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Municipal and County Engineering

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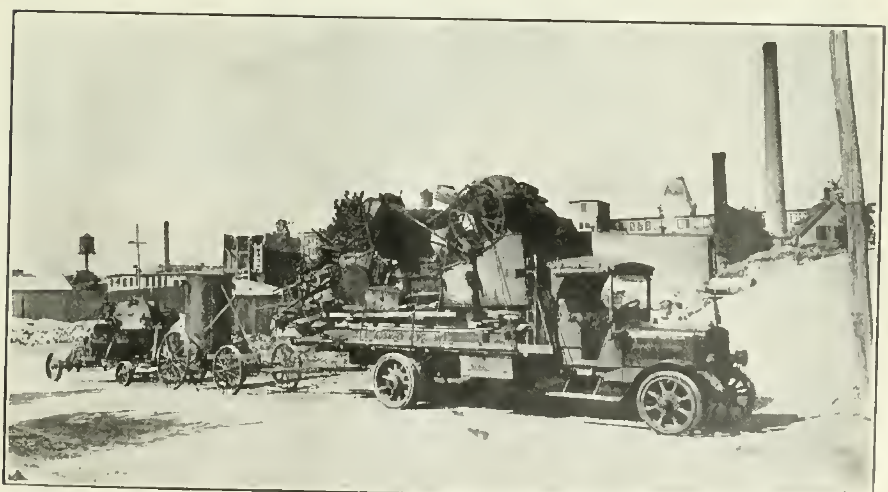
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



ACME 5-TON TRUCK, WITH TWO TRAILERS, HAULING CONTRACTOR'S ROAD BUILDING OUTFIT 35 MILES IN SIX HOURS.

Motor Truck Operation and Accounting LXV

Moving Road Building Outfit by Truck

The view on the title page of this truck section illustrates what a 5-ton motor truck can accomplish when necessity arises. Simpson Brothers' road building outfit, consisting of concrete mixer, boiler, machinery and tools, loaded on two railroad flat cars at Marion, Mass., were wanted in a hurry at the city of Brockton, 35 miles away, to finish a street paving project. Shipment by rail would have meant a delay of several days, so it was decided to haul the outfit by truck. The trip was made in less than 6 hours.

The Austin Motor-Driven Pick-Up Sweeper

An accompanying view illustrates the Austin motor-driven pick-up street sweeper recently put on the market by the Austin-Western Road Machinery Co. This sweeper is performing so well that even the expectations of the manufacturer are exceeded. This piece of equipment not only sweeps the streets cleaner than can be done with either hand labor or horse-drawn equipment, but the cost of doing the work is about 50 per cent. less than by the old-style methods.

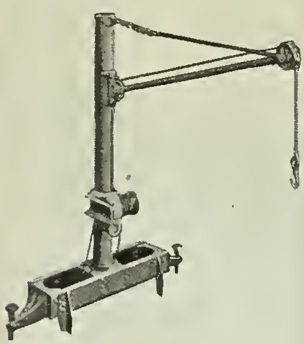
THE AUSTIN MOTOR DRIVEN PICK-UP SWEEPER.

Duplex Trucks Meeting with Success in Contracting Fields

The Louisiana State Highway Department finds the Duplex 4-wheel drive truck highly satisfactory, both in performance and cost of operation and maintenance. The Duplex truck is also giving satisfaction in Bridgeville, Pa., where heavy loads and indifferent roads are the rule. Polk county, Oregon, uses Duplex trucks in road building. They say that no matter how hard the work or what the road conditions, nothing ever stops a Duplex. Officials of Lee county, Iowa, use Duplex trucks in bridge building work. The A. B. Crump Construction Co., of Macon, Ga., are doing work with one Duplex in a day and a half of time which would take 6 mules a total of 15 days.

A company of street surfacers of Denver, Colo., are using Duplex trucks to replace several other makes of trucks up to 7 tons capacities, including some 75 to 90 caterpillar tractors. A Duplex truck in the service of Genesee county, Michigan, is in daily operation. Figured on a team-work basis, they are earning as high as $50 a day. Ingham county, Michigan, is now operating six Duplex trucks for grading and gravel hauling. It is reported that each truck more than pays for itself in one season by its saving over team haulage.

The officials of Butler county, Iowa, owners of a Duplex truck, report that their haulage costs have been cut square-



ly in two. A contractor in Portland, Ore., expected two Duplex trucks might be able to move his 26-ton steam shovel. One was enough to not only haul the shovel, but to carry a 3-ton clam-shell bucket besides. Out in Colorado the Duplex is hauling 6 tons on a 5-ton trailer, making 5 return trips daily over a 5-mile course. The advantage of Duplex liberal road clearance is being demonstrated by a firm of road builders in Walla Walla, Wash., who desired a truck capable of operating in the "Blowsand" along the Snake river.

The extensive road building projects which have been in contemplation and development during the past two years will be well under way within the next few weeks, and the resources of road building contractors will be tested to the utmost. Such a condition does not tolerate the use of any but time and labor-saving equipment, especially for the haulage of materials, and the demand for heavy duty motor trucks for this service is going to be larger than the supply. "This particular serviceability of Duplex 4-wheel drive trucks for contractors, road builders and gravel haulers is too well known to require much comment," is the claim of the Duplex Truck Company.

New Hook and Ladder Fire Truck

A new 216-in. wheelbase hook and ladder fire truck, with a 40-gal. chemical tank, has been put into service by the city of Ashland, Wis. This fire-fighting equipment is mounted on a 3-ton FWD chassis. Power is furnished by an unusually powerful type J Wisconsin motor of 5.1-in. bore and 5½-in. stroke. The truck is run at an average speed of 25 miles per hour and has an excess power available for maintaining this speed under poor road and grade conditions.

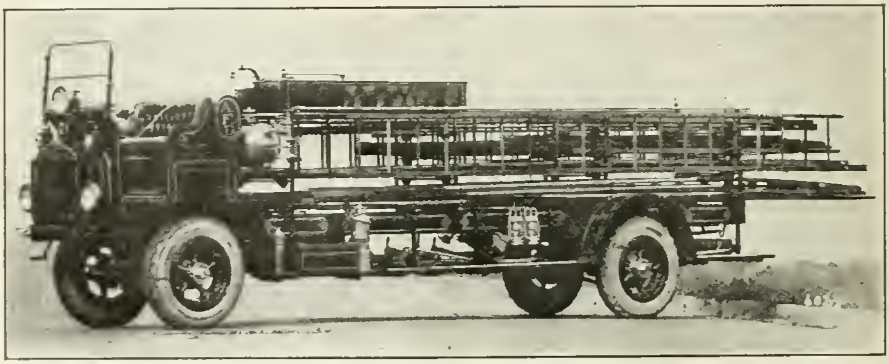
Because of its 4-wheel-drive principle, which gives it pulling power on all four wheels, enabling it successfully to negotiate soft and muddy roads as well as the heavy snowdrifts of winter, the FWD truck is rapidly winning favor as a fire-fighter through its ability to overcome these conditions.

Overloading Big Factor in Road Wear

What is the real cause of excessive road wear? That is a question uppermost in the minds of highway engineers and public road officials at this time. Some contend it is the large capacity motor truck, but government tests and various investigations tend to disprove this theory in the light that to eliminate large trucks would greatly increase the number of small trucks on the road, thereby increasing road wear.

R. E. Fulton, Vice President of the International Motor Company, says it is the practice of overloading, and in a letter sent recently to all Mack truck branches, dealers and salesmen, makes a strong plea to discourage overloading among truck users in the interest of highway preservation.

"Truck overloading is disastrous to both the vehicle and the highway," he says. "If its results were confined to the truck, it might be well to let each individual learn for himself that it does not pay. But unfortunately overloading is one of the principal causes of road wear.



F. W. D. HOOK AND LADDER FIRE TRUCK, WITH CHEMICAL TANK, AS OPERATED BY ASHLAND, WIS.

"A motor truck designed to carry a certain tonnage is constructed throughout, including width of tires and safety factors, to handle just its rated load. Any considerable overload gives more than the standard 800 lbs. per inch of tire width and concentrates the load on this small point of contact. Furthermore, the overload is not distributed on all four wheels, but rests entirely on the rear axle, which

further concentrates the load. Overloading does not materially cut down the speed, and the result is that a higher rate of speed is maintained than should be given to the load, even though properly tired.

"It has been extremely noticeable in sections where the use of large capacity trucks is discouraged that there is a strong tendency to overload small trucks. This is only natural, since the demand for motor hauling service remains the same and practically none can be diverted to other channels. When the smaller vehicle is overloaded, its effect on the road is tremendously magnified, because its springs fail to function properly and the narrow bearing surfaces of its tires concentrate the impact forces so that they are greater than the road is capable of withstanding.

"There is economy both as to road wear and as to truck operating costs in big unit loads, but not when they are carried on vehicles too small to handle them."

Indianapolis Successfully Employs Tractors and Trailers in Hauling Ashes

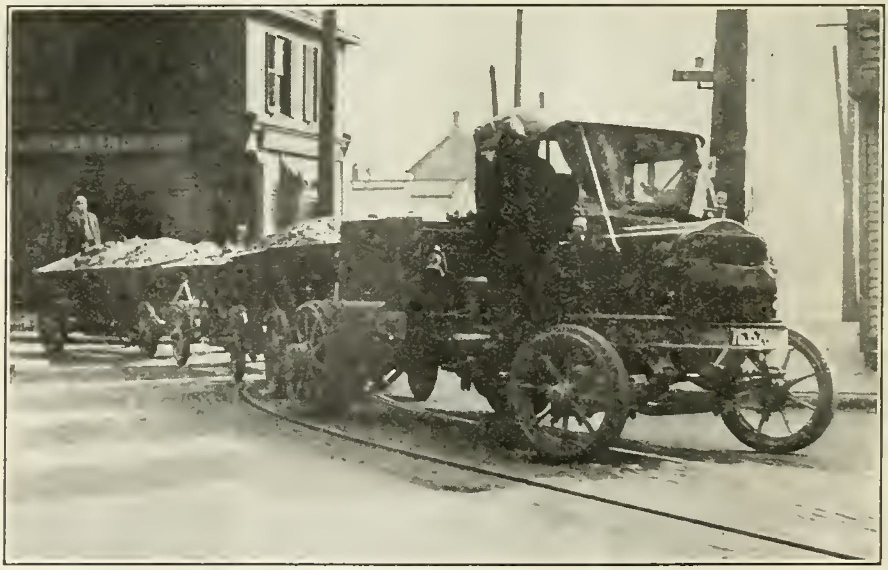
On Oct. 1, 1918, the contract for hauling Indianapolis' ashes expired. The contract had been held by the Indianapolis Hauling Company, which submitted a new bid. Beginning Jan. 1, 1919, it would be worth \$84,000 a year and \$54 an acre for annexed territory to continue the ash-hauling work for a period of 5 years.

The city decided to purchase four 5-ton White trucks and 25 trailers. This fleet went to work immediately. That was in the winter of 1918-19. Since that time the motor equipment has gone faithfully along, writing itself off the books. During 1919 a total of 115,286 cu. yds. of material was collected and haued to the dumps.

Figuring 7 years as the life of the trucks and trailers, the item of depreciation for 1919 was approximately \$8,286. Operating costs (including oil, gasoline, tires, repair parts, labor on trucks and trailers) totaled \$12,305. Allowance of 6 per cent. interest on the balance of the cost of the equipment adds \$2,784 to the year's total. Then throwing in a pay-roll of \$53,063, the total cost for 1919 amounts to \$76,439, which, on the basis of 115,286 cu. yds. of ashes collected, gives approximately 66 1/3 cts. as the haulage cost per cubic yard.

But the real advantage of the motorized and city-controlled ash-hauling system is not at once apparent in these figures. Recall that the renewal term proffered by the private contractors was not a flat figure of \$84,000, but rather that amount plus \$54 an acre for annexed territory. Since taking over its own ash-hauling job the city of Indianapolis has extended its service facilities to a greatly enlarged territory, which, had it been annexed under the terms of the tentative new private contract, would have run the expense of that service very close to \$100,000.

Moreover, the city now owns its own equipment and controls its use. Whereas



WHITE TRUCK WITH A TRAILER TRAIN LOADED WITH ASHES, CITY OF INDIANAPOLIS, IND.

formerly some sections of the city were neglected at times when the weather was inclement, and complaints were accordingly vociferous and vexing, calls and collections are now made regularly, in fair weather and foul, and complaints have consequently been reduced to a negligible number, according to Mr. Thomas A. Riley, supervisor of Indianapolis' Ash-Hauling Department.

Few Complaints Now

"We used to have to listen to as high as 200 complaints a day," declared Mr. Riley. "Now, thanks to the day-after-day dependability of the tractors, complaints average only 10 a day, a truly remarkable record when you consider that we have 70,000 homes to serve and an intricate maze of alleys to thread."

Perhaps the best indication of the complete satisfaction which motor equipment has given is the authorization made recently by the Board of Public Works and City Purchasing Agent Dwight S. Ritter for the purchase of two additional White 5-ton trucks and a half dozen more trailers.

The old trucks are all in good shape to face their third winter and promise to go on indefinitely, according to Mr. Ritter, who characterizes the showing they have made thus far as "an unanswerable argument in favor of the motor method of collection."

Lost Time Minimized

The Indianapolis method of ash collection is as follows: Horses, hauling trailers, pass through given alley routes, collecting ashes from house to house. The loaded trailers are then left at predetermined street locations, where empty trailers are waiting. The horses are hitched to the empties and lose no time getting out for new loads. Meanwhile the tractors, on their way to the ash dumps, couple the loaded trailers which have been abandoned at the street corners, to their trains, and continue on their respective journeys.

A trailer will hold 4 cu. yds. of ashes. Each tractor pulls a train of three trailers, making six round trips a day. The entire fleet of four trucks and 24 trailers thus hauls 288 cu. yds. of ashes daily. One cubic yard will weigh between 1,100 and 1,200 lbs.

One of the outstanding features of the motor equipment is its flexibility ,according to Mr. Ritter. The equipment is frequently diverted from ash-hauling to snow-cleaning duties. During an intensive three weeks' springtime clean-up campaign 15,000 cu. yds. of refuse were hauled. Every Saturday evening 35 trailer loads of refuse are hauled away from the city market place.

Trucks in Rescue Role

When a fire at the loading platform created an emergency in the garbage hauling department, the trucks again came to the rescue, and so impressively as to precipitate a well-defined agitation for the motorization of that department. Customarily, garbage collections are made by 35 wagons, which haul their loads to the loading platform in the central part of the city. There cranes deposit the boxes on flat cars, 20 boxes to the car. Three cars are required to haul a day's collection of garbage to the city-owned reduction plant, located about 4 miles from the loading platform.

Wagon hauls range from a few blocks up to 5 miles. One wagon will average three loads a day. During the three weeks that the trucks played the rescue role they cut practically in half the hauling expense in the garbage department. One truck proved to be the equivalent of three wagons, and it was found that a truck could be loaded in an hour and one-half. Thus a single truck accomplished in an hour and one-half the equivalent of a day's work for a horse. Moreover, the trucks traveled all the way to the reduction plant outside the city instead of only to the loading platform.

"If the garbage collection department is ever completely motorized, we can eliminate the railroad spur from the loading platform to the reduction plant, and even the loading platform itself," asserted Mr. Riley. "Each is quite a considerable item of expense." Between 90 and 100 tons of garbage are collected daily in Indianapolis.

LOAD LIMITATIONS FOR PRIMARY AND SECONDARY HIGHWAYS

By Charles J. Bennett, State Highway Commissioner, State House, Hartford, Conn.

The topic under discussion is directly connected with the consideration of the efficiency of highway transportation, a subject which heretofore has not been very seriously studied by the majority of highway engineers.

Preliminary to discussion of this topic it may be said that most of us are faced in a greater or less degree with an abnormally heavy highway traffic which has been placed upon our highways from various causes, regardless of their suitability or strength. We know that we shall be required to carry tremendous loads over the highways. We do not know the

magnitude of these loads, nor have we any assurance of a limit, either to the weight of the units or to the total volume of traffic to which our highways will be subjected.

It seems evident that before we can intelligently design highways, bridges or other structures, we must know the character, amount, weight and speed of vehicles which we are expected to accommodate. It would also seem axiomatic that it is not fair to ask for the development of highway systems everywhere to carry the extreme loads which are now being borne by motor trucks. This would mean the expenditure of vast sums of money for the accommodation of a limited number of units. Hence, we develop a need for a separation of highways into classes. For the purpose of discussion, we shall assume that highways can be divided in two classes as outlined in the subject of this article.

Primary and Secondary Highways

In order to more clearly indicate the scope of the problem, we must define the terms which we are using. In other words, we must answer the question, what are primary and what secondary highways; and, again, for purposes of discussion and not determination, let us roughly define primary highways as those highways connecting centers of industry, whether manufacturing or agricultural, over which must be carried commercial products in large quantities continuously at all seasons of the year. Secondary highways may be said to include all other highways than those classified as primary, or perhaps those roads which are required to carry traffic of a secondary importance, whether passenger cars or light commercial vehicles. These highways are those which eventually must serve all parts of the community and aid in the progress and development of the Nation.

Roughly speaking, the routes thus classified should be so correlated and so designed as to provide for the most efficient use of the motor vehicle for commercial purposes without infringing upon the field of other methods of transportation, such as rail or water. Provision must be made in design that the primary highway systems may be expanded as the need arises without undue loss in original investment. Here we have a very large field for investigation. It is not herein intended to give an absolute solution of the problem, nor to cover all of this investigation. We have suggested the need for limitation of load, and the impossibility of improving all highways to the maximum requirement has been superficially indicated.

A National Problem

The restriction of loads under these suggested limitations should be further considered. In the first place, the subject must be approached not as one concerning any particular state or group of states or any small unit of government. It must be studied as affecting the administration of all highway departments throughout the United States. In other terms, any limitations which are placed upon loads should be universal and apply to all motor vehicles, whether operated in Maine or California. This, of course, implies the passage of national or uniform state laws.

It can easily be seen from this statement that the problem is not one of easy solution. It requires broader study and stronger co-operation than we have yet been able to accomplish. It demands a knowledge of motor truck operation that is not yet available. It suggests numerous lines of thought which can be followed to conclusions which, when reached, can be collected together and used as information to impose restrictions as to weight and as data for design. The subject is not alone one of load limitation, but should be enlarged to cover any limitations which may be placed upon the operation of motors and loads, such as speed, width, height, length, number of units in a train, design of mechanism, and myriads of other things that will develop as we pursue our way.

These are, of course, generalities. We must have a starting point. We must have some specific suggestions as to the limits of the loads which may be operated on routes designated as primary and on those defined as secondary. Of course, for the purpose of securing a definite point of beginning, we must go into what has already been done along these lines.

The Limitations Set in 1918

Referring to a discussion held in 1918 in Chicago, at which both the highway officials and the motor truck manufacturers were represented, certain limitations of motor vehicles were decided. So far as the speaker is concerned, there has nothing developed since that time which would modify the conclusions there reached. These conclusions have to do with the maximum weights, widths and heights of motor vehicles, and are consequently applicable only to the primary routes, which we have defined above as those which may be considered as the main media of highway transportation. The limits thus set were a maximum gross weight of 28,000 lbs., or 800 lbs. per inch width of solid rubber tire. The width of the load was to be 108 ins. and the maximum height, if this is correct information, 12 ft. These restrictions would allow the use of a 5-ton truck as now built, loaded to capacity, and it would seem that this is the maximum weight of truck which may be efficient for primary highways. We must realize that this limitation is not for today alone, but for the future as well, and should last for the life of the road.

Seasonal Regulation of Loads

Until, however, we have finally completed our primary highway systems, we must modify these restrictions somewhat. In other words, we must provide for the operation of these units only at such times as they will subject the road surface to the minimum wear. We must provide some method of restricting these loads to a still smaller amount at seasons of the year when the maximum damage to highway surfaces occur. This power, again, should be universal and in the hands of those intrusted with the care and upkeep of highways. Means must be provided whereby the maximum loads will be operated only on the primary systems.

Considering further the question of secondary highways, here we have still a larger subject, for we must provide a standard of construction and maintenance for all other highways than primary routes in order to carry a specified load. This portion of the problem is much more complicated and harder of solution than the former portion, for we must realize that we are dealing with the far larger amount of traffic over the secondary routes than over the primary routes. In other words, as we increase the restrictions on loads or amount of load, we are approaching closely to the maximum number of motor vehicles operated.

Restriction of Secondary Highways

For illustration, taking a certain 20,000 commercial motor vehicles licensed, only 750 of these vehicles are in excess of 4 tons capacity, while upwards of 16,000 are less than 2 tons capacity, so that our restrictions for a secondary system of highways must be such that we shall secure the maximum efficient operation of the larger number of commercial motor vehicles. For this reason it is suggested that the maximum allowable total load for secondary highways shall be 12,000 lbs., unless the load is carried on pneumatic tires, when it may be increased to 15,000 lbs. We may inquire why this increase may be made. Roughly, it is thought, and experiment tends to prove, that the pneumatic tire, properly inflated, does less damage to the highway surface than the solid tire, especially when the solid tire is partly worn. It is hoped that these assumptions may be checked up in the future and more formulae developed which will be exact rather than empirical. None of the limitations suggested have taken into consideration the passenger car, as either system, properly designed, should properly accommodate the passenger car when load alone is considered.

Enforcement of Regulations

Again, as a general conclusion to this discussion, we must admit that if any limitation of loads is determined upon, it must be enforced. There is no use or reason in attempting to establish restrictions on traffic with no intention or means of enforcement. A study of this subject would not be complete, or even partially so, without a suggestion of methods of follow-up to see that the rules laid down are carried out. The writer has knowledge of many instances where laws restricting weights are written without attempt to enforce. It is evident that such a practice is almost of no use.

In order that the universal rules suggested above may be properly carried out there will be need for co-operation between the different states in the enforcement of their licensing rules and in the checking up of the vehicles registered. Consequently, it appears that any highway system should be developed in cooperation with the motor vehicle department, and a proper policing department provided whereby it may be thoroughly established, that the laws regarding the use of the highway by loads are absolutely carried out. These departments should all be built up on a standard scheme of organization.

As outlined above, this is not an attempt to solve once and for all a problem which has been presented to us. This is impossible. There are many steps ahead of us in the proper solution of this difficulty. We have a long road to travel, but it must be traveled, and we must make a start.

This paper by Mr. Bennett was presented before the recent annual meeting of the American Association of State Highway Officials.

EDITORIALS

RETURN TO A POPULAR SIZE

As announced in the November, 1920, issue, we return, with the present number, to the size used by this magazine for the period of 25 years, from 1890 to 1915. There have been many suggestions from the older readers, familiar alike with the earlier size now readopted and the size used during the past five years, that we return to the original size so long employed with complete satisfaction to readers, advertisers and publisher. The younger readers will soon come to prefer the smaller size because of its handiness and, we are confident, for other reasons also. Advertisers, necessarily advised of the change by letter, as well as by published announcements, have cheerfully co-operated in making the requisite changes of a mechanical nature and the publisher is deeply appreciative of this constructive spirit of co-operation which, while anticipated, is not to be taken for granted without a formal expression of sincere thanks. As was to be expected the advertisers were quick to perceive the advantage to everybody in the very greatly increased distribution of Municipal and County Engineering, effective with this issue, made feasible, in some measure, by the return to the smaller size. Contributors will note with satisfaction the opportunity to address a greatly increased number of readers and this fact suggests the great gain to the individual reader inherent in very wide distribution of the magazine.

RAILWAY AND HIGHWAY RELATIONS

In two editorials published in recent issues of this magazine we have suggested, in a polite and parliamentary manner, that the steam railway "interests," to use a collective, impersonal term, might not be inconsolable if the highway movement should bog down. We have been taken to task for this by a gentleman, long of New York and now of Ohio, who wanted to know if we are from "Ioway," associating, apparently, all unorthodox views on railway topics with the state named. Although lacking the distinction he was willing to accord us we have observed some things which have shaped our railway views according to the Iowa pattern. He suggested that it is preposterous to suppose that the railways are not friendly to the great movement for better highways, since good roads will carry business to the steam lines. This is a natural starting point for one who would invest the railways with qualities they do not possess.

We doubt if the railway nature has changed greatly in its opposition to progress. Surely many readers can remember that the yoke couplers, operated from the outside of the track, were adopted by the railways only under compulsion. Without public intervention the roads would have gone on indefinitely in the use of the old link and pin coupling and switchmen would have been getting "trimmed up," as they called it, to this day, and the railways would have continued paying damages for personal injuries and employing the maimed men for flag jobs and other light work. It was once a practice to keep engine crews on the road until the driver dropped from exhaustion to the floor of the cab, and accidents of all sorts, both major and minor, resulted from this cause. The law put an end to this visionless practice. Who does not remember the opposition the railways put up to the grade separation movement at the outset? Incidents might be multiplied at length to show that much of the progress the railways have made has been under compulsion and against the will of their managers who always have a clearer view of the dollar going out than of the dollar that may come in. Therefore, to suggest that the railways are essentially friendly to the highway movement because of a possible increase in railway business due to good roads is to reveal a very short and casual acquaintance with the railway manager's peculiar mentality. The highways will take, and are taking, some business from the railways, as everybody knows, and the railway manager is likely to be very much more impressed by this present fact than by any probable future increase in railway business in a fully developed nation with adequate highways. It is well to remember this in considering highway and railway relations.

There is no great pleasure in making these observations but, as a journal devoted in part to the highway field, we feel that we must warn all highway workers not to expect voluntary co-operation from the steam railways in all cases. Read in this issue how poor railway service retarded highway work in Kansas in 1920, for example. Note particularly how employes of the state highway department were threatened with arrest for trespassing when they entered railway yards in search of badly needed cars which were being held in idleness.

We would not be understood as hostile to the railways, necessarily, but as somewhat familiar with their motives and methods in dealing with any public agency such as the highway. Quite likely they intend to be as generous as they feel the exigencies of the case will permit. We would credit them with the best of intentions if we were sure public opinion was sufficiently aroused to see that the intentions were practiced.

ATTEND THE 1921 ROAD SHOW

The Twelfth National Good Roads Show will be held, under the auspices of the American Road Builders' Association, in the Coliseum, Chicago, February 9, 10, 11 and 12, 1921. All those who are in any way interested in working for better highways should attend this show, as it will undoubtedly be the best, from every standpoint, ever held. The time is right and so is the place (with respect to access), and the season is exceptional in its promise of great road-making activities. Every necessary element of success is present and those who attend the show will not be disappointed.

HOME OWNING

Now that the housing shortage is so acute throughout the country, and since the housing problem is rated as an engineering problem, perhaps it is permissible for us to comment on certain aspects of home owning.

For a good many years the own-your-home movement was hampered by the attacks made on it by salesmen of blue-sky stock such as "skunk farm common" and "pecan orchard preferred." These gentlemen insisted that the purchase of a home is a bad investment because of structural depreciation, and because interest on the investment accrues against the owner instead of in his favor, etc. Now the home-owning question is just as complicated as life itself and cannot be adequately discussed in a short editorial but it may be serviceable to point out that this old bookkeeping convention, called interest on the investment, is the one thing above all others that has deterred young people from putting their savings into a home. We call it a convention for the reason that it is arbitrary. Why should a man figure interest on money invested in a home and fail to do the same on money spent for food or clothing? We shudder to think of the "cost of living" if we were required by the habit of the business community to figure the cost as of today of the food and clothing purchased in 1900, to name only one of many years, with interest on the "investment" compounded semi-annually down to this date!

All we wish to suggest is that it is easily possible to assign altogether too much weight to "interest on the investment." The average family is lucky to save some of the principal and should not be unduly concerned over the interest. If this commonplace truth can be impressed on young people there will be more home owning, more thrift, greater contentment and happiness and fewer housing shortages. The regularly recurring obligation to the young people paying for a home on a contract is the best saving device yet devised.

A home, not unlike a wife and children, is, indeed, "an impediment to great enterprises, whether of virtue or mischief," and this is well. A home is not a quick asset, fortunately for the home owner. It can't be sold in a minute, ordinarily, and the owner can think several times before he finds a buyer. This safeguards him against all manner of unwise undertakings.

There are doubtless some valid arguments against home owning, but, while accountants insist we are wrong, we could never include "interest on the investment." We have said that home owning is as complex as the fabric of life itself, being so thoroughly interwoven with it, and to us it seems that figuring the interest on money invested in a home comes close to a profane effort to put a price on the unrebuked laughter of little children.

SALVAGING OLD ASPHALTIC SURFACE MATERIAL TAKEN FROM STREET PAVEMENTS

By C. J. Van Etta, Superintendent Street Construction and Repair, City Hall, Milwaukee, Wis.

In looking over the proceedings of the convention of the American Society for Municipal Improvements, held in Buffalo in 1918, I have come upon a discussion as to the question of the use of old asphaltic mixture taken from asphalt paved streets. A municipal engineer of Buffalo, a city which has the reputation of having more asphalt streets than any other city in the country, replied to a question as to what is done with the old asphalt that is removed from cuts, etc., that it is taken to the dumps and that they have no further use for it. He says that it is used in some cases for filling holes, etc. He says it is never used for relaying. The general discussion arose as to the use of the old asphalt taken out of the streets, during which it was said the only thing that could be done with the old material, and this came from the gentleman from Buffalo, is to throw it away. He said you can't give it away and it is worth money if you can give it away. It certainly was surprising to me when I read this discussion on the use of this old material, and especially so in coming from the source it did, men who are prominent municipal engineers and road-building experts, and who, I presume, have had considerable experience in the handling of these materials.

WELLS STREET, MILWAUKEE, WIS. LOOKING EAST FROM WEST WATER STREET TO ONEIDA STREET BRIDGE.

Old Asphaltic Surface With Binder Course Taken Up, Remelted and Replaced. Has been Doing Service Under Heavy Traffic Since 1912.

Milwaukee Experience in Handling Old Asphaltic Surface

I am going to relate my experience as it applies to the use of this old asphaltic surface taken from streets, as to its wearing qualities and the cost of handling. For the past eight years I have been in close contact with this work, and I am satisfied that there can be no question as to the economy of the use of this old material. In the first place, our specifications are so written that they require an asphalt paving contractor, where a street is being resurfaced, to deliver the old surface material to our central asphalt repair plant. This does not cost the city a cent. This material is broken up and remelted, and there is a very small percentage of new bitumen added, depending entirely upon the life of the old material. I find that this old material, after being reheated, which includes the binder stone which clings to the surface, when put back into the street, gives better wearing service than did the original mixture. It appears that the reheating gives it added strength and it is a tougher mixture generally than the original.

ONEIDA STREET, MILWAUKEE, WIS. LOOKING WEST TO ONEIDA STREET BRIDGE.

Old Asphaltic Surface With Binder Course Taken Up, Remelted and Replaced. This Old Material Has Been Under Heavy Traffic Since 1912.

This mixture is used entirely for patchwork, and I have in mind two different stretches of work, about two city blocks in length, which were entirely resurfaced with this old material, in a district where traffic is extremely heavy. I am showing photographs herewith of this particular stretch, to give an idea of the durability of this old mixture. This resurface work was done about eight years ago, and up to date we have spent little or nothing on its maintenance. I do not believe that a more severe test could be made than upon this particular stretch of street pavement.

Patching with Remelted Material

Our patchwork will also show that,

where a patch of this remelted material is laid, it outwears the original pavement. The cost of this work for the past eight years has averaged about 55 cts. per square yard, with approximately 400,000 sq. yds. laid during that period. I figure that the average cost of this work, if contracted, taking the eight years into consideration, would amount to about $1.75 per square yard. So it can be readily seen that we have been able to save the city of Milwaukee a great sum in this particular branch of repair work.

I was interested in 1919, while attending the convention at New Orleans of the American Society for Municipal Improvements, upon coming in contact with one of the asphalt repair gangs which was operating on one of the main streets, and inquiring of the man in charge of the work as to what he did with the old material that was taken out of the street, he informed me that it was hauled to the dump. I asked him if it could not be put to some use; he laughed at the idea and told me it was impossible to remelt the old material, as it could not be used in that state, and also that the cost of rehandling would be so great that it would be unprofitable to attempt it. I did not stop to argue the question with him, for I was satisfied that he was so thoroughly convinced, wherever he developed the notion, that he could not be shown, so I went on my way without discussing the value of using old asphaltic surface material again.

Suitable Equipment Not Available for Old Material

Up to date I have not found equipment suitable for handling this old material, although there are a number of plants which are intended solely for the use of new material for asphaltic repair work. We bought such a plant a few years ago, and to look at it today you would not believe it was the same piece of equipment we bought. It was necessary for us to rebuild this plant to take care of this old mixture. I was very much interested in the early part of the season of 1920 when a representative of the manufacturer whose plant we are using called on me, after visiting our central repair plant, and informed me that we had made changes in this plant that would be of great value to his company. This was after he had inspected the old material used, the mixture turned out and the laying of it in the street. He was very much surprised that we had been able to transform this plant from one which was intended for new material to one which is now handling old material entirely. He said that when he had called at the plant he was unable to determine whether or not this was his product. When I informed him of the percentage of new bitumen we used in this old mixture, which did not exceed 3 per cent., he would hardly believe my statement.

Other Cities Should Consider Milwaukee Experience

I find in such cities as Detroit, Buffalo, New York, Chicago, and a number of the other large cities, that they are also hauling this old material to dumps, where no use can be made of it.

I believe that any city that has any great amount of asphalt streets which have to be maintained, can do no better than follow the plan adopted by this department. In throwing this old material away cities are wasting thousands of dollars each year. I am sure that men in charge of this repair work, if they followed out our plan will, when they get well under way, readily appreciate the great saving in cost that they would be able to bring about where this particular branch of repairs is concerned.

METHODS AND COST OF EXCAVATING FOR SMALL SEWERS IN ROCK

By D. B. Davis, City Civil Engineer, City Hall, Richmond, Ind.

In constructing small sanitary sewers up to 9 ft. in depth, and where one-third to one-half the lower depth is of rock, the writer has found the following procedure is both economical and expeditious:

First, the top earth is plowed and scooped off to the side with teams to a depth of about 2½ ft. and 5½ ft. wide. The removal of this extra width has been found to pay where the earth banks will cave off into the ditch when the rock below is blasted. It also has been found more economical than trying to hold the banks with bracing, especially where the earth is only 3½ to 4½ ft. thick above the rock.

When the upper portion has been scooped out, the balance of the soil and clay above the rock is excavated with pick and shovel. The rock is then drilled, either by hand drills or steam, to a depth of at least 8 ins. below the flow-line of the pipe. This extra depth of the holes will obviate the necessity of excessive sledging to get the lower layer of rock loosened.

