridge single span 18-ft. long, one beam steel, concrete floor. Piles to be 24-ft. long, imbedded in concrete. C. C. 5 per cent. Address C. C. Misfeldt, County Auditor.

Fairfax, Minn.—June 8, 2 p. m., County Boards of Renville and Browns Counties, Village Hall, building state bridge across Minnesota river. Plans and specifications State Highway Commissioner, St. Paul, and County Auditors. C. C. 10 per cent. Louis G. Vogel, County Auditor, Brown County; J. L. Johnson, County Auditor, Renville.

LaMoure, N. D.—June 19, 2 p. m., Board of County Commissioners, LaMoure County, for furnishing materials and building four bridges according plans and specifications on file office of County Auditor. One bridge built on section line between Sections 20 and 21, 20-ft. steel span, concrete floor, or, a 12-ft. steel span, concrete floor, or, a 12-ft. concrete slab floor resting on five steel piles at each end. One bridge on section line between Sections 26 and 27, 1 12-ft. steel span, concrete floor, or, a 12-ft. steel span, concrete slab floor. One bridge on section line between Sections 17 and 18, 1 20-ft. steel span, concrete floor, or, a concrete slab floor. One bridge on section line between Sections 35 and 36; 1 16-ft. steel span with plank floor or concrete slab floor. C. C. 5 per cent. O. C. Temple, County Auditor.

Mohall, N. D.—June 12, 2 p. m., Renville County Board of County Commissioners, construction three stone bridges according specifications on file. C. C. 5 per cent. R. D. Johnson, chairman Peter Carlson Co., Auditor.

Valley City, N. D.—June 11, 2 p. m., County Commissioners, constructing bridge according plans and specifications. C. W. Nelson, County Auditor.

CONTRACTS AWARDED.

Albany, N. Y.—W. S. Rae, Pittsburgh, Pa., has contract for rebuilding two spans, Alplaus bridge over Mohawk river and barge canal.

Bethlehem, Pa.—Contract construction temporary bridge over Lehigh river was awarded to Horsehead Construction Co., Horsehead, N. Y., at $24,000.

Elizabeth, N. J.—Board of Free Holders let contract for new bridge, Eastman St., Conford, to Dover Boiler Works, Dover, N. J., at $19,000.

Franklin, Ky.—Contract for constructing a bridge over Red river on Springfield road was awarded Virginia Bridge and Iron Co., Roanoke, Va., at $11,000.

Kansas City, Mo.—Contract for constructing bridge over Blue river, at Leads, was awarded by Board Public Works to N. Miller, 3112 Highland St., at $37,033.

Linton, N. D.—Linton Bridge Construction Co. awarded contract construction of 60-ft. span steel bridge, with 18-ft. roadway, located between Sections 9 and 10.

Martinsburg, W. Va.—Thomas Sheehan, Hagerstown, Md., lowest bidder for erecting of sub-structure for Kentucky Memorial Bridge, which will span the Potomac river. Total cost, $1,000,000.

Newton, N. C.—Contract for constructing the horse ford bridge over Calawaha river, between Calawaha and Caldwell Counties, was awarded to C. W. Requarth Co., Charlotte County, at $38,000.

Paterson, N. J.—Board of Freeholders awarded contract for reinforced concrete arch bridge over Passaic river, Singac, Pompton-Newark Turnpike, to Logan Construction Co., 13 Park Row, New York, at $63,500.

Richmond, Ind.—Isaac E. Smith, Richmond, awarded contract by Board of County Commissioners for constructing Main St. bridge, across Whitewater river, at bid of $169,990.

Seattle, Wash.—Board Public Works awarded J. A. McEachran, local contract for constructing wooden draw bridge at $61,606.49. Cost of steel to be added, total cost, $70,000.

Seattle, Wash.—Contract for constructing a 1,705-ft. pile trestle over north end of Lake Washington was awarded to C. Geske & Co., Pacific Blk., at $12,354.

CONTEMPLATED WORK.

Albany, N. Y.—Assembly passed bill appropriating $225,000 for constructing bridge across Mohawk river, between Crescent and Rexford, near Schenectady.

Brookville, Ind.—July 2, 1 p. m., Franklin County Auditor, $28,000 bridge bonds, 4 per cents. Chas. G. Reifel, Auditor.

Duluth, Minn.—Ordinance providing issuance $50,000 of bonds for repairing, reconstructing and filling of bridges at Oneota St. and Forty-third Ave., Sixty-fifth Ave., North, and Grand Ave., Woodland Ave., and St. Marie St., and Tenth St. and Fifth Ave., East, in City of Duluth.

Elgin, Ill.—Definite plans for new bridge across the river at Kimball St., to come within $60,000, were submitted by two bridge engineers.

Ft. Wayne, Ind.—An appropriation of $20,000, approved by Allen County Council, for construction of proposed bridge.

Milwaukee, Wis.—Department Public Works plans construction of reinforced concrete bridge, 1,553 ft. long, 40-ft. roadway, on North Ave. Estimated cost, $400,000.

Reading, Pa.—Carpenter Steel Works having plans made for reinforced concrete bridge at its works, to cost about $65,000. Wm. H. Dechart & Son, Baer Building, Engineers.

PAVING.

BIDS REQUESTED.

Bluffton, Ind.—June 6, 2 p. m., Commrs. Wells Co., const. 2 stone sts. 2,228 and 1,334.5 ft. in length; also stone rd. in Lancater twp. 6,485 ft. in length. C. F. Kain, Auditor.