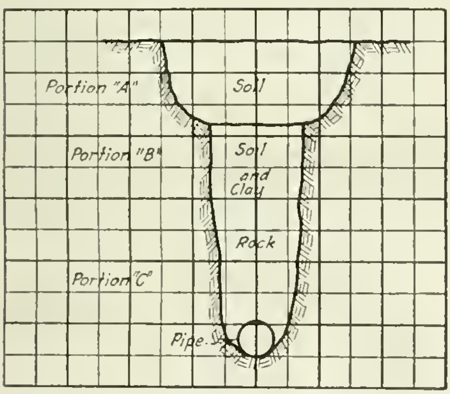
After the rock has been blasted the loosened material is excavated with pick and shovel. The quantity of dynamite to be placed in each hole depends largely upon the stratification of the rock to be blasted. In this vicinity the nature of the rock requires about 1¾ lbs. be used in a 5-ft. hole and about 1 lb. be used in a 3-ft. hole.

Fig. 1 shows a typical cross-section of a sewer trench.

Oftentimes these small sewers are dug in alleys where the space is very limted, in which case it is often a problem where to deposit all the excavated material.

The scooping of the top earth is usually done with one or two teams, with a laborer filling the scoops. It has been found that this upper portion, as represented by Portion A in Fig. 1, requires approximately 0.187 team and driver hours and 0.23 labor hours to excavate each lineal foot of trench.

The earth and clay shown by Portion B is removed with pick and shovel and requires approximately 2.14 labor hours per cubic yard of material. This portion should be thrown back from the trench as far as possible to keep it from falling into the trench when the blasting is done.

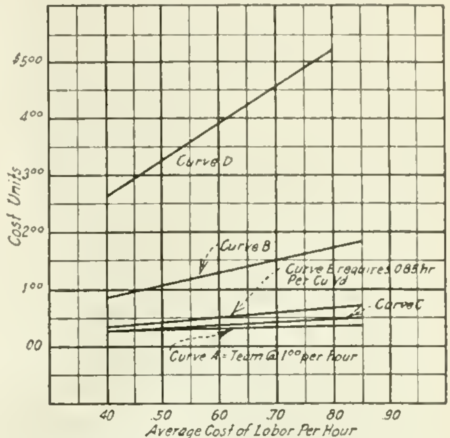


Portion "A" removed with scoops requires 0.187 team hours and 0.23 labor hours to excavate. One lineal foot of trench
Portion "B" requires 2.14 labor hours to loosen with pick and shovel out of bank per cubic yard
Drilling rock by hand requires 0.6 labor hours per lineal foot of hole
Portion "C" requires 6.5 labor hours per Cu Yd. to blast and excavate blasted material.

FIG. 1. TYPICAL CROSS-SECTION OF SEWER TRENCH FOR SMALL SEWERS WITH ROCK IN BOTTOM.

Hand drilling is usually adopted on these small sewers because the trenches are too narrow to work around and move steam drills handily. It requires the average laborer 0.60 labor hours to drill per lineal foot in depth. The holes are drilled 30 ins. apart.

The operation of blasting with electric caps and excavating the loosened material down to flow line for laying of pipe requires approximataely 6.5 labor hours per cubic yard of material removed. The pipe layer will usually carry 2 ft. of depth in the bottom and deposit it upon the pipe already laid. The labor of the pipe layer is included in the 6.5 labor hours.



Curve A = Cost per lin. foot of trench to scoop off top earth 2½ ft deep and 5½ ft wide. Requires 0.187 team hrs and 0.23 labor hours per lin foot
Curve B = Cost per Cu Yd to loosen and throw out earth above rock Req 2.14 hrs.
Curve C = Cost per lin ft to drill by hand.
Curve D = Cost per Cu Yd to blast and throw out loosened rock to flow line. Req 6.5 hours.
Curve E = Cost per cu yd to back fill by hand

FIG. 2. COST OF SEWER EXCAVATION UP TO 9 FT. DEEP WITH ROCK IN LOWER PART.

The back-filling, when the trenches are dug in alleys where the space is very limited, is performed by hand and requires approximately 0.85 labor hours per cubic yard of material shoveled.

Fig. 2 shows a chart of the above costs at various rates for labor.

HOW POOR RAIL TRANSPORTATION CHECKED HIGHWAY BUILDING IN 1920

(Editor's Note.—Generally speaking, we believe the production of new highways in 1920 was disappointing to those in any way interested in road building. Poor rail transportation for highway materials was the prime cause of this disappointment. It is important to review the circumstances of 1920 to prevent, if possible, their repetition in 1921. The following very interesting statements, while pertaining primarily to Nebraska and Illinois, are considered typical for the Middle West, at least. At the recent annual convention of the American Association of State Highway Officials one of the topics for discussion was: "Difficulties Experienced by the States in the Matter of Rail Transportation." Mr. M. W. Watson, State Highway Engineer of Kansas, and Mr. S. E. Bradt, Superintendent of Highways in Illinois, submitted the following data and discussions on this topic.)

In Kansas (By M. W. Watson, State Highway Engineer)

The highway program of Kansas and neighboring states suffered far more by the inefficiency of rail transportation during the past season than from all other causes combined. Of course, we had some other troubles, such as inefficiency of labor, shortage of cement and bad weather, but these troubles were Lilliputian in comparison with the rail situation. Although labor was inefficient, there seemed to be plenty of help available. What we lacked in quality we could make up by quantity or the substitution of machinery. The cement shortage seemed to be traceable back to the unsatisfactory rail situation. The hesitancy of cement companies to contract for definite deliveries was due to uncertainty. While we had more wet weather than during ordinary seasons, there were many ideal days for road building that were lost on account of the non-arrival of materials.

During 1919 and 1920 we placed under contract in Kansas 357.8 miles of Federal Aid road work; 77.1 miles of earth roadway and culverts preliminary to surfacing; 69.2 miles of gravel; 30.1 miles of macadam; 125.8 miles of concrete and 55.4 miles of brick. Of this amount we had completed on Nov. 9, 1920, a total of 90.5 miles of all types; 12.8 miles of earth, 24.2 miles of gravel, 5.3 miles of macadam, 30.9 miles of concrete and 23.3 miles of brick. Under normal conditions practically the entire mileage should have been completed at the close of the 1920 construction season.

The situation in our state is aggravated by the location of our hard stone supply so close to our coal mining territory. There is a decided lack of a well-distributed supply of stone having sufficient hardness to be used in the construction of concrete roads. Our main deposit of material of a satisfactory character is the flint spalls and chats from the zinc and lead mines of the Joplin district, being in southeastern Kansas, southwestern Missouri and northeastern Oklahoma. This deposit not only supplies a large part of Kansas, but also southwest Missouri, a considerable part of Oklahoma and a portion of Arkansas. The coal fields which supply a large part of Kansas, Missouri and Oklahoma are also located in southeastern Kansas and southwestern Missouri, only a few miles distant from the flint regions. The transportation of coal and stone by rail utilizing the same class of equipment renders it impossible to utilize returning empties (toward the coal mines) for the shipment of flint, as the road projects are located in the same direction from the coal mines as the markets for coal.

The bulk of our sand comes from the Kansas and Arkansas rivers, and in only a few instances are the plants so located as to utilize returning empties from coal shipments.

Why Call All Open-Top Cars Coal Cars?"

The producers of materials demanding open-top equipment for their shipments are now discovering that they have overlooked a valuable piece of propaganda which has been of decided service to the coal interests during the past construction season. The general public has been trained to term all cars of the open-top variety as coal cars until even the Interstate Commerce Commission seems to think that there is only one use to which such cars can be put. This fact, together with the apparently well-organized lobby of the coal interests, has been the means of securing embargoes and priority rulings until we become dizzy if we attempt to trace these orders around the circle they have been following. This Congress would render a great service to industry in general, and especially to the construction activities, if they would legislate out of use in the commercial world the three words that have spelled a large part of our grief, "embargo, priority and permit." It is true that in the end we were obliged to resort to the permit system for the highway shipments, but only to counteract the methods others interests were employing, and after all other measures had failed. Such practices during war time may be necessary, but after the close of hostilities they should be placed in the discard. They can lead only to one end—that is, preferential treatment for the industry best organized in the way of a lobby. Chairman Clark, of the Interstate Commerce Commission, recommended to the Senate Interstate Commerce Committee that a differential freight rate be granted so as to distribute the coal shipments throughout the year. Quoting his statement in part, from *Railway Age*, March 26, 1920:

Distributing Coal Shipments Throughout Year

"Such legislation would obviate very largely the pressing necessity for more coal cars. The present supply of coal cars, while totally insufficient to handle the fall and winter rush under existing conditions, would be fairly adequate to carry all the coal desired by consumers if this equipment could be kept moving with greater regularity throughout the year, as would be the case if the advantage of lower summer and spring freight rates could be held out to induce consumers to receive coal shipments in advance of their winter needs. Under the present system thousands of coal cars lie idle during the spring and summer, while the whole available supply of coal cars is entirely insufficient to handle the fall and winter emergency.

"The acquisition of more coal cars does not afford a practicable and complete remedy for existing difficulties. Under the transportation act recently approved the Interstate Commerce Commission is given the power to require carriers to provide themselves with sufficient cars. But most of the railroads have neither the money nor the credit with which to buy a supply of coal cars adequate for current needs under the present system of large seasonal shipments, so it would be useless for the commission to order them to purchase this equipment. On the other hand, most of the railroads which have enough money or credit to finance such purchases already possess an adequate number of coal cars to care for the needs of their own patrons, and they could not reasonably be required by the commission to purchase additional cars to take care of the traffic of other lines."

Reducing the Scope of the Nation's Activities

Apparently Chairman Clark is not broad enough in his vision to realize the existence of other industries than coal. The fact of concentrated coal shipments has been the solution of our problem in the past. Coal shipments were greatest when the needs for fuel were greatest—that is, during the winter months. These cars were then available for building materials during the summer months, which is the only time when building operations can be carried on satisfactorily. The clever coal propaganda has done nothing more than secure the increase of price desired by the operators. Part of the time this season when the open-top cars were withheld from stone shipments our mines were idle. It would seem the policy of the Interstate Commerce Commission to reduce the scope of the Nation's activities to the size of our present rail transportation rather than utilize what we now have to develop our other avenues of transportation.

Holding Cars in Idleness

The other classes of equipment were also scarce, at least for our use. The grain producers of Kansas were unable to secure relief. Grain was piled high in the open in many places throughout the states while the elevators were filled to capacity. When orders were given to ship empties to the West for the relief of this situation we observed that the empty cars were allowed to stand idle in the yards for many days, while our most urgent appeals were of no avail to secure them for loading westward, even though they were to pass empty through points where the materials were needed. Refrigerator and cattle cars hold the same status as box cars in our shipping arrangement. They go eastward through the state when loaded and empty westward. Long trains of empties passed by the cement and brick plants, but were not available for use.

Through the co-operation of the State Industrial Court and our local engineers it was found that empty cars would stand in the railroad yards throughout the state for days and even weeks at a time. In some instances they were moved from one end of the yards to the other and then in a few days returned. When the railroad officials discovered that our men were checking their yards they ordered them to stay out and threatened arrest for trespassing. Why?

Conditions Changed Rapidly After Rate Raise

The most curious part of the entire procedure is the speed with which conditions changed when the higher rate went into effect and the government guarantee was removed. It seems a general theory of public utilities operation that when a higher rate is requested the service becomes almost unbearable until the public is willing to try anything for relief. Gas service becomes decidedly improved after the rate is increased, and central will give you the number requested, at least a portion of the time, after the telephone rate is advanced. Records show that the larger railroad lines operating in Kansas, and, in fact, in other states as well, are not utilizing their present equipment to its fullest capacity. One of our roads gets from 54 to 86 car miles per car day out of its freight cars, while another gets from 17 to 22, or not quite as far in a day as the average team will travel.

The investigations of our Industrial Court brought out that many unaccountable delays occurred at terminals. They followed closely 412 open-top cars used in coal shipment from the mines to destination and return. Of these cars, 171 were loaded with company coal. The average number of days consumed in the assembling yards was 4.25. Company coal required an average of 4.29 days to travel to destination, commercial coal 3.54 days. The total car days consumed at destination in unloading and delivery to connecting lines amounted to 1,773 for company coal and 760 for commercial coal. The average travel per car day for company coal was 6.3 and for commercial coal 13.4. Of 273 cars unloaded, 4 required 30 days, 11 required 29 days, 4 required 28 days, 9 required 27 days, 10 required 26 days and 18 required from 13 to 25 days, and the surprising part of the statistics is that the railroad companies seemed to be the ones who were longest in unloading their cars. This does not look as though the grave warnings issued to shippers by the Interstate Commerce Commission were placed in properly addressed envelopes.

Some Railroads Fight Highways

Let us hope that conditions will continue to improve, but in the meantime the highway industry, which is the coming industry, should awaken to the necessity of securing adequate recognition from the powers governing the railroad situation and a better understanding with the carriers themselves. Some of our railroads have assumed the policy of fighting highway improvement and seem to look upon the highway, with its improved transportation facilities, as a serious competitor. We know that this country is developing more rapidly than all the methods of transportation, so that the highway program should be aided by the railroads rather than hindered.

If the construction of highways could be worked out so that they would build themselves by allowing the hauling of materials over the newly constructed roads as we go, we might be independent of the railroads. But it is not possible in highway work to regulate the places where we are to start as well as might be were it a private enterprise, and in most states we must depend on rail transportation for the success of our highway program.

In Illinois (By S. E. Bradt, Superintendent of Highways)

The difficulties encountered in Illinois have not differed materially from those encountered in the states of the Mississippi valley, and probably are similar to the difficulties encountered in all of the states attempting to carry on a large program of highway construction.

Shortly after the signing of the armistice in November, 1918, the states were urged by the U. S. Department of Agriculture to proceed as fast as possible with the construction of roads, with money made available from the Federal appropriation. This was urged because of the possibility of idle labor due to the slow absorption of the released army into their ordinary pursuits and because of the releasing of the thousands of people employed in the war industries.

Work Accomplished in 1919

Illinois, acting in harmony with this suggestion, proceeded to make preparations, and awarded contracts for about 570 miles of hard-surfaced roads, costing some $32,000 per mile. It was hoped that at least 400 miles would be completed during the 1919 season. This was a new era of road building in Illinois, hence many contractors were obliged to buy complete equipments, and all of them at least some additional equipment. The manufacturers, instead of being able to furnish them equipment within 30 days, as promised, required from 60 to 90 days to make deliveries. This prevented an early start on the part of the contractors. As soon as the contractors were ready for the delivery of material, a shortage of open-top cars developed. This was followed by the shopmen's strike, which crippled the motive power of the railroads; and later in the season came the coal strike, in anticipation of which all open-top cars were taken from the building industries and sent to the coal mines. The result was that instead of 400 miles being completed, we ended the season with 170 miles of finished roads and carried over to the 1920 season approximately 400 miles unfinished.

What Happened in 1920

The Bond Issue Law called for construction at the rate of approximately 1,000 miles per year. Accordingly, we made tentative plans for putting that mileage under contract for 1920 construction. Because of the handicap placed upon the 1919 construction work through the inability of the railroads to furnish sufficient equipment for the transportation of material, we visited the officials of the Railroad Administration with a view to ascertaining the possibility of obtaining cars if we undertook a program involving the addition of 1,000 miles of roads. We explained to them that the building of 1,000 miles of roads meant the delivery of 1,000 cars of material a day. Figuring that each car would consume 8 days in making the round trip, our requirements would be at least 8,000 cars continuously during the highway construction season. We were advised that in the spring of each year, from March 1 to July 1, there was ordinarily a supply of a quarter of a million or more of idle cars, and that if we could arrange to have a large portion of our material delivered before July they would be able to take care of our requirements. In accordance with these suggestions from the officials of the Railroad Administration we arranged with our contractors for the storage of materials. They began in February and March to call for cars, but instead of the required number of cars being available it developed that the year 1920 was unlike any of the preceding years, and that there was no surplus of idle cars available. As a result, few contractors were able to get a supply of material stored in advance of construction. As soon as we asked for bids on new construction it also developed that, owing to the uncertainty of transportation, the increased price of labor and material and the uncertainty of the general situation, our bids—instead of averaging $32,000, as in 1919—averaged $44,000 per mile. With all these things facing the department, it was decided to reject bids and to award contracts for only about 50 miles instead of the amount originally planned, putting all of our effort into the completion of this 450 miles. To this end, Governor Lowden called a conference of both producers of materials and the railroad presidents, all of whom pledged the fullest possible measure of co-operation in the carrying out of the plans of the department—and it is but fair to say that in our opinion this pledge was fulfilled to the best of their ability.

Idle Construction Equipment in 1920

The contractors who were working in 1919 closed the season with approximately 100 paving machines on the ground, ready to start the 1920 construction work as soon as materials were available and weather conditions suitable. At no time during the entire season, however, were there more than 53 of the 100 machines in operation, and the average for the season was much less than 53. This situation was due almost entirely to insufficient transportation facilities.

Troublesome Orders Emanating from Washington, D. C.

The first interference with our work came in the shape of a switchmen's strike, which caused a congestion of freight cars in practically all of the centers of population in this vicinity, and prevented their movement for a number of weeks. However, the most serious difficulty experienced has been the various orders issued from Washington by the Car Service Commission and the Interstate Commerce Commission. Early in June the former commission issued an order requiring that coal mines should be given 50 per cent. of their rated car requirements, and that plants producing other commodities, requiring open-top equipment, should be restricted to the use of the remainder of the cars, whatever that might be, but not exceeding, to any one plant, more than 50 per cent. of its output. This immediately reduced the shipments of road materials. This order was followed on June 21 by another order, issued by the Interstate Commerce Commission, providing that open-top cars could be used for hauling material other than coal only when returning in the direction of the mines. This order was to be in force only 30 days, but was renewed at the end of each 30-day period and remained in force throughout the construction season. Perhaps 50 per cent. of our contractors were doing work in localities that permitted all of the material for their work to be handled in accordance with this order without interruption. The other 50 per cent., however, were getting material in localities requiring a "back-haul," which was in violation of the above ruling. Within a short time after the order went into effect the material coming to them was stopped. We appealed to the Interstate Commerce Commission and a hearing was called early in July. The result of this hearing was the issuing of special permits, but only after a delay of several weeks. These permits were granted only for the hauling of material for the completion of old contracts where work was being done on sections of important roads. Our work was all being carried on upon the main highways of the state; accordingly, by the middle of August we had secured permits for most of those contractors requiring a "back-haul" for their material. These permits were generally put into effect by the railroads, but occasionally some road would get an order from Washington to deliver a certain number of cars to some special plant for a specific coal loading, which, of course, interfered with work in that vicinity.

Much Time Spent in Getting Cars

In September an order was issued from Washington suspending all permits for a period of 10 days. This again held up the movement of material for road work. At the expiration of the 10-day period road work was resumed, but early in October another order came from the Interstate Commerce Commission canceling all permits and requiring that additional evidence be submitted before those permits would be renewed. We succeeded in securing the renewal of not more than 5 of the old permits. Because of this interference, mainly through the two commissions above mentioned, we have been able to complete only a little more than 300 of the 450 miles. In order to do this much of the time of the officials of the department, as well as all of the time of experts hired for that purpose, has been given to the securing of car equipment and connecting it up with the producers of road materials, so as to keep contractors supplied with as large an amount of material as possible.

During the seasons of 1919 and 1920 we have built 500 miles of high-class, hard-surfaced roads. The same effort put forth under ordinary conditions and without the hindrances herein enumerated would easily have completed 1,000 miles of the same class of roads, which result would have proven reasonably satisfactory to our people.

Contractors Subject to Excessive Losses

As a result of this situation it will be seen that the people of Illinois have suffered great inconvenience because of the inability of the contractors to finish their work promptly, that the contractors have been subject to excessive losses because of insufficient transportation facilities.

It will also be seen that the producers of material, through their failure to secure cars for a normal output, will be subject to losses, due to the fact that the overhead expenses remain practically the same under a reduced output as under a normal output.

All of these losses will in a large measure come back to the people in the added cost of construction of future work. We cannot remedy the past; our problem lies in the future. We have the contractors. These contractors have the equipment. Labor has been in fairly good supply in 1920 and the indications are that it will be more plentiful in 1921. The money is available. Materials are in ample supply at their source.

Rail Transportation Principal Limiting Factor in 1921

As near as we can judge, the one principal limiting factor in 1921 will be transportation. In so far as the railroads are able to solve this problem of transportation by the purchase of added railroad equipment, by the repair of present equipment, by increasing the number of car miles per car per day, so as to carry on our work without governmental interference, just so far the improvement of the highways of Illinois and other states in the Mississippi valley will be carried on in an increasing portion. This is the important problem.

WHY ROAD BUILDING MATERIALS SHOULD BE SHIPPED AND STORED DURING WINTER AND EARLY SPRING

The road building season in the Northern States is from May to November—about six months. The average contractor, however, is able to build roads only about half of this time, for he has to contend with rainy weather, some of his men may fail to show up for work some mornings, a piece of equipment may go wrong, he may not have material, etc. There are a hundred and one things that may happen on a road job to delay it, and as a result the end of the season finds the contractor with only 75 to 100 actual working days to his credit.

The contractor is constantly trying to anticipate and prevent these delays. He adopts methods and plans his work to overcome as far as possible delays because of rains. To eliminate labor trouble he buys modern machinery that does work formerly done by hand. But his biggest delays have been because the railroads have not delivered material to him regularly during the construction season.

If the roads which are needed and wanted are to be built, something must be done to assure the contractor when he starts work in the spring that he will have his materials when they are needed. It is useless to expect him to build any considerable mileage of roads when he has to shut down his work every few days waiting for sand, stone or cement.

For that reason the Lakewood Engineering Company sent letters to contractors, highway engineers, banks, chambers of commerce, railway officials and others interested or concerned with the country's highway program, pointing out that if road materials are transported and stored during the winter and early spring months, when open-top cars are more readily available than they are during the construction season, the contractors can proceed with considerable less interruption and their working season will be increased accordingly.

What Has Been Done in Some Places

A great many replies have been received to these letters. Most of them are in hearty accord with the plan suggested and offer help in making it a success. Several letters tell what has already been done along this line. For instance, at Ogden, Utah, materials for 20 miles of road were shipped in last winter, and this road was completed during the past season in record time. The State of Delaware has followed this practice for three years.

The Board of Freeholders of Passaic county, New Jersey, have acquired a central storage yard for stock-piling road materials this winter. An Illinois city, Belleville, has already stored cement for next season's work.

It is surprising that the idea is apparently new to many. It was strongly urged last year by several State Highway Departments, as well as the U. S. Office of Public Roads. Nevertheless, many of the letters which we have received indicate that the idea is a new one in many parts of the country. The replies which have been received now make it possible to analyze the subject in detail from the viewpoint of every one interested, taking into consideration the arguments against as well as the arguments for. This analysis follows:

The Supply of Open-Top Cars and Its Relation to Road Construction

Road building materials are usually shipped in open-top or gondola cars. In the Northern States the greatest demand for these cars comes in the summer months, when they are required for handling coal, ore, sand and stone for construction work and road building, etc.

In a few instances it has been pointed out by railway executives that on their own particular lines this condition does not exist and these cars are more in demand in the fall, winter and early spring months than during the summer. However, taking the country as a whole, it is a fact that there is generally a shortage of open-top equipment in the summer and a surplus in the winter. One reason for this is because the navigation season on the Great Lakes closes in November for the transportation of coal and ore. Many cars are needed for this service during the summer and early fall.

At the close of the navigation season these care are released, and for a short time are busy carrying coal to the local territory, which can be served after the lake trade is taken care of. But this local service is practically at an end by the last of December, when there begins to accumulate a surplus of open-top equipment. The transportation of coal slumps off rapidly after this time, as coal contracts are made on April 1, and from January until that time there is only a very small amount of this business for the railroads.

It has been the general practice to request shipments of road materials during the actual construction season. The result has been that the railroads are always contending with a peak load just at the time the contractor could do his most effective work if he were able to get his materials. The inability of the railroad to furnish the necessary cars very often makes it impossible for the contractor to get well started on his work, with the result that the close of the season finds him with a job which must be carried over until next year.

On the other hand, if the surplus cars which are available during the winter and spring months could be put at work hauling materials to be stored by the contractor until his season opens, he would be assured of steady work when he did get under way.

Financing the Transportation and Storage of Materials Ahead of Time

The questions most frequently asked about the early transportation and storage of road building materials are: How is the contractor to pay for the materials and for their transportation, and why should he contract for materials at the present prices when there may be a possibility of a decline in price?

A number of states, recognizing the advantage of the early transportation and storage of materials, have made it possible to pay the contractor, in full or in part, for material when it is delivered. This can now be done in the following states:

Alabama	Michigan
Arkansas	Nebraska
California	New Hampshire
Colorado	New York
Connecticut	Rhode Island
Delaware	South Dakota
Georgia	Tennessee
Idaho	Virginia
Illinois	West Virginia
Iowa	Wisconsin
Kansas	Wyoming
Maine	District of Columbia
Maryland	Oregon
Minnesota	Vermont

In ten other states such procedure is

not possible at the present time under existing statutes. In only three states is there any sentiment against this proceeding.

In those states where it is not possible for the highway departments to make such payments it will of course be necessary for the contractor to finance the transportation and storage of materials ahead of time. In such instances he will have to arrange with his banker for the needed funds. But even if he does have to borrow the money, there is every reason why he should do so. The interest on the amount required is absolutely insignificant when compared to the sum the contractor will lose if he should have to shut down his job even only a few days because he cannot get regular delivery of material during the construction season.

There now seems no possible reason to look forward to lower prices for materials next year. Freight rates have increased and a larger demand for material is expected. The demand is increasing in many localities faster than the supply. Freight rates and the law of supply and demand are the two principal factors governing price. Therefore, it does not seem that material prices will go down. Yet even if there were hope for a decline by next season, the extra cost to the contractor buying his materials for winter and spring storage will really be only a small insurance premium guaranteeing that he will not have to close down his work every few days to wait for materials. Such slight extra cost is mighty cheap insurance.

The banks of the country are more than willing to help. A contractor needing financial assistance to aid him in shipping and storing materials early should not hesitate to go to his banker. Money loaned for this purpose is really backed by the security of the state for which the road is to be built. And what better security could be wanted?

Freezing Weather Will Not Prevent Winter and Spring Shipments of Road Material

The difficulty of unloading sand or stone which has frozen in transit is an objection which is frequently raised to the shipment of road materials during the winter months.

It is true that these materials may freeze in the cars, but material for road construction is shipped generally only a comparatively short distance, and such freezing will be confined to a thin crust unless the cars are delayed in transit or unloading. The proper unloading equipment will make it possible to get the materials out of the cars in a minimum amount of time, which will prevent it from freezing solid.

Where material is delayed and becomes frozen in severe weather, it of course will be necessary to employ steam pipes, or to apply heat in some other way to thaw it before it can be handled from the cars. But such procedure is far from impossible.

In the fall it is not possible to continue actual paving where the subgrade freezes slightly at night. Although the temperature during the day may not be below freezing, the contractor will not be permitted to place concrete. But such weather is ideal for continuing unloading and storing materials for next season's work.

In some of the Northern States, where very severe weather prevails, it would of course be necessary to withhold shipments during extremely cold weather, because even though they are transported for only a short distance, they may become frozen solid in a very short time under such conditions. However, in such states where these conditions do prevail, it is possible to ship materials at all times except during the dead of winter.

Quarries Often Do Not Supply Material During the Winter Months

Many quarries close down during the winter months; therefore, an argument has been made that materials will not be available for winter shipment.

So far as learned, the quarries close down largely because of habit. There has been no active market for them during the winter months. They have preferred to stop their work instead of assuming the burden of stocking their materials until the next season. If a market could be assured for the quarries which would absorb their output, there is no reason why they should not operate twelve months out of the year, with the exception of the time required to make repairs.

Every one who is interested in the completion of highway projects which have been planned can accomplish much good by bringing this subject to the attention of those actively concerned with the contemplated improvements. The more publicity which can be given to the entire proposition, the better. Such publicity will lead to further discussion, and such discussion will generally bring out the advisability of this practice.

FROM A VALUED READER FOR 30 YEARS

To the Editor:

You were very kind to send me the copy of "Paving and Municipal Engineering" of November, 1890 (30 years ago), with the article on the "Paving Problem" which I wrote.

A few years previous to 1890, when I finished college with the degree of C. E., I looked about to see what branch of engineering had been either neglected or not been filled with engineers. I found that the construction of pavements and roads was that field in our country. I had just returned from a trip to Europe to examine the specifications for the construction and maintenance of good roads, especially in France, Switzerland and in Germany. I therefore decided to specialize in this branch of engineering.

In 1890 the first issue of a monthly magazine called "Paving" appeared on my desk, and I at once not only subscribed for it, but wrote to Mr. Fortune, its editor and owner, that there was great need of such a publication in the U. S. and that I would gladly do what I could to help it.

The result was that he requested me to furnish a series of articles, among the first ones being the one in the issue you sent me, on the "Paving Problem of the U. S." The problem then was: First, to overcome the ignorance and apathy in our cities, counties and states in respect to roads and pavements. Second, to get rid of the construction carried on by empiricism and conservatism of politicians and contractors. Third, to apply scientific means and methods, by getting good specifications written out in full and enforcing them through the employment of engineers-in-charge.

I knew that the construction of a few good roads and pavements of properly selected materials, put together in the right way and placed in various cities and parts of the U. S., would attract the attention of the public, and that more and more would become a necessity and be in great demand. In the last 30 years the results, *so largely helped by your publication*, have been excellent and enormous. From a few miles thus constructed then there are now being constructed annually almost one billion dollars' worth, or several thousand miles of good roads and pavements.

The era of good roads and pavements in America has fully come, and the problem now is practically that of maintaining them in constant, good, viable condition, also thereby conserving the enormous capital investments in them. Economic maintenance and not cheap first cost is true economy for all public works, including roads and pavements.

It is further wise to remember that subsoil study and preparation are as important for permanent success in this branch of engineering, as the construction of pavement foundations and wearing surface layers, which, when properly done, makes it possible to maintain the surfaces in constant, good condition.

Very truly yours,

J. W. Howard, Consulting Engineer.
1 Broadway, N. Y., Dec. 28, 1920

OBSERVATIONS ON SOME FAILURES OF MODERN HIGHWAY BRIDGES

By A. H. Hunter, District Engineer, Illinois Division of Highways, 302 Apollo Theatre Bldg., Peoria, Ill.

To the casual observer it is apparent that the general type and character of bridge improvement work now being done by townships and counties of the State

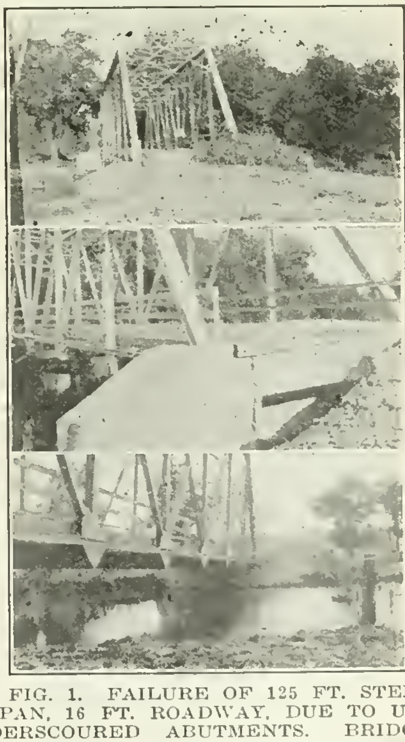


FIG. 1. FAILURE OF 125 FT. STEEL SPAN, 16 FT. ROADWAY, DUE TO UNDERSCOURED ABUTMENTS. BRIDGE DESIGNED BY BRIDGE DEPARTMENT OF ILLINOIS DIVISION OF HIGHWAYS AND CONSTRUCTION SUPERVISED BY COUNTY OFFICIALS DURING 1917. FAILURE OCCURRED IN JUNE, 1920.

of Illinois has improved steadily from year to year. Possibly this development has been more marked during the last eight or ten years than previously. I take it that the old wooden bridges and culverts have been replaced with reinforced concrete entirely, or, in the case of longer spans, with concrete abutments and steel superstructures, as fast as circumstances or funds permitted. The highway departments of the several counties have been in position to insist upon the proper design and location details. They are further to be complimented on their ability to secure reasonably first-class construction. In the face of the foregoing, however, I wish to present a word of caution, inviting their attention to the question of foundations.

For a number of years in my professional experience as District Engineer of the Division of Highways, Department of Public Works and Buildings, my superiors endeavored to impress me with the fact that more bridge failures must be attributed to poor foundations than to any other cause. Their teachings were recalled when in the early summer of 1920 I had opportunity to make inspection of some highway bridges in central and western Illinois which had failed at the time of an extreme flood. I was fortunate on this inspection in having present several county superintendents of highways, who had been present at the time of the original construction and who were more or less familiar with features encountered at that time.

Failures Due to Inadequate Support of Wings and Abutments

On traversing the territory affected, however, I was particularly impressed with the fact that practically without exception the failure of these drainage structures had occurred by reason of inadequate support for the footings of wings and abutments. It is true that many of the bridges destroyed were old and had possibly served their days of usefulness. It is regretted, however, that I have to mention that several failures were found on structures which were relatively new and had been built on approved plans prepared by experienced engineers. In order to avoid confusion, I made reasonably close inspection of the general character of materials involved. I was favorably impressed with the general character of the concrete and the workmanship that had been placed therein. Possibly there were some inherent details, such as location and distribution of reinforcing steel, which could not be determined by such casual inspection as I was able to make. In general, however, I think that the conditions as we found them positively indicate that failure of the bridges must be charged to foundations alone.

Failure of 125-Ft. Steel Span Due to Settlement of Foundation

By means of the accompanying photographs I think any one can really see the conditions that must have led to settlement. I wish to expressly invite attention to the photographs in Fig. 1, representing a large steel bridge over a small river in the western part of the State—a steel superstructure of 125-ft. span, 16-ft. roadway, supported on reinforced concrete abutments which extended some 4 or 5 ft. below the stream bed. In conversation with the county superintendent I was advised that the material encountered at the time of original construction consisted of sandy gravel, with some loose shale rock. Apparently the stream tide of high water had temporarily changed its course, with the result that scour developed along the face of the abutment and around the one wing. The result was that a settlement of 2 ft., or slightly more, had occurred in one corner, while the other wing had possibly not settled more than half that distance.

The reader will observe from the photograph that the unequal settlement caused a serious warping of the steel truss and concrete floor. A few cracks could be observed in the floor, particularly in the vicinity of the panel points. From a casual inspection, however, they did not appear to be serious, and I have reason to believe that when the bridge is jacked back to former elevation, they will not affect its strength. Later in the season extensive repairs were made at this point, and when a temporary cofferdam was constructed and the water pumped out, it was found that the scour had dug out for a depth of 5½ ft. below the bottom side of the concrete footing.

In a prairie country it sometimes seems that we are taking unjustifiable protection when we insist on placing foundations to a depth of 4 or 5 ft. below the stream line elevation. I wish now to invite attention to Fig. 2, which is that of a concrete bridge, 20-ft. span, 16-ft. roadway, built about 1910 under plans prepared by the Division of Highways. Further, inspection in the field was handled by one of our engineers, who had reasonable assurance that the structure was built according to plans, and, if we are to judge from outward appearances, it was a very creditable piece of work. It appeared that for some reason or other, as the years went by, it developed a natural wash which had lowered the elevation of the stream line to the extent that on the day of inspection both footings were exposed. One had already settled

FIG. 2. REINFORCED CONCRETE BRIDGE, BUILT ABOUT 1910. PLANS AND PRELIMINARY ENGINEERING, INCLUDING INSPECTION, HANDLED BY ILLINOIS DIVISION OF HIGHWAYS. FAILURE OCCURRED IN JUNE, 1920.

possibly as much as 1 ft. to 18 ins. At the time of settlement the earth pressure had forced the wing and abutment towards the stream. I was advised by men present, who were familiar with the original construction, that the nature of the soil encountered at this place would normally have been considered excellent for supporting bridges, as it was a very tough blue clay. Possibly some of this failure might have been avoided if reasonable care had been exercised and the curtain walls built before the footings had become entirely exposed. In our judgment, on the day of inspection, the bridge could have been placed in serviceable condition at a reasonable expenditure.

I am of the impression that it is good practice, not only in highway work, but considered so on railways also, to provide structures that will accommodate the water for average conditions and not take into account those great floods which possibly occur once in a period of 15 or 20 years.

A Failure Due to an Extraordinary Flood

The photographs shown in Fig. 3, in my judgment, represent one of those cases where no sane engineer certainly would have endeavored to construct a bridge to accommodate the water that was forced upon it at the time of this flood. We arrived at the site a few days following the high water and had sufficient evidence from the driftwood and debris deposited to indicate clearly that when the water was at the highest point it certainly was not more than 6 ins. below the top of the girders at the higher end. I mean by this that after settlement of the one abutment had taken place, the only exposed portion of the bridge would be the tops of the girders at the opposite end. This reinforced concrete bridge was a 40-ft. span, 16-ft. roadway, built about 1916 in accordance with plans provided by the Division of Highways. The settlement that occurred possibly did not exceed 2 ft. at one corner. The opposite corner on the same abutment settled some, but possibly not more than 1 ft. One can readily imagine that with the abutment taking this position, a serious warp would occur in the superstructure. Casual inspection of the floor revealed a small number of cracks. None of these were more than hair lines, and as far as I was able to see the floor could be reported in reasonably good shape. The girder on the side where the maximum settlement occurred was seriously cracked. Strangely enough, the larger cracks were found in the vicinity of the top of the girder where the twisting action had warped the concrete. I was led to believe that should the depressed end be elevated to normal, these cracks in the top of the girder would be closed up partially. To date I have not heard that arrangements have been made for repairs. I take it that inspection after repair would be

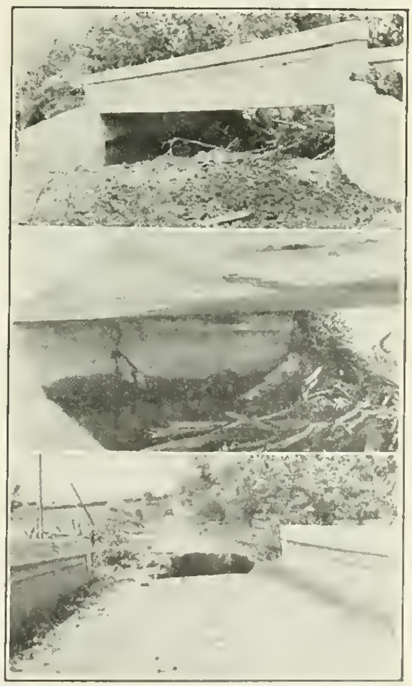


FIG. 3. REINFORCED CONCRETE BRIDGE, 40 FT. SPAN, 16 FT. ROADWAY, BUILT IN 1916 ACCORDING TO PLANS APPROVED BY THE ILLINOIS DIVISION OF HIGHWAYS, FAILURE OCCURRED IN JUNE, 1920.

well worth while and certainly instructive as to the general behavior of these cracks.

Suggested Precautionary Measures

Other photographs might be submitted as being of interest, but I think those given are typical of the conditions found. In friendly criticism of construction of this nature, I think effort should be made to impress those in responsible charge of construction of the importance of substantial supports for highway structures. In many counties I think that very few realize the importance of having experienced inspection on such work. It is appreciated that many counties are not financially able to make arrangements. I certainly would advocate, however, that those interested make effort, when excavation is completed, to assure themselves of the permanency of the foundation before permitting the contractor to proceed with construction of the substructure. In case of doubt, provide for piling, and should there still be some hesitancy on the part of the local official, consult, in the case of townships, with the County Superintendent of Highways, and should there still be some uncertainty, call upon the District Engineer of the Division of Highways in the locality.

SOME FEATURES OF THE LAKE ASPHALTUM INDUSTRY

By J. Strother Miller, Jr., Chief Chemist, The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa.

Asphalt, as produced in nature's own laboratories, in so uniform a manner as to require little if any refining to make it suitable for use in paving and road building and for other purposes, has been of interest to engineers since about 1870.

In more recent years there has appeared another class of asphalt, produced in the oil industry when certain types of crude asphaltic oils are distilled. The presence on the market of asphalts from these two general sources naturally draws attention to the formation of the natural or lake asphalt considered in the present article, which also treats of a definition of asphalt that will differentiate between the two groups.

Since native lake asphalt from the famous Pitch Lake, on the Island of Trinidad, in the British West Indies, probably has had the widest application in road and street paving, the study of its origin has been conducted by engineers and geologists with careful attention.

Theory of Formation

The theory now generally accepted is that asphalt is in the process of formation today. It does not originate as asphalt, but is a secondary product, resulting from the transformation of suitable lighter forms of bitumen, malthas, or even thinner oils, into harder bitumen, by condensation and polymerization, a reaction in which sulphur and probably sulphates seem to take an important part. No high temperatures apparently are necessary, once the change is initiated, but time is required.

In the manufacture of oil asphalt, an asphaltic oil is distilled, the gasoline, naphthas, burning oils, gas oils and lubricating oils are obtained from the distillate, and the residue is controlled to give the best grade of oil asphalt obtainable from the particular crude oil under manipulation, without economically sacrificing any of the more valuable distillates.

Some Definitions of Asphalt

Almost every author of books on the subject of asphalt has advanced his own definition of the product, and as a result of this chaotic condition, several different technical and engineering societies are devoting serious attention to the subject at the present time. To show the variance, the following definitions will suffice:

First—Asphalt may be simply defined as a solid or semi-solid form of mineral bitumen, either pure or containing more or less mineral or other earthy matter. Speaking in general terms, it may be said there are three grand divisions of natural mineral bitumens, viz., gaseous, liquid and solid. The asphalts consist of a mixture of various saturated and unsaturated solid hydrocarbons and their derivatives.

Second—(1) Asphalt, solid or semi-solid native bitumens, consisting of a mixture of hydrocarbons, of complex structure, largely cyclic and bridge compounds, together with a small proportion of their sulphur and nitrogen derivatives, but free from any appreciable amount of solid paraffines, melting upon the application of heat and evidently produced by nature from petroleum containing little or no solid paraffine. Solid or semi-solid residues produced from probably similar oils by artificial processes are sometimes called asphalts, but should properly be termed oil asphalts. The more common types of native asphalts are known by the name of the locality in which they occur, such as Trinidad, Bermudez, Maracaibo, Cuban, California, etc. Native asphalts with few exceptions contain water, ex-

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(1) Office of Public Roads, Dept of Agri., Circular No. 93.

traneous organic or vegetable matter and inorganic matter, such as clay, sand, etc.

Third—(2) Solid or semi-solid native bitumens. Solid or semi-solid bitumens obtained by refining petroleums, or solid or semi-solid bitumens which are combinations of the bitumens mentioned with petroleum or derivatives thereof, which melt on the application of heat, and which consist of a mixture of hydrocarbons and their derivatives of complex structure, largely cyclic and bridge compounds.

NATIVES MINING ASPHALT IN TRINIDAD LAKE.

The Two Great Asphalt Lakes

The largest amount of native lake asphalt has been produced from Trinidad and Bermudez asphalt lakes. Roads and streets paved with these materials are found in virtually every state in this Nation, as well as in many countries in foreign lands, and these materials have withstood traffic in many cases for 30 years or longer.

The two great asphalt lakes are situated in South America, the Trinidad lake on the western coast of the Island of Trinidad, and the Bermudez lake on the eastern coast of Venezuela, about 30 miles inland by air route. The Gulf of Paria, about 85 miles in width, lies between Trinidad and the mainland of South America.

Trinidad is about 2,000 miles south of New York City and about 700 miles north of the equator. Its area is about 1,700 square miles, or a little less than that of the State of Delaware. The climate is tropical, but the island is favored by the trade winds, which tend to ameliorate the intensity of the heat. The temperature averages about 85 degs. F. the year round and never varies more than 20 degs.

The term "lake," when applied to a deposit of asphalt, may seem a misnomer, but "lake" best describes the places where nature has concentrated the output of bitumen.

The Trinidad Lake

Trinidad asphalt lake is situated about one mile from the sea, 138 ft. above sea level, and is about 114 acres in extent. Its surface is undulating, the mass of asphalt seemingly lying in great folds. Where these folds meet great crevices occur, their depth varying from a few inches to a few feet. Miniature canals, formed by the collection of rainwater in the crevices, run in all directions over the surface of the lake.

The mass of asphalt is in imperceptible, constant motion, which can, however, be detected only by noting the relative position of the miniature canals at various times or by observing the deflection from the vertical of drills used in borings to find the depth of the deposit.

Depth of Lake

The greatest depth of the lake never has been found. Recently a drill was forced more than 150 ft. below the surface, the entire boring being through solid asphalt of uniform character and composition, but the drilling had to be abandoned, as the tube or casing had been carried so far from the vertical (1 ft. in 6) as to render any further efforts valueless.

The depth found, however, indicates an almost inexhaustible supply of uniform material. While mining of asphalt at Trinidad has been carried on continuously for more than 38 years, the level of the lake has dropped only 6 or 8 ft.

BERMUDEZ ASPHALT LAKE, SHOWING SURFACE WATER IN FOREGROUND.

The new material is either of the same character or replenishment is so very deep that the borings do not indicate a change in character. The borings near the edge of the lake show considerable slope to the sides, and it is believed the lake rests in a bowl-like depression, probably an extinct mud volcano.

Taking Asphalt from the Lake

A narrow-gage railroad runs from the refinery and an endless cableway out over the lake, turning in a large semi-circle so as to traverse as much of the lake as pos-

(2) Standard definitions of terms relating to materials for roads and pavements, Serial Designation D-8-18, American Society for Testing Materials.

sible. Although this road is not ballasted, there is very little sinking of the ties into the asphalt. A train consisting of several small flat cars, each equipped with a dumping bucket of about 500 lbs. capacity, is pulled over the track by an endless cable running over the ties, and by means of a portable clutch a native on the front of the train controls the stopping and starting.

Natives equipped with broad mattocks dig great lumps of the asphalt from the lake, loading them into the cars by hand.

LOADING SKIPS ON THE NARROW GUAGE RAILROAD WHICH TRAVERSES TRINIDAD ASPHALT LAKE.

The depression left by a day's mining operations is filled within 48 hours, another proof of the continual motion of the mass of asphalt.

The loaded cars are pulled either to the refinery or to the terminus of an endless overhead cableway, which carries the buckets down hill and out over the dock to the steamer. From a high pier the buckets are dumped directly into the hold of the waiting vessel.

In the holds of the steamers which carry the crude asphalt to all parts of the world, the material amalgamates into a solid mass, and it is necessary to dig it out in lumps at the end of the voyage.

The Bermudez Lake

The location of the Bermudez asphalt lake, in Venezuela, is in striking contrast with that of Trinidad's deposit.

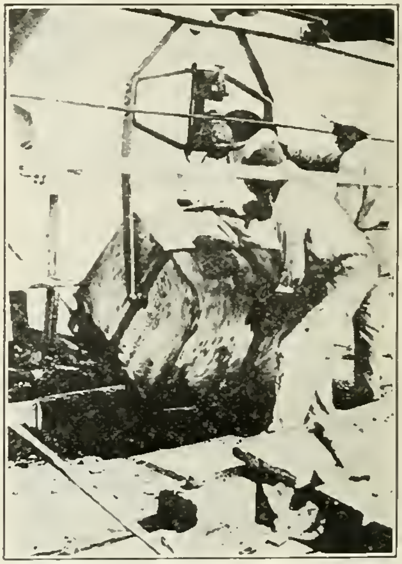
The only means of approach to Bermudez Lake from the Gulf of Paria is by steamers, up an uninhabited river called the San Juan. During the five-hour trip the only scenery consists of mangrove swamps on each side of the wide and placid stream, and the only signs of life are multitudes of myriad-colored birds.

The last five miles of the trip is up a tributary of the San Juan, the Guanoco river. In reality, the Guanoco is little more than a deep creek, and is so narrow that steamers are forced to turn at its mouth and back up stream, that they may have a straightaway course when loaded.

From Guanoco, the loading point for steamers, a narrow-gage railroad leads through 7 miles of dense tropical jungle to the asphalt lake. It is impossible to step from the bed of the railroad without going ankle or knee deep into water. Tropical flowers of wondrous beauty and birds with plumage of many colors abound in the forests and swamp lands.

Bermudez Lake covers an area of about 2,000 acres, and in those parts which have been worked the depth of the asphalt varies from 3 to 10 ft. The asphalt is softer than that of Trinidad, and it is necessary to move the ties of the railroad which traverses the lake at frequent intervals, to prevent them from being submerged in the asphalt. There is considerably more water on the surface of the lake, rendering the operation of mining more difficult. There is also a large amount of muddy silt, washed in from the hills to the west, which must be mucked off the top before asphalt is reached.

Consequently the vegetation on Bermudez Lake far surpasses that on Trinidad



DUMPING ASPHALT FROM SKIP BUCKETS DIRECTLY INTO HOLD OF STEAMER AT BRIGHTON, TRINIDAD.

Lake, where a few "islands" of stunted trees and straggly bushes dot the surface at infrequent intervals.

Taking Asphalt from Bermudez Lake

The asphalt is loaded by hand into dump cars, which are pushed by natives to an elevated track at the edge of the lake, where they are dumped into wooden skips. The skips are hauled on flat cars 7 miles to the steamer's side, at Guanoco, where the asphalt is dumped into the hold. The crude material runs together the same as does the Trinidad.

The refining of both Trinidad and Bermudez asphalts is the same, so the description of the process through which the former material is put will suffice.

Refining Trinidad Asphalt

As obtained, crude Trinidad asphalt contains approximately, and uniformly through all cargoes, 39 per cent. of bitumen, 32 per cent. of mineral and other matter, and 29 per cent. of water. For comparison, Bermudez crude varies as to its water content, averaging about 25 per cent., 1 to 3 per cent. of mineral matter, and 68 to 72 per cent. of bitumen.

Refining consists of driving off the water in a steam-heated still, open at the top, at a temperature of about 350 degs. F. The asphalt then is either drawn off into slack barrels, surface cooled by water to prevent splashing while being hauled about the refinery yard, and shipped direct to customers, or it is fluxed before being drawn from the still.

Fluxing of a refined asphalt consists in adding a predetermined quantity of a petroleum residuum, or flux, which ts bougbt under stringent specifications, assuring a uniform material suitable for paving and other purposes.

Refined asphalts have a consistency or penetration of from about 2 degs. for Trinidad to 20 degs. for Bermudez, and are too hard for use in paving operations. The proper consistency is dependent upon climatic and traffic conditions, as well as the grading of the mineral aggregate with which it is mixed to produce a paving mixture.

The fluxed asphalt must not be too hard in cold weather, and yet not too soft in summer.

Every one probably has noticed, and heard unfavorable comments upon, the softness of some sheet asphalt pavements in summer months. But few can recall seeing a sheet asphalt street with heel marks, horse calk marks or tire tracks in it in winter. The marks iron out, and a pavement that does not mark a reasonable amount in summer must be viewed with suspicion, for it probably will be too hard during the colder periods. This is one instance where technical control has been and will continue to be of material assistance to the paving industry.

When the refined asphalt is fluxed, it is called an asphalt cement, since it is used to cement particles of mineral matter together. The fluxed material is shipped in barrels, and is ready to use when received, with the exception that it has to be remelted.

Asphalts have been applied to many different uses in the past few years, and the simple fluxing to varying degrees of consistency is not the only operation today. Asphalt for some uses must be the softest that can be produced, while for some other uses asphalt with the same melting point, but a much harder consistency, is required. Such variations are obtained by proper blending of two or more asphalts or the incorporation of materials other than asphalts.

Obviously the type of material suitable for use in hard rubber compounds would not be suitable for saturating canvas to produce a water-proof and mildew-proof piece of goods. The asphalt for either of these products would not be applicable for building tank linings to withstand temperatures up to 120 degs. F. and mixed acids, such as sulphuric and nitric of about 25 per cent. strength, such as are met in the dye industry.

Colloidal Matter in Trinidad Asphalt

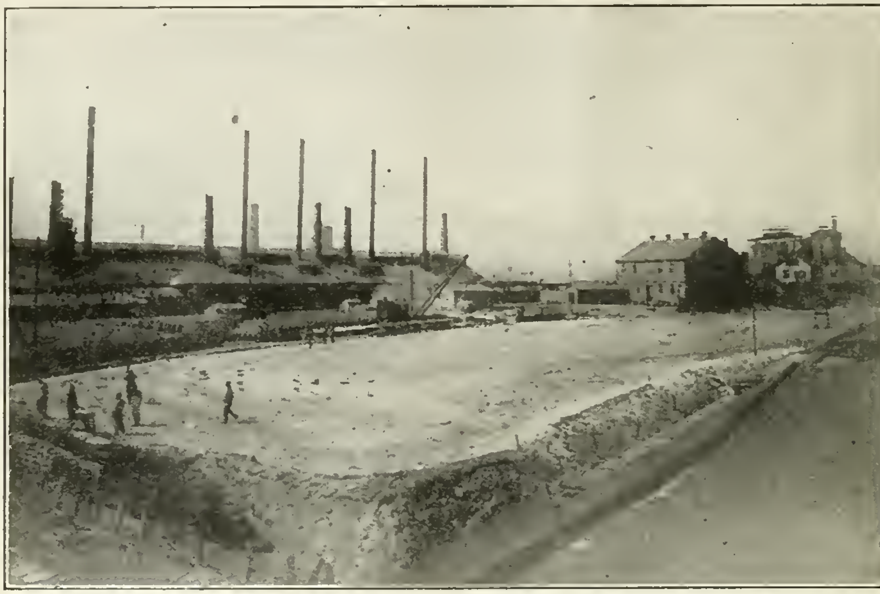
The presence in Trinidad Lake asphalt of mineral matter in a colloidal state differentiates this bitumen from either the asphalt from Bermudez Lake or the artificial or oil asphalts. Scientific investigations have convinced us that the colloidal clay has a direct bearing upon the service which Trinidad streets have rendered, and are rendering today.

For many years the insistent presence of a small percentage of mineral matter in all bitumen extracted from Trinidad Lake asphalt baffled the operators. While all felt it was a very finely divided clay, it was not until 1914 that Clifford Richardson initiated the work that finally showed these particles in the ultra-microscope.

How this clay occurred in this manner is explained by Mr. Richardson briefly as follows :

"The crude asphalt in the lake consists of a complex system of several phases, gaseous, liquid and solid, organic and inorganic, more or less in equilibrium, displaying colloidal properties of industrial as well as scientific interest. The asphalt owes its origin to certain geological conditions existing side by side in that locality. Oil sands occur at different depths, which contain vast quantities of petroleum, as has been demonstrated by the many wells which have been successfully sunk, a petroleum of unique character, differing from any previously known, and of a highly asphaltic nature. Rising toward the surface along some line of least resistance, the petroleum meets the paste of fine silica and clay which form the mud of the spring. With this the oil becomes emulsified, probably by the action of the natural gas which accompanies it at very high pressure. In the lapse of time the entire crater of the spring has been filled with the resulting material and it has overflowed the rim, running down the slopes of the sea. Fresh material is in process of formation today and issues at several points on the surface of the deposit, of a consistency so soft that the air, while if the soft asphalt is sealed up in a tin can the latter will explode in the course of time from the gas pressure developed.

"The main mass or older form of the asphalt in the crater is sufficiently hard to make it possible to flake it out in large pieces of from 50 to 100 lbs. in weight. In this form it resembles an exaggerated Swiss cheese, owing to the gas cavities it contains. While brittle enough for this, an excavation of some depth at any point is filled up and obliterated in 24 hours by the flow of asphalt from the adjoining material. Large masses of the asphalt



MINIATURE ASPHALT LAKE AT THE REFINERY AT MAURER, N. J., INTO THIS BASIN CRUDE ASPHALT IS DUMPED WHEN UNLOADED FROM STEAMERS, AND LEFT UNTIL NEEDED. THEN IT IS DUG OUT AND REFINED.

it can be readily moulded into balls with the hands, without adhering to them, owing to the free water with which it is associated. This so-called 'soft pitch' is also accompanied with natural gas of unusual composition, containing in addition to the hydrocarbons usually found in such gas, carbon dioxide and hydrogen sulphide, in some localities in the neighborhood of the deposit, as much as 33 per cent. of the former and 3.5 per cent. of the latter. At the same time the soft pitch itself is evolving gas, either the result of the release of pressure or of a reaction going on between the bitumen and the mineral matter it contains, this gas consisting largely of hydrogen sulphide and carbon dioxide, probably the latter cause, as it continues for years after the material has been exposed to taken from the deposit and kept in storage, without lateral support, present all the features of the glacial flow of ice.

"The asphalt, therefore, originating in a soft condition, as demonstrated by the fresh material, which is constantly being formed and which emerges near the center of the deposit, becomes hard in the course of a year or two. The cause of this and of the evolution of the gas which is observed may be attributed to the presence of a catalyzer. The asphalt contains clay in highly dispersed condition, carrying adsorbed ferrous sulphate, which may play such a role."

In the endeavor to reproduce these conditions clays from many different sources, including clays from oil springs found on the Island of Trinidad, have been experimented with in many ways, and that method showing the most promise is to make a clay slurry with water, adding this to a pure bitumen at a temperature below that of boiling water and slowly cooking out the water. This method results in some colloidal particles in the bitumen, but not nearly approaching the number per unit of volume as found in the lake asphalt.

These minute particles of clay no doubt adsorb the bitumen, creating a surface energy far in excess of any type of mineral filler added to a bitumen in the usual dry way, such as in making a sheet asphalt mixture.

First Modern Asphalt Pavement

Asphalt from Trinidad Lake was used in the first modern asphalt pavement by the originator of this now standard form of paving, in 1870. The inventor, E. J. DeSmedt, in an effort to get away from the use of coal-tar as a cementing material, laid a pavement with a mixture of sand, powdered limestone and Trinidad asphalt, softened with the residues from the distillation of petroleum. His idea was to imitate the rock asphalt pavements of Europe, since the material used abroad was not readily available or economical at that time in this country.

The asphalt paving industry properly started with the laying of the first piece of pavement of any size in front of the City Hall in Newark, N. J., in 1870. In 1871 or 1872 another piece was laid in Battery Park, New York, and in 1873 a section of Fifth avenue, opposite the Worth Monument, was put down. The latter section, with one or two resurfacings, remained in place until 1887. Eighteenth street, between Fourth avenue and Irving Place, was paved with a Trinidad mixture in 1874 or 1875, as were Twenty-eighth street, between Broadway and Fifth avenue, and Thirty-eighth street, from Fifth avenue to Madison avenue.

These small pieces of work originated the modern asphalt paving industry in America. They were sufficiently successful to attract attention, and when Congress, in 1875-76, provided for paving Pennsylvania avenue in Washington, from the Capitol to the Treasury, the commission appointed to select the type of pavement decided upon asphalt. The work with the Trinidad mixture proved successful, and from that date on native lake asphalts were used in increasing quantities in almost every large city in the United States.

Bermudez Lake asphalt has been used extensively for asphaltic concrete and asphalt macadam highways, when the increasing use of motors called for roads capable of carrying an enormous volume of traffic.

UNIQUE SEWER CONSTRUCTION IN KANSAS CITY, MO.

By Paul A. Hartung, Mem. Am. Soc. C. E., Engineer of Sewers, City Hall, Kansas City, Mo.

The construction of a sewer with very difficult and unusual features has recently been completed in Kansas City, in which the contractor proved himself to be both prolific of ideas and ingenious in their execution.

An Old Sewer

About 40 years ago a 5-ft. 6-in. 2-ring brick sewer was constructed in Walnut street, extending from Twelfth street to Seventeenth street, and as this portion of Kansas City was undeveloped the sewer angled across the block to Eighteenth and Main streets, thence south in Main street to Nineteenth street, west in Nineteenth to the alley immediately west of Main street, thence south in the alley to an outlet into O. K. Creek.

As this part of the city developed it became necessary to abandon that part of the sewer extending from Seventeenth and Walnut streets to Eighteenth and Main streets, for the reason that the sewer was so shallow that it interfered with basement installation and basement drainage and was of no further value.

From Eighteenth and Main to its present terminus (into a concrete sewer constructed by the Kansas City Terminal Railroad Company), the depth of the sewer rendered it useless for basement connections, and due to the fact that the property contiguous to the sewer is rapidly developing, and in all cases basements are being installed, it became necessary to conform to the demands of the property owners to relieve the situation. This department therefore proceeded to prepare plans, and after passing through the customary legal matters, the contract was awarded the Wm. D. Boyle Construction Company, under the date of Aug. 24, 1920.

Description of New Sewer

Beginning in an existing 18-in. sewer in Main, at Eighteenth street, the plans show the new work starting out with a 21-in. vitrified clay pipe across Eighteenth to the south side of Eighteenth and west side of Main, west to alley west of Main; at this point the depth of sewer is 25 ft.; south in alley to Nineteenth, where old sewer is diverted into it, continuing in alley in 33-in. monolitbic concrete paralleling old sewer, and being 8 ft. below the bottom of same at Twentieth street, where a 24-in. brick and an 18-in. vitrified clay pipe sewer are taken in; continuing in 36-in. monolithic concrete to a point 680 ft. south of Twentieth street, where it intersects the old sewer. The old sewer was in fair condition, but was repaired by placing a concrete invert up to the spring line. The alley is paved, and, as a trafficway, serves many industries which continually use it, and a wave of protest arose when the contractor began construction by the old method of open trench work, which would have entirely blocked the alley and made it impossible for these industries to function.

Sewer Constructed in Tunnel

The contractor was therefore ordered to dispense with this method and to tunnel for intervals of 250 ft. between shafts. This method was carried out successfully throughout the work, a distance of 1,-700 ft.

Owing to the depth of the sewer and its closeness to the buildings which line the alley and the old sewer, this appeared to be a hazardous undertaking, but not a single accident occurred during the entire work.

The tunnel was excavated 4 ft. wide by 4 ft. 6 ins. high, and as the material was loosened it was loaded into wheelbarrows and taken out at the shaft and temporarily disposed of in vacant lots adjacent to the work. As the tunnel was driven foot by foot, the material was held in place by placing 2x12-in. timbers entirely around the heading, thereby forming a solid box. This method proved to be so successful that in not one instance was a cave-in recorded.

Concrete Poured to Tunnel Through Auger Holes

Concrete was mixed and poured from the surface of the alley by boring holes with an ordinary 12-in. auger down to the sewer. The invert to the spring line was poured first, then forms were inserted and the top was poured. One man kept constantly in the tunnel to ram the concrete as it flowed in. (The writer personally inspected a large percentage of the completed sewer and found very few honeycombs.) The necessary slants were placed and recorded, and the existing connections to the old sewer changed to the new. The 21-in. vitrified clay pipe was placed by lowering it at shafts and conveying to the point of usage.

The Contractor's Skill

The contractor commenced work Sept. 1, 1920, and finished Dec. 15, 1920, although the contract date of completion was April 1, 1921, an approximate saving of one-half the time. Much credit is due the contractor for the very efficient manner in which the work was handled, being without delay to traffic, an accident to life, injury to adjacent buildings and without interruption to the sanitary flow in old sewer, which he was required to maintain during construction.

The total cost of this work is in the sum of $44,000, which will be paid in four annual tax bill assessments against property in this district, at the rate of $0.0346 per sq. ft.

LONG SECTION OF NEW CHICAGO-ST. LOUIS HIGHWAY DEDICATED AND OPENED

A 117-mile link of the new Chicago-St. Louis highway, from Sparland to Chatham (Ill.) was recently formally dedicated and opened to the use of the public, and the opening of the road was attended with some noteworthy features. This is the longest stretch of paved road yet completed under the Federal Aid Act.

The entire road is paved with concrete and along this magnificent rural boulevard lie the cities of Springfield and Peoria, as well as a score or more of smaller towns and villages and hundreds of farms in what is one of the richest farming districts in the world. Special significance is attached to the completion of this road, since it is the first large project to be completed of the 4,800 miles of hard-surfaced roads that are to form a connected and state-wide system of highways in Illinois.

Much enthusiasm was exhibited over the road by those served by it, and large delegations of state, city and county officials came from various cities along the route, meeting at Mason City for the dedication and celebration exercises. In spite of rain and generally unfavorable weather, several hundred cars started out on the road, arriving on schedule, without discomfort or inconvenience, while the muddy and slippery feeder roads gave a constant reminder of traveling conditions on unimproved highways. As the procession proceeded farmers were waiting at their front gates and at every cross-road to fall in line and help celebrate.

Governor Lowden Principal Speaker

Governor Frank O. Lowden was the principal speaker at the dedication. He complimented the public for its vision in building the road and the engineers for the manner in which they had carried on the work in spite of the handicaps of strikes, railway transportation difficulties and other embarrassments. He drew attention to the fact that Illinois was a close second to Pennsylvania, that State having built the most mileage of paved highways during 1920, and approved in general the road work that is proposed and the completed work as exemplified in the concrete pavement just finished. Clifford Older, Chief Highway Engineer, told of the immense amount of work required to build highways, and pleaded for the proper care of finished roads, saying that they would last if not subjected to loads for which they were never designed. He asked that caution be practiced in driving, to prevent accidents and injuries. S. E. Bradt, Superintendent of the Division of Highways, and Frank I. Bennett, Director of Public Works and Buildings, also addressed the gathering as representatives of the State engineering and road-building officials. Mr. Bennett said 800 miles of improved road would be completed by the end of next year.

The Father of Good Roads in Illinois

Perhaps the most applauded speaker of the day was Hon. Homer J. Tice, of Greenview, who is known throughout the State as the father of good roads and who is responsible for much of the constructive legislation on the statute books that allows roads to be built in their present state of efficiency. "For 27 years I have been preaching the gospel of good roads," said Mr. Tice, "and today I feel that actual good has been accomplished. People are generally recognizing that the greatest force for citizenship and Christianity is hard-surfaced highways." Officials of various cities addressed the crowd, invariably remarking on the benefits that the new road is bringing.

Effect on Other Communities

One of the most interesting events of the day was the arrival of boosters from Havanna, the county seat of Mason county. The concrete road does not pass through that city, and a special train was hired by that city and headed by its band to parade the streets, bearing signs on which were the legends, "We are walking because we have no paved roads," "Our Road is Paved with Straw," and other propaganda designed to enlist interest in connecting Havanna with the concrete road between Peoria and Springfield. Ed. Hull, one of the leading road enthusiasts of Peoria, called attention to the fact that Havanna had helped get the main road through and that it was now the duty of the places that already have roads to help outlying districts to connect up with the main system.

Road Location Features

Much comment was elicited from the automobilists traveling the newly finished road, particularly the safety features incorporated by the engineers in charge. For the most part, the road follows section lines, but there are frequent jogs and many turns. Where these turns are less than an eighth of a mile new locations have been made and easy reverse curves put in their place. All right angles have been reduced to curves having a radius of not less than 205 ft., and the curves are super-elevated or "banked" 1 in. to the foot, making them safe for traffic at good speed. All curves have good visibility, so that approaching cars may avoid meeting head-on at turns.

Willis Evans, Executive Secretary of the Peoria Association of Commerce, believes that the concrete road running through that city will help take care of the house shortage, but will change the shape of the city. He thinks the future trend of the city population will be along the road, tending to elongate the city limits and relieving the congestion that comes with a concentration of population. Wm. E. Stone, President of the First National Bank of Peoria, said that the new road was the greatest improvement that could have been made to either the city or the surrounding country, and he hoped the full program of paving would be carried on as speedily as possible.

MODERN GRANITE BLOCK, ASPHALT-FILLED, PAVEMENT CONSTRUCTION IN CINCINNATI

Frank Krug, Chief Engineer of the city of Cincinnati, Ohio, has the reputation of getting more value per dollar of expenditure for his street improvement funds than is usually obtained, and his method of procedure, while interesting, is by no means a mystery.

In the first place, Mr. Krug is a great believer in fitting the type of improvement to the local conditions. When a paving improvement is proposed he makes a detailed study of the street, taking into consideration property values, district to be served, present and probable future traffic, grades, drainage—in fact, endeavors to consider the proposed construction from all angles. With this information

VIEWS OF ASPHALT-FILLED GRANITE BLOCK PAVEMENT CONSTRUCTION IN CINCINNATI, OHIO.

Left: Applying Texaco Asphalt Filler After First Sweeping Pebbles into the Joints. Right: Second Sweeping of Pebbles into Joints Immediately After First Application of the Asphalt Filler.

at hand, he decides upon the type of pavement which will best suit all conditions for the particular street improvement.

The following is a specific instance of how Cincinnati, through its Engineering Department, receives its dollar value:

The Cincinnati-Hamilton pike within the city limits is known as Hamilton avenue and receives the bulk of the traffic entering the city from the north. Naturally this traffic includes all types, from fast-moving, heavily laden trucks to pleasure automobiles and one-horse vehicles. Taking into consideration the heavy traffic this street receives and the fact that it undoubtedly will increase rapidly in the future, together with the various grades, it was decided after thorough investigation that the most satisfactory and economical pavement, considering all conditions, would be granite block.

The following provisions are included in the detailed construction specifications for Hamilton avenue:

A foundation of 7 ins. Portland cement concrete, mixed in the proportions of 1:3:6, was laid on a thoroughly compacted and well-drained sub-grade. Upon this a paving bed of 1¼ ins. in thickness, of clean coarse sand free from pebbles over ⅜ in. in diameter, was placed. The blocks used in the pavement were Georgia granite from the Lithonia district, near Atlanta, Ga. The sizes were from 3¾ to 4¼ ins. in width, 3¾ to 4¾ ins. in depth, and from 8 to 10 ins. in length, averaging about 32 blocks to the square yard. The joints of the pavement were filled with asphalt filler and clean, dry pebbles passing a ½-in. screen and retained on a 3/16-in. screen, as follows:

The pebbles were hand-swept into the joints in three operations, each application being followed with a hand applica-

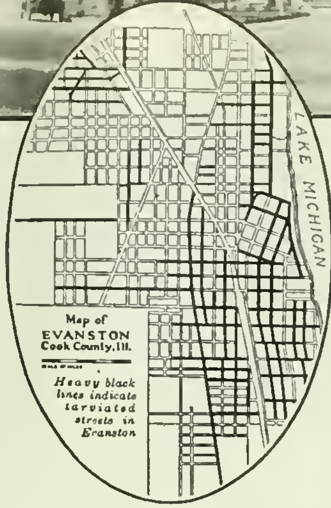
VIEWS OF ASPHALT-FILLED GRANITE BLOCK PAVEMENT CONSTRUCTION IN CINCINNATI, OHIO.