Corydon, Ind.—June 7, 1 p. m., Commrs. Harrison Co., constr. rock roads in Harrison and Morgan twps. Sam C. Mauch, Auditor.

Dayton, O.—June 14, Bd. of Commrs. of Montgomery Co. will receive bids for paving Wolf Creek Pike with brick to a length of 2 mi. Plans on file. C. C. $1500. Walter H. Asling, Clerk.

Elbow Lake, Minn.—June 18, 2 p. m., Office Co. Audr. of Grant Co., constr. of job No. 1704, St. Road No. 9, as follows: Excavation, 27,210 cu. yds., $8,103; borrow, 4,100 cu. yds., $820; turnpike, 18,015 cu. yds., $1,260. Estimated total cost, $9,243. Plans and specifications with County Auditor, or Office Hwy. Commission, St. Paul. C. C. 5 per cent. C. N. Nelson, County Auditor.

Harrisburg, Pa.—June 12, 10 a. m., St. Hwy. Dept. will receive bids for vitrified block or reinforced concrete paving (about 3* lin. ft.) in Cecil and Strabine Twps., Washington Co., and S. Faye Twp., Allegheny Co. Frank B. Black, Hwy. Commr.

Hattiesburg, Miss.—Bd. of Cuprvs. receive bids for constr. 46 mi. of rds. in Forrest Co. Estimated cost $81,694.10. Engr., F. Myers.

Lafayette, Ind.—June 6, 10 a. m., Commrs. of Tippecanoe Co., constr. 2 gravel rds. in Wayne Twp. 2.01 and 1.39 mi. in length. George W. Baxter, Auditor.

Laporte, Ind.—June 7, 10 a. m., Commrs. Laporte Co., constr. rds. in Center and New Durham Twps. Fred A. Hansheer, Auditor.

Lebanon, O.—June 12, Clerk of Village receives bids constr. concrete combination curb and gutters on both sides of Orchard Ave. Plans with City Engineer. C. C. $100. M. E. Gustin, Clerk; Roy E. Miller, Cy. Engr.

Minneapolis, Minn.—June 12, 11 a. m., Office Co. Auditor, bids will be received for grading and surfacing 96,186 lin. ft. of roads No. 4 and 38 in towns of Minnetonka and Eden Prairie, according to plans and specifications. C. C. 5 per cent. A. P. Erickson, County Auditor.

Montgomery, Ala.—June 6, 12 m., Baldwin Co. Commrs., at Court House, Bay Minette, Ala., constr. grading and otherwise improv. public hwy. from Robertsdale, Ala., to Munnez Ferry, Ala. 18 mi. long. Specif. J. M. Garrett, Engr. C. C. $500. L. Glendinning, Commrs.

Peru, Ind.—June 11, 12 m., Commrs. Miami Co., constr. rd. in Jefferson Twp. and one on line Clay and Harrison Twps. Frank H. McElheny, Adr.

Thief River Falls, Minn.—June 12, 8 p. m., City Council, constr. of concrete sidewalks and st. crossings according to plans and specif. A. H. Facial, City Clerk.

Yankton, S. D.—June 11, 9 a. m., for furnishing all tools and labor and materials to pave alley running east and west to the west half of block 25. Plans and specif. office City Audr. C. C. $100. John W. Summer, City Auditor.

CONTRACTS AWARDED.

Aberdeen, Wash.—Bids for paving Hume and Michigan Sts. were received from: Grays Harbon Constr. Co., Hoquiam, Wash., asphalt, $12,211.40, asphaltic concrete, $12,314.60; Hankle-Hegg & Co., Aberdeen, Wash., asphalt, $12,611.00, concrete, $11,435.70.

Akron, O.—The Peters Carpenters Handy Co. have contract paving North Howard st. extension at their bid of $74,466. Contract for aqueduct, Weber and Charlottte Sts., was awarded to Charles H. Waters, Akron, for brick pavement and grout filler and stone curb at $26,000.

Contracting News

Albany, N. Y.—Dale Engr. Co., Utica, only bidder imprvt. Barners Corners, West Lowville Rd., part 1, in Lewis Co. Road is 5.37 mi.; bid., $57,940.

Auburn, Cal.—The Tibbits Pacific Co., San Francisco, awarded contract by city Trustees for paving business sts. for $40,891.15.

Bayfield, Wis.—Contract for paving 7 blocks has been let by City Council to Sweeney Bros., Reedsburg, Wis. Material, vitrified brick on sand foundation with asphalt binding. Work will cost $1.85 per sq. ft. for paving, 50c per lin. ft. for gutter and 45c per cu. yd. for excavations.

Brazil, Ind.—Co. Commrs. of Clay Co. awarded contract for constr. stone road on line between Perry and Posey Twps. to Campbell & Hawkins, at $16,448.

Brookhaven, Miss.—Contract for constr. 19.7 mi. rd. Dist. No. 4, was awarded by Bd. of Suprvs. of Linton Co., to Middleton & Smith, at about $37,941.

Burlington, Ia.—City Council awarded contract for paving and grading High St., Main to 4th, to Burlington Constr. Co., $2.06 sq. yd.

Chicago, Ill.—Contract imprv. of 18½ mi. Higgins road awarded Commonwealth Improvement Co., Denver, Colo., for $448,000.

Chicago, Ill.—Joseph Plasey & Co. low bidders on east section of Dundee Rd. at $70,946.01; Andrew Ward & Sons, Oak Glen, Ill., west section, at $94,399.33.