Left: Second pouring of Texaco Asphalt Filler Following the Second Sweeping of Pebbles into the Joints. Right: Making Third Application of the Asphalt Filler Completely Filling the Joints and Leaving a Flush Coat on the Block and Covering This With ¼-in. Layer of Dry Pebbles.

The "Evanston Plan" of Street Maintenance

Orrington Ave., Evanston, Ill., Old waterbound macadam surfaced with "Tarvia-A" June, 1919.

Sheridan Road, Evanston, Ill., One of the Improvement Association Streets, constructed with "Tarvia-A" in 1915-1916.



WITH natural pride in their beautiful city, which lies just north of Chicago, the property owners and city authorities of Evanston, Ill., have worked out what has come to be known as the "Evanston Plan" for keeping their macadam streets in first-class condition.

The property owners on many streets have local Improvement Associations, who voluntarily contribute to the cost of maintenance of their street. This fund was formerly used for street sprinkling, but is now being used in systematic Tarvia maintenance. The work is handled by the street department under the direction of the Commissioner of Streets. This has worked out so satisfactorily that some of the Associations have a surplus in their treasury, where formerly all the funds went into street sprinkling, and the streets are dustproof, waterproof and automobile proof.

Keeping Ahead of Old General Neglect

The policy of the City of Evanston is to repair and re-treat the streets *before it is absolutely necessary.* Three patrol gangs are kept on the streets all summer, immediately patching any spot in the macadam that begins to show signs of wear. As a result, the entire system of more than a half million square yards of Tarvia-treated macadam pavement is kept in wonderful condition all the year round.

In fact, the streets of Evanston form a striking testimonial to the efficiency of systematic Tarvia treatment and low cost maintenance.

The Efficiency of Barrett Service

The present Commissioner of Streets, Mr. R. M. Brown, writes as follows:

> "Efficiency of service by your company in the delivery and application of Tarvia to the City of Evanston during the past season has been very satisfactory.
>
> I assure you that your efforts in our behalf are appreciated, as we are able to keep our pavements in good serviceable condition despite the fact that they are subjected to unusually heavy traffic."

Property Owners Prefer Tarvia

Former Commissioner of Streets Mr. Walter W. Krafts, before leaving office, wrote as follows:

> "The people of Evanston are satisfied in every respect, and in asking for work to be done on streets, are asking for Tarvia in preference to other binders."

The Evanston plan of street maintenance is attracting a great deal of attention in other municipalities.

We should be very glad to explain this plan in greater detail to any interested city official or property owner upon request. In writing, address the nearest Barrett Company office.

Tarvia

Preserves Roads—Prevents Dust

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 any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York, Chicago, Philadelphia, Boston, Detroit, New Orleans, Birmingham, Kansas City, Salt Lake City, Seattle, Peoria, Atlanta, Johnstown, Lebanon, Youngstown, Toledo, Elizabeth, Buffalo, Baltimore, Omaha

The Barrett Company

St. Louis, Cleveland, Cincinnati, Pittsburgh, Minneapolis, Dallas, Nashville, Syracuse, Duluth, Milwaukee, Bangor, Washington, Columbus, Richmond, Latrobe, Bethlehem, Jacksonville, Houston, Denver

THE BARRETT COMPANY, Limited. Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

tion of asphaltic filler sufficient to fill the voids in the pebbles. Third application consisted of a flush coat over the entire surface of the pavement, completely filling all joints, and leaving a light coat of the asphalt on top of the blocks. A ¼-in. covering of dry pebbles passing a ¼-in. and retained on a ⅛-in. screen was then evenly applied to the surface and well rolled into it with a tandem roller. This completed the pavement, which was immediately opened to traffic.

GRANITE BLOCK PAVEMENT CONSTRUCTION IN CINCINNATI, OHIO.
View Illustrates the Laying of the Block, the Application of the Texaco Asphalt Filler, the Completed Pavement, Turned Over to Traffic and the Grading of the Street, All Without Delay to Traffic or Street Car Service.

The object of the above construction was to secure a granite pavement free from expansion and contraction trouble, in which the joints will remain filled with a material that will wear even with the pavement.

The width of the street is 40 ft. between curbs, and in order to avoid closing the street to traffic or disrupting the streetcar service, one-half of the pavement was laid at a time.

The work was done by the Kirchner Construction Company, of Cincinnati, O., Superintendent Quill in charge, and under the personal supervision of Mr. Frank Shipley, Division Engineer of the city of Cincinnati.

RECORD MILEAGE OF CONCRETE ROADS BUILT IN PENNSYLVANIA

The State Highway Department of Pennsylvania, during the 1920 construction season, built approximately 410 miles of concrete roadway 18 ft. in width. This is a world's record for one season for this type of highway. In 1919 the Pennsylvania Highway Department completed 253 miles of concrete roadway.

The maintenance forces of the State Highway Department during 1920 entirely resurfaced 377 miles of macadam highway and surface treated 1,480 miles of the same type of thoroughfare. In all, the forces of the department maintained 9,503 miles of roadway. Of this mileage, 463 miles were in boroughs and on state-aid roads.

Illinois made the closest approach to the State Highway Department of Pennsylvania in the 1920 construction of highways of a durable type, having put down approximately 339 miles of concrete during the season of 1920.

The Pennsylvania Highway Department now has under construction approximately 350 miles of concrete, the completion of which was impossible in 1920 because of the lateness of the season. The department plans the awarding of contracts for an additional 350 miles of concrete roadway early in 1921, and hopes to be able to complete not less than 600 miles of durable highway in this year.

During 1920 the Pennsylvania Highway Department was somewhat handicapped through lack of materials and because of the great transportation difficulties.

WATER WORKS SECTION

DAYTON TO ADOPT A COMPLETE RESERVOIR AND STANDPIPE SYSTEM

"The city of Dayton, Ohio, is practically ready to adopt a complete reservoir and standpipe system," writes H. C. Wight, Superintendent Division of Water, in a letter to Municipal and County Engineering.

"Our pumpage is practically 17,000,000 gals. per day, of which 3,000,000 is pumped to the hilltops with a pressure of 350 ft. at the pumping station, the rest of which goes to the center of the city and leaves the station at a pressure of 200 ft. In 1916 we completed a 900,000-gal. standpipe on the North West high-pressure service. We have secured the site for a second standpipe in the South East high-pressure territory, and hope to duplicate this installation during 1921. In 1918 we completed a 10,000,000-gal. concrete covered reservoir on the low-pressure service. On Jan. 10, 1921, we received bids on a second low-pressure reservoir of 10 to 15-million-gallon capacity, the size depending on the price submitted, inasmuch as this will be the second of a series of four reservoirs planned for the city of Dayton. We are leaving the question of the formal contract largely to the bidders and received proposals on either lump sum contract, or on the cost plus fixed percentage basis, our idea being to get the best possible bids for the city of Dayton, and we are not sure but that this can only be secured from an open letting which will suit the customs of all who wish to compete.

"It is our desire to complete this reservoir before the dry period, which usually occurs in July and August. We believe it is possible when this reservoir and standpipe are in operation to supply the city of Dayton for 24 hours with the pump station out of service, or for 48 hours with the operation of our auxiliary station, which was completed during the past summer. This, of course, gives an additional feeling of security, which means much to the operating man who knows he has a margin of safety ahead of him."

NEW REINFORCED CONCRETE WATER TOWER, RESERVOIR AND CENTRIFUGAL PUMPING PLANT FOR THE CITY OF ALBERT LEA, MINN.

By S. von Mehren, Engineer in Charge of Construction, with J. H. A. Brahtz, Consulting Engineer, 409 Metropolitan Bldg., St. Paul, Minn.

In the design and construction of the water works improvements recently completed for the city of Albert Lea, Minn., are incorporated several new ideas, and it is believed that a short review of the main features will interest readers of Municipal and County Engineering.

The improvements consist of a new concrete water tower of 125,000 gal. capacity, replacing an elevated steel tank of approximately the same capacity; a new 1,500,000-gal. capacity concrete reservoir, and a new electrically driven pumping plant, replacing the steam driven pumping station.

Reservoir and Tower

The only suitable location for the reservoir and tower was an area about 120 ft. square, owned by the city, and in close proximity to the pumping station. To make this limted space sufficient for both tower and reservoir it was necessary to place the tower inside the reservoir. To design the 108-ft. diameter reservoir bottom strong enough to support the 145-ft.-high concrete tower, with its 500 tons of water load concentrated in the center of the plate, and at the same time make this plate continuous and prevent it from cracking, was, owing to the indeterminate nature of the problem, an engineering feat both difficult and laborious.

A careful investigation of the compressibility of the subsoil under loads approximating those imposed by the structure was carried out. The subsoil was found to compress very closely in proportion to the superimposed loads and the necessary depth of the bottom plate and the reinforcement of it were determined by the theory of elasticity. The depth of this slab within 20 ft. radius from the center was made 18 ins., tapering to 12 ins., the minimum thickness at the circumference

The diameter of the bottom plate is 108 ft., of the reservoir 100 ft., and of the tower 30 ft.

To accommodate the use of slip forms in the construction of the walls of the reservoir and the tower, these were made of uniform thickness, the reservoir walls 12 ins. and the tower walls 6 ins. The tower walls were strengthened with 8 symmetrically placed piers, 3 ft. x 1 ft. 3-in. section throughout, built monolithic with walls. Both the wall piers and the walls of the tower were securely anchored to the bottom plate and reinforced below the level of the reservoir roof, to withstand full water pressure from both inside and outside. This portion of the tower therefore serves as an integral part of the main reservoir as well as an auxiliary reservoir, in which all valves necessary for the operation of the tank and the reservoir are installed, so as to give easy access in case of breakdowns. It can be isolated from the main reservoir by means of a sluicegate when cleaning or repairs are necessary.

To construct the main reservoir wall monolithic with bottom slab was impractical. As already mentioned, the use of slip forms in the construction of the reservoir had to be considered in the design, and consequently the thickness of the reservoir wall was made uniform throughout the entire height. To have retained the thickness necessary at the bottom of the wall, about 18 ins., if monolithic construction were adopted, up to the roof level, would have increased the cost of the structure considerably. Expansion joints were therefore specified at the bottom and the top of the reservoir wall, i. e., between bottom slab and wall and roof slab and wall. The latter was necessary on account of the expansion and contraction of the roof slab. The expansion joints consist of three alternate layers of asphalt and burlap, and this construction has proven absolutely leak-proof against the 26-ft. head of water.

Before asphalt for expansion joints was decided upon it was, together with other materials under consideration, submitted to the following test: A concrete cylinder of 2 ft. diameter x 2 ft. high x 3 ins. thickness of wall, and closed at one end with an ⅛-in. thick iron plate tapped for a ½-in. pipe, was constructed. The material to be tested was placed at the required thickness on a level concrete slab, and the open end of the cylinder was pressed against the layer and loaded until the compression per square inch was the same as that which would be exerted by the wall of the reservoir. Water was then

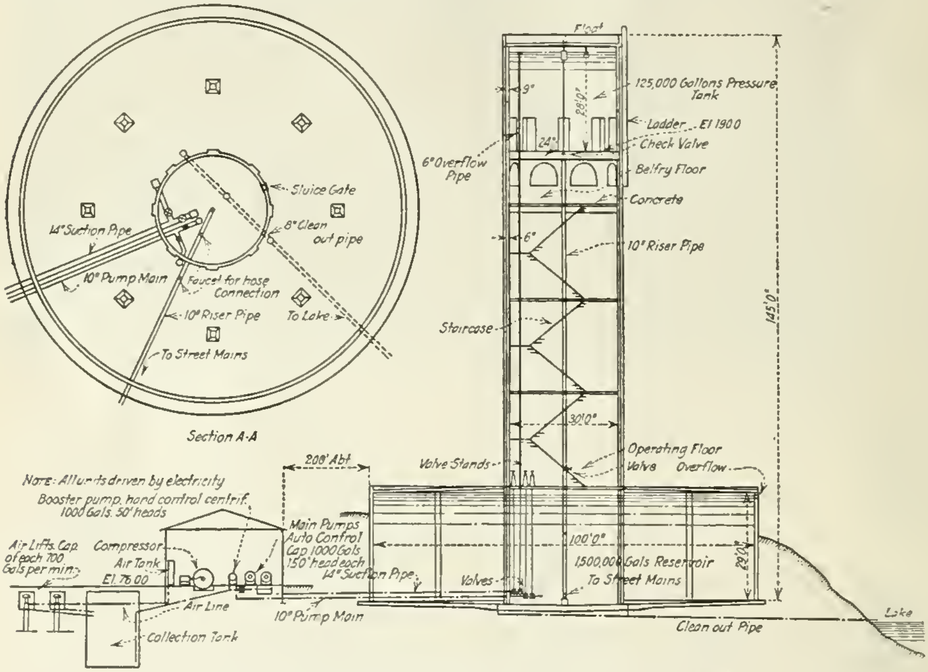


FIG. 1. SECTION OF TOWER AND RESERVOIR AND THE NEW ELECTRICALLY DRIVEN PUMPING PLANT AT ALBERT LEA, MINN.

pumped into the cylinder through the ½-in. pipe until the pressure gage registered the desired pressure. Besides asphalt, sheet lead and raw cotton fibers were tested. Cotton proved to be absolutely unsuitable, but lead and asphalt

FIG. 2. RESERVOIR COMPLETED, TOWER UNDER CONSTRUCTION, ALBERT LEA, MINN.

gave satisfactory results, and asphalt, being the cheaper and easier to place, was adopted.

The roof of the reservoir is an 8-in. thick reinforced concrete slab supported between walls of reservoir and tower by beams and eight columns. Inside the tower the roof slab serves as a floor for the operating chamber. A wooden staircase inside the tower connects the operating chamber with the belfry floor, situated 12 ft. below bottom of the pressure tank. The tower walls are discontinued 4 ft. 6 ins. above belfry floor and semicircular arches built over openings between piers for architectural effect.

The bottom of the pressure tank is a 24-in. thick reinforced concrete slab built monolithic with piers and tank walls, which are 9 ins. thick between piers.

In the original design an expansion joint between the walls and the bottom of the tank was contemplated. However, owing to the fact that even a slight seepage would be very objectionable and maintenance of the expansion joint very difficult, asphalt was not considered a very desirable material to be used in this exposed position. It was therefore decided to redesign the tank for monolithic connection between the walls and the bottom. The considerable bending movement was taken care of, without changing the appearance of the structure and without increasing the thickness of the walls, merely by making the thickness of the piers 3 ft. 6 ins. throughout a height of 9 ft. The roof of the tank is a 7-in. thick reinforced concrete slab.

Concrete Mixtures and Quantities

The following concrete mixtures were used in the structure: 5,400 cu: yds. of 1 cement to 2¼ sand to 4 rock in reservoir bottom, roof slabs and tower, and 800 cu. yds. of 1 cement to 1¾ sand to 3 rock in reservoir wall and pressure tank. The cement used totaled 1,750 bbls. and the reinforcement 114 tons. The excavation, mostly gravel, totaled 5,400 cu. yds.

Electrically Driven Centrifugal Pumping Plant

The water supply of the city of Albert Lea is drawn from two 12-in. artesian wells about 1,200 ft. deep, which tap the water-bearing stratum known as St. Peter sandstone. Previous to building the reservoir the flow of the wells had been considered sufficient for the needs of the city, although during the summer it was often necessary to restrict the water consumption. Two steam-driven pumps delivered the water to mains against a 55-lb. pressure controlled by an elevated steel tank. Shortly after the construction of the res-

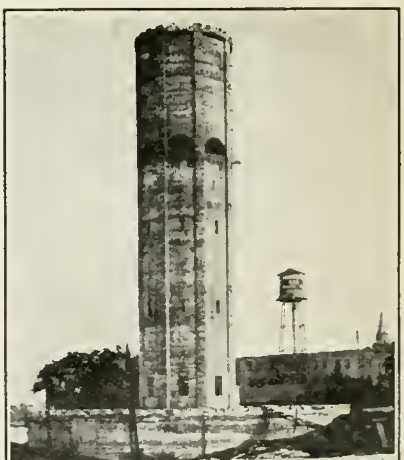
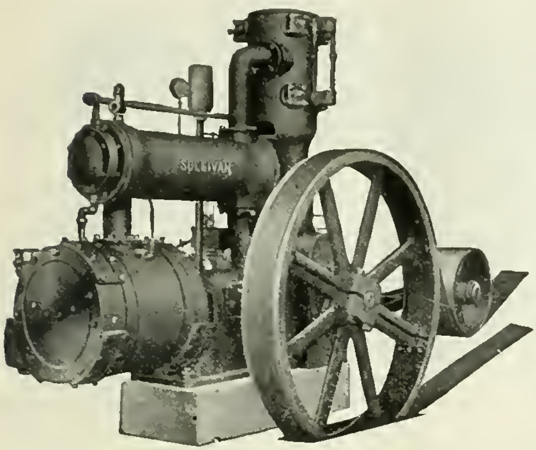


FIG. 3. RESERVOIR AND TOWER COMPLETED, ALBERT LEA, MINN., WATER WORKS.

ervoir was commenced the City Council decided to electrify the pumping plant and to boost the flow of the wells and instructed the consulting engineer to prepare tbe necessary plans and specifications. After an investigation it was decided to eliminate the old steam plant and install the following new equipment:

Air-Lift Equipment

1. Two air lifts, each of 700 gals. per minute capacity. These are 5-in. standard Sullivan air-lift pumps. The discharge is against umbrella tops placed in concrete



SULLIVAN ANGLE COMPOUND AIR COMPRESSOR OF TYPE INSTALLED AT ALBERT LEA, MINN.

pits, from which the water gravitates to the collector tank.

2. One two-stage compressor, 120 lbs. per square inch, driven by a 50-H.P. electric motor, hand controlled, for operation of air lifts. The compressor is a 14x8¾x 10-in. Sullivan angle compound.

3. One single stage volute centrifugal pump, capacity 1,000 gals. per minute against 50-ft. head, driven by a direct connected 15-H.P. motor, hand controlled, for pumping the water from the collector tank to the reservoir.

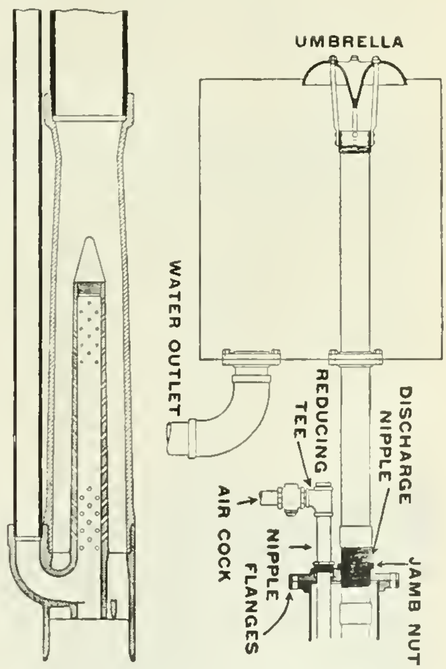
4. Two 2-stage diffuser centrifugal pumps, capacity of each 1,000 gals. per minute against 150-ft. head, driven by two direct connected 50-H.P. electric motors, automatic control, for pumping the water from the reservoir into mains and pressure tank.

The two 1,000-gal. pumps are so installed that they can pump as well in parallel as in series. It is thus possible, in case of fire, to double the pumping capacity or the pressure. A check valve in the bottom of the tank automatically cuts off this as soon as the pressure exceeds the limit, 65 lbs., controlled by the tank. Emergency suction pipe is also installed from pumps to collector tank, so that when the reservoir is empty the pumps can draw from the wells without using the booster pump.

The daily operation of the new system is, as far as practical, based upon automatic control as seen from the foregoing. Manual operation is only required for operation of air lifts and booster pump and in case of fire. This arrangement is essential with regard to the air lifts, the operation of which is only necessary during summer, when the flow of the wells is insufficient for the demand, the aim being to use the air lifts only when needed. The booster pump was installed, in spite of the fact that the air lifts might have been used for furnishing the water direct to the reservoir, because of higher operating efficiency.

Cost

The total cost of the concrete structure was $44,000, and the work was done by McManis & Tarnoski, of St. Paul, Minn.



SULLIVAN STANDARD AIR LIFT PUMP AND UMBRELLA TOP, WITH CASING FLANGES AND CONNECTIONS OF TYPE USED AT ALBERT LEA, MINN.

The cost of the new pumping equipment was $26,000; of the piping, valves and other equipment necessary for the operation of reservoir and tank, $15,000; these were installed by Wm. Danforth, of St. Paul, Minn. Mr. J. H. A. Brahtz, of St. Paul, Minn., was consulting engineer.

COAL AND ASH HANDLING SYSTEMS FOR POWER PLANT BOILER HOUSES

By W. F. Leggett, 2017 Sherman Ave., Evanston, Ill.

Almost the first sentence passed upon primitive mankind was the edict that he must earn his bread by the sweat of his brow, and for thousands of years no real attempt was made to set aside the judgment. In less progressive localities it is still observed with undiminished vigor, although the effect of synchronizing effort with perspiration has made the personnel of many a job 100 per cent. kaleidoscopic, and the "sweat of honest toil" is the mark of a decadent system. Mankind gradually learned that sustained labor could not be regulated by ukase, and it was this feeble ray that developed the wheelbarrow and hod—neither of which is quite extinct—but with the advent of these simple substitutes for human brawn a germ of endeavor developed, which became the genesis of present-day material-handling systems.

When applied to municipal and industrial power plant boiler houses, coal and ash-handling systems should be characterized by directness and simplicity. Therefore many laymen infer that a series of standard specifications should be made to cover average conditions, thus enabling a purchaser to select material-handling equipment in much the same manner that he chooses a talking machine or an automobile. It is true that there are certain combinations of equipment that are adaptable to a large number of power plant boiler houses that burn approximately the

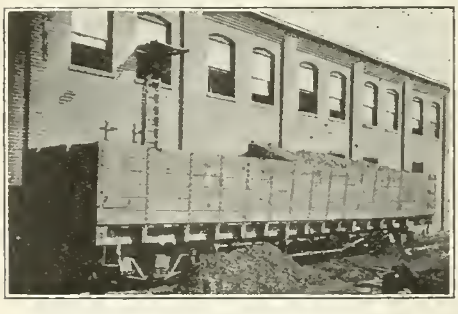


FIG. 1—RECEIVING COAL IN TRACK HOPPER.

same quantity of coal, but it is equally true that each installation should be a law unto itself, warranting special study by experienced engineers, to the end that the equipment will be correctly designed and in proper articulation to the system as a whole.

In all essentials the installations described in this article are the average types of their kind. They include a track hopper, a feeding device from hopper to bucket elevator, methods for carrying coal

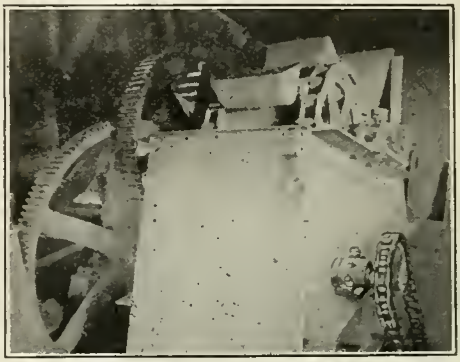


FIG. 2—ELEVATOR HEAD WITH TOP CASING REMOVED.

from the elevator and distributing it to either a single bunker or series of bunkers. It is, however, important that an expert decide whether the feeder be a reciprocating steel apron or rotary type; whether the elevator has centrifugal discharge or continuous bucket; whether the distributing conveyor be belt, screw or scraper type—with the possible substitution of a V-bucket or a pivoted bucket type for both elevator and conveyor. These factors are always governed by local conditions, and unless two boiler houses are exact duplicates in capacity, equipment and location of coal supply—a condition that is most rare—each installation will differ in some more or less important manner from its predecessor.

A Typical Chain Elevator and Screw Conveyor Installation

A typical belt and screw conveyor installation begins with the usual concrete or steel track hopper, shown in Fig. 1. Attached to the hopper outlet is the feeder which supplies the inclined elevator, the feeder being a reciprocating plate type so well adapted to handling slack coal, especially when the distance between the hopper and the elevator is comparatively short. The feeder plate is usually about 5 ft. in length, having a variable stroke, and carries forward a load of coal 16 ins. wide and 9 ft. long. This plate is propelled on rollers which are driven by a forged steel connecting rod and crank, that crankshaft being driven by means of a chain from the foot shaft of the ele-

vator. Fig. 2 shows a detail of the elevator head, with cap and casing removed. The buckets are malleable iron, 16 ins. wide, and are attached to parallel strands of combination chain by means of angle iron clips. Because of the incline the chains run on angle iron guides installed the entire length of the casing on both the carrying and the return runs, the only exception being at the point where the buckets pass over the head and deflector shafts employed in slow moving, perfect discharge elevators. The buckets travel at a speed of 115 ft. per minute, and in order to prevent coal from spilling and falling over the head shafts as the buckets turn, the sprockets are connected to a steel drum, Fig. 2, which carries the spillage into a spout. In the case of faster elevators, when the lineal travel and size of headwheel are more nearly related, the bucket loads are discharged directly into the spout, and no drum is necessary.

Two screw conveyors are used to distribute the coal into the boiler bunkers, each conveyor being of equal length, and both being driven by a single chain from the elevator head shaft. When desired, the coal can be conveyed to a separate storage bin. There is always a possibility that slack coal may not be available, and to meet this condition provision can be made for a crusher for use with run-of-mine coal. When used, the crusher is installed between the feeder and the elevator, the coal passing over a screen through which the slack is delivered directly to the elevator, the remaining lumps traveling through the crusher to the elevator.

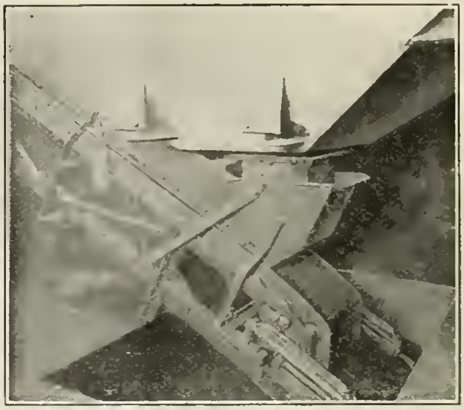


FIG. 3—CONVEYOR BENEATH TRACK HOPPER.

No equipment for handling coal mechanically in a more simple or direct manner can be designed for power plants of average size. The equipment described will easily handle a rated capacity and demonstrates the fact that the mechanical handling of coal can be accomplished without the installation of complicated machinery. Not only is such equipment comparatively inexpensive, but it is a real

FIG 4—TOP RUN OF CARRIER FROM DRIVE GEAR END.

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asset in that it will release coal handlers and stokers for other work.

A Typical Coal and Ash-Handling Installation

In a typical installation which includes ash removal as well as coal handling, the coal is brought in cars which are usually switched into the boiler house extension, in the upper portion of which is placed the ash hopper. Under the tracks is the usual concrete hopper, varying in size, which feeds an inclined apron conveyor, Fig. 3, the latter being set to receive the coal, which is discharged from the track hopper, conveying it to the crusher, from which it is discharged to a pivoted bucket carrier, the buckets of which pass beneath the crusher. In case the coal requires no crushing it can be by-passed to one side of the crusher, to a spout, and discharged directly into the bucket carrier. Just past the crusher the carrier makes an upward turn, and at a proper height it again turns for the upper horizontal run over the bunkers, shown in Fig. 4. Above each bunker is a tripper device which is arranged for raising and lowering, by means of a geared toggle mechanism controlled by a hand wheel. When in the down position the trippers are inactive and permit the buckets to pass without interference, but when raised they cause the buckets to tilt as they pass, thus dumping their contents into any selected bunker. Placed at the distant end of the top horizontal run is the drive for the carrier, so located that it is at the farthest point of possible load, thus placing the system in tension at all times. Passing the drive sprockets, the buckets turn for the vertical descent along the end wall, traveling past the boilers in the basement. Here another turn starts the lower horizontal run to meet the ash hoppers, Fig. 5, which are located below the boiler furnaces. When not receiving coal, the bucket carriers may be used for the disposal of ashes, these being dropped directly into the buckets from ash hoppers. A system of spouts, Fig. 5, may be connected with the bucket carrier at this point and through them floor sweepings and other rubbish may be carried away.

Ashes and refuse are conveyed past the crusher until the buckets reach a tripper placed above a receiving hopper spout, through which they are delivered to an incline conveyor which carries them to an ash storage bin in a wing of the building, where they remain until dropped into cars for removal.

This system provides a most complete method of coal handling and ash removal, and particularly applies to power plants of medium size, handling a fairly large flow of coal.

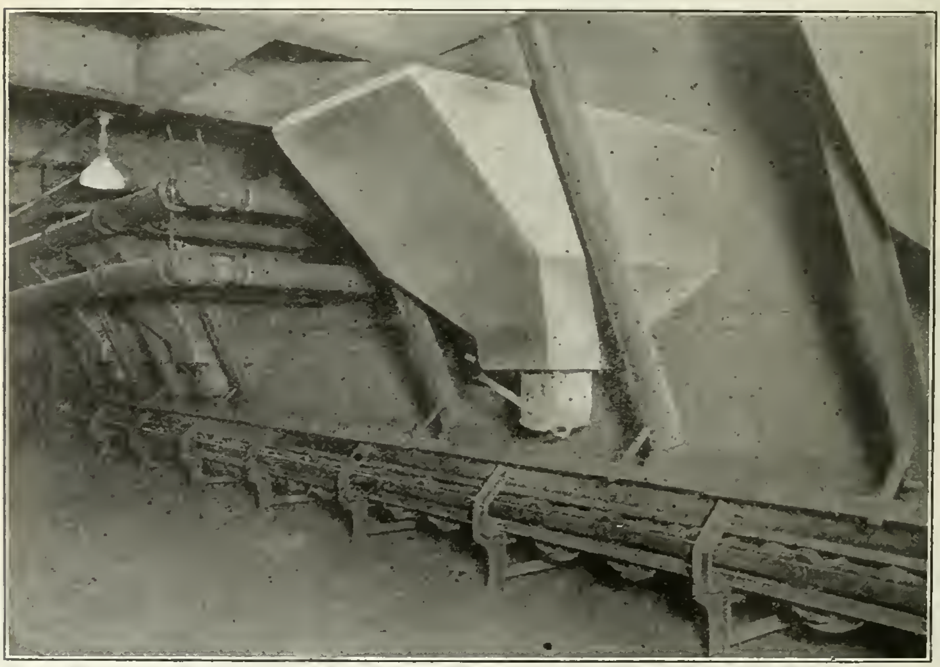


FIG. 5—BOTTOM RUN OF CARRIER UNDER ASH PIT HOPPERS.

SOUND FINANCIAL BASIS FOR MUNICIPAL WATER PLANTS

By George W. Fuller, of Fuller & McClintock, Consulting Engineers, 170 Broadway, New York, N. Y.

For five years prices of labor, materials and supplies have been high and the cost of water works operations has been correspondingly increased above the so-called pre-war normal. The cost of service rendered by various privately owned utilities, in those States where regulatory commissions have jurisdiction over them, has been increased. In some instances rates have been increased several times, as is true of the steam railroads, with approval of the Interstate Commerce Commission. But most city-owned water plants have increased their rates of charges but little, if at all.

Continuance of this policy has caused so much deferred maintenance and replacements, with such a resulting stress as to operating conditions, that some water plants should not or cannot so continue much longer. Although some recession of prices is at hand, there are many cities which should consider putting their water plants at once on a sound financial basis. At Buffalo, Commissioner Andrews, of the Water Bureau, and the writer investigated this question, with the result that the City Council recently adopted a new schedule of rates that will increase the gross revenue of the bureau over 30 per cent.

Incident to those investigations of the financial policies of Buffalo and some other lake cities it was found that the local deficits in earnings were caused by a widely different financial program adopted by the Buffalo Water Department than at several other cities. Thus at Buffalo it was the custom for years to issue bonds to pay for all pipe extensions and for all other improvements. In fact, no betterments have been paid for out of earnings during the past ten years, and water bonds at maturity have been taken care of frequently by issuing new bonds secured by the taxing power of the city. The outstanding water bonds at Buffalo amount to more than 72 per cent. of the plant investment. At Milwaukee, Chicago and Erie the bond issues amount to about 2 per cent. or less; at Toledo and Detroit the bonds are less than 25 per cent., while at Cleveland they amount to about 50 per cent. and at Duluth to about 65 per cent. of the plant investment. The above does not tell the whole story, because the cost of ordinary pipe extensions at Milwaukee and at Cleveland is assessed against the property benefited.

At Buffalo the report on rates was founded on the viewpoint that the Water Department should be conducted as a self-supporting business enterprise for the benefit of the citizens. On the one hand it should not create any demands on the tax rate or general bonding program of the city except for fire-protection service. On the other hand a surplus account should not be created from earnings so as to provide more than a reasonable contingent reserve account or what is reasonable in anticipation of the cost of large betterments such as all plants require at intervals.

Sound policy demands that before rates are increased or deficits are charged against the tax budget of the city, every reasonable effort should be made to effect economies through the reduction in needless pumpage, by reduction in the number of the operating force if practicable, by the most advantageous purchase of materials and supplies, and by developing the efficiency of management to a maximum.

With all these steps taken and with a recognition at this late date that it is impracticable at Buffalo to assess the cost of future pipe extensions against the property to be benefited, it was necessary to draw a conclusion as to whether needed revenue should be obtained by increased water rates, by obtaining funds from the tax budget of the city, that has abundant ways of otherwise spending its income, or by the sale of city bonds secured by the taxing power of the city. The latter custom was considered inadvisable because its adoption in the past had made it necessary to apply in 1919 more than 42 per cent. of the total receipts of the local Water Department to interest and sinking fund payments, even with some of the bonds carrying no sinking fund provision. Furthermore, uncertainties as to ability to market bonds made that method for the time being a precarious one.

After due consideration of all aspects of the Buffalo proposition it was decided to increase the water charges more than 30 per cent. and to continue activities in reduction of waste and thus pave the way for a future filter plant. The total revenue estimated to be required for the current year was a little more than $2,250,000, or about $4.50 per capita per year, equal to about 1¼ cts. per inhabitant per day. The first quarterly collections under the new rate schedule were made with very little complaint, and the Water Bureau at Buffalo, for the first time in recent years, has been placed upon a sound financial basis.