Cincinnati, O.—Bd. of Control awarded contract for widening the intersection of Linwood and Eastern Aves. to Kirschner Constr. Co., Cincinnati, at its bid of $30,000.

Danville, Ind.—Co. Commrs. Hendricks Co. awarded contract constr. rd. in Washington Twp. to Hurst, Sweet & Co., Coatesville, at $20,000.

Dayton, O.—Ed. Ryan, Springfield, only bidder, paving Third St. from Perry St. west to River, and from Wyandotte St. east to the railroad. Estimated bids will approx. $40,000 on this job.

Decatur, Ill.—State Highway Commr. awarded William G. Amman, Decatur, contract constr. state aid highway between Macon and Blue Mound, a distance of 27,000 ft., his bid being $10,322.55. Other bidders were: Stewart & Fluff, Oreana, $10,573.44; A. O. McCoy, Varsailles, $11,236.09; Duis & Olson, St. Joseph, Mo., $11,179.08; Hendricks & McGary, Decatur, $11,090; Cameron Joyce & Co., Keokuk, $10,917.26.

Des Arc, Ark.—P. F. Connelly Pav. Co., Little Rock, Ark., has contract 5½ mi. concrete sidewalk.

Dubuque, Ia.—C. B. McNamara Co., local, awarded brick paving contract, $95,000.

Fargo, N. D.—C. T. Welch & Co., Minneapolis, were awarded contract by the City Council for paving on 8th St. and 7th Ave., souts. Bituminous concrete will be used and total cost will be $37,995.

Frankfort, Ind.—Bids were received for improvements of East Morrison and Sims Sts., as follows: Patton & Son, Veedersburg, $15,167; A. F. Cohes, $15,769; W. J. Nees & Co., $15,630.50.

Galion, O.—Forest Constr. Co., Galion, has contract building the Olivesburg Road, a distance of 1½ mi., at their bid, $29,000. Road will be a 14-ft. tar-bound macadam.

Greenville, O.—Bd. of Control awarded contract, paving of Washington Ave., to John M. Manix, local contr., at $19,347.18.

Greenville, O.—Nine bids were received for improvt. Vine and Sweitzer Sts., by paving: Sweitzer St., Karch & White, Celina, $29,686.73; J. W. Heffner & Son, Celina, $33,385.09; John H. Manix, Greenville, $32,643.43. Vine St., Karch & White, $14,522.14; John H. Manix, $15,200.97; McHugh Bros., Springfield, $16,041.10; Heffner & Son, $15,525.63; S. A. Warner, Greenville, $17,330.10.

Hartford, Conn.—Edw. Balf Co. awarded contracts for paving portions of Albany Ave. and Windsor, $27,512.00; portions of Capitol Ave., Ann, Ferry, North and Kilburn Sts., $28,911.90.

Idaho Falls, Idaho—J. C. Maguire, Butte, Mont., awarded contract paving Water Ave., gravel bitulithic 6 in. in thickness, at $1.70 per yard and 50c per ft. for curbing. Total, $27,673.64.

Jefferson, O.—Contract for paving with brick of Dorset-Cherry Valley Rd. was awarded T. P. Fitzgerald, Ashtabula, at $63,890.80.

Jersey City, N. J.—Bd. Freeholders let contract to Wm. J. Coughlin, 665 Newark Ave., Jerseyl City, for paving Newark turnpike at $547,857.

Los Angeles, Cal.—Brashaer-Burns Co., Los Angeles, lowest bidders at $28,093.30 for 4.1 mi. concrete paving on state hwy. in Los Angeles Co., between Castiac and Castiao School. Work involves 23,100 cu. yds. of excavation, mixing and laying 3,950 cu. yds. of concrete in pavement, building concrete and corrugated metal culverts and guard rails.

Marion, O.—Bd. of Control awarded contract for paving of 5 sts. to H. T. Striecher Co., Toledo, with sheet asphalt, at their bid approx. $53,000.

Marshalltown, Ia.—Bd. of Supvr. awarded Tim Ryan, Loveland-Marietta rd., city limits in Summit St. to Marietta, 4½ mi.; estimated grading 28,473 cu. yds. at 21c per cu. yd. ;estimated graveling 4.260 cu. yds. at 50c per yd.; Wm. Cox, Vinton, 3½ mi., estimated grading 30,029 cu. yds. at 23.5c per cu. yd.; P. E. Shugart, Nevada, 1 mi., estimated grading 17,763 cu. yds. at 27c per cu. yd.; Morrison Construction Co., Des Moines, 1 mi., estimated grading 25,833 cu. yds. at 24.7 c per cu. yd.

Mason City, Ia.—Contract was let to P. E. Sugart, Nevada, for approx. 54,000 cu. yds. in all, making contract price nearly $13,000.

Monticello, Ind.—Co. Commrs. of White Co. awarded contract constr. rd. to G. A. Killenburger, Reynolds, at $16,500.

Morris, Minn.—Contract for paving several streets was awarded S. Loher, Chokio, at $13,331.00.

North Chicago, Ill.—Contract for paving 10th St. was awarded by Bd. of Local Improvements to C. P. Moran, Waukegan, at $15,736.

Ottawa, Ill.—Joseph J. Leix, Ottawa, awarded two paving contracts by the city. Bids as submitted for Forest St., Joseph Leix, Ottawa, $6,933.40; F. E. Ball, Ottawa, $7,616.44; T. W. Keys, LaSalle, $7,983.42; Johnson & Schafer, Pekin, $8,009.76. Lafayette St., Joseph Leix, Ottawa, $21,660.15; F. E. Ball, $23,169.87; Johnson & Schafer, $24,589.38; T. W. Keys, $24,691.24.

Peru, Ind.—Co. Commrs. of Miami Co. awarded contract for constr. Jacob Moore Rd. No. 8 in Pipe Creek Twp. to John L. Miller & Co., Bunker Hill, at $12,497.

Rochester, Ind.—Contract constr. stone rd. was awarded by Co. Commrs. of Fulton Co. to E. J. Williams, Macey, at $16,387.

Rochester, N. Y.—Thomas Holahan, local, low bidder Genesee Park Blvd., $98,000; Ribstein & Holter, local, low bidders on Orange St. pavements.

Roundup, Mont.—Contract awarded Warren Constr. Co., Portland, Ore., at $75,389 as next lowest bidder when G. H. Nash, Missoula, withdrew his bid of $71,427.50.

Spencer, Ind.—Contract for const. of crushed stone road was awarded by Co. Commrs. of Owen Co. to L. P. Hays, Worthington, at $11,000.

Springfield, Ill.—Contracts for state aid road work were awarded by State Highway Commr. as follows: Earth rd. in Massac Co. to Quincy Martin, Metropolis, at $1,539; village earth rd. in Jersey Co., to Edw. Connors, Jerseyville, at $4,871; earth road in Marshall Co. to D. M. Dean, Lacon, at $11,986.

Toledo, O.—County Commrs. awarded contracts to: M. T. Nannon, 4 mi. Saeman road at $43,345; Phil Garygon & Son, Toledo, ½ mi. Tank Rd. at $15,734; Doan & Langerderger, 2 mi. Davis Rd. at $21,868.

Topeka, Kans.—City Commrs. awarded Ritchie Bros., Kansas City, contract paving 9 blocks with brick, $32,547.43.

Tottenville (Staten I.), N. Y.—Uvalde Asphalt Paving Co., 1 Broadway, New York, awarded contract for paving sec. No. 2 of Amboy Rd. from Tottenville to New Dorp, at about $100,000.

Trenton, N. J.—Contract for repairing Greenwood Ave. and Lawrence Rd. was awarded by Bd. of Freeholders of Mercer Co. to C. A. Reed & Co., 623 Monmouth St., at $10,921.

Vincennes, Ind.—Bd. of Co. Commrs. gave contracts for constr. of the Joseph Miller and Otto Kraemer brick roads to the S. R. Adams Co., of Princeton. Miller road will cost $41,318; Kraemer Road, $52,929. Both roads are about 2½ mi. long.

Warren, O.—Contract for the Youngstown-Kingsville Rd. has been awarded to Gustavus Constr. Co., at their bid of $14,481.

Wenatchee, Wash.—Commrs. awarded C. M. Payne, contractor of Spokane, contract for paving with concrete 1.25 mi. rd. this side of Monitor on the Wenatchee-Cashmere Hwy. Bid $19,631 for 18-ft. pavement.

Yonkers, N. Y.—St. Hwy. Comm. received following proposals for work on Tuckhoe and White Plains Rds., 2.74 mi.; James McAvoy, New York City, $67,809.60; Wilkes-Cassey Co., New Rochelle, $80,303.10.

Yonkers, N. Y.—St. Commrs. Hwy. reports following proposals for rd. constr., repairs in West Chester Co. Rd 503, Granite Contracting Co., Inc., Cohoes, $36,387; Lewis Petrillo, Mt. Vernon, $36,406; Daly & Merritt, Inc., Pt. Chester, $37,485.

Sacramento, Cal.—The following proposals were received by St. Hwy. Commrs. Highway Imprvt. in Santa Barbara Co., Div. V, Route 2: Sec. E, Robt. Sherer, Los Angeles, $61,550.75; L. G. Garnsey, Los Angeles, $81,974.75; J. P. Fitzpatrick, Sacramento, $76,323.90; Conners, Green & Co., Eureka, $66,707.60; Sandercock Transfer Co., Inc., San Luis Obispo, $63,065; Conner Constr. Co., Los Angeles, $123,560; C. H. Hudson, Los Angeles, $69,742.10; Erickson & Peterson, Inc., San Francisco, $87,016.25; Ira Hodson, San Luis Obispo, $59,949.83. Solano Co., Div. III, Route 8: Sec. A, W. A. Dontanville, Salinas, $32,749; P. H. Hoare, Oakland, $32,577.50; Chitlock & Gorrill, San Francisco, $33,747.50; Harlan & Harlan, Williams, $26,976.75. Los Angeles Co., Div. VII, Route 4: Sec A, M. T. Shafer, Los Angeles, $43,500.50; Conner Constr. Co., Los Angeles, $34,850.50; Brashear-Burns Co., Hollywood, $28,093.30; D. M. R. Co., Inc., Los Angeles, $34,997.10; L. G. Garnsey, Los Angeles, $40,902.65. Almeda Co., Div. IV, Route 5: Sec. B, Whitlock & Gorrill, San Francisco, $39,272; E. H. Hoare, Oakland, $30,185.40; Bates, Borland & Ayer, Oakland, $29,306; T. M. Onley, Oakland, $33,964; The Western Constr. Co., Oakland, $33,627; W. J. Schmidt, Berkeley, $34,327; Tieslau Bros., San Francisco, $46,782.

CONTEMPLATED WORK.

Brooklyn, N. Y.—Queen's Park Commr., John Weier, will receive $25,000 to build a road from Neponsit to Government Reservation at Rockaway Point. Will be 25 ft. wide.