DETERIORATION OF INSULATION RESISTANCE IN THE HIGH PRESSURE FIRE SERVICE MOTORS, CITY OF NEW YORK

By William W. Brush, Deputy Chief Engineer, Bureau of Water Supply, Department of Water Supply, Gas & Electricity, Municipal Bldg., New York, N. Y.

The seasonal lowering to a marked degree of the insulation resistance of the electric motors installed in the pumping stations connected with the high-pressure fire service systems of the boroughs of Manhattan and Brooklyn, has occasioned concern as to the safety of operation of these motors. Careful watch has been kept of the resistance of the motors, especially during the past two years, and this record, together with an outline of the experiments made, may be helpful to others who have electrical equipment subject to similar conditions. A brief outline of the equipment and its history will first be given.

High-Pressure Fire Service Station Equipment

There are four pumping stations serving the high-pressure fire service system of the city of New York, exclusive of the small Coney Island system. Two of these stations are in Manhattan and two in Brooklyn. Each Manhattan station has six 5-stage centrifugal pumps driven by Allis-Chalmers 6,600-volt induction motors. The delivery capacity of each unit is 3,000 gals. per minute against 300 lbs. per square inch. Five of the machines were installed in 1908 and one in 1911. The Brooklyn installation consists of General Electric 6,300-volt motors, with pumping units similar to those in Manhattan, all installed in 1907. There are five of these pumps in the main station and three in the reserve station.

Location of Stations

The Manhattan stations and the main Brooklyn station are located on the river front, so that salt water could be used in an emergency, while the reserve Brooklyn station is about one mile from the river. The position of three of the stations exposes them to humidity above the normal, and in the Brooklyn main station the floor level is equivalent to one story below the street level, with a damp cellar below, thus further increasing the moisture in the air.

System of Operation and Maintenance

In Manhattan one pump is started when an alarm is received within the territory covered by the station, and 125 lbs. per square inch is maintained until the pressure is either increased or the station closed down due to the extinguishment of the fire. The alarms for each station average somewhat less than two per day. Every day each motor that is not run on an alarm is operated as a test for five minutes.

In Brooklyn, up to about the end of 1917, the motors were started on alarms and daily tests made similar to those in Manhattan. The Catskill supply was introduced in 1917, and since then the direct Catskill pressure in the high-pressure mains has given the firemen about 100 lbs. per square inch, which is ample for all first alarms. As there is less than one alarm per month where more than this pressure is called for, the motors and pumps are now mainly run for the five-minute daily test.

Failure of Insulation of Brooklyn Motors

A prolonged fire in Brooklyn on Aug. 20, 1917, required the output of one motor in the main station. The first one on the service ran for 48 minutes and then burned out. A second motor lasted for 42 minutes, a third for 66 minutes, and a fourth finished the run by operating for 45 minutes without burning out. An examination showed the insulation on the stators had failed and these were rewound by the manufacturers in about four months' time at a cost of $5,300. On test, one of the motors showed a short circuit in its rotor which required two months to repair and cost over $2,000.

Steps Taken to Prevent Further Failures

To prevent, as far as possible, further trouble, the motors were thereafter run for 30 minutes only and then a fresh motor introduced in service. Tests made on the two undamaged machines shortly after the failures, showed an insulation resistance of 1 to 1.8 megohms when the motors were cold. These machines were then heated by using direct current sent through the stator coils, and after 20 hours of this treatment the resistances warm were from 0.7 to 1.8 megohms, while when cold the resistances had increased to from 4 to 6 megohms.

After this baking or heating process had been continued for about one week, the resistance cold had risen to from 8 to 10 megohms.

Result of Resistance Tests

The resistance tests were continued and showed relatively high results during the period of the year when the buildings were artificially heated and low results in the summer season, especially so during very humid spells. Thus, during nine days of rain in July, 1919, the resistance of some of the motors, both in Manhattan and Brooklyn, was as low as 0.4 of a megohm. The rewound motors in Brooklyn showed much higher resistances during the entire year than did the other machines.

The result of tests made approximately weekly showed since Aug. 30, 1920, the following results at the Brooklyn main station and at the Oliver street station in Manhattan :

MAIN STATION

Machine No.		1	2	3	4	5
Aug. 30	Megs	30	27	1	30	2¾
Sept. 7	"	40	40	2¾	35	4½
Sept. 13	"	40	30	1¾	30	3½
Sept. 20	"	100	125	5½	125	18
Oct. 11	"	100	90	6	100	10
Oct. 18	"	60	60	4	50	7
Oct. 25	"	70	70	6	60	9
Nov. 1	"	100	125	8	100	14
Nov. 8	"	100	125	8	100	20
Nov. 15	"	150	175	15	150	35
Nov. 22	"	125	150	13	125	20
Nov. 30	"	200	200	20	150	125
Dec. 6	"	200	175	15	150	20
Dec. 13	"	150	175	20	175	15

OLIVER STREET STATION

Machine No.	1	2	3	4	5	6
Aug. 30— Megs.	1.5	2.3	1.8	2.2	2.2	2.8
Sept. 7— Megs.	2½	3.8	2¾	3½	3½	5
Sept. 13— Megs.	2¼	2.8	2.8	2.9	3	3.1
Sept. 20— Megs.	8	12½	11	13	20	15
Oct. 11— Megs.	7½	9	9	9½	12½	15
Oct. 18— Megs.	5	4¾	4¼	4½	6	6¼
Oct. 25— Megs.	6	6	4½	6	8	7
Nov. 1— Megs.	12½	12½	10	15	20	15
Nov. 8— Megs.	20	15	12½	17½	17½	17½
Nov. 15— Megs.	30	25	22	25	26	25
Nov. 22— Megs.	20	12	12	16	15	18
Nov. 30— Megs.	28	24	22	40	30	30
Dec. 6— Megs.	17	15	15	22	25	20
Dec. 13— Megs.	18	17	18	24	25	22

During the summer season the motors were covered with canvas and the surrounding air under the canvas heated. In Brooklyn gas was used and at Oliver street hot-water coils. The temperature under the canvas was about 11 degrees above the room temperature. Experiments in Oliver street were also made, using unslaked lime to dry the air. While these measures prevented the very low resistances shown when the motors were not protected in any way, the results were so far below those shown during the winter season that it is evident a more effective drying of the air is necessary to obtain the desired results.

It is believed that for safety at least one set, and preferably two sets, of stator coils should be kept on hand for each make of motor, and the existing coils, after removing them from the machines, treated to increase their moisture penetration resistance. Further experiments in drying the air are to be tried during the next summer season. The manufacturers and others have been consulted on this question of maintaining the insulation resistance, but no one appears to have had an experience which closely approximates the conditions herein outlined.

The high-pressure system of New York has fully met expectations and demands, but evidently the motors must now either be renewed or the insulation resistance increased to reasonably safeguard continuity of service in the future.

FEATURES OF NEW AQUEDUCT FOR BUTTE, MONTANA

Wooden stave pipe was specified for the major portion of the new Butte aqueduct, but steel pipe was specified for the portions of the line having the highest pressures. The use of oxy-acetylene welded, instead of riveted or screwed joints, and in preference to welding by other processes, is one of the important features of the project from an engineering point of view, and is the feature chiefly considered in the present article.

General Features of the Project

The project presented unusual physical obstacles. In places the line climbs abrupt slopes, threads tunnels through solid granite, and clings to sheer mountain walls. In one place a 10-horse team, used in an effort to haul a 3-ton "T," had to be abandoned and block and tackle substituted. Caterpillar tractors, motor trucks and heavy excavating machinery were in constant use. Where grades were too steep for trucks, horses were pressed into service, and where they could not negotiate the climb the caterpillars were hooked on.

The new pipeline duplicates the old line (in service since 1900) and was built to supplement, not to replace it, excepting during periods when repairs to the old line become necessary. The new line is composed partly of steel-banded redwood stave pipe, and partly of ½-in. thick, double-coated pipe, the sections being on the average 17½ ft. in length and weighing from 2,000 to 2,400 lbs., according to diameter. The wood pipe is used up to a hydrostatic pressure of 300 lbs. per sq. in. and the steel pipe for pressures in excess of 300 lbs. There are approximately five miles of the steel pipe in which the working pressures vary from 350 to 400 lbs. per square inch. In one place a grade of 38 degrees is maintained for a distance sufficient to elevate the line 400 ft., and there is a lift of 800 ft. in a distance of 3,000 ft.—from pumping plant to standpipe.

This standpipe, which is made of concrete and stands 75 ft. high, was erected at the same elevation as the "South Fork" reservoir, some nine miles distant, its function being to take up the "water-hammer" in the pipe. The water rises or falls in the standpipe with each stroke of the pump, thus equalizing the pressure on the line.

It is claimed that the pumps, three in number, are the largest ever built, and that but one pumping station in the world lifts a column of water to a greater height. The three pumps are capable of delivering 15,000,000 gals. of water every 24 hours. Besides this volume, the South Fork reservoir receives daily 1,000,000 gals. drawn from the south fork of Divide Creek, bringing Butte's total available water supply up to 16,000,000 gals. per diem.

Following are the chief elements in the completed line:

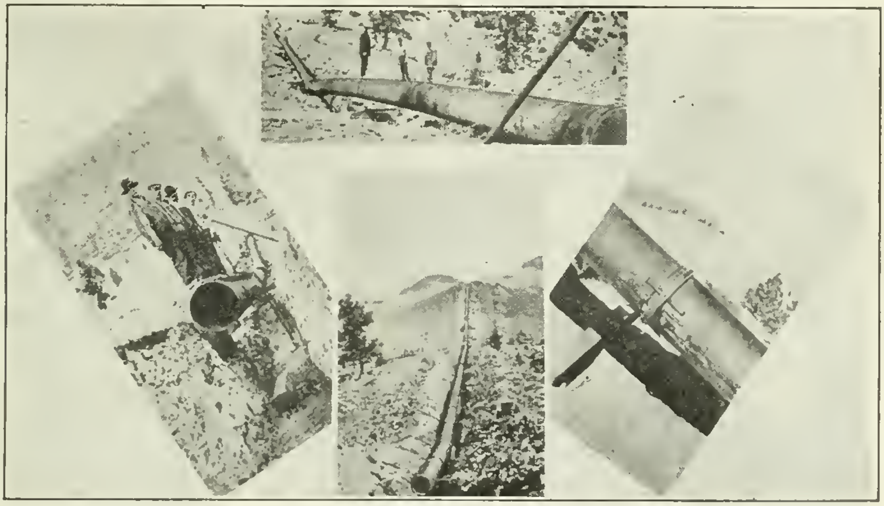
26-in. Oxy-acetylene Welded Pipe		3,674 ft.
24-in. Oxy-acetylene Welded Pipe		22,368 ft.
Total Oxy-acetylene Welded Pipe		26,042 ft.
26-in. Steel-Banded Redwood Stave Pipe		42,326 ft.
24-in. Steel-Banded Redwood Stave Pipe		71,954 ft.
Total Redwood Stave Pipe (lineal)		114,280 ft.
26-in. Gate Valves	(No.)	9
24-in. Gate Valves	"	9
24-in. Balance Float Valves	"	4
Concrete Float Valve Chambers	"	4
Concrete Weir Chamber (at Reservoir in Butte)	"	1

The construction of the pipeline required 1,125 tons of steel pipe, 1,750,000 board feet of redwood staves, 1,100 tons of steel bands (used on the redwood pipe) and 426,000 malleable shoes, weighing from 6 to 8 lbs. each, for the wooden pipe construction. There were 160,000 cu. yds. of excavation, including earth, loose rock and blasting.

Why the Line Was Welded

The reason for using welded construction instead of the customary riveted or screwed connection is primarily one of efficiency, though it also resulted in a marked economy. To have secured the same strength in the joints with screwed pipe, very much heavier pipe would have been required, and if riveted pipe had been used lapping the joints would have been necessary. In either of these cases the material cost for pipe alone would have been considerably higher than it was. The labor cost of the welded construction, everything considered, was also lower than it would have been for screwed connections. Another great advantage was a greater flexibility of the welded joints, which readily yielded to conform to the contours of the trenches. Flexibility is highly important in a country where many sharp curves must be followed. Another consideration was the advantage in speed of construction—an important element in this work, where an average of 350 men were employed over a continuous period of five months. It was very important also to have the work completed in the early fall, before the rigors of winter should halt it entirely, and this might not have been possible had it been handled differently. But, were there no other consideration, the fact that the steel pipe lies embedded several feet under the surface, where the joints are exposed to seepage from rain and snow and to the attack of rust, would be conclusive in determining many engineers on using some form of welded construction, owing to the probable ultimate economy of this method of jointing.

The process employed in welding the pipe was given very careful consideration, and it was decided that oxy-acetylene welding would insure the best jointing of the pipe to stand up under the service for which the line was designed. It then became merely a matter of awarding the work to a responsible welding contractor, having standard equipment and employing competent welders. The welding was done under the superintendence of F. E. Woodbridge, of Butte and Helena, Mont. Oxweld apparatus was specially ordered for the work.



VIEWS OF NEW STEEL PIPE AQUEDUCT OF BUTTE, MONTANA, WATER WORKS FEATURING OXY-ACETYLENE WELDING.

How the Welding Was Done

The method of welding the steel pipe is interesting. Joints were lined up by means of pump jacks and held in position by steel clamps made of ¾-in. strap steel 3 ins. wide. The joints were then tacked in four places, after which the operator proceeded from any one of the tacks as a starting point. It was possible in many cases to turn jointed lengths 200 ft. long to 300 ft. long at one time, thus enabling the welder to operate continuously on top of the pipe. Where long curves were necessary many of the joints were made by the operator welding around the pipe in place, but supported on skids, thus eliminating the necessity of excavating bell-holes in the solid rock, which would have been very expensive.

The curves were very numerous on this work, and the joint construction was so carried out as to distribute the bend over several connections, a small amount being allowed for each weld. This not only gave the line a graceful appearance, but reduced friction to a minimum, which is one of the great points in favor of welded construction. Owing to the fact that the pipe will carry water to its full capacity the year round, the expansion and contraction are practically nil, but as a safety measure, where the curve occurs in the line or the pipe descends or mounts an incline, additional curve is allowed to provide for a slight expansion or contraction.

Lowering Pipe Into Trench

The pipe was suspended over the ditch by 8x8-in. skids for distances of from 300 to 400 ft., and, when ready for the trench, one end was slightly raised with the pump jacks to allow removing the skids at that point, when the unsupported end was allowed to drop into the ditch. The succeeding skids were then taken out in a similar manner and succeeding sections of welded pipe were thus lowered to the bottom of the trench. In some cases there were as many as seven joints suspended between the point of the jack and the first skid, causing a total strain of approximately seven tons on one of the joints. It will be noted that one of the photographs shows four men at the end of a pipe section suspended in midair by means of a chain block placed back of the joint. The full weight of the pipe and of the four men (approximately 2,800 lbs.) comes on the joint in this case, visually indicating the great strength of a joint where properly welded by the oxy-acetylene process.

In some cases, when the wind was very severe, shelter was necessary for the flame, as air currents tend to cause oxidation. With the Oxweld blowpipe, however, in which the mixing of gases is automatically controlled, very little trouble was experienced, regardless of the weather, and the welding measured up to every inspection requirement.

It will be appreciated, of course, by those familiar with oxy-acetylene work, that it was necessary to have the metal clean and free from foreign substances and to avoid an excess of either of the gases, as the pipe in this aqueduct has to withstand heavy pressure. All of the cutting and welding operations on this project were accomplished with Oxweld equipment, exclusively.

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Construction News and Equipment

MODIFICATION OF HIGHWAY CONTRACTS TO MEET PRESENT CONDITIONS

By W. R. Neel, State Highway Engineer, Walton Bldg., Atlanta, Ga.

In presenting a new form of contract, I wish to remove from the minds of every one any suggestion or thought that I have devised a form of "cost plus" under a new name. However, the "cost plus" contract, when originally drawn, embodied two fundamental principles involving fairness to every one:

First, that the owner or beneficiary should pay the cost of the improvement; second, that the contractor effecting the improvement should be fairly compensated for his efforts. Recognizing these two principles, then, we have had as a result several forms of contracts based on these fundamentals. The cost with a percentage of whatever that cost might be, to cover the compensation, commonly known as the "cost plus," is in bad repute, and certainly the results of the use of this method during the late war have given every one just cause for prejudice against it. In an effort to remove the incentive to an unscrupulous contractor to increase the cost, thereby increasing his profit, the cost plus a fixed fee was tried out and proved more satisfactory to the owner and also the conscientious contractor.

My principal criticism of the cost plus a fixed fee is that there is no incentive for the contractor to keep down the cost of the work other than a desire to secure a reputation for economical and efficient work. In public work, where it is necessary to advertise and receive bids, thereby removing to a great extent the discretionary powers of the public official in selecting the contractor, something more than the two above mentioned forms of contract are needed. In attempting to embody the two fundamental principles recognized by every one as a basis for any contract, and at the same time perfect a contract more adapted to the execution of public work, the Form "B" Contract was written.

The Form "B" Contract of Georgia

The original draft was submitted to a large number of people, such as experienced engineers and contractors, as well as legal talent of varied ability, and changed to meet those suggestions we thought worthy of consideration.

Since initiating work under this form of contract other changes have been made to perfect its weak points, and I wish it understood that in submitting this I am cognizant of the fact that it will probably be changed from time to time as experience in its use directs.

In approaching the demand for a new form of contract in Georgia, I was confronted with a constantly ascending scale of unit prices, each succeeding set of bids being a little higher than those preceding, until it was a question of either suspending the letting of new contracts or of devising a means of decreasing the cost of the work. I do not wish to place all the blame for the excessively high bidding upon the contractors; they, in turn, were under the fear and actual conditions of constantly ascending prices for material and labor, together with the uncertainty of freight rates, until no one knew where he stood nor how to bid. It was a gamble, as the old form of contract always has been, with the odds heavily against the contractor, and, as a consequence, the high bidding. Furthermore, every one was affected by the many uncertainties, and the bonding companies, realizing the greater risk, demanded of the contractor higher bidding. On several occasions contractors have informed me, after the bids had been rejected, that they were willing to submit a lower bid, but could not secure a bond if they did so.

State Assumes Risk and Costs Decrease

It therefore appeared to me that in order to meet this situation it would be necessary for the State of Georgia to carry a large part of the risk, and, briefly, the actual use of the present form of contract immediately produced the desired results in decreasing the cost of the work to the State.

The use of this form of contract does not eliminate competition. The contractor, in submitting his bid, divides it into two parts—the estimated cost and the desired compensation. In order to have an incentive to keep down the cost, the contractor is allowed 25 per cent. of any saving on the estimated cost, provided it does not exceed 50 per cent. of the total compensation in the proposal, and should the cost exceed the estimate, 50 per cent. of this excess is deducted from the compensation, with the provision that the compensation must not be reduced more than 75 per cent. Therefore, the contractor is assured of at least 25 per cent. of the compensation, as shown in his bid, for which he must furnish at his expense a superintendent and any overhead expense, such as the maintenance of his general office. It is calculated that the 25 per cent. will allow the contractor to break even, with no loss other than that of his time. The contract also provides for a machinery and equipment rental, a form being provided which must be filled out and which forms a part of the contract cost of work. However, the rental schedule is fixed, and only the interest on the value of the equipment is allowed, plus a fair compensation for depreciation, insurance and estimated repairs. In this way no profit can be made other than that shown as compensation, and this amount varies with the skill and zeal used in prosecution of the work. Thus the minimum compensation obtainable by the contractor will be 25 per cent. of the compensation shown in the bid, and the maximum will be the compensation shown in the bid plus an additional 50 per cent. of this amount. If the contractor should be so fortunate, the owner should not begrudge him this additional compensation, as additional compensation means a saving of 75 per cent. to the owner.

Features of the Contract

The cost of the work is paid by the owner, who is required to pay promptly all bills, in order to take advantage of any cash discounts. A bonded accountant in the employ of the owner makes up payrolls and supervises the paying of all labor, etc. All materials are purchased by the purchasing agent of the State Highway Department, and the prices for all materials, f. o. b. railroad siding, are included in the proposal. In this way, the only financing required by the contractor is in purchasing equipment pertaining to the job and in paying the salary of his superintendent. This has resulted in the immediate delivery of all necessary materials for the vigorous prosecution of the work as soon as practicable after the awarding of the contract.

The contractor is called upon to furnish the necessary equipment and a skilled organization, properly directed by an experienced and efficient superintendent. The elimination from the requirements of the contractors of practically all financing results in a considerable reduction in the compensation demanded by them, so that this is practically net profit to the State under this form of contract.

Contract System Preferred to Force Account

At first thought it might appear that the compensation of a contractor could be saved by an organization operated by the Highway Department, but analysis makes it evident that the item of compensation of a contractor, if conservative, would closely correspond to the operating expenses of an organization owned by the Highway Department, and, while it should not be the case, I am afraid in actual practice it would be hard to get supervision for a state contract in an organization working on salary that would exert the same effort in construction as would a contractor, under the Form "B" contract, where incentive in dollars and cents would be to keep the construction cost under the estimate. At the same time the estimate must be conservative in order to meet the competitive feature.

In addition to this objection to a state construction organization, there would be the enormous investment in equipment which could only be used on state highway work, whereas a contractor has for a field not only state highways within the state, but in other states, as well as municipal, railroad work, etc.

Gives Good Contractors of Small Means a Chance

One of the first advantages in this new form of contract is that it permits honest contractors of small means to show their ability on a larger scale than would be possible under the old form, under which a surety bond is required for the full amount of the contract, which many contractors of small means are unable to make. At the same time, the facilities of financing this Form "B" contract open a field for intelligent, honest bidders who would otherwise be unable to participate in a project of very great magnitude, except as sub-contractors, although their ability might be ample to handle the project. A striking example of this is a recently completed concrete paving project. The successful bidders could not have financed a project of this extent under the old form of contract, and yet they have had charge of the construction of more miles of concrete pavement within the state than any other contractor.

The result has been that 5½ miles of

18-ft. concrete pavement were laid in 3¼ months at a 15 per cent. net saving on the contract as awarded. The contractors not only earned their compensation as set forth in their bid, but an additional 50 per cent., the maximum amount permissible. The advertisement for the letting of this contract, as is our custom, called for bids under both forms of contract. The successful bid was on Form "B," and was 24 per cent. less than the next lowest bid, which was on the old form of contract, and it therefore resulted in an actual net saving of practically 30 per cent. under the Form "B" as against the standard form of contract.

Project 1-A/F-2, concrete pavement, is showing a saving of 11.3 per cent. on first estimate.

F. A. Project No. 162, a grading job, shows a saving of 13.2 per cent., and the work has been under way for more than 3 months.

Results Attained

The contracts now under way in Georgia under the Form "B" amount to over $1,500,000, and a saving of a little over $20,000 has been effected in bond premiums alone, as a minimum bond is required under this form of contract.

The supervision that is required under the Form "B" contract by the owner requires a very high-class man, preferably one with experience as an inspector on the old form contract, and also experience as a contractor or superintendent for a contractor. His duties are to watch for violations of the contract and to catch the leakages on the job. The former duty should be performed subconsciously, but most of his thoughts should be centered on methods to reduce the cost. The cost sheet tells him a very true story, and should be kept up to date, so that he can see at a glance where he should put most of his attention.

I will conclude by stating that, in my judgment, this form of contract requires a more intelligent insight into construction details and a more thorough knowledge and analysis of costs by the engineer than the old form.

This address by Mr. Neel was delivered at the sixth annual meeting of the American Association of State Highway Officials.

NEW SNOW LOADER HAS SUCCESSFUL TRIAL ON CHICAGO STREETS

A gang of 50 or 60 men for removing snow from the streets of Chicago was replaced by four men and the new snow loader manufactured by Barber-Greene Co., Aurora, Ill., in its initial test following the first heavy snow of the winter. Besides successfully replacing so many men, the machine was able to load so quickly that a great reduction was possible in the number of trucks required. Four trucks only, each being loaded in an average of 5 minutes, were needed where 12 were required before, when most of their time was spent in waiting during loading.

No change had to be made in the usual scheme followed in removing the snow by hand. Snow plows attached to trucks placed the snow in long windrows in the gutters. In place of swarming gangs of men shoveling into high trucks, came the loader, filling the trucks to overflowing so quickly that side boards for the trucks to carry a greater load became imperative.

The machine is mounted on crawlers to gain the best traction. It is powered by a Buda 4-cylinder truck-type gasoline engine. A 2-armed apron scoops up and throws the snow onto a wide cleated belt, which carries it up to discharge into waiting motor trucks. This apron plow is ad-

NEW BARBER-GREENE SNOW LOADER WORKING ON CHICAGO STREETS.

justable. It is possible to scrape the surface clean or leave enough space to pass over any obstruction. Adjustment is made by the operator from his platform on the loader. Skirt boards 12 ins. deep keep the largest lumps on the belt and give it an effective carrying width of 36 ins. The belt is positive drive, being fitted with roller chain on each edge.

Chicago city officials put the loader to work the day after Christmas to remove the snow on Michigan boulevard. After working the downtown length of the boulevard, the machine worked across into the loop district. It ran for 30 hours without a pause, being operated by three shifts of 8 hours each. A minor repair was made and the machine continued. One of the things that recommended it most highly to the officials in charge was the fact that it would work just as hard between midnight and morning as at any other time; this is the time when men are least efficient, if they will work at all.

This is the first machine of its kind to be put on the market and it is covered fully by patents. Mr. Barber developed the idea late in the summer of 1920. It had its first try-outs in coal and ashes. Chicago expects to use the machine for ash and gravel loading during the summer.

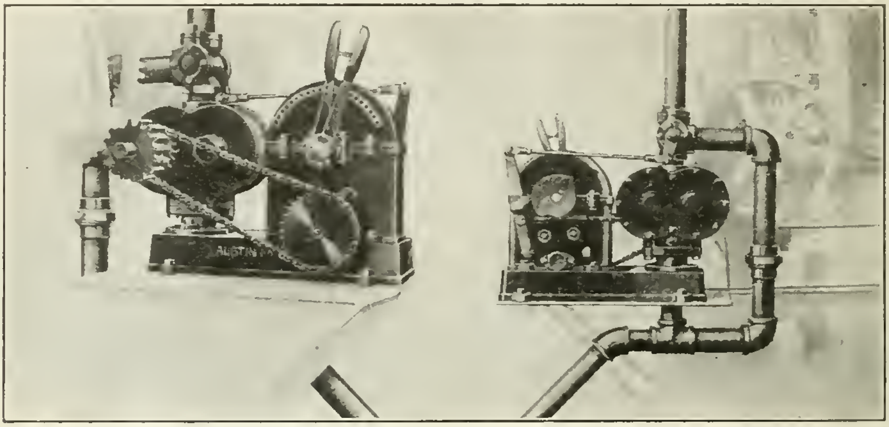
A NEW AUTOMATIC METER-PUMP

Considerable interest is being manifested in a detailed report just published on a series of tests recently undergone by a new automatic meter-pump designed by an engineer connected with the Austin Machinery Corporation of Chicago. Formal announcement at an early date is promised.

This novel device, as its name implies, measures the water discharged into concrete mixers and paving machines. It insures a uniformly accurate quantity for each batch. It is fast. "A better batch faster" sums up the advantages claimed for it.

Simplicity is its main characteristic—it is surprisingly simple in both construction and operation. Setting a pin for the exact quantity of water required takes but a moment, and then no more attention is required until the job is done, except, possibly, to move the pin a hole or two to offset any variations likely to occur in the moisture of the ingredients.

The device consists of a pump, a valve, a timer, and a few pipes and fittings. The pump is driven from the mixer shaft. It works continuously. It can lift water approximately 12 ft. from dead water to pump, or take water from hydrant. The two-way valve is "opened" and "closed" by means of a cam on the timer controlled by the starting lever. When the valve is "open" the water is discharged into the mixer; when "closed," it circulates through a return loop in the pipe.



VIEWS OF THE NEW AUSTIN AUTOMATIC METER-PUMP.

The operator "opens" the valve by throwing the starting lever over to the timing pin. Then he forgets it until the next batch is ready for water. The valve "closes" itself automatically at the precise moment the pre-determined quantity of water has been discharged.

How much or how little water is required makes no difference to this device, as it has a range of about 250 per cent. between minimum and maximum discharge. Throwing the starting lever is the work of an instant. It does not interfere in any way with the operator's regular duties. The total weight does not exceed 200 lbs.

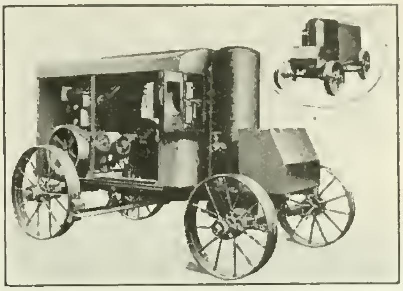
The report states that the tests to which this device was subjected were not confined to the usual factory routine, but extended over a period of time in actual practice.

A NEW ELECTRICALLY DRIVEN PORTABLE AIR COMPRESSOR

Contractors using compressed air are already familiar with the Ingersoll-Rand gasoline engine driven "Imperial" portable compressors. These units are driven by tractor type gasoline motors and built in three sizes, with capacities of 45, 118 and 210 cu. ft. per minute.

To meet the ever-increasing needs of the contractors, street railways and public service companies, having available electric current, an electric motor driven "Imperal" has been added to this portable family. This unit is of 118 cu. ft. capacity and weighs approximately 4,450 lbs., depending upon the weight of the motor. As in the corresponding gasoline motor driven compressor, this electric unit is an all-steel outfit from its sheet canopy to the broad tired steel wheels. Light steel doors completely house the entire unit protecting it from the weather. These doors are easily removed to allow free access to all parts.

Suitable intake unloader is provided, assuring efficient regulation. Either alternating or direct current motor can be



THE IMPERIAL ELECTRIC DRIVEN PORTABLE AIR COMPRESSOR.

furnished. In any case, the motor control is in accordance with standard practice and specifications covering the type of motor used. Additional equipment includes air receiver, safety valve, drain valves, pressure gage and service valves, to which air hose lines may be connected.

BLASTING ROCK IN BUILT-UP SECTIONS

By James Veness, Connecticut.

I find that many contractors hesitate to use dynamite for blasting in rock if other buildings are near-by. It is my opinion, based on long experience, that damage to buildings, and especially windows, is almost always caused by loading bore holes too heavily or by trying to break up too great an area of rock in a single blast.

Of course, the temptation is strong to put down a number of holes, connect up the charges in series, and fire simultaneously, to get the cumulative effect resulting from that method of loading. Of course, that is the economical way, the time-saving way, the way that should be adopted when the excavation is a safe distance away from other structures, but otherwise single-hole shots and small charges should be the rule.

At the Kent School, New Milford, Conn., the cellar was to be 36 ft. x 26 ft. and 7 ft. deep. Rock extended 2 ft. above the ground—that is, 9 ft. of rock excavation. A three-story glass-front building stood within 30 ft.

Several contractors refused the job because of the risks. By employing the following simple method, I got away with it without doing a cent's worth of damage: Bore holes were drilled 18 ins. deep and loaded with 1½ lbs. of 40 per cent. ammonia dynamite. Charges were covered with four or five railroad ties chained together and fired a single shot at a time. Only 70 lbs. of dynamite were used on the job, which was completed by three men in three weeks.

RESURFACING WORN BRICK PAVEMENTS

The Asphalt Sales Department of The Texas Company has just issued a new and highly instructive booklet on how to save worn brick pavements with Texaco asphalt. The literature loses no time in getting down to "brass tacks," and states in a plain, concise, non-technical manner the exact method of procedure in using Texaco asphalt to surface worn brick pavements. Aside from giving the steps in construction in words, there are also diagrams which illustrate the work thoroughly. Supplementing the literature and the diagrams are photographs from which one can gain a comprehensive and thorough knowledge of the exact steps in this construction. Copies of this booklet may be obtained by a request directed to this magazine, or to The Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Contracts Awarded

ROADS AND STREETS.

Ala., Guntersville—W. G. Taylor Construction Co., Wilsonville, Ala., awarded contract to grade and drain 18 miles Guntersville and Boaz Rd., $150,000 available.

Ariz., Globe—McPeak, Dillon & Bruckman, 620 Security Bldg., Los Angeles, awarded contract for paving Broad St., 1.1 miles, with one course conc., at $163,943.

Ariz., Tucson—R. Mackay & Co., 312 E. 4th St., awarded contract for bldg. 6-mile Sec. 2, Arivaca Rd., at $57,327.

Cal., Fresno—Federal Constr. Co., Fresno, awarded contract for constructing Sec. A, Route 8, and parts of Secs. B, Route 8 and A, Route 7, county highway; 4.5103 miles, at $110,240; also contract for paving Secs. A & B, Route 26; 9.11 miles, with asph. conc., at $218,078.

Cal., Los Angeles—Wm. Liddington, 420 E. 60th St., awarded contract for impvt. of first alley west of Kingsley Drive betw. 1st alley so. of Temple St. and First St., at $4,174; Rogers Bros. Company, 350 Merrick St., awarded contr. for paving Lark Ellen Ave., in Rd. Impvt. Dis. 168, with oil macad. on disintegrated granite base; also constructing metal pipe and conc. culverts, at $57,360.

Cal., Los Angeles—W. D. McCray, 424 Am. Bk. Bldg., awarded contr. for impvt. of Gleason Ave. betw. Indiana and Lorena Sts., at $22,936; Wm. L. Riley, 210 S. Fremont Ave., awarded contr. for impvt. of Berkeley Ave. betw. Lemoyne St. and Lakeshore Ave., at $1,941; Wm. Liddington, 420 E. 60th St. awarded contract for impvt. of 1st alley so. of 7th St., no. of Carondelet St. and another alley, at $4,767; Lagana Land Co., Consolidated Realty Bldg., awarded contract by city for paving Cudahy Ave., involving 560 cu. yds. excav., 4,316 ft. shaping roadbeds and 10,625 sq. ft. 4-in. Willite pavement; Janss Investment Co., Metropolitan Bldg., will grade and oil streets, constr. cem. curbs and walks, lay gas, water and sewer mains in 60-acre subdiv., on Lus Felix Rd. and Vermont Ave., by Day Labor under supervision of W. H. Tuck, Engr. Est. cost abt. $10,000.

Ga., Chatsworth—Hagedorn Constr. Co., Commerce, awarded contract for bldg. 6.7 miles soil surface road betw. here and Whitfield-Murray County line, at about $75,000.

Ill., Glen Ellyn—E. M. Scheflon, Elgin, awarded contr. for paving Forest and Penn. Aves., Park Blvd. and Oak St., rein. conc., at $67,609.

Ia., Carroll—Peterson, Shirley & Gunther, 1217 W. O. W. Bldg., Omaha, awarded contract for impvt. of 19 miles Coon Rapids-Dedham-Templeton-Manning Rd., 24 ft. wide, at $125,266.