Burlington, Wis.—$17,000 available for improvement on the Sheridan Drive from Milwaukee to Racine, a stretch of about 5½ mi., hwy. to be 18 ft. concrete.

Clarinda, Ia.—City Council decided to pave 34¾ blks. this summer with either asphaltic concrete or bitulithic, or brick paving block.

Dayton, O.—City Commission authorized contract with E. D. Murray, Dayton, for paving Highland Ave. from Wayne Ave. to Wyoming St. with brick. Bid $28,259.85.

Fort Wayne, Ind.—Bd. of Works authorized pavements of 15 sidewalks, petition; improvements of 30 sts. ordered. Frank M. Randall, City Engr.

Frederick, Okla.—Paving for South 10th st. from south side of Calla Ave. to the north side of Astor Ave. was declared necessary by meeting of city council.

Gary, Ind.—$180,000 will be expended in street and highway extensions and imprvts.

Gates City, Va.—Lowell Dist. of Scott Co. voted to issue $45,000 road bonds. Address County Clerk.

Grand Rapids, Mich.—Cy. Engr. James R. Rumsey preparing plans and specif. for paving Plymouth Rd., from Weathy St. to Lake Drive, with bituminous macadam. Est. cost $12,000.

Great Falls, Mont.—It is proposed by the Cascade Co. Commrs. to gravel Sun River Road. Est. cost, $40,000.

Kansas City, Mo.—Plans for pavement of the Paseo, 47th to 63rd Sts., and Meyer Blvd. from the Paseo to Swope Park Entrance, a double stretch of rdway. 3 mi. long, were adopted by Park Board, and advertisement for bids authorized.

Livingston, Mont.—Park Co. will spend $60,000 on park road.

arksville, La.—$120,000 bonds to be used for road constr.

Martinsburg, W. Va.—Issue of $250,000 St. Imprvt. Bonds has been voted. Address City Clerk.

Mount Ayr, Ia.—Ringgold Co. will receive $40,000 from state and federal governments for road work.

Omaha, Neb.—Ordinance passed ordering improvement of that part of Redick Ave.

Contracting News

from 24th St. to Minne Lusa Ave. within St. Improvement Dist. No. 1546, by paving with asphaltic concrete class "B" and curbing with artificial combined curb and gutter. T. J. O'Connor, City Clerk.

Philadelphia, Pa.—Asst. Dir. Baldwin of Dept. P. W. received and scheduled proposals $650,000 hwy. imprvt. Principal imprvt. completing S. Broad St. plaza, $125,000.

Pocahontas, Ark.—Rd. Dist. No. 2 has been formed for purpose of building 35 mi. macadam rd. from Pocahontas to Missouri state line; cost about $125,000. J. D. Wells, Commr.

Portsmouth, O.—City Council ordained it necessary to improve 21st st. from west curb line of Timmonds Ave. to east property line of Summit St., by grading, setting curbs and gutters, constructing the necessary drains and retaining walls, paving the roadway with vitrified or hard-burned brick, constructing and laying cement sidewalks. Louis A. Zucker, Clerk.

Portsmouth, O.—City Council ordained it necessary to improve by paving, Massie St. from the south property line of Second St. to the north property line of Front St.; Armstrong Place, from the north line of Gallio St. to the north line of second alley north; Kendall Ave., from south property line of Gallia Ave. to north line of B. & O. Louis A. Zucker, Clerk.

Providence, R. I.—St. Hwy. from Sugar Loaf Hill to Matunuch Rd. about 3½ mi. long, with bituminous concrete. Estimated cost $478,000.

Raymond, Wash.—Co. Commrs. ordered special election for purpose of voting bond issue approx. $260,000 for constr. system of permanent highways.

St. Bernard, O.—May 31, 12 m., $70,000 street imprvt. bonds for purpose if improving Towney Ave., from Mitchell to Ross Aves.; Washington Ave., from Carthage Pike to Greenlee Ave.; Bertus St., from Delmae Ave. to Albert St.; Albert St., from Leonard to Zetta Aves.; Sullivan Ave., from Washington to Ross Aves.; Railroad Ave., from Carthage Pike to Ross Ave., by grading and resurfacing paving and setting curbs and repairing roadways. C. C. 5 per cent. W. L. Taylor, Audr.

St. Joseph, Mo.—Improvement of 4th St., Mitchell Ave., to Sacramento St., by repaving with brick blocks being prepared by City Engr Carl P. Hoff. Same being authorized by Bd. of Public Works.

Sioux Falls, S. D.—Resolution made by Bd. of City Commrs. deeming it necessary to grade Madison St. from Lincoln Ave. to the west boundary of the city. Also to grade alley in block 7, Summit addition. Walter C. Leyse, City Auditor.

Sioux Falls, S. D.—City Commission has passed resolution deeming it necessary to pave 20th St. from First Ave. to 7th Ave.; 10th St. from Phillips Ave. to bridge over the Big Sioux River; First Ave. from 12th St. to 21st St.; alley running east and west from Main Ave. to N. & S. alley in block 15, J. L. Phillips addition, also alley in blockade; alley in block 14, Bennett's first addition. Walter C. Leyes, City Auditor.

Waldron, Ark.—About 30 mi. macadam rd. to be built; cost, $160,000. J. S. Hill, Chairman.

Youngstown, O.—Ordinance passed to issue $15,000 bonds for purpose of street improvement.

Yankton, S. D.—Resolution made deeming it necessary to pave Lynn St. and 4th St. to 6th St. with either asphaltic concrete, bitulithic or Portland cement concrete. John W. Summers, City Auditor.