Ia., Kimberly—Warren Constr. Co., Portland, Ore., awarded contr. for 9,350 sq. yds. Warrenite-B pavement on 4-in. crushed rock fdn., and 13,200 sq. yds. Warrenite-B pavement on 3-in. crushed rock fdn.

Ill., Lockport—R. F. Conway Co., Chicago, Ill., awarded contract for asph.-conc. pavement on Hamilton St., at $215,901.90.

Ia., Sioux City—C. F. Lytle Constr. Co., Lytle Blk., Sioux City, awarded contract for grading and paving 14 miles of rd. betw. Sioux City and Moville; also 3.73 mi. betw. Sioux City and Sargent's Bluff. Contr. includes 66,067 cu. yds. grading at $1.25 per yd.; 188,236 sq. yds. paving at $3.69 per yd. reinf. conc. paving, 8 in. thick, 20 ft. wide, and gravel furnished f. o. b. pit near Correctionville, Ia.

Ia., Webster City—C. A. Barnes, 323 5th St., Des Moines, awarded contract for grading 11 miles Grant Hwy. east of here, 24 ft. wide, at about $35,000.

Kans., Columbus—W. C. Judsch, Sapulpa, Okla., awarded contract for grading and graveling 13 miles Oswego Rd., 18 ft. wide, at $187,504.

Ky., Frankfort—Geo. M. Eady Co., Louisville, awarded contr. for construction of 4-mile Kentucky rock asph. Louisville-Bardstown Rd., Nelson Co., at $99,752.

La., New Orleans—Peterman and Loustalot, Franklin, awarded contract for bldg. 10.43 miles Hammond-Baton Rouge Hwy., gravel, Livingston Parish, at $125,714; Craven & Lang, 1015 Hibernia Bk. Bldg., awarded contract for paving Audubon St., Zimple St. to St. Charles Ave., Bitulithic, at $28,623; bldg. subsurface drains to A. P. Boh, 4148 Banks St., at $49,106.

Mich., Crystal Falls—Smith-Sparks-Burridge Co., Crystal Falls, awarded contract for Co. Rd. 73-1-B, Stamnaugh Twp., at $32,703; Class A gravel, 16 ft. wide.

Mich., Lansing—Oakland County Road Commrs., Pontiac, awarded contr. for impvt. of 1,366 miles State Trunk Rd., involving 72.1 stations fine grading and 16,029 sq. yds. bitum. conc. wearing course, at $39,658; T. H. Duvall, McBain, awarded contract for grading, draining and surfacing 3.575 miles State Trunk Line Rd., 20-1, 6 ft. wide, Osceola County, at $33,313.

Mich., Lansing—Jenks & Dewart, 1514 Military Ave., Pt. Huron, awarded contract for grading and surfacing with conc. 16.595 mi. F. A. Proj. 38, St. Clair Co., Sects. A, B and C, at total cost of $635,231.

Minn., Grand Rapids—E. W. Coons Co., 230 Center St., Hibbing, awarded contract for bldg. 7 mile Job 2004, State Rd. 9, at about $150,000.

Minn., Luverne—Hanlon and Okes, 338 Lumber Exch. Bldg., Minneapolis, awarded contract for 150,000 sq. yds. conc. paevment on 6-in. base, at $3.08 per sq. yd.

Mont., Big Timber—A. Carlson, Columbus, awarded contract for 3 mi. graveling, Proj. 134, at $35,080.

Minn., Mantorville—Cameron, Joyce & Co., Keokuk, Ia., awarded contract for bldg. F. A. Proj. 200, at abt. $50,000.

Mont., Butte—A. Carlson, Columbus, awarded contract, subject to approval of Federal Bureau of Public Roads and county commissioners, for Proj. 134, Sweet Grass Co., at $35,080.

N. J., Middlesex—Standard Bitulithic Co., New York City, awarded contract for 12,087 sq. yds. Warrenite-Bithulithic pavement on 6-in. conc. fdn.

N. M., Sante Fe—Dan La Roe, Palestine, Tex., awarded contract for F. A. Proj. 22, Guadalupe Co., at $132,400, exclusive of 10 per cent. for engrg. and contingencies, also contr. on F. A. Proj. 28, Grant Co., at $214,090, exclu. of 10 per cent. for engrg. and contingencies; J. V. Stryker Constr. Co., Denver, Colo., awarded contract for F. A. Proj. 23, De Baca Co., at $33,672, exclusive of 10 per cent. for engrg. and contingencies, and contr. for F. A. Proj. 43, Torrance Co., at $19,853, exclusive of 10 per cent. for engrg.

N. C, Raleigh—Porter & Boyd, Realty Bldg., Charlotte, awarded contr. for impvt. of 8.73 miles road from Hornet Creek to city limits of Whitakers, 18 ft. wide, F. A. Proj. 73, Nash Co., at $143,375.

N. C., Greensboro—R. G. Lassiter & Co., 327-33 Monticello St., Arcade Bldg., Norfolk, Va., awarded contract for paving Woodlawn St., conc. or other hard surf. material, at cost to exceed $100,000.

N. C., Raleigh—State Hwy. Comm. let contract for impvt. of 4.54 mi. rd., Forsyth Co. line to Guilford Co. line, 18 ft. wide, Davidson Co. to Helig & Sherill, P. O. Box 9, Winston-Salem, at $56,587; contr. for impvt. of 7.63 mi. rd. betw. Wilson-Wayne Co. line and Wiggins Mill, 18 ft. wide, and 6.25 mi. rd. from Wilson Twp. line to Wilson-Nash Co. line, to Bd. Rd. Commrs., Wilson Co., Wilson, at $30,826, and $25,984, respectively.

Ohio, Dayton—C. Hoolihan, So. Main St., awarded contract for paving 1.7 miles Troy Pike from Vandalia southward 20 ft. wide, involving 20,000 sq. yds. conc. on conc. base, at $90,881.

Okla., Antlers—Jno. W. Rocks, McAlester, Okla., awarded contract to construct 8 mile gravel road, at $62,186.

Okla., Idabel—S. B. McCartney, Valiant, Okla., awarded contract to construct 12 miles of road, at $152,139.

Okla., Newkirk—Ben Flynn, Newkirk, awarded contract for paving 1⅛ miles conc. road, at $62,617; M. A. Swatek & Co., Oklahoma City, contract for .79 miles brick road, at $61,613.

Okla., Oklahoma City—Western Paving Co. awarded contracts for paving various streets here at $85,000.

Okla., Wilburton—J. S. Terry, Poteau, Okla., awarded contract to construct 2¾ miles gravel road at $42,350.

R. I., Providence—Lane Constr. Co., 37 Colony St., Meriden, Conn., awarded contract for constructing section of Danielson Pike for distance of 5 miles bitum., in town of Scituate, at $175,520.

S. C., Columbia—J. L. Carroll Co., Anderson, awarded contract for bldg. 12,722 miles Columbia-Savannah Hwy. with necessary bridges betw. city limits of Orangeburg and sta. 1187 near Bamberg Co. line, at $61,189.

S. C., Walhalla—Elliott & Sons, Union, awarded contract for topsoiling 8 miles Seneca-Walhalla Rd., at about $45,000.

S. D., Tyndall—Peterson, Shirley & Gunther, Omaha, Neb., awarded contr. for grading and draining 12.942 miles Tyndall-Lake Andes Rd., 36 ft. wide, F. A. Proj. 38, Bone Homme Co., at $48,811.

Tenn., Knoxville—Murray Constr. Co. awarded contract to pave Thompson Place, White Ave., Patterson, Payne and Central Sts.—Scott Ave. to Southern Ry., etc., at $126,000.

Tex., Center—Smith Bros., Crockett, Tex., awarded contract to construct 35.5 miles Hwy. 22—San Augustine Co. line to La. State line, at $319,490.

Tex., Dallas—Uvalde Paving Co. awarded contract to pave Thomas St., at $76,383; Texas Bitulithic Co. contract to pave Dickason St., at $9,939.

Tex., Georgetown—W. Dozier, Taylor, Tex., awarded contract to construct 60 miles hard-surfaced road. $900,000 available.

Tex., Leavenworth—Contracts for grading, constructing culvts. and bridges, etc., on Sects. D. E and D, 12 miles of Fort-to-Fort Hwy. betw. Tonganowie and Wyandotte Co. line, awarded as follows: brdgs. along the 12 miles of highway awarded to D. Munroe, Kansas City, Kans., at $73,417; culvts. and small brdgs. on Sec. F, Proj. 13, to F. M. Clark, Savannah, Mo., at $38,476; grading on Sec. F, to Gaines Bros., Fairland, Okla., at $96,079; List & Hallett, Kansas City, Mo., grading and culvert work on Sec. F, at $128,977.

Tex., Nacogdoches—Following road contracts awarded: H. F. Bland, St. Augustine, Tex., 9.73 miles Highway 35, at $76,838, and 23.17 miles Hwy. 21, at $712,319; also contract for 19.58 miles Garrison Rd., from Nacogdoches to Shelby Co., at $138,607.

Tex., Orange—Houston Constr. Co., McKinney Ave., Houston, awarded contract for grading surfacing and draining 4.98 miles Hwy. No. 3, Orange-Beaumont Rd., at $245,598, including 10 per cent. for engrg. and contingencies.

Tex., Sinton—San Patricio Co. Commrs. will construct 12.5 miles Corpus Christi Rd. in District No. 5; let contract to Defined Road Dist. No. 5, care of Commrs. Benson, Caldwell and Vogel, at $188,148, including materials; also contract to same Dist. for 15.06 miles Hwy. No. 9, at $162,138.

Wash., Seattle—F. McLellan, 1720 16th Ave., awarded contract for paving, grading and curbing Seattle Blvd. et al., involving 10,270 sq. yds. brick blk. on 6-in. base, 10,760 sq. yds. 8-in. conc., 3,250 lin. ft. armor conc. curbing, 6,500 lin. ft. special conc. curbing and 65,000 cu. yds. earth excav., at $176,888.

Wis., Elkhorn—McGucken Constr. Co., Milwau-

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

NEW TWO-WAY SIDE DUMP BODY FOR HAULING ASHES AND GARBAGE.

Motor Truck Operation and Accounting LXVI

KEEPING HIGHWAY DEVELOPMENT ABREAST OF HIGHWAY TRANSPORTATION

The warning note struck some time ago by Chairman S. M. Williams, of the Federal Highway Council, against establishing highway transportation beyond highway development, is finding lodgment in traffic circles.

As a result, prominent traffic men cooperating with the Federal Highway Council are now taking hold of the transportation problem with a determination to insure the construction of roads around industrial and commercial centers that will prevent a return to congested conditions.

They do not propose, according to C. W. Reid, manager of the Transportation Bureau of the council, to be caught napping when the traffic tide begins to rise again. "For this reason," said Mr. Reid, many traffic managers throughout the country are going to give a closer study and a more determined application to the motor truck terminal zones as a cooperating branch of the railway and express service." Now that the railway express merger has been approved by the Interstate Commerce Commission, it is the belief that the next great step forward will be to throw short haul tonnage to the motor truck as fast as the change can be brought about along practical lines.

Rather than run the risk of getting the "cart before the horse," it must be understood that the policy of the Council is along the lines indicated by Chairman Williams in his statement at the recent conference held by the Council's Transportation Committee in New York.

"The Federal Highway Council," said Mr. Williams, "is working upon the belief that the future development of any type of transportation will largely depend upon the economic service which that type may render the communities served. We have heard a great deal about the short haul and the necessity for its being turned over to the highway. Articles have been written, columns have been published, and the public has been worked up to a fever heat over the tremendous possibilities of diverting the short haul to the highways. I fear, however, that the important part of the entire subject has been overlooked, that is the necessity for an improved highway.

"Admitting that the short haul freight is not a function of the railroads, and recognizing the necessity of relief to the railroads so that their equipment may be employed in the longer and more profitable haul, I do not feel that the Public Utilities Commissions of the various states will be willing to relieve the railroads of that responsibility until the public is assured of a substitute that will give at least as satisfactory and dependable service. With the exception of a few instances the highways of our country are not in position to assume the burden of the short haul now handled by the railroads, and therefore, is it not time to begin the promotion of this subject from the bottom, rather than from the top?

"I feel that as part of the very important work of this committee, it will be necessary for them first to analyze what intelligently constitutes the short haul. Secondly, they should ascertain by intensive study and investigation highway conditions in the various communities, with a view to encouraging the development of highways necessary to meet this specific traffic need."

Illinois Has Motor Truck Test Road Under Construction

The following interesting paragraph is from Bulletin No. 5, of the Illinois Highway Commission, recently issued:

The introduction of motor trucks has caused more confusion and uncertainty to the highway engineers designing road pavements than the change from the horse drawn vehicle to the passenger car. The questions which arise to confront the engineer today are: "Where is the economical limit for motor truck loads; and the corresponding limit for the type and thickness of the pavement?" "What is the load carrying capacity of the standard types of hard surfaced pavements of varying thickness?" In order to answer these questions with some degree of certainty former Governor Lowden has urged

that Illinois carry on some definite experiments looking to the solution of these problems. The construction of a test road, in which the federal government is co-operating, is now well under way. The road will be completed early in the summer of 1921, and the tests will be made immediately following its completion. It is believed that the results obtained will give a very definite idea of the value of the different types and thicknesses of pavement for carrying truck loads; and also will furnish a basis for deciding how heavy our pavements should be built, and the limits of the loads which should be carried thereon.

Automotive and Railway Relations

Railroads welcome the motor truck, according to the well-known "Railroad Review." This will be interesting news to the motor truck manufacturing interests. There has been reported in the past an apparent attitude of antagonism toward the commercial car in general. It has been claimed that where good roads were general, the truck was cutting into the tonnage of the railroads. "There was some reason for the general comment regarding the antagonistic feeling of the railroads for the motor truck," said W. G. Rath, of Napoleon Motors Company, Traverse City, Mich., "for wherever any section such as California possessed ideal highways in great system, making possible a wide-spread transportation of freight without recourse to railroads, the loss to the railroads in freight haulage was considerable. It is in cases where long distance hauling is possible that the railroads suffer. The latter now recognize that the economy in the use of motor trucks over moderate distances is not to be questioned. They are unwilling to grant the economy of truck transportation for long distances ,and their antagonism in districts where this is possible has hardly been questioned in the past. With the great additions planned to American highway systems throughout the country there can be no doubt that the railways will suffer a decline in business as the truck will prove much more economical, both in time and in handling of the goods. What applies today to moderate distances applies to long distances in California, and will apply elsewhere in the same way as road conditions improve, as they will do steadily."

Motor Truck Versatile in Road Building

Hauling gravel from the pits to points along the road is just one phase of the work performed by the 5-ton White truck owned by the county of San Luis Obispo, California, and another truck of like capacity operated on the same job by John Guy, hauling contractor. When all phases are considered, the effect is to establish the versatility of trucks and to define sharply the contrast between old and new in hauling equipment and methods, for struggling along with the powerful motor trucks a few teams of horses are still retained. Their presence affords an unescapable opportunity literally to measure the "horse power," the endurance and capacity for work of the motor truck.

Reduced to figures, the exact superiority of the 5-ton truck over the horse would read something like this, according to Supervisor E. C. Loomis, in charge of road work in San Luis Obispo County:

"Each truck daily made six round trips, averaging 13 miles in length, carrying between 5½ and 6 yds. of gravel. Four horses, pulling a wagon and 2 yds. of gravel, made two round trips a day, two teams thus transporting 4 yds. to every 35 hauled and spread by a single motor truck.

"Besides, horses tire quickly. They also consume an enormous amount of feed. Motor trucks are tireless, require little attention, and their upkeep cost is negligible when the amount of work they accomplish is considered."

When not engaged in hauling gravel or spreading it along the road, the trucks are used in pulling road machinery or, equipped with 1,500-gal. in sprinkling the road.

The present method of excavating, loading, transporting and spreading gravel by motor truck is estimated to cost two-thirds less than in the days when horses were the sole equipment. Now, workmen plow up the tenacious gravel and scrape it within reach of the mechanical loader installed at the side of the gravel bank. A truck can be loaded and started on its way in ten minutes. Arrived at its destination, the truck distributes its load by means of the spreader which is part of its mechanism. During five months of 1920, eight miles of gravel were laid in San Luis Obispo County.

New Two-Way Side Dump Body

A new two-way side dump body constructed according to the ideas of various city engineers, is now being marketed by the Warner Manufacturing Company, of Beloit, Wis. The peculiar conditions attached to ash, rubbish and garbage removal in municipalities, have been given due consideration in the design of both

PACKARD

Investing Public Funds in Trucks of Proven Worth

Municipal officials, in specifying Packard trucks for fire, police, and public improvement work, are investing the public funds in motor equipment of proved dependability and worth.

In the city of Peoria, Illinois, for example, two Packard trucks have been in the service of the fire department for a year and a half.

During this time, one truck answered 396 alarms, at which 50,550 feet of hose were laid, worked 329 hours, and covered 808 miles. The other answered 222 alarms, at which 30,300 feet of hose were laid, worked 316 hours, and traveled 289 miles.

Public property has been protected by Packard truck speed and dependability. Public expenditures have been reduced by the savings in ton-mile and repair costs effected by this equipment.

Such performance has its source in the correct design of Packard trucks, the precise way they are built, the scientific manner in which each truck is specified to its job.

PACKARD MOTOR CAR COMPANY • DETROIT

Ask the man who owns one

trailer and body. The combination of trailer and body is covered by patent. It is claimed that this equipment has been tested under the most severe conditions over a period of several months and has stood up well under the tests. The following features are claimed:

Low price. Interchangeability of the trailer equipment with other bodies for other uses. Simple construction in both trailer and body, guaranteeing low rate of depreciation and long life. Possibility of operating trailer and turning it around in narrow alleys. Simple body construction, assuring complete discharge of the load. Loading edge from ground, 2½ yd., 59 ins.; 3½ yd. body, 62 ins. When body is dumped, the lower edge of body clears the dumpage. Body is under constant control of cables, thereby eliminating the jumping off of body from the trailer. Quick operation, as it takes only 50 seconds to raise the body to complete dumping position, and after dumping, the body returns to its horizontal position by gravity.

Light weight of the entire outfit in comparison with the usual drop frame construction, which will permit hauling by mules or horses.

Motor Trucks are Bringing the "Wagon" Coal Mines to the Railroad

Now that the government, mine operators, miners and railroads are once more pulling together, the problem of coal transportation is again holding the attention of transportation and business men. In an investigation recently conducted by the Federal Motor Truck Co., of Detroit, Mich., some interesting facts concerning the transfer of coal from the wagon mines —mines without railroad switch facilities—to railroad sidings, were brought to light.

The new government rule specifying that wagon mines must receive their share of coal cars, but requiring the mines to load them within 24 hours, has compelled wagon mine operators to adopt more efficient methods of loading and delivering their coal, and most of these mines are now operating trucks instead of their old horse equipment.

While the saving in time that the trucks effected is interesting and important, the investigations produced some interesting comparison of costs between the new and old methods. These costs, of course, vary in different localities, but a fair average of the cost of the horse and wagon equipment showed that it cost approximately $1.50 per ton to haul the coal to railroad sidings. The use of trucks lowered this cost to approximately 50 cts. per ton, and made a saving in the total cost of mining coal of from $3.55 per ton to $2.55 per ton, or approximately 28.2%. The methods of unloading trucks at the sidings were also carefully studied. It was found that special facilities for unloading were necessary. Accordingly the Federal Motor Truck Co. designed a special elevating dump body by which the truck load was lifted mechanically to a level with the top of the gondola cars and could be dumped in from 1 to 3 minutes. Unloading the same load by hand usually required about 30 minutes.

Figuring Truck Depreciation

"Five years from now this motor truck will be off the roads, hence it must also be off our books."

Thus, arbitrarily, the cost accountant was formerly wont to give any new motor truck his employer might purchase five years to toil, depreciate and finally disappear, after having returned its original cost, subsequent upkeep and a tidy surplus for profit.

So far, so good. But five years later the error in such an inflexible cost system became apparent, for the motor truck, if it was a good truck, refused to retire from active duty despite the fact that, theoretically, its working days were over.

In fact, so many trucks that went into service 10 years ago are still working and earning, years after they have written their original cost off the books, that a few cost accountants have chosen to measure truck longevity by miles rather than years. Age yielded to mileage as the unit of measure—and 100,000 miles was considered a liberal allowance for a truck.

But once more matters were complicated by the good trucks, for so many of them rounded the 100,000-mile post and kept right on going that the record ceased to excite wonderment. For instance it is announced that 533 Whites still in service are known to have traveled 100,000 miles; 106 have exceeded 150,000 miles; 94 are somewhere on the 200,000 to 300,000 miles lap; while 25 trucks have forged ahead of the field, well beyond the 300,000-mile mark. The figures in each group are approximately double those revealed by the 1919 tabulation of letters from owners.

Truck Makes Good Record on Road Work

Mr. J. D. Harvey, sales manager of the Southern Clay Manufacturing Co., Chattanooga, Tenn., recently gave the follow-

ing information on the performance of a 2-ton Federal truck on road work:

"Have just looked up our records on the truck and find we purchased it in December, 1916. From that time until this date, our repair parts bill has only been $119.56, and some of this was for repair parts for the dumping hoist and an oversize set of piston rings. From Dec., 1916, to Jan., 1919, our repair parts bill was $9.06. The remainder of the cost has been since then, or in the third and fourth years of this truck's service.

"We have used this truck hard—it has been on all the paving and road work done by us in Florida and Alabama in the last four years. We still have the original set of tires on it. On our Volusia County, Fla., job we handled over 10,000 tons of shell alone with this truck in addition to a large quantity of other material. At Troy and Enterprise, Ala., we handled about 15,000 tons of paving brick, 12,000 tons of sand, gravel and rock, and 5,000 bbls. of cement. It is now doing good work every day on a road job near Milton, Fla., hauling sand, slag and cement, etc., through heavy sand over as poor a road as I ever trucked over.

"I don't recall of this truck ever being in the shop, and believe that all the repairs necessary have been done by the drivers. The motor has never been down except recently to install oversize rings. In addition to work service, the truck has been driven cross country from job to job, hauling men and camp outfits. Some of the trips were over 300 miles.

"We feel we have gotten our money's worth out of this truck. I only wish all our trucks had given us half as good service as the 2-ton Federal. After this job is finished, will need a new set of tires all around, and believe large pneumatics would be the thing."

3½-Ton Truck Saves $1,300 per year Over Horse Hauling

"Motor trucks have a distinct advantage over horses for a business requiring irregular hauling," says Mr. E. O. Johnson, one of the proprietors of the Anchor Stone Co., of Minneapolis, Minn.

"A horse will do just so much work a day, and then he is through. He eats as much whether he is standing in the barn half the time or out on the road all day. A good motor truck will go fast and far and long as you want it to. When it isn't working, it costs you nothing for gas and oil.

"This difference is particularly noticeable in our business, which is the manufacture of concrete laundry tubs and concrete building blocks. Our work is done on order, so that the daily amount of hauling varies greatly. When we are rushed, it would take two 2-horse teams to make our deliveries; at other times one team could do the work. A truck is flexible enough to take care of the fluctuation. Horses are not.

"We are using a 3½-ton Garford, purchased in the latter part of 1916, so that it is nearly four years old. We also have a small light car for running errands, but the truck does our real work. It delivers building blocks and laundry tubs on order; and when in a pinch our sand supply runs low, it goes out and brings in a load.

Makes Capacity Deliveries Over Unpaved Streets

"When the truck is hauling stone, it is loaded to capacity. It's never overloaded, however, no matter how big our rush, because we know that doesn't pay. Only this morning I saw a truck go by here carrying a double load and running at top speed. That driver is a fool, and the owner of the truck is going to have a big repair bill. Most of our work is done for construction jobs, and in making deliveries it is often necessary for the truck to run over unpaved streets and into vacant lots where the going is bad. This means hard usage for a truck. Our driver never runs faster than 12 miles an hour, and usually he goes slower.

"The truck travel 29.6 miles a day on the average. This is not bad, considering that it often works only part time, and seldom makes long trips. Occasionally it goes to St. Paul, 12 miles from our plant, and it has made longer runs that we would not attempt with horses. But most of our jobs are located near the plant and the chief demand on the truck is for many short deliveries.

Does Heavy Hauling at a Cost of $11.46 A Day

"In spite of the rough usage it frequently gets, our truck is practically never in the repair shop. The first two years its total repair bill was only $25.62. The third year we gave it an overhaul at a cost of a little over $200. We estimate $175 a year for maintenance and repair. The actual repairs certainly will not exceed this amount, and the driver maintains the truck when it is idle.

"During the year ending July 1, 1920, the truck worked 270 days and traveled a total of 8,000 miles. Our operating cost, based on the National Standard Truck Cost System, was only $11.46 per day, including $5.81 for driver's wages. Such a remarkably low cost for a 3½-ton truck doing heavy hauling is one reason why we think so much of our truck.

Saves $1,300.00 a Year Over Cost of Horse-Hauling

"A 2-horse team capable of doing our work would cost us $12.50 a day with driver, or $1 a day more than our truck. This is a saving of $270 a year for the 270 days the truck actually worked. But our rush periods, when we should need two teams, would approximate one-third this time, or 90 days each year. If we could get that additional team for only the 90 days when it is absolutely necessary, it would cost us $1,305 a year. So our truck actually saves us $1,305 a year on our hauling, so that it more than paid for itself the first three years.

"In addition to this cash saving, we must give the truck credit for increased business range and capacity, and greater flexibility in making deliveries. All these factors have definitely helped in extending our business."

STUDY AND TREATMENT OF HIGHWAY SUBGRADE AND FOUNDATIONS

By Charles M. Upham, Chief Engineer, State Highway Department, State House, Dover, Del.

The subject of subgrade and foundation construction is not a new one, for there are many evidences that attention has been given to this detail ever since the art of road building has been recorded. In practically every instance, however, this detail of construction was masked under the name of "drainage," a detail always recognized as of great importance, much talked about, but not ordinarily practiced.

A few years ago many of the failures in roads were type failures, which meant that the pavement did not have the inherent strength to withstand the demands of traffic, even though supported on a stable foundation or subgrade. In other words, the surface pavement broke down under traffic.

Although we have now developed road surfaces that satisfactorily carry the present-day traffic if properly supported, we still find there are failures of these standard types.

During the period of lighter traffic many standard types of road surfaces were developed that carried the traffic satisfactorily, even on the less stable subgrades; but with the coming of the heavier types of vehicles it was found that these standard types of pavement would carry the heavy traffic only over well-drained and stable subgrades.

While much has been said and a certain amount of research has been made on drainage problems, it is quite obvious that until recently the greater concerted study has been made on pavement surfaces, and comparatively little complete investigation has been carried on relative to stabilizing the subgrade or road foundation.

Problem of Subgrade Stability

Within our present knowledge of permanent surfaces we can with reasonable limits compute the strength and resistance to traffic, provided we know the condition and nature of the subgrade; but when we inject the varying factors that influence the stability of the subgrade, the conditions present a new problem, one composed of many variables and difficult to solve. The high first cost of road construction and the excessive cost of road maintenance make it necessary that a determined effort to solve, if possible, the question of stabilizing the subgrade, no doubt the most complicated problem yet remaining in road building.

Some engineers have recognized for several years that different soils and soil conditions present varying degrees of stability in the subgrade. Various methods have been followed in the subgrade treatment, but in general standard pavements have been laid on subgrades of different degrees of stability. In some cases the subgrade was not sufficiently firm to support the pavement and traffic, and in others the subgrade was of such a nature that a cheaper pavement would have been sufficient. This practice produces an uneconomic condition, which is not flattering to the highway engineering profession, and must be corrected as quickly as possible, if we do not wish to bankrupt every state in the Union before our state highway systems are completed.

Present Terminology

In this paper the pavement is considered the artificial surface, the road foundation as that part of the subgrade that has been replaced or treated, and the subgrade as that part of the road beneath the road foundation.

In general the strength of a pavement is a function of its depth; therefore, any increase in depth will materially strengthen the pavement. It would probably never happen that the foundation would be as strong as the pavement, but the nearer the foundation approaches this condition, the greater would be the strength of the pavement, for the foundation would act in a proportionately greater capacity in assisting the pavement to resist traffic forces. The same holds true with regard to the subgrade in stabilizing the foundation, which, in turn, stabilizes the pavement.

It would be practically impossible to classify all the various kinds of subgrade materials.

The wide range is evident on roads that have failed. Many times a standard pavement has failed in spots or short lengths, although the entire road has been subjected to the same traffic. Apparently this is due to the fact that the foundation or subgrade is not as stable in these places that have failed as elsewhere. These failures afford opportunities for the study of subgrade and foundation treatment, as well as road surface design.

Thin Layer of Clay Causes a Failure

An interesting example of this is a bituminous macadam road that has been failing in certain points for a lengthy period. The majority of the soil in this vicinity was easily drained and the subgrade close to the pavement seemed satisfactory, but further investigation showed an impervious layer of clay, not over 1 in. in thickness, lying in a generally horizontal position, which prevented moisture from draining away from these points in the subgrade where the failures occurred; or, in other words, there was retained sufficient moisture to make the subgrade unstable at the points where this impervious material became a part of the subgrade, thus producing a condition which caused the pavement to fail.

Below this impervious layer of clay which retained the moisture was a sand that was easily drained. Had this clay been removed this sand would have afforded a stable foundation that would undoubtedly have prevented the pavement from failing.

Subgrade Testing Instrument

Such mistakes as this could probably be brought out and corrected by means of some subgrade testing instrument. At the present time there are several tentative designs, some of which afford means of securing many valuable data. There is much to be done in perfecting these instruments, however, due to the variation in results obtained when different degrees of moisture are present. It is not possible to control this factor by artificial moisture, for the results would not be comparable, due to the fact that different amounts of moisture do not have the same effect on the stability of different soils. Thus it can be seen that the results obtained from subgrade testing instruments are at present only comparative, and reliable only between very narrow limits. Some instruments for testing subgrades have shown results varying as high as 200 per cent. where the difference of the amount of moisture was not sufficient to be perceptible to the eye.

Stabilizing the Foundation

The subgrade problem resolves itself into stabilizing the foundation either by draining, by excluding the moisture, or by constructing a foundation course. Whichever method is followed simply increases the effective depth of the road surface or pavement, inasmuch as the stabilized foundation or subgrade will act as increased depth of road surface. The problem consists of deciding just how much should be spent in the drainage and how much should be spent in stabilizing the subgrade.

It seems perfectly proper to assume that the bearing power or stability of most soils is increased by the absence of moisture, so our problem can be more easily solved if we minimize the amount of moisture in the subgrade. The moisture enters the subgrade from the surface in the form of rain, from the sides as seepage or horizontal capillarity, or from the bottom as vertical capillarity, or, as in the case of grades, by following along impervious strata which intersect the road surface or foundation.

It would be a simple matter to take care of the water that enters the subgrade from above, as this would mean simply the waterproofing of the surface and shoulders, and the results obtained would be far in excess of the effort and the cost expended.

The water from side seepage or horizontal capillarity could be taken care of by an intercepting ditch or tile and stone drain. This would mean that the only other source of disturbing water is from below, and this is the difficult portion of the problem to solve.

Capillarity

In many soils capillarity will draw the water from 2 to 5 ft. in comparatively large quantities. Some authorities claim that the capillary action will extend many feet more. It is quite likely that this capillarity, assisted by the vibratory action of traffic, would cause sufficient moisture to rise in the subgrade to render it unstable. There have been many attempts to break up the capillarity, some of which have been successful; this reduces the problem to a certain extent. Experiments have been tried by placing a layer of material of low capillarity beneath the pavement. The tendency is to prevent the moisture from rising above this layer, thereby giving greater stability to the foundation, which is in a degree equivalent to increasing the thickness of the pavement.

These are conditions that exist at different seasons of the year when the subgrade or foundation is weakest. This is when the subgrade is saturated with moisture, which usually occurs during the spring thaw. If the ground has been frozen and is suddenly thawed, there is a layer of saturated subgrade directly above the frozen material. That this is the worst condition that may exist is evidenced by the general breaking up of the roads in the spring of the year. Subdrainage under these conditions is of little value. This condition is best overcome by open ditches, allowing the water to run off as soon as the frozen material is melted.

If the conditions are such that the subgrade or foundations cannot quickly dry out, the pavement, almost regardless of type, will have a tendency to fail. If the subgrade cannot be quickly drained, then one of the best methods of stabilizing the subgrade is to build up a foundation with a material of high bearing value, capable of carrying the load.

Some Methods Successfully Used

In some States it is customary to build a foundation using rocks varying in size from 3 to 15 ins. Although this method of treatment is costly, it is very effective, and many roads with these foundations have been carrying heavy traffic, although surfaced with only a medium heavy pavement. While a foundation of this sort can stand considerable moisture without deleterious effects, still a constant effort should be made to exclude moisture.

Another method that has met with success is by replacing the unstable subgrade with a layer of a higher bearing value material, such as gravel or crushed stone. This not only stabilizes the foundation, but prevents water rising so high by capillarity. Also, it provides a means of drainage should the moisture for any reason rise in large quantities into the foundation.

Another method of treatment, though possibly less effective, is a replacement of unstable subgrade with sand. This also tends to decrease the capillary action and additional drainage in some cases should not be necessary.

Waterproofing the Subgrade

Capillarity is dependent on the size of the pore spaces between the particles. If these are large, then capillarity ceases; if they are filled with certain material, then capillarity ceases. This suggests a method of treatment of the subgrade such as filling the subgrade with some waterproofing material. If the subgrade can be stabilized by this method, then the effective depth of the pavement is increased by the amount that the subgrade has been stabilized. A number of experiments of this nature are now being conducted by the Bureau of Public Roads, the results of which are bound to be of much interest and great importance.

There are undoubtedly many small details that could be followed that would assist in the stabilizing of subgrades. It has been shown that by plowing or breaking up the surface moisture will be retained. Therefore, it would seem that the reverse should be true, and to exclude moisture the subgrade should be thoroughly rolled and compacted.

Another place where this subject can be effectively handled is in the establishing of the grade line. Keep the grade high unless, by making a cut, an impervious material can be removed from the subgrade and pervious material secured.

Direction Studies Are Taking

It cannot be hoped that a single paper can more than touch the salient facts of this subject, as great questions are yet to be solved. The treatment of subgrades will depend on the results found in the experiments on the bearing power of soils; on experiments to prevent capillary action; on results obtained in underdrain experiments. In other words, there are so many questions that must be solved, or partially solved, before the question of economically treating the subgrade and foundation can be completed.

Our present knowledge of the subject assures us that the stability of the subgrade or foundation depends upon the amount of moisture in the subgrade; the sandy or gravelly soils are more stable, but in order to stabilize the clay soils, they must be kept dry or replaced with different material. The design of the subgrade or foundation will always depend upon the drainage, and the engineering problem is to decide whether it is more economic to treat or replace the subgrade material, or to provide elaborate drainage, or a combination of the two.

This paper by Mr. Upham was read at the annual meeting of the American Association of State Highway Officials, held in Washington, D. C., on Dec. 14, 1920.

Start construction early-Move materials NOW

EDITORIALS

SHIP CONSTRUCTION MATERIALS NOW

High railway officials are now admitting that there is, for the present, a surplus of rail transportation facilities. This is indeed a great change from the assertions of rail men, only a few months ago, that some years must pass before rail equipment could be made sufficient to the country's needs. Recognizing much political and other forms of propaganda in all railway utterances in recent years, it seems true that the steam lines now need business. An important publication, devoted to railway interests, is conducting a "Ship Now" propaganda and as that publication usually speaks with full, inside knowledge on all rail topics it is fair to assume that the roads do need business and can therefore handle the business brought to them by the construction, or any other, industry. Since it appears that the railroads can handle the shipment of highway and other construction materials now it is clearly wise to move as much material as possible in advance of the opening of the construction season.

In recent editorials we have urged this action and there is no occasion for repeating the supporting arguments previously advanced in this connection. The public wants a record-breaking output of new roads in 1921 and if this result is to be achieved it is essential that the materials be at hand when and where wanted.

The very mild winter, with its freedom from ice and snow, has facilitated rail transportation and enabled the roads to keep up with the demands made on them. The same cause has decreased the movement of coal, thereby easing winter traffic requirements. The rail rate advances have overreached their mark and the law of diminishing returns has at last come into operation. The industrial depression has also lessened the volume of rail business. So, for a variety of reasons, the steam roads are looking for business and it is to the interest of the construction industry to take advantage of this opportunity to get good service from the railroads.

Other big shippers are preparing to grasp the opportunity at this time. While the railroads are now looking for business it does not follow, by any means, that they will be so situated in the spring. With the gradual improvement in industry now apparent will come a gradual increase in railway business. The 1920 crop is yet to be moved. It may easily happen that by the time the construction season opens the railways will have good business again; if so the construction industry will not be the most favored shipper.

To take advantage of this opportunity award contracts as soon as possible and ship the requisite materials immediately thereafter. It will be a matter to regret if this is not done.

THE PUBLIC INTEREST IN PROPER COMPENSATION FOR ENGINEERS

In many of our editorials on the compensation of engineers we have tried to emphasize the fact that it is to the interest of the general public to pay adequate salaries to engineers so as to get and hold good men. An illustration of this point, possessing much dramatic interest, comes to us now in the announcement of the resignation of the State Highway Engineer of Wisconsin.

He has been in office 14 years and is widely and favorably known as a competent and conscientious public official. He has had very exceptional experience and his powers may be said to be at their zenith now. At just this time his state has much money to spend on road construction; half as much, in fact, for the year 1921 as for the years from 1912 to 1920, inclusive. Surely it is unfortunate for a state to lose such an official under the circumstances.

We can only hope that the public will heed the lesson taught in this resignation. Mr. Hirst has issued a statement explaining why he decided to take this step. It has been widely published and perhaps the people of Wisconsin will appreciate the significance of his sacrifice.

After telling of his natural pride in the work he has accomplished and of his pleasant relations with all his associates, his statement says that despite the fact that his work has not been profitable in terms of money and that it has been hard and, at times, extremely trying, he would, nevertheless, gladly have continued for the rest of his active life had he felt reasonable assurance that public sentiment would support the legislature, the highway commission and the county boards in the payment of salaries adequate to maintain organizations of the proper capacity to handle with efficiency the tremendous expenditures ahead.

To quote from his statement:

"A proper organization to control this kind of construction enterprise cannot be political, it cannot suffer too great annual changes in personnel. It must be an organization able to meet on an even footing of brains, training and experience, the best organizations that the manufacturers of road machinery and materials can buy. It must be able to stand knee to knee with the best and worst contractors and get for its clients, the people of Wisconsin, good construction at a fair price. The public must equip itself with eminently fitted representatives in this struggle, or the losses in poor roads and unjustified prices will be appalling.

"I had hoped to build up such an organization for Wisconsin. Until the public mind grasps the situation and supports a proper scale of salaries in the public service, I am convinced that I cannot succeed. As fast as I train men, the best are picked for service in the commercial field. In 1920 the Commission lost 27 per cent of its principal employees, and indications are that the losses in 1921 will be even greater. This will continue to be the case until the public realizes that it must protect itself by paying more nearly the market price for highway training, business experience, brains and energy."

The statement is too long to quote in full but its general character is indicated in the two paragraphs quoted. One must admire Mr. Hirst's presentation of the case as well as his courage, and his devotion to the public interest even in resigning his office. The case for the trained, well paid public servant has never been stated better than Mr. Hirst has stated it and we shall watch the effect of his action and his arguments, on the people of the exceptionally progressive and enlightened commonwealth of Wisconsin, with the very closest and liveliest interest. If the public can anywhere be expected to rise to such an occasion it is in Wisconsin. Here is a chance for that magnificent State to set another mark for the rest of the states to shoot at as it has so often done in other matters in the past.

ROAD SHOW SUCCESSFUL

The 1921 Road Show, held in Chicago, Feb. 9-12, was a distinct success in the opinion of exhibitors and visitors. A good deal of equipment was sold on the spot and many good prospects were discovered. In all our years of exhibiting copies of our magazine at conventions and shows we never saw the demand for it that existed at this road show. In fact the very liberal quota of copies set aside for this use was exhausted before the show ended. Other publishers had the same experience, of course.

These matters are worthy of note as evidence of a very great interest in everything pertaining to road construction at this time. Undoubtedly this will be the greatest year the highway field has ever known, with useful work and plenty of opportunities for everybody.

END OF THE NEWER MUCKRAKING

There are evidences that the newer muckraking has about run its course. Let us hope so. We refer, of course, to the damning of the federal government, for everything it does or refrains from doing, and everybody connected with the government whatever his past conduct or creed. Since the signing of the armistice until very recently there has been one tirade after another "agin the government" and these assaults have not added much to the reputation of the American people as "the best half-educated lot in the world."

Recently, in Washington, Gen. Dawes made himself very popular by denouncing further partisan criticism of the conduct of the war. The favorable popular reaction to this suggestion was very marked, although he didn't say a word which any rational adult might not have said two years ago. The way the country enjoyed the cussing he administered to the "smelling" committee is a good indication that the muckraking of the government is about over. Let us all give the new administration our best wishes, and our loyal support.

THE PRE-CAST CONCRETE SLAB PAVEMENT ON CASPER-SALT CREEK, WYOMING, ROAD

By C. H. Bowman, District Superintendent, Wyoming State Highway Department, Cheyenne, Wyoming.

Twenty-four hundred feet of experimental concrete pavement was laid in place and put in service between Casper and Salt Creek Oil Field, on State Highway No. 71, during the month of December, 1920.

Oil was discovered in the Salt Creek oil field, 44 miles north of Casper, now known to be one of the best fields in the world from a producer's standpoint, in 1886. Active development started in 1911. With the beginning of drilling operations the trail between Casper and Salt Creek was soon lined with many string teams hauling building material, oil well and commissary supplies.

First Truck Appears on Trail

In the year 1916 the first motor truck made its appearance on this trail. Teamsters with their 16 to 24-horse string teams, who had struggled with their loads of freight across the sticky gumbo flats during the spring thaws and across the sandy stretches in the hot, dry summer months, predicted speedy disaster to the interloper. However, despite high centers and bad road conditions this truck stayed with the game and from that time on trucks increased rapidly in number, while the number of string teams decreased correspondingly.

With the arrival of more trucks in the hauling field the agitation for road improvement began, and as a result, in 1917 the county, state and Midwest Oil Company joined in a Federal Aid project reaching north from Casper 39 miles. This 39-mile stretch was graded and provided with proper drainage structures and the first 5 miles north of Casper was paved with concrete 16 ft. wide, this work being finished in 1919. During 1920 the remaining 5 miles to Salt Creek was graded and drainage structures installed preparatory to paving.

LAYING PRE-CAST CONCRETE SLAB PAVEMENT ON CASPER-SALT CREEK, WYOMING, HIGHWAY.

Heavy Motor Traffic

While these improvements greatly facilitated the motor vehicle traffic, the great increase in number of vehicles made the transportation problem an increasingly difficult one. By late spring of 1920 the tonnage passing over this road had increased until in a single month the Midwest Oil Company, the leading producing company in this field, loaded out 6,000,000 lbs. of freight from their warehouses. A very conservative estimate of the tonnage hauled by other companies during the same month is 4,000,000 lbs. Add to the motor trucks required to haul this tonnage another 100 motor vehicles per day passing over this main north and south state road, and the necessity for a hard surface road of the very best type is apparent.

Concrete Pavement Planned

Plans were made by the State Highway Department for a concrete pavement the remaining distance of unpaved road, 39 miles to Salt Creek. Thorough investigation of the country on both sides of the road developed the fact that the only source of supply for aggregates was in the gravel bars of the Platte River at Casper, and that there was no dependable source of water supply anywhere north of Casper on this road. The long haul for aggregates and other materials, the necessity of a heavy expenditure for pumping plant and the scarcity of labor during the post war conditions of 1918 and 1919 prevented the State Highway Department from going ahead with this work.

Idea Conceived of Casting Pavement in Slabs

While the State Highway Department was conducting studies of the surfacing problem on the Salt Creek Road, the idea was conceived of casting this pavement in slabs at Casper, the source of aggregate and water supply. By so doing the pavement could be placed at a minimum of interference with traffic, a minimum of camp expense, a minimum of equipment expense, and a minimum of labor. War Department trucks of the Maintenance Division of the State Highway Department were available for the hauling.

Experimental Section 2,400 Ft. Long

The Midwest Oil Company and the Bureau of Public Roads were asked to contribute 50% each to the construction of this pre-cast slab pavement. There were many Doubting Thomases as to the probable success of the undertaking, but the State Highway Superintendent, D. S. McCalman, finally got the approval of the Bureau of Public Roads for an experimental section 2,400 ft. long, the Bureau paying half the cost and the Midwest Oil Company the other half.

The state law of Wyoming provides that state highway construction work of more than $2,000 cost shall be done by contract. As there was plenty of work for contractors at high prices, great difficulty was experienced in letting a contract at reasonable prices on this proposed new type of pavement. However, in September, 1920, a contract was let by the Highway Commission to the Levy Construction Company, of Denver, Colo.

Design of the Slabs

Reinforced concrete slabs 6 ins x 8 ft. x 9 ft. with wire mesh and 8½-in. bars were designed by the State Highway Department and approved by the Bureau of Public Roads. Six different types of joints were planned, giving a trial section 400 ft. long for each type of joint. Type A joint consisted of a reverse curve, warped surface with radii of 9 ft. 10 ins. and 8 ft. 1 in. Type B was similar, but with the two curves of the warped surface having radii of 4 ft. 8 ins. and 6 ft. 5 ins. Type C joint was an ordinary right angle joint. Types D and E joints had a batter of 2 ft. 9 ins. and 1 ft. 9 ins., while Type F had four sets of interlocking U-bolts locked with a ⅝-in. rod. All joints to be sealed with a bituminous filler.

Slabs Laid in Sub-zero Weather

The pouring of the slabs did not start until October, and before the pouring was completed, in November, there was considerable freezing weather and temperatures as low as 12 above zero were recorded. While the work was handicapped by snow and cold weather, the aggregates and water were heated to prevent freezing.

The slabs were laid in December, during which month there were several snow storms and the thermometer went to 6 deg. below zero. Anyone who knows the Wyoming winter with its constant high winds, will realize that conditions for slab laying were far from ideal. This work was under the very close supervision of the State Highway Department and the hauling was done with the State Highway trucks by the Maintenance Division.

The loading and unloading apparatus consisted of 10-in I-beams for trolley tracks mounted on A-frames. Three-ton trolleys with 3-ton Triplex chain hoists were used for raising and placing the slabs.

Cost

The cost of casting was high on account of the experimental nature of the work and the high overhead for the amount of pavement cast, as well as the cold weather conditions encountered. The cost per yd. would have been greatly reduced on a larger contract as the Levy Construction Company bid just twice as much per yard for casting a 2,400-ft. section as they bid for casting a two-mile section. The cost of preparing the subgrade was high because of frequent freezes, but as the soil where the pavement was laid was very sandy, no trouble from heaving was anticipated. The hauling cost, allowing $6.00 per day for depreciation on each truck, was 39 cts. per ton mile.

This 9-ft. slab pavement has been laid on one side of the center line of a 24-ft. roadway, so that another strip of the same width can be added on the other side of the road.

Early Impressions of Results Secured

At the time this article is written heavy truck traffic has been passing over this slab pavement for two weeks and the very excellent surface of the pavement does not yet show any sign of the displacement that some critics feared. The relative value of the different types of joints cannot at this time be determined, although apparently the interlocking joint is the least desirable.

While the real value of such a pavement on a heavy traffic road can only be determined after several years' trial, a service has been rendered to the engineering profession in demonstrating that a pre-cast slab pavement can be successfully built. In future years short stretches of soil requiring pavement on otherwise good gravel or dirt roads and roadways in desert stretches may be paved in this way.

HOW LAKE FOREST, ILL., MAINTAINED WATER-BOUND MACADAM PAVEMENTS, AND PUT THEM IN PERFECT CONDITION AT LOW COST

By Neil N. Campbell, City Engineer, Lake Forest, Illinois.

In the spring of 1917, Lake Forest found itself with many miles of water-bound macadam pavements which were literally in "rotten" condition. New pavements had been planned for several of the streets, but on account of the restrictions brought on by the World War, this program was impossible, so a plan of efficient maintenance, low in cost as to labor, material and money had to be evolved in order to keep the roads in passable condition.

Lake Forest, being situated between the Great Lakes Naval Training Station and Fort Sheridan, and all motor and team traffic between the Naval Station and Chicago having to pass over its streets, and on account of the urgent request made by the commandants at Fort Sheridan and Great Lakes, the city of Lake Forest felt itself obligated to put its roads in good condition so as to make heavy motor traffic possible and to do its share in winning the World War.

Financing the Resurfacing

The plan was a rather comprehensive one and the work was undertaken under the personal direction of the writer. It included practically every macadam pavement in the city.

Each street was carefully inspected and a detailed estimate of the cost of resurfacing made. The estimated cost was then apportioned between all the abutting property owners as to frontage, and an agreement blank attached thereto, showing the amount assessed against each property and a blank line for the signature of the property owner.

This estimate of cost, together with the agreement blank was then turned over to some resident—on the street—who undertook to see each property owner and obtain, if possible, his co-operation. In this manner the city was enabled to finance the resurfacing project, about 80% of the total cost being assumed by the abutting property owners, the balance being paid by the city out of the street and bridge fund.

Two Classes of Streets Resurfaced

The pavements to be resurfaced were divided into two classes:

(1) Pavements that were in such a bad state of repair that it was necessary to scarify the surfaces and add new stone in order to put the pavement in reasonably good condition.

(2) Pavements that were in such condition that they could be put in reasonably good repair by patching the holes.

Scarifying and Adding New Stone

The work undertaken on pavements of the first class was as follows:

(1) Thoroughly sweep the surface of the old pavements with a horse-drawn rotary broom and remove from the street all dirt, litter and foreign material.

(2) Scarify the entire surface of the old pavement to a depth of from 2 to 4 ins. using a gasoline tractor to furnish the motive power.

(3) Re-shape the old pavement with a horse-drawn road grader, being careful to mix as thoroughly as possible the coarse and fine material and to bring the pavement to as perfect a surface as possible.

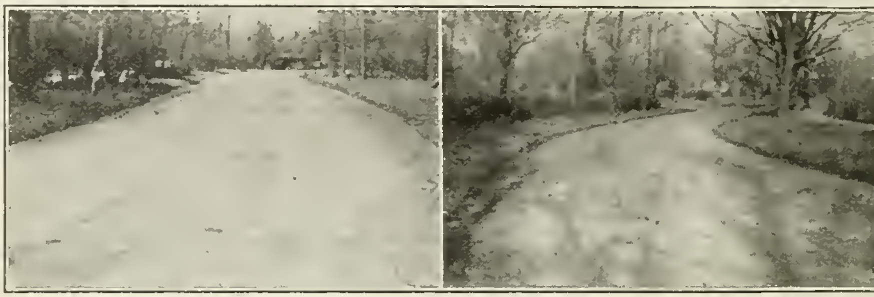
(4) Add new broken limestone, ranging in size from 1¾ ins. to 2¼ ins., to a depth of from 2 to 3 ins. This layer of stone was spread by hand and the surface of the pavement brought to a true and uniform crown and grade.

(5) After a light rolling to key the stone together, sufficient limestone screenings to fill all the interstices between the stone was added and the entire pavement was flooded with water and rolled until the whole mass was thoroughly compacted and smooth.

(6) After the pavement had dried out the street was opened to traffic for a period of from one week to ten days.

(7) The surface of the pavement was then thoroughly swept by means of a horse-drawn rotary broom and all surplus screenings removed, leaving the surface slightly roughened with the coarse stone exposed on the surface.

(8) The pavement was then surfaced with an application of Tarvia "A" applied hot, under pressure, using from 0.4 to 0.5 gals. per sq. yd. of surface and the whole given a liberal coating of red granite chips, using approximately 1 cu. yd. of chips to 70 sq. yds. of surface, and thoroughly rolling it until the granite chips were firmly imbedded in the Tarvia and the entire surface smooth and hard.



VIEWS OF RESURFACED MACADAM STREETS IN LAKE FOREST, ILL.
Left: Lake Road, North from Barberry Lane, Resurfaced in 1917. Right: Westminster East, North from Deerpath East, Resurfaced in 1918.

The following is a copy of the Engineer's report showing the itemized cost of resurfacing a part of Sheridan Road:

Itemized Cost of Resurfacing Sheridan Road from Brushwood Road to Rosemary Road

Work Done: The road was first scarfied and reshaped. Thereupon we added 3 ins. of new stone and screenings, flooded and rolled same to a hard and even surface and treated the entire pavement with Tarvia "A" and red granite chips.

Itemized Cost Per Square Yard

Scarifying	$ .0112
Reshaping	.0072
3 ins. new stone and screenings	.1574
Tarvia Treatment .444 gal. per sq. yd.	.0577
Granite surface	.0622
Engineering and Superintendence	.0080
Total	.3037
Estimated cost per sq. yd.	.37
Balance	.0663

Itemized Cost: Totals

Scarifying	$ 40.06
Reshaping	25.59
148.76 cu. yds. stone at 1.45	215.70
86.72 cu. yds. screenings at 1.45	125.75
Labor on stone and screenings	199.17
Rolling (city roller)	26.00
1,599 gals. Tarvia "A" applied at 13c	207.87
53 cu. yds red granite chips at $2.35	124.55
Labor applying granite	99.66
Engineering and Superintendence	28.80
Total	$1,093.15
Total estimated cost	$1,332.00
Balance	$ 238.85
Total sq. yds. pavement surfaced	3,600

Patching Holes

The work undertaken on pavements of the second class was as follows:

(1) Thoroughly sweep the surface of the old pavement with a horse-drawn rotary broom and remove from the street all dirt, litter and foreign material.

(2) Repair all holes and bad depressions with new stone and Tarvia.

(3) Resurface the entire pavement with Tarvia "A," applied hot, under pressure, using from 0.4 to 0.5 gals. per sq. yd. of surface, and apply a liberal coating of red granite chips, using approximately 1 cu. yd. of chips to each 70 sq.

yds. of surface, and thoroughly rolling it until the granite chips were firmly imbedded in the Tarvia and the entire surface smooth and hard.

The following is a copy of the engineer's report showing the itemized cost of resurfacing a part of Lake Road:

Itemized Cost of Resurfacing Lake Road from Barberry Lane to Woodland Road

Work Done: The old surface was first thoroughly cleaned and patched and afterwards the entire pavement was surfaced with Tarvia "A" and red granite chips.

Itemized Cost Per Square Yard

Cleaning and patching	$ .0239
Tarvia "A" treatment .439 gal. per sq. yd.	.0571
Red granite chips wearing surface	.0511
Engineering and Superintendence	.0071
Total	.1392
Estimated cost per sq. yd.	.12
Deficit	.0192

Totals Itemized Cost

Cleaning and patching	$ 45.45
835 gals. Tarvia "A" applied at 13c	108.55
27 cu. yds. red granite chips at $2.35 per cu. yd.	63.45
Labor applying granite	33.88
Engineering and Superintendence	13.50
Total	$264.83
Total estimated cost	$228.24
Deficit	$ 36.69
Total sq. yds. pavement resurfaced	1,902

or less, per sq. yd., there is bound to be some weak spots caused either by their not receiving their full application of Tarvia, or on account of loose screenings or dust being left on the road surface. After one year's wear these weak spots are likely to show up, and by patching them with a little Tarvia and chips immediately preceding the second application, you are insured of obtaining a uniform surface that will withstand a great amount of heavy traffic.

Cost of Second Application of Surfacing Materials

The average cost of the second application of Tarvia "A" and red granite chips on a total yardage of 36,402 yds., applied in 1918, was 9.4 cts. per sq. yd. The Tarvia was applied at the rate of 0.27 gals. per sq. yd., and surfaced with red granite chips using 1 cu. yd. to each 70 sq. yds. of surface.

Results of Resurfacing

In all the resurfacing work great care was taken in the reshaping of the old macadam pavement and in patching the holes and depressions to bring the pavement to as near a true crown and grade as possible. Immediately preceding the application of the Tarvia the pavement

VIEWS OF MACADAM PAVEMENT IN LAKE FOREST, ILL.
Left: Barberry Lane, Showing Typical Condition of Macadam Pavements Before Resurfacing. Right: Sheridan Road, North from Westminster East, Resurfaced in 1917.

Excellent Results Secured

In all the work undertaken the engineer estimated, included in addition to the first or original resurfacing, a second application of Tarvia "A" and red granite chips to be applied the following year. This practice has given excellent results and the pavements so treated have stood up under very heavy traffic and are in perfect condition after practically four years' wear. In fact, during the war as many as 300 machines per hour, for a ten hour period, have passed over Sheridan Road (a pavement 18 ft. wide).

Our experience has been that where a new macadam surface is treated with such a small quantity of Tarvia as ½ gal.,

was carefully swept by a rotary horse-drawn broom and by hand brooms so that all dust and loose material was removed, insuring a good, hard, uniform, clean surface for the Tarvia to adhere to. The application of the Tarvia was carefully inspected and the quantity applied gaged to meet the requirements of the particular street being treated with the result that out of a total of 114,200 sq. yds. of pavement resurfaced during 1917, 1918 and 1919, there is only one short stretch of pavement that is not in first class condition. This section of pavement is located on Sheridan Road on a fairly steep grade and carries very heavy traffic, and although the surface has not broken, it has shoved in places and is getting wavy. This pavement withstood two years of very heavy traffic during the war without showing any tendency to shove or get wavy, but during the third and fourth seasons wear has developed waves in places.

Why Waves Developed in One Place

There are two principal factors which enter into and are the chief causes of this condition. The first and perhaps the principal, is the tendency to skid the machine when the brakes are applied on the down grade, and the excessive traction of the power wheels in climbing the grade. The second is due to the fact that on the first application of Tarvia in the resurfacing of this section of pavement too much Tarvia (0.61 gals. per sq. yd.) was used with the result that we were unable to work in enough chips to take up all the Tarvia, leaving a surface carpet which became slightly plastic excessive traction of the power wheels caused it to shove and become wavy. Our experience has been that where the pavement surface is in good condition and the Tarvia applied skilfully by means of a mechanical pressure distributor that from 0.4 to 0.45 gals. per sq. yd gives the best results, care being taken to apply all the chips the Tarvia will take up, and thoroughly rolling it immediately after the chips are applied.

The work of resurfacing was handled by a very small force, the major part of the work being done with one team and four men, one of whom served as foreman. Extra teams were hired to haul the crushed limestone and granite chips. The Tarvia was purchased from the Barrett Company, who delivered and applied the hot Tarvia under pressure on the pavement, by means of their special auto truck service.

THE SAGITTA: A USEFUL BUT FORGOTTEN TRIGONOMETRICAL FUNCTION

To the Editor:

It is a far cry from the days when mankind used the bow and arrow as the principal weapon of defense to the present day when big guns are constructed, which will shoot a projectile 20 miles or more. Yet in those days, perhaps 800 or 1,000 years ago, the foundations were laid for the nomenclature which we use today in many of the sciences, particularly in the science of mathematics, which, of course, was much farther advanced than the other sciences of those early days. So far as our present records show the ancient mathematicians, who are supposed to have lived about 2,000 years ago, were already in possession of all the fundamental points in mathematics, and trigonometry especially. By analogy, there is every reason to believe that some of the most advanced mathematicians of today are also 2,000 years ahead of the rest of us mortals, or that it will take about that long before the theories now developed get any application in practical life.

The development of the various branches of mathematics is very unequal, however, and while the above remark applies to the science in general, there are some branches that are even at the present time far behind the requirements of their practical applications, and consequently compel us to use the so-called "rule-of-thumb" methods, simply because science has no answer or solution to the problem. One of these branches, for instance, is the "theory of conform representation," as practically applied to map-making.

As stated above, the names which we now use in trigonometry were probably created in the days when the bow and arrow were the most familiar objects to which mathematical lines could be compared. For instance, our word "arc" corresponds to the Latin word for "bow," and our word "chord" corresponds to the Latin word for "bow-string." Now the word "arrow" in Latin is called "sagitta," from which is derived the name of the constellation "Sagittarius," or "the archer"; and it seems certain that this name was originally given to some part of the radial line which bisects the arc. The name itself was commonly used from the earliest antiquity, of which we have any record, so far as the history of trigonometry is concerned, until perhaps 40 or 50 years ago, but seems to have been forgotten by our modern authors. Curiously enough, the available authorities differ widely in regard to the exact meaning of the word, that is, to what part of the above mentioned radial line it did apply originally.

The earliest mention of the word sagitta in connection with trigonometry of which we have any record seems to be in a book entitled: "The practice of "Geometry" (translated title) by Leonardo of Pisa, also known as Fibonacci. This book is supposed to have been written in the year 1220, and since this was before the invention of printing, it could only have existed in manuscript form, and it probably was not printed until after 1500. The edition which we now have was printed in Rome in 1862. Now one of the historians of this subject claims that Leonardo has mixed up, or identified, the sagitta with the sinus versus.

On the other hand the "Century Dictionary," printed in 1889 to 1911, states under the word "Sagitta," definition No. 7: "In Geom...: (a) The versed sine of an arc, so-called by Kepler (1579-1630) because it makes a figure like an arrow upon a bow. (b) The abscissa of a curve. (Hutton)." Whether it was Kepler or Leonardo, or somebody else, who first mixed up these functions, it is reasonably certain that the mix-up is of an early date, because it occurs also in "Zedler's Universal Lexicon," printed in 1742.

In order to form an idea of the probabilities in this case, regardless of the "conflict of authorities," let us imagine one of the "long-bowmen," of olden times, holding his bow and arrow in a vertical plane, with the arrow resting lightly against the tensed bow-string, and pointing upward in a slanting direction, and comparing this mental picture, with a geometrical diagram or figure drawn on paper, consisting of a circular arc, with its central and terminal radii and terminal tangents. Remembering that the term "sinus versus arcus" or versed sine had probably long before been applied to designate the part of the central radius, between the arc and the chord, as referred to the half-arc, it seems natural to reserve the term "sagitta" or "the arrow" for the extension of the central radius between the arc and the meeting point of the terminal tangents, also as referred to the half-arc. It is difficult to see how or why any mathematician should confuse the line so defined, which is entirely outside the circle of which the arc in question is a part, with the versed sine, which is entirely inside the same circle. Some modern authors, like Raymond (1896) and Allen (1903) have renamed this line, and called it the "external secant."

By this time, no doubt, the question arises in the mind of the reader of these lines: "What has all this ancient history stuff got to do with us, who live in the enlightened twentieth century?" Simply this: by the study of the sagitta the present writer was led to develop a method whereby a common slide-rule, or a 5-place, or a 7-place logarithm table will give 3, or 5, or 7 places, respectively, in every case, thus practically doubling the usefulness of these helps in calculations.

The complete mathematical demonstration is much too long and complicated for publication in an engineering journal addressed to men of widely varying interests, but I shall be glad to give information of value to computers who will drop me a line.

M. J. EICHHORN,
502 W. 60th Place, Chicago, Ill.
Jan. 31, 1921.

SEWAGE TANKS—AGAIN

By G. Everett Hill, Consulting Engineer, 45 Seventh Ave., New York, N. Y.

When Mr. Kirchoffer's paper, "Operating Experiences with Imhoff Sewage Tanks" appeared in Municipal and County Engineering of March, 1920, I read, and reread, it with great interest and appreciation because it crystallized in admirable form doubts and beliefs which had evolved from my own experience with digestion tanks of various types. The comments by other engineers, published in the September issue, and the renewed discussion of the subject in the January, 1921, number are likewise interesting; but I feel that one or two points of real significance have been overlooked or under emphasized, and these I desire to lay before the readers of Municipal and County Engineering, in the hope that they —and particularly Mr. Kirchoffer—may consider and criticize them.

Some Doubts About the Imhoff Tank.

When the Imhoff tank first appeared above the horizon to enlighten a benighted world, its effulgence was clouded by a large doubt which formed in my mental atmosphere. I did not believe that destruction of sewage sludge by biological processes could be complete and rapid in a shut-in sludge-chamber, where there was no flowing liquid to remove the autotoxins produced by the reducing organisms. There is a biological law—so wide reaching as to appear practically without exception—that decrees loss of energy or actual death to organisms that remain surrounded by the metabolic products of their own vital functions. The destruction of pathogenic germs with toxic products of like germs is daily routine work of the physician.

I confirmed this belief by experiment. I filled two glass containers with sewage and covered them with glass plates. The sludge which settled in the two was alike in quantity and quality. Characteristic putrefaction ensued, ran its course and ceased. Anaerobic digestion was apparently complete; and no further change in character or volume could be detected during a period of four weeks. One of these containers remained untouched, as a check. Into the other a very gentle continuous flow of fresh filtered sewage was introduced, under conditions which produced no apparent mechanical disturbance of the sediment, but gradually displaced the supernatant liquor. *Activity within the sludge itself was resumed* and maintained for some days, resulting in *a further diminution of volume.*

Dr. Imhoff Quoted.

In an article published (in translation) in the Engineering Record of July 22, 1916, page 101—an article very pertinent to this discussion, but which has not yet been quoted, Dr. Imhoff himself admits:

(a) That in sludge where there is no moving water decomposition "will be relatively feeble."

(b) That it is "logical to feed the sludge that is properly decomposing," and that, to maintain efficiency, fresh sludge should be introduced and mixed with the older sludge.

(c) That this mixture must be thorough and intimate.

(d) That in separate sludge-decomposing chambers much coddling of bacteria is necessary; he even suggests stimulation by "warm water supplied from a central heating plant."

An Eminently Sensible Thing.

In introducing raw sewage directly into the sludge chamber, Mr. Kirchoffer has done more than the eminently sensible thing of putting the solids at once where we want them eventually. He has also passed moving water through this sludge chamber, and he thus removes, as fast as formed, the products of decay, which in the unmodified Imhoff tank paralyze the sludge-destroying agents.

Mr. Kirchoffer, in his last contribution, might be interpreted by some as insistent upon the accepted structural type of "two-storied" tank. The "hopper and slot" safeguard and the "upward flow" can be secured in a tank no deeper than the usual single-story sedimentation and digestion tank, as shown in the accompanying drawing. When construction lies in rock or in quicksand the cost of deep tanks is heart-breaking.

What a Single-Story Tank Accomplished

I know from experience that the single-story tank may be made to yield an efficiency not usually attributed to it. A tank of this type which I built at Wayne, Penna., put in commission September 26, 1907, ran without *any removal of sludge* until April, 1915. Throughout this time it served continuously an average of 3,200 people. The total solids it received in these seven years and seven months must have been about 1,200 tons. Of course, this was not all destroyed in the tank. Much of it escaped in comminuted form and was caught by coke-filled roughing filters before the sewage passed to the sand-beds; but neither roughing filters nor sand-beds were renewed in this period, —they simply received ordinary cleaning; and *two* sand-beds at a time, out of a total of eleven with a combined area of 2.11 acres, took the entire flow. The greatest mechanical removal of solids in this time averaged two and a half wheelbarrow loads a day (something less than 50 lbs.), raked from the sand-beds and from the sludge bed which received periodically the drainings from the roughing filters.

My experience in sewage treatment during the last 30 years seems to justify certain special features of single-story tank construction. Brief mention of them may be interesting.

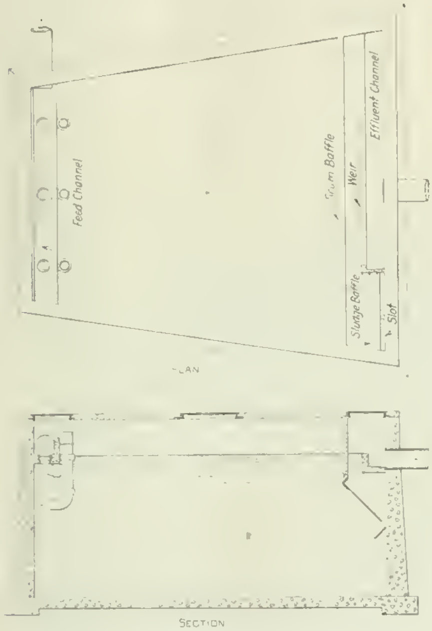
Special Features of Single-Story Tanks

I prefer to build each chamber with diverging side walls, with the inlet at the narrower and the outlet at the wider end. Prolonged tests of such a tank, side by side with one of equal capacity but with parallel walls, showed the average sedimentation efficiency of the rectangular tank to be but 82% that of the radial-walled tank. The reason seems obvious. At the wide outlet end of the flaring tank the velocity is markedly lower than the mean velocity, which is the constant velocity of the rectangular tank. Some solids that weigh little more than water, which would be carried indefinitely by the mean velocity, settle and remain in the tank; and masses of gas-buoyed sludge, rising near the outlet end, have a somewhat better chance to settle again before the outflow is reached.

Moreover, I have found that in the flaring tank there is a pronounced gain in digestive efficiency. The causes are obscure; but the phenomenon may perhaps be due to the elimination—or lessening—of bacterial antagonisms by the approximate segregation in different zones of the many different kinds of saprophytic bacteria, preferring different foods and finding them in the several classifications of solids, according to weight, caused by the sliding scale of velocities.

Dr. Schmeitzner, in his book "Clarification of Sewage," compares the efficiency of a tank at Sheffield, with parallel sides, and one at Viersen, with widening cross-section. He reports the removal efficiency of the former as 49.3% and of the latter as 82%. Mr. Fuller, in his "Sewage Disposal" (1912), also proves "a progressive increase in width of tank toward the outlet, so as to reduce the velocity of flow."