SEWERS.

BIDS REQUESTED.

Crookston, Minn.—June 12, 8 p. m., Office City Clk., bids will be recd. for constructing a 9-in. and 15-in. vit. c. p. sewer in Walsh St., between Central and Summit Aves.; and in Linden Ave., between Walsh St. and Summit Ave.; and in Summit Ave., between Linden and Riverside Aves. Plans and specif. on file. C. C. 10 per cent. Louis Ellison, City Clerk.

Kenyon, Minn.—June 8, 8 p. m., Vil. Rec. will receive bids for constr. sewers on Front St., Redwing, Pine, Langford and Holmes Sts., according to plans and specif. on file. C. C. 25 per cent. O. B. Strand, Vil. Recorder.

CONTRACTS AWARDED.

Albert Lea, Minn.—Illstrup & Olsen, of Minneapolis, awarded contract const. of sewer in Home addition, $10,947.31.

Fargo, N. D.—Contract for completion of the $50,000 sewer and water system for city of Garrison was let to Haggert Constr. Co., Fargo.

Grand Rapids, Mich.—Vander Wele Bros., 810 E. Fulton St., Grand Rapids, awarded contract for building storm sewer in East Grand Rapids, $10,865.

Omaha, Neb.—J. J. Hanighen awarded contract for completion of Saddle Creek storm sewer, between Marcy and Harney Sts.; cost, $62,689.35.

Piqua, O.—W. C. Kirschner & Son, Dayton, awarded contract for constr. Water St. sanitary and storm sewer; storm sewer $22,535, sanitary sewer $15,275, from Downey to Wayne, $1,025; total bid being $38,835.

River Falls, Wis.—City Council awarded Cast Stone Constr. Co., Eau Claire, contract for laying sewer on Main St. Cost of constr. est. between $20,026 and $25,000.

South Bend, Ind.—Bd. of P. Wks. has awarded Hoban & Rouch, South Bend, contract for trunk sewer on Portage Ave. Contract prices, $59,970. Trunk sewer system for High St. and Ewing Ave. was awarded to L. M. Webster Co. Sewer will be of vit. pipe. Contract price, $29,604.

Virginia, Minn.—City Council awarded Christopherson, 512 N. Second St., contract at $11,981.28.

CONTEMPLATED.

Gary, Ind.—Plans expending $420,000 for sewer constr.

Hamilton, O.—Cy. Engr., Frank Weaver, submitted estimate $11,089.20, install sanitary sewer in East Hamilton.

Little Chute, Wis.—Resolution was passed regarding the establishing and determining upon general sewer system in village. M Van Hoof, Village Clerk.

Menominee, Mich.—City Engr. T. R. Hasley is laying out plans for the constr. of a new sewer line which has been deemed necessary.

Northfield, Mich.—City Engr. F. O. Rice, has presented his plans and specif. for proposed West 1st and 2nd St. sewers.

Painesville, O.—Resolution declaring it necessary to improve Sanford St. beginning corporation line and running in an easterly direction to North State by constr. sanitary sewer of vit. p. reinforced with concrete together with necessary outlets. G. E. Guisewhite, Clerk.

Sioux City, Ia.—Resolution was made deeming it necessary to construct an 8-in. sanitary sewer in West Morning Side, to be more than 3 mi. long. Also considering constr. sanitary sewer in Nebraska St., between 23rd and 24th Sts. West 17th St., between West St. and a point opposite the east line Lot 4 in Block 4 of Coe Addition.

Sioux Falls, S. D.—Resolution adopted for constr. of a service connecting sewer on 20th St. from Phillips Ave. to 7th Ave. Walter C. Leyse, City Auditor.

Youngstown, O.—City Council ordained it necessary to improve following streets by constructing following sewers: Hunter Ave. between Japan St. and Campbell St.; Hillman St. from Indianola Ave. to South line city; Stamboy Ave. from Edwards St. to Hillman St.; Park Cliff Ave. from Hillman St. to west line city, lot 24029; Clearmount Drive from Edwards St. to W. side city lot 24091; Idelwood Ave. from Indianola Ave. to Ravenswood Ave.; Edwards St. from Indianola Ave. to Ravenswood Ave.; Butler Ave. between Salt Spring St. outlet 845; Manhattan Ave. between city lot 21682 and city lot 12027. M. F. Highland, City Clerk. F. M. Lilly, City Engineer.

Youngstown, O.—City Council ordained it necessary to improve Carlyle St. between Clifton St. and 350 ft. west of Wert St. by constructing a sewer. Smithfield St. between Manhattan Ave. and Belle Vista Ave., by constr. sewer. F. M. Lilly, City Engineer.

SEWAGE DISPOSAL PLANTS.

Ardmore, Pa.—Engr. Harrison, Mertz and Emlen, Commercial Trust Bldg., Philadelphia, making plans for local sewage disposal plant.

Allentown, Pa.—City planning for installation of sewage disposal plant. Chas. D. Weirbach, City Engr.

Barberton, O.—Council accepted bid of Central Saving and Trust Co. for bond issue of $250,000 for constr. sewage disposal plant.

Newark, N. J. Bd. of Freeholders authorized immediate call for bids for reconstruction and imprvt. of sewage disposal plant at Overbrooke Hospital.

Weston, W. Va.—Legislature approved appropriation of $44,000 for installation of sewage disposal plant.

WATER WORKS.

CONTRACTS AWARDED.

Grand Rapids, Mich.—James R. Fitzpatrick has contract to build water works plant at Gobleville, Mich.

St. Marys, O.—Contracts approx. $47,000 for constr. of Municipal Light and W. Works Plants and distributing system including ornamental St. lamps, awarded by Bd. of Control to Skeldon Engineering Co., and National Supply Co., Toledo and Chas. I. Zahm, Detroit.

CONTEMPLATED.

Anamcose, N. D.—Civil Engr. T. R. Atkinson, Bismark, has been asked to prepare plans and specif. for installation of water works and sewage system of the town.

Barberton, O.—Supt. Long reports est. cost for installation of pump for new pumping station will be $61,000.

Camden, N. J.—Council approved bond issue of $45,000, for extensions and improvements in water system. Wm. D. Brown, Clerk.

Chardon, O.—The Mayor announces that in view of the passage of $58,000 water works bond issue, installation of water works system will proceed at once.

Canton, O.—Council decided to carry out recommendation of Engr. Chas. G. Burdick, Chicago, for improvements of water works system by installation of low lift pumps and the connecting by a main of the two groups of wells. Estimated cost $15,000.

Defiance, O.—F. G. Gettrost, Con. Engr., Kent, recommended to the Council that city build filtration plant and use the Maumee River as water supply. Roughly est. cost at $65,000.

Edgeley, N. D.—Engineer est. the total cost for contemplated water works and sewage system at $56,000.

Mansfield, O.—City council passed ordinance authorizing Dir. of Service to extend water works pumping station building $35,000.

Marshfield, Wis.—Petition for water main on N. Pale St. from C to D streets; and on South Maple St. from 9th St. to 100-ft. south of 11th street was granted. John Soubert, City Clerk.

Perth Amboy, N. J.—Bd. of Aldermen authorized $200,000 bond issue for extensions and improvements at water works: new pumping engines and buildings $53,000; new boiler and bldg. $35,000; suction lines $40,000; dams and spillways $15,000; trestle and coal pockets $20,000; wells and connections $20,000.

Pitman, N. J.—Boro council adopted ordinance for acquisition of plant and system Pitman Water Co., $48,000. Possession in July. Extension and imprvts. planned.

Riverside, N. J.—Special election called to vote bonds for $18,000 for Municipal Water system.

MISCELLANEOUS.

Bayonne, N. J.—City comm. planning for purchase of portable asphalt plant for municipal service. Est. cost $10,000. Wm. P. Lee, Cy.

Martinsville, Ind.—City council awarded contract for constr. new City Hall to W. W. Wilson, of this city, for $18,114.58.

Murray, Utah—City Commissioners plan purchasing of the Freeze and the Godfrey Groves for city park. Issuance of $60,000 for purchase of park and improvements.

Syracuse, N. Y.—Common council considering purchase of stone crushing plant for a municipal quarry. Est. cost $10,000.

Classified Dept

CITY MANAGER WANTED.

Goldsboro, North Carolina, invites applications for the position of city manager. Goldsboro is a progressive city of over 11,000 inhabitants, with healthful climate and good trade conditions—located on three railroads in the heart of the most fertile section of eastern North Carolina.

Applicant must have pleasing personality, good business judgment and broad vision. One posssessing qualifications of sanitary engineer preferred, though this is not absolutely essential.

Excellent opportunity for energetic man of ability to produce results.

Salary will probably range from $200.00 to $250.00 per month. Applications will be received up to July 1, 1917. Information and data furnished upon request.

CITY MANAGER COMMITTEE,
P. O. Box 461, Goldsboro, N. C.

NOTICE TO CONTRACTORS.

Sealed proposals for the improvement of two squares on Main street in the city of Shelbyville, Kentucky, will be received by the City Council until 6 p. m., June 7, 1917.

The work to be done involves approximately:

2,000 Cubic yards excavation.
5,500 Cubic yards surfacing.
925 Cubic yards concrete base.
100 Lineal feet 12-in. c. i. pipe.
75 Lineal feet 24-in. c. i. pipe.

Bids are asked for on three kinds of construction, brick, concrete and wood block on each square.

A certified check for $500.00 must accompany each bidder's proposal.

The right to reject any or all bids is reserved by the City Council.

Plans and specifications may be seen at the office of Commissioner of Public Roads, Frankfort, Kentucky, or City Engineer of Shelbyville, Kentucky.

CHAS. RANDOLPH, Clerk.

FOR SALE: An old subscriber to Municipal Engineering has for sale the first 39 volumes, unbound, 1890 to 1910 inclusive, and nine extra numbers. He will sell to the highest bidder, but expects at least $2 a year for them. Address MUNICIPAL ENGINEERING, 702 Wulsin Bldg., Indianapolis, Ind.

SANITARY AND STORM SEWERS.

Yuma, Arizona.

Bids will be received at the City Hall until 8 P. M., June 12th, for the construction of Sanitary and Storm Sewers; estimate cost, $30,000.

S. FRANK STANLEY,
City Clerk.

WANTED—Credit for two months' subscription to MUNICIPAL ENGINEERING or 20 cents in cash will be given to any one sending copy of any of the following back numbers to the publication office, Indianapolis, Ind., plainly marked so that the sender's name can be found:

July, 1907	September, 1911
April, 1910	October, 1911
October, 1910	October, 1912
December, 1910	December, 1915
January, 1911	April, 1916
May, 1911	

CALUMET SEWAGE PUMPING STATION EQUIPMENT.

THE SANITARY DISTRICT OF CHICAGO

Chicago, Ill.

Sealed proposals, endorsed "Proposals for Pumping Equipment at Calumet Sewage Pumping Station," will be received by the Clerk of The Sanitary District of Chicago at the office of said District, Room 700, Karpen Building, 910 South Michigan Avenue, Chicago, Illinois, until 12 noon, standard time, on Thursday, June 28th, 1917, and will be opened publicly by the Board of Trustees of said Sanitary District at a meeting to be held on that day or at the first meeting thereafter.

The work for which tenders are invited includes the furnishing, delivering and installing of equipment as follows:

Division A—Six (6) vertical centrifugal pumps, of nominal capacity, one (1) at 50 c.f.s., two (2) at 75 c.f.s., three (3) at 275 c.f.s.

Division B—Three (3) vertical synchronous-induction motors and three (3) vertical induction motors, prime movers for above pumps).

Division C—Two (2) turbo-generator units with accessories, of nominal capacity each of 3,000 K.W.

Division D—Eight (8) water tube boilers, with furnaces, chain grate stokers, steam superheaters, and soot blowers, of nominal rating each of 500 horsepower.

The equipment under each of the above divisions is to be furnished and erected complete, with appurtenances, as specified, at the Calumet Sewage Pumping Station of The Sanitary District of Chicago, Chicago, Ill.

Proposals may be made on one division or any number of divisions, complete, but not on part of the items under any one division.

All proposals must be made upon blank forms of proposal furnished by said Sanitary District and shall be made in accordance with and to conform to all of the terms and conditions set forth in the "Requirements for Bidding and Instructions to Bidders," attached thereto. Specifications, forms of proposal and drawings may be obtained upon deposit of ten dollars ($10.00) at the office of said Sanitary District, which sum so deposited shall be refunded if said plans and specifications are returned in good condition within thirty days following the opening of bids.

Each proposal must be accompanied by a certified check on a responsible bank doing business in the city of Chicago, or cash, to the amount or amounts as follows:

Division A, ten thousand dollars ($10,000.00).

Division B, ten thousand dollars ($10,000.00).

Division C, twelve thousand dollars ($12,000.00).

Division D, twelve thousand dollars ($12,000.00).

The Board of Trustees of The Sanitary District of Chicago reserves the right to reject any and all proposals.

THE SANITARY DISTRICT
OF CHICAGO,
By JOHN McGILLEN, Clerk.

Chicago, May 16th, 1917.

VITRIFIED BLOCK PAVEMENT.

Harrisburg, Penn.

Pennsylvania State Highway Department. —Sealed proposals will be received at said office until 10 a. m. June 12, 1917, when bids will be publicly opened and scheduled and contracts awarded as soon thereafter as possible, for the reconstruction of 1,270 lineal feet of Vitrified Block pavement 26 feet wide, situated in Swatara township, Dauphlin County, State-aid Application No. 570; 14,128 lineal feet of Vitrified Block pavement, 16 feet wide, situated in Clarion and Paint townships, Clarion county, State Highway Route No. 65; 32,923 lineal feet of Vitrified Block and Reinforced Concrete pavement, 16 feet wide, situated in Jackson and East Taylor townships, Cambria county, on State Highway Route No. 52, and 36,170 lineal feet of Vitrified Block and Reinforced Concrete pavement, 16 feet wide, situated in Cecil and North Strabane townships, Washington county, and South Fayette township, Allegheny county, on State Highway Route No. 108. Plans and specifications may be seen at office of State Highway Department, Harrisburg, 1001 Chestnut Street, Philadelphia, and 904 Hartje Building, Pittsburgh, Pa. Full particulars and information on application to Frank B. Black, State Highway Commissioner.

WATER-WORKS IMPROVEMENTS.

Kendallville, Ind.

Notice is hereby given that the Common Council of the City of Kendallville, Indiana, will receive sealed bids and proposals for the furnishing of materials and construction of the following improvements to the Municipal Waterworks System in said City, according to the plans, drawings, profiles and specifications now on file in the office of the City Clerk of said City, until one o'clock P. M. on the 12th day of June, 1917:

500,000 Gal. Reinforced Concrete Covered Reservoir 40 ft. x 85 ft. x 20 ft.

1 Motor Driven Low Service Centrifugal Pump, capacity 350 G. P. M., total lift 70 feet.

1 Motor Driven Domestic Service Centrifugal Pump, capacity 400 G. P. M., pressure 60 lbs., and

1 Motor Driven Fire Service Centrifugal Pump, capacity 1,000 G. P. M., pressure 100 lbs., or

2 Duplicate Motor Driven Centrifugal Force Pumps, capacity 700 G. P. M., each, pressure 60 lbs.

Piping, Valves and Fittings.

Each bid shall state the prices in words and figures on the blanks provided therefor, and said bid shall be enclosed in a sealed envelope marked "BID FOR WATERWORKS IMPROVEMENTS," and addressed to the said City Clerk. Each bid shall contain the full name of every person or company interested in it.

Each bidder must file with the said City Clerk, when he files his bid, the usual statutory affidavit, and deposit with him a certified check upon a solvent Bank, payable to said City, in the sum of 10 per cent. of said bid, as a guaranty that he will accept said bid and carry out the construction of said work. The successful bidder will be required to give a bond within 10 days from the date of award of contract with surety to be approved by the said Common Council, insuring the faithful completion of said work according to contract.

The Common Council reserves the right to reject any and all bids, and readvertise said work.

By order of the Common Council of the City of Kendallville, Indiana, this 15th day of May, 1917.

O. E. MICHAELIS, City Clerk.
GEORGE CHAMPE, Civil Engineer,
Toledo, Ohio.