The effluent escapes over a smooth dead-level weir-wall (protected by scum-retaining and sludge-retaining baffles)



PLAN AND SECTION OF SINGLE STORY SEWAGE TANK OF UNUSUAL DESIGN.

that extends across the whole wide outlet end of the tank. Drawing equally from all points on this long line, the displacement within the tank itself is practically uniform from wall to wall. Moreover increase of velocity is very slight (until the weir is actually reached); and the thin film of water creeping over the weir is too shallow to float sludge masses, which stop when they hit the edge and crumble gradually into minute particles too small to see. I have found wire-glass, supported by angles or channels, admirable for baffles. It also makes excellent hopper plates for small Imhoff tanks.

The best feed device I know is the reverting pipe inlet shown in the accompanying illustration. This is the result of a long series of experiments with inlets of various designs, at different depths, in a glass tank filled with clear water and fed with colored water containing solids of varying sizes and specific gravities. Three quarter-bends check initial velocity, and the last delivers, above the sludge and below the scum—not horizontally toward the outlet, where it would induce currents—not vertically where it would stir up deposits—but horizontally *against the rear-wall* of the tank, so that the liquid spreads at once and almost uniformly across the whole vertical cross-section of the inlet end of the tank before it begins its slow travel toward the outlet end. Thus maximum section of displacement and minimum velocity are secured. (A good idea of the diffusion accomplished may be gained by standing one foot from a vertical wall and blowing against it, at right angles, a gentle stream of cigar smoke.) In large tanks, inlets of this kind are in multiple, opening from a common feed channel.

BITUMINOUS FOUNDATIONS FOR PAVEMENTS

By Hugh W. Skidmore, of Chicago Paving Laboratory, Consulting and Inspecting Engineers, 160 N. Wells St., Chicago.

(Editor's Note: While considerable information on this topic has been published in recent months, Mr. Skidmore, in this paper, presented at the 1921 meeting of the Illinois Society of Engineers, has brought together data along lines largely untouched in previous discussions of this important subject.)

For a number of years past, the majority of engineers engaged in highway work in this country have thought in terms of rigid pavement foundations. Rigid foundations came into wide use for a number of reasons.

Highway engineering, as distinguished from civil engineering in general, is of recent development and consequently is lacking in much of the essential knowledge and refinement necessary to reduce the art of building pavements to any very great degree of exactness. Constant increase in volume and radical changes in the character of traffic have very naturally hampered progress. A wide variety of local conditions has prevented laying down any hard and fast rules.

Paving engineers have been confronted with the problem of meeting the demands of traffic under a variety of conditions as presented by the rapid development of a new country; while at the same time attempting to carry forward such investigations, research and analysis as was required for even a fair knowledge of the many factors involved. Therefore, it is not surprising that we should still be correcting early mistakes.

Influence of Precedent

Inexperienced engineers in charge of the design and construction of pavements have of necessity turned to outside sources for their specifications and details of design, usually without sufficient time for investigating the suitability of type with respect to ultimate economy. This fact in conjunction with the very human tendency to follow in a given channel once started, may in a large measure explain not only the growth of the rigid pavement type irrespective of traffic requirements, and an almost universal disregard for adequate drainage and proper subgrade preparation; but likewise a rather general display of more or less hesitancy in giving serious consideration to the accomplishments of others thinking along different lines.

European engineers generally, and those of Great Britain and France especially, with the advantage of a much longer period of time in which to study pavement construction, and with governmental bureaus which are not subject to the interruption and upheaval due to a change of political complexion, such as we are accustomed to here, have paid particular attention to drainage and still maintain an extremely skeptical attitude towards rigid pavements.

History of Bituminous Base

For many years the use of bituminous foundations in the United States has continued uninterruptedly. The oldest examples are to be found in some of our Eastern cities; some of these pavements were laid more than forty years ago, and while the refinements of street pavement design during this period have necessitated both the removal and alteration of many of these old pavements, it is nevertheless a fact that even today some of the original foundations, either in whole or in part, may be found to exist. It has been said of "Black Base" in the city of Washington, that the trouble with the old pavements was not in the foundation, but rather that such defects as did occur were traceable to faulty composition of the wearing surface. The binding material has usually been found to be in an excellent state of preservation and gave every indication of offering several years of additional service, despite the fact that these old pavements were not laid under present day knowledge of the art and modern methods of scientific control.

Bituminous Base Much Used in the West

In more recent years the use of bituminous foundations has grown rapidly in the west until at the present time the yardage in California, Oregon and Washington alone runs well into the tens of millions. There are numerous examples of more limited yardages throughout the middle west. Examination of several of these pavements has revealed a variety of soil and drainage conditions; both hot mix and penetration methods of construction; various thicknesses of both base and top courses, ranging from a total pavement depth of 4 to 9 and 10 ins., depending upon the traffic and character of the subgrade; the employment of both sheet asphalt and bituminous concrete as a wearing surface; the use of all-gravel coarse aggregate, various kinds of crushed material, and a combination of gravel and crushed stone; and service records of from 1 to 20 years at the time of examination. None of the pavements examined gave any evidence of disintegration, internal movement, displacement or cracks, although in one or two cases there was some indication of subsidence over weak subgrade areas (it was planned to repair these by means of the well known "skin patch"), and it might be said of each case of this sort, that all of the trouble could have been readily avoided by better subdrainage.

It will not be the intention of this paper to indulge in an extensive technical discussion, as it is thought that recent articles in the technical press have presented in a most comprehensive manner the reasonableness of this type of construction from a theoretical standpoint. In this connection, however, for the purpose of reference, attention is particularly directed to an article by Lester Kirschbraun which appeared in the Engineering News-Record of June 21, 1917, and an article by Prevost Hubbard, appearing in Engineering News-Record of Dec. 30, 1920. On the other hand, the writer's thought in presenting this paper was first, to outline briefly the history of bituminous foundation construction for the purpose of showing that the type is not new or untried, but has been satisfactorily used for upwards of 40 years; second, to point out its practicability and economy, and third, to briefly outline some of the more important features of construction.

Practicability

To engineers, who have had experience with various types of broken stone and macadam pavements and foundations, and who have laid wearing surfaces upon either new stone bases or have resurfaced old pavements, the use of either hot mix or penetration method bituminous foundations should appear as the logical step in the direction of progress and better construction. It would seem in this connection that experience over a period of many years should leave no doubt as to the advantages of flexible foundations such as Telford macadam, waterbound macadam, broken stone, gravel macadam, etc., over some of the inherent disadvantages of cement-concrete as it is usually laid for foundation purposes. The rigidity and resiliency of cement-concrete prevents uniform contact with a subgrade incapable of providing uniformity in supporting power, and as is a well known fact, cement-concrete does crack; often this will occur even when precautions are taken to provide underdrainage. The well-known affinity of cement-concrete for moisture results in a film of moisture at the contact plane between the foundation structure and the wearing surface. In the case of bituminous wearing surfaces, the almost constant presence of such a film of moisture on the surface of the foundation tends not only to disintegrate the bituminous structure, but also acts as a lubricant which in many cases is the direct cause of what is known as "pushing" or "rolling" of the asphaltic surface on concrete base. It may readily be seen that should the surface of the concrete happen to be somewhat smooth, any tendency of the wearing surface to become displaced under traffic will be greatly encouraged in the case of a well lubricated plane of contact.

It may be interesting to recount here an incident in the writer's personal experience which well illustrates the point just mentioned. A few years ago, while examining asphaltic concrete pavements in a certain city for the purpose of making a report to the city engineer and board of commissioners relative to the cause for certain sections of the pavement displacing under traffic, the writer made the statement to the local engineer that investigation would undoubtedly show that, first, the concrete base under these areas was extremely smooth, and, second, that even during the hottest summer weather (during which time the maximum displacement occurred) there would be a film of moisture on the surface of the concrete foundation. The city engineer took exception to the last remark, saying that the summer had been extremely dry, there having been no rain for a matter of some two months. Removal of the wearing surface for the purpose of replacing the mixture in the affected areas, proved conclusively that both of the writer's assertions were true.

LAYING 5-INCH ASPHALTIC CONCRETE BASE AT OWENSBORO, KY.

The results of certain impact tests on slabs and beams, as disclosed in Mr. Hubbard's article mentioned above, indicates not only the fact that bituminous concrete considered as a slab or beam, provides very appreciable resistance to the most destructive of traffic forces, namely, impact, but that also in the light of these tests, it will be possible to use under similar subgrade and drainage conditions, a thinner base course of bituminous concrete than will be required of Portland cement-concrete. The conclusions which may safely be drawn from the tests thus far reported, place bituminous concrete foundations in even a more favorable light than might have been predicted by even its strongest advocates in the absence of such tests.

It is true that reasonably good drainage must be provided if real success is to be obtained from the use of bituminous mixtures for foundation purposes. In this regard bituminous concrete is in the same category with other types of foundation, as drainage is unquestionably the first essential to be considered in the case of any type of pavement if maximum utility and enocomy is to be considered worth while.

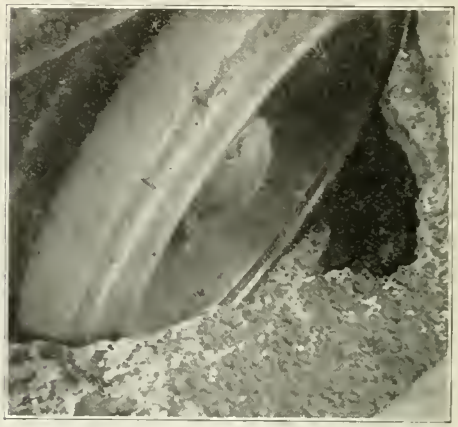
As an illustration of the economy of providing an adequately drained subgrade, Owensboro, Kentucky will be cited as an excellent example, not with the idea that this is the only example, but rather because the writer was particularly impressed with the excellent condition of the pavements in that city, which, without a doubt, is largely due to the fact that a 4-in. tile drain was laid under each curb at a distance of some 2½ ft. below the gutter. These drains in turn were connected with the sewers. The pavements in Owensboro are laid on practically all types of foundation including asphaltic concrete, cement concrete, waterbound macadam and gravel, and with the exception of one or two of the old sheet asphalt pavements, laid some 20 years ago, which show a few cracks due to the drying out of the wearing surface, there are to be found in some ten miles of pavements no cracks, upheavals, or other evidence of pavement disturbances. To digress while speaking of Owensboro, it is desirable also to mention that the city engineer, by careful study of his materials, has produced a bituminous concrete mixture both for foundation and wearing surface which employs washed Ohio River gravel and a combination of Ohio River sand and local pit sand, which develops unusual density and stability despite the fact that it has long been the theory that round particles in an asphaltic mixture would not make for the maximum of stability. It would, therefore, seem that density alone is a very important item so far as the resistance to the displacing effect of traffic is concerned.

Advantages

The advantages of bituminous concrete foundations can be enumerated briefly as follows:

1. Provides homogenity of mass and positive bond between foundation and wearing surface when bituminous top courses are employed.

2. Provides uniform contact with the subgrade, thus insuring the benefit structurally of all of the beam strength possessed by the foundation slab and by the same token, makes certain uniform distribution of load to the subgrade.



WHAT HAPPENS WHEN CEMENT-CONCRETE BREAKS OVER A WEAK SUBGRADE.

3. Because of the inherent flexibility of the material, the foundation slab will at no time be called upon to act as an arch over weak subgrade areas, therefore the possibility of the foundation rupturing, as is frequently the case with Portland cement-concrete, will be reduced to a minimum.

4. Provides freedom from cracks and upheavals.

5. Insures against the presence of moisture in the foundation structure, thus prolonging the life of the pavement.

6. May be easily repaired at minimum cost; the surface patch method being applicable except in the case of very serious defects.

7. Provides decided economies in construction as it disposes with the equipment and organization necessary to lay cement-concrete, thus affording the con-

tractor the advantage of exclusive use of that portion of his ordinary equipment and labor organization which in actual operation has heretofore proven to be the most economical and thereby profitable.

8. Does away with the long period of time required for curing of the foundation, thus permitting the opening of completed work to traffic immediately and providing a rapidity of turnover to the contractor not possible in the case of rigid foundations.

9. Permits the use of the same materials, except cement, as are employed in cement-concrete work.

10. Under similar conditions, using the same aggregate materials, bituminous concrete of equal thickness will be found to be cheaper than cement-concrete at present prices.

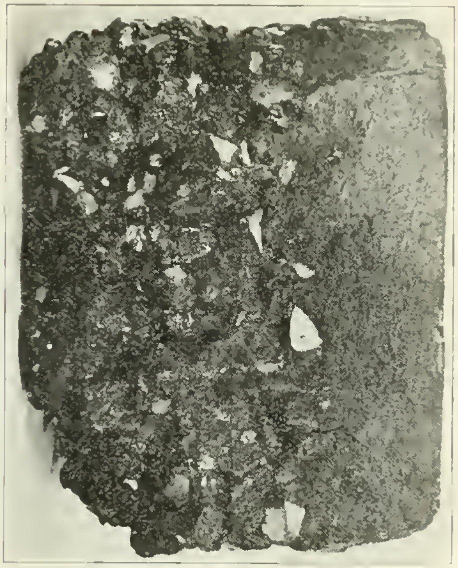
Economy

The opportunities for economy have been touched upon under "Advantages of Bituminous Foundations" just as enumerated. It is the opinion of contractors who have laid this type of foundation, as well as of those who would like to lay it, that a saving may be effected of from 35 cts. to $1 or more per sq. yd. Again citing as an actual example, Owensbore, Ky., a saving of better than $1 per sq. yd. was shown on the basis of 1917 prices, by the use of bituminous concrete as compared with the cost of cement-concrete of the same thickness and using identically the same aggregate materials. Inasmuch as contractors engaged in laying bituminous pavements seem to be agreed that that part of their organization necessary for laying cement-concrete has proven to be the least profitable, and that this class of labor has been the least efficient, and have expressed their confidence in the practicability and economy of bituminous concrete foundations as compared with cement-concrete, there should be no hesitancy on the part of the engineers in specifying this form of construction for fear that they will experience difficulty in receiving bids from contractors. Further opportunity for economy of construction is to be offered by the existence of many old pavements throughout the country which are in such a state of repair as to render them of questionable value even as foundations, yet many of them possess intrinsic worth considered in the light of an artificial subgrade which may be overlaid with coarse mixture bituminous concrete which in turn will be covered with a suitable wearing surface, thus giving a first-class pavement at even somewhat lower cost than has been above indicated, since in most such cases a thinner base course will be found ample.

The use of bituminous foundations is not necessarily restricted to bituminous surface types, but may also be used to equal advantage, although possibly with not quite as much relative economy, for brick, creosoted block and even granite block wearing surfaces.

Conclusion

In conclusion, the writer wishes to emphasize that there is nothing in the way



BITUMINOUS BASE AND SHEET ASPHALT TOP IN PERFECT CONDITION AT AGE OF 19 YEARS, WHEN REMOVED AT HAMILTON, OHIO, UPON CONDEMNING STREET TO MAKE WAY FOR A FACTORY BUILDING. NOTE POSITIVE BOND BETWEEN BASE AND TOP.

of an insuperable mystery surrounding the construction of bituminous pavements. While it is true that careful attention to details of design and common sense in connection with the selection of materials and construction methods, are necessary, as well as intelligent and careful supervision and control of plant and street operations, these requirements are in no way peculiar to this type of construction and cannot be offered as an excuse for the adoption of some other type when a bituminous foundation would be found more satisfactory and economical. The employment of either penetration or hot mix type will call for no more precautions than are customary with standard construction, in fact, standard specifications for these types of pavements may readily be adapted to use in building a foundation.

The maximum size of coarse aggregate allowable will depend upon the thickness of the base course, but will not exceed 2½ ins. in its largest dimension, due to the desirability of laying the foundation in courses not to exceed 3 ins. in depth after rolling. For the hot mix type a mixture such as follows is suggested:

Asphaltic cement, 4 to 6%.
Sand, or fine aggregate passing a 10-mesh screen, 25 to 30%.
Coarse aggregate, 65 to 71%.

The sand considered alone will contain from 40 to 50% of particles passing a 40-mesh screen, and as to the combined aggregate, from 45 to 60% should pass a ½-in. screen, and not more than 35% should pass a 10-mesh screen.

In laying the foundation, it will be found necessary to thoroughly roll the hot material in order to insure maximum compression. For this purpose a heavy 3-wheeled roller will be found preferable to the tandem type, as these is less tendency for the roller to ride even slight elevations at the expense of proper compression in adjoining depressions; however, in laying the wearing course, tandem rollers will be needed in order to remove roller marks.

In constructing bituminous base pavements with bituminous wearing surface, it is possible to secure a smoother surface than is obtainable in the case of the same type of wearing surface laid on a rigid foundation, the reason being apparent from the use of two, three and even four layers, thereby reducing the tendency to duplicate surface irregularities in the subgrade through successive layers of thoroughly bonded, homogeneous material.

The thickness of either type of bituminous foundation will depend naturally upon traffic requirements, such local conditions as character and drainability of the soil, supporting power of the subgrade, and other items such as may arise which will require consideration in designing any type of pavement. The penetration type, however, will be limited to lighter traffic roadways, whereas the true concrete or hot mix type of sufficient depth, will be suitable for any traffic condition where bridging power is not the major consideration.

SEWAGE TREATMENT EXPERIMENTS AT GRAND RAPIDS WITH SPECIAL REFERENCE TO DORR SEWAGE CLARIFIER

By Milton P. Adams, Sanitary Engineer in Charge of Sewage Disposal Studies, City Hall, Grand Rapids, Mich.

The sewage treatment experimental work conducted at Grand Rapids, Mich., during the past 18 months has not covered the wide scope of experiments generally conducted in a sewage testing station. Rather, it has been an intensive operating study of a life-size sedimentation unit. The present article is in no way a technical treatise on sedimentation, but recounts merely the experience Grand Rapids has had, particularly in respect to the Dorr sewage clarifier.

The Grand Rapids Problem

Our problem is one in plain sedimentation and sludge disposal, our efforts being directed toward the meeting of a state supreme court injunction rendered in 1913. This decision called for the removal of the sludge forming materials in the city sewage before being discharged into the local watercourse.

The city is sewered on the combined plan and has a normal dry weather flow of 30 millions gals. of sewage per day.

Main Sewers

The sewage of the city is discharged into the river at present through four main interceptors, two on the west and two on the east side of the river. These were completed in 1911 as part of a flood protection program, there being an average annual rise and fall of 16 ft. in the river stage. A flood relief pumping station is located adjacent to the outfall of each trunk sewer. Gates, coarse bar screens, and low lift centrifugal pumps are provided in each station by means of which the levels in the respective sewers are kept below the danger point during this high water period. It is planned that the permanent disposal plant will be out of operation during this time, the sewage being pumped directly to the river as at present.

Sewage treated at the experimental station is typical of 75-80% of the total city flow and includes practically all the commercial and industrial as well as 9/10 of the domestic sewage of the east side. Thus it can be seen that the sewage has been as nearly representative of future conditions as could be obtained.

From June, 1919, to March, 1920, the

station was operated with the 32-ft. diameter tank as a Dortmund unit.

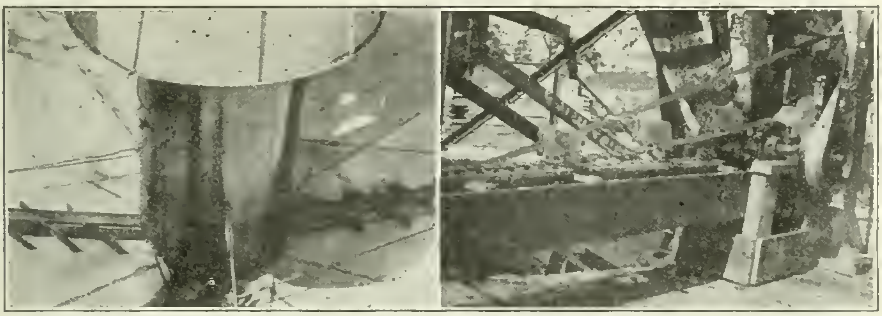
A Dorr Clarifier Installed

During April, 1920, a Dorr sewage clarifier was installed in the former Dortmund tank and operated until November last, when the station was closed down for the winter.

Sewage is delivered at the inlet trough of the primary tank by a 6-in. centrifugal pump belt driven from a 10 h.p. motor. Due to intake troubles, the rate of flow would occasionally fall to 0.2 million gals. per day. Our maximum rate was 1.1 and in the average day 0.6—0.8 million gals. of sewage were put through the primary tank. The flow was recorded hourly by the operator during the test day by reading the head over a standard rectangular V-notch weir placed in the effluent line from the tank.

tom. The 45 deg.-slope was never satisfactory even with squeegeeing to bring the sludge to the tank pump.

If for any reason sludge was allowed to accumulate, or was held in the Dortmund tank for more than ten days in warm weather, "tank boiling" invariably occurred. Masses of sludge varying in size from a teacup to a dish pan would be buoyed upward through the tank by entrained gas. They would suddenly appear at the tank surface, the gas would be released, the sludge mass break up—a part settling back into the tank and a part passing out over the weirs with the effluent. At times the action became very general over the surface of the tank. At these times the effluent and tank efficiency suffered severely. But the drawing of sludge would generally relieve this situation.



VIEWS OF GRAND RAPIDS, MICHIGAN, SEWAGE TESTING STATION.
Left: Bottom of Sewage Inlet Jacket and Original Dorr Sludge Well. Right: Sludge Delivered to Horizontal Flight Conveyor.

Every effort was made to operate the station as a continuous day and night plant after Aug. 9, 1919. There was an operator in attendance at least 16 hours of each week day, and after the clarifier was installed, there was an operator in attendance constantly. In addition to the hourly flow readings, the operator made hourly settling solids and turbidity determinations on both crude sewage and effluent. Every third day, constant amounts from the hourly samplings were kept to form a composite of the day's run.

All samples and composites of sewage and sludge have been analyzed at the city laboratory located in the local filtration plant. This division of the work has been under the direct supervision of Chief Chemist Walter A. Sperry.

As the result of our experiments with the Dortmund tank, we determined that 57 deg. was very close to the limiting slope which could be used and not allow lodgment of the sludge on the tank bottom.

Sludge Troubles

Considerable difficulty was occasionally encountered in starting a movement of sludge from the Dortmund tank. Backflushing with city water pressure through the sludge outlet into the tank was resorted to. This clogging or sticking of the sludge in the outlet was not due to the character of the sludge alone, but to structural limitations of the outlet itself and occasionally to lodgment of foreign material in the outlet.

During the normal operating day the surface of the tank was clear at all times and presented a good appearance with practically no odor whatever.

During the nine months' operation of the Dortmund tank a total of 105 million gallons of sewage were treated with an average removal of 45% of the suspended solids. Five hundred and eighty-three cubic yards of sludge were produced in the primary tank of an estimated average moisture of 93.5%.

The second set of sedimentation experiments starting in May, 1920, were carried on with a 32-ft. Dorr sewage clarifier installed in the primary tank.

Nearly three carloads of cinders were required to fill the sump of the original tank, over which a 5-in. concrete slab was laid having the Dorr standard 1¾-in. on 12-in. slope toward the center. The central sewage depth of the new tank was now a little over 14 ft. with a depth at the periphery of the tank of 12 ft.

Description of the Dorr Apparatus

The Dorr apparatus can be briefly described as consisting of a centrally located vertical shaft to the bottom of which is keyed a 4-way spider to which radial arms are attached conforming to the slope of the tank bottom. A series of parallel squeegees are set at an angle of 45 deg. with the line of each arm. These are so adjusted as to just brush the tank bottom when the mechanism is rotated. The entire mechanism is suspended from a superstructure which bridges the tank. The driving of the mechanism is accomplished by means of worm and gear. The speed of our installation was 3/50 R.P.M., and driven by a 2 h.p. motor.

A watertight cylindrical wall of sheet steel, 4 ft. in diameter was fastened to, and supported by the four arms. It was symmetrically located with respect to the central shaft and turned as a unit with it. This original sludge well furnished by the Dorr Company had a clearance of 5 to 6 ins. from the tank bottom and extended to a point about 12 ins. above the sewage surface in the tank. The rotation of the arms was designed to roll the sludge over and over coming in the path of the squeegees, and finally bring it within the central sludge well.

A circular, galvanized iron jacket surrounding the sludge well received the incoming raw sewage from the surface inlet trough. By means of a throat in the jacket converging to within 2 ins. of the sludge well, a uniform distribution of sewage was obtained into the tank. The jacket was stationary and hung from the superstructure. It was 6 ft. in diameter at the top and 6 ft. deep, releasing the sewage in the tank 5 ft. below the sewage surface. The effluent was drawn off by a series of V-notch weirs set around the periphery of the tank. Thus so far as sedimentation goes we had a remodeled Dortmund tank.

Operations Commenced

Operation was commenced May 15, 1920. First sludge appeared in the well on June 1st, and on the 2d, 16 cu. ft. of 92.6% moisture sludge was removed from the well. Sludge was pumped every 2 or 3 days until the middle of June, when it became so concentrated that the pump would not handle it. The pump was a 2-in. diaphragm type furnished by the Dorr Company. Enough liquor was removed from the well during this period to allow it to re-fill with sludge.

We wired the Dorr Company for help on the 9th, stating that the situation was getting beyond the control of our equipment, and within a few days they had an engineer on the job who, jointly with the speaker, devised and built a mechanical sludge conveyor system. The conveyor was driven from the same countershaft which drove the clarifier.

With this apparatus, sludge was removed from the surface of the well by a chain of quart buckets, elevating to a tray, from which the sludge slid into a horizontal flight conveyor running in a wood trough. As the sludge approached the end of the trough, it dropped down an almost vertical chute into a loading hopper. Wheelbarrows were loaded with this sludge, and wheeled to the beds, where it was spread out to dry. The wheelbarrows were calibrated so that the amount of sludge removed from the tank could be recorded in this way. During a period of ten days in June, there was no movement of sludge into the well, that portion of sludge at the bottom and around the entry to the well took an "initial set," to use the concrete engineer's term, or concentrated to such an extent, that after the conveyor was put into operation, about 40 cu. ft. of sludge were all that could be withdrawn. The black, sulphurous smelling liquor remaining in the well could not be removed fast enough to force more sludge in.

Pumping of sewage was accordingly stopped and the tank was drained the first of July. After removing most of the sludge on the tank bottom it was discovered that an "island of sludge" had formed about the well which had been rotating as a unit with the mechanism. The entry to the sludge well was practically plugged.

During May and June, 24 million gallons of sewage were passed through the tank with an average removal of suspended solids of 30% corresponding to an indicated removal by settling solids determinations of 94%. A total of 1,900 cu. ft. of sludge were produced with an estimated average moisture of 87.8%. Of this amount 370 cu. ft. of an average of

90.2% were actually removed at the surface by pump or conveyor.

In fairness to the Dorr clarifier as a sedimentation device, it must be admitted that sludge development and not sedimentation was the object sought during the entire 6 months' run. As a result there are but few periods when the tank had a chance to show what it could really accomplish. The normal week day tank efficiency under fair conditions of operation showed a percent removal of 45 to 50%.

The lowest tank efficiency generally occurred on Sunday when the suspended solids in the crude sewage would fall below those in the effluent for more than half of the day.

Flaring the Well at the Bottom

Mr. Peck, of the Dorr Company, visited the experiment station about the middle of July, having been previously notified of the predicament the sludge had caused in the sludge well.

He conceived the idea of flaring out the well at the bottom, which was intended to overcome our difficulty and accomplish the following ends:

1. Increasing the area of sludge opening into the well by making the opening equivalent in length to the circumference of a larger circle.

2. The storage and covering of a greater volume of sludge within the well would make for better conditions in the outer sedimentation compartment, as well as to give greater flexibility in handling of the sludge.

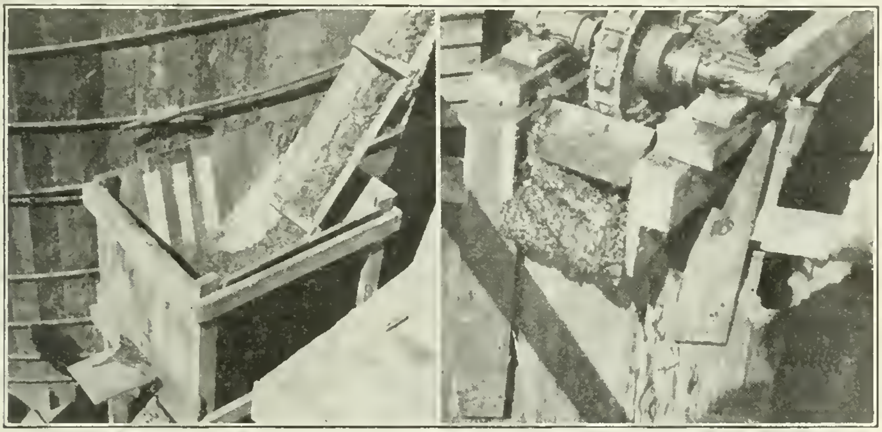
3. The concentration of as much evolved gas as possible within the well. The beneficial action of the gas in the 4-ft. well had already been noted both from its buoyant effects on the sludge as well as the drying power it had exerted in passing through the upper layers of sludge.

The "Grand Rapids" Sludge Well

Accordingly, the so-called "Grand Rapids" sludge well was constructed—a truncated cone of galvanized iron 10½ ft. high with a bottom diameter of 11 ft. and an upper diameter of 4 ft.

Provision was made at the upper diameter to attach one 4-ft. length of the 4-ft. well, bringing the upper rim of the composite well about 18 ins. above the tank surface. The change increased the sludge well storage from 1,400 to 5,000 gals., and increased the area of sludge opening from 5 ins. x 12½ ft. to 9 ins. x 34½ ft.

Operation was resumed the 30th of July and continued with but two or three shutdowns until the 21st of November. The first sludge was removed from the well on Aug. 24th, and amounted to 47 cu. ft. of 67.5% sludge. This was scum sludge, removed for the most part above the water surface in the tank, and was the dryest that we had obtained. All of the surface sludge had been removed by the 31st, several feet of black sludge liquor now appearing at the top of the well. This liquor was removed by a 4-in. Goulds diaphragm pump delivering 30-35 gals. per minute, and returned to the incoming sewage. About 4,500 gals. of liquor were removed from the well at this pumping, which allowed the well to completely fill with sludge from the tank bottom. Havoc was generally played with the tank effluent when this liquor or soft sludge was returned to the sewage inlet.



VIEWS OF SLUDGE HANDLED AT GRAND RAPIDS TESTING STATION.
Left: Sludge Entering Loading Hopper from Which it Was Wheeled to Beds.
Right: Character of Sludge with 80 Percent Moisture.

The effluent cones would be darker than the raw sewage cones for several hours. The suspended solids and turbidities also ran much higher at those times than in the raw sewage, although the settling solids readings were not appreciably affected.

The station was closed the last of November, the primary tank being entirely open and exposed to the elements. The approaching cold weather also made the handling of the sludge at the surface with mechanical apparatus next to impossible. For a week or ten days immediately preceding the shutdown, vain efforts were made to fill the well with sludge. Several thousand gallons of liquor were pumped out of the well, but it was found by soundings that there was hardly sufficient sludge in the tank to trap the bottom of the well. Hence, it could not be expected that the well would fill with sludge.

Plans for Future Tests

It is tentatively planned to reopen the station in the spring applying the clarifier to a still shallower tank, reduce the sludge opening into the present well, and develop an underflow sludge delivery from the bottom of the tank. The sewage and liquor inlet to the tank will also be revised.

Performance of the Clarifier

During August and September, the clarifier treated 18.5 million gallons of sewage with an average removal of suspended solids of 50%. During the last two months of operation this figure fell to 24%. From August to November 48.2 million gallons of sewage were treated in the Dorr clarifier; 2,311 cu. ft. of sludge averaging 83.2% moisture were produced. Of this amount 933 cu. ft. of 79.2% sludge were actually removed by conveyor, the balance remaining in the tank at the end of the run.

"Pin-Point Boiling"

In commenting on special features of operation of the clarifier, probably that, which for lack of a better term, we have called "pin-point boiling" is the most interesting. The surface of the tank in operation represents any quiet body of water over which fine particles of sand are being sprinkled. This is caused by the bursting of minute gas bubbles at the surface. This gas is evolved in the sludge on the tank bottom and released by the periodical moving of squeegee arms through the sludge.

This is not our theory, but has been proven to be a fact, for on shutting down the mechanism in warm weather, this "pin-point boiling" stops altogether—the tank surface is clear for 8 to 10 hours while gas is collecting and being retained in the sludge below. Finally, enough gas is entrained to buoy masses of sludge to the surface where it is released—the action being identical with "tank-boiling" experienced in the former Dortmund tank. On shutting down for a few days in June, a 6-in. leathery scum of sludge formed over the tank surface in 24 hours. Thus, the necessity of the operation of some kind of agitator in a tank of the type in promoting good sedimentation is clearly evident.

Effect of Baffling

Tiny globules of oil generally accompany these fine gas bubbles to the surface. It is this iridescent coloring of oil on water, which constitutes the only visible effects of this action. One half of the tank was baffled during the last three months of operation, the oil being caught just before passing out over the outlet weirs. As a result the effluent from this half of the tank was greatly improved although the appearance of the baffled half of the tank was accordingly sacrificed by the collection of the thin layer of scum retained upon it. It could not be proved that this "pin-point boiling" decreased the efficiency of sedimentation.

Sludge Characteristics

The 80% sludge produced during 1920 was a fairly stiff semi-solid and dried much less readily on the beds than the 94% sludge of 1919.

The original Dortmund tank went into operation June 30, 1919. On July 25th, the first sludge was drawn from the tank through its sump outlet and delivered to a secondary tank.

Its tarry odor, brownish-black color, and curdy consistence, as we have since come to know them, were at once evident. Moisture determination ran 94%. On the 7th of August about 300 gals. of this sludge were allowed to run directly to the sludge beds from the primary tank. Eighteen days later, this same sludge was removed from the beds in pieces—a matted, porous, fibrous cake. After a few days' further drying, this sludge was burned in piles on the dike surrounding the beds. A fluffy, reddish ash was left behind. This performance was duplicated many times during the summer and early fall with the same favorable results. Contrary to the behavior of most sludges which fissure vertically in drying, this sludge seemed to dry in layers, separating laterally. Visitors at the station often compare the appearance of this sludge to that of heavy brown paper.

Secondary Tank Digestion Dispensed With

This very unusual behavior of a practically raw sewage sludge drying on sand beds under all sorts of weather conditions without nuisance or even appreciable odor, caused us to dispense entirely with secondary tank digestion during the past year. But two of the 20-ft. diameter sludge digestion tanks were ever used for this purpose. They were operated on the fill and draw principle. The same difficulty attended the drawing of sludge from the tanks as was experienced at times with the primary tank. Since there was so little to be gained by the use of secondary tanks they were abandoned with the idea that we would operate the station under the hardest conceivable conditions by drying a primary tank sludge on the sand beds and kick up a nuisance if possible! Well, we failed Another case in point of where the engineer is given an inch, he'll take a mile!

In addition to the many hundred gallons of sludge dried on the beds, thousands of gallons have been pumped from the tank at times of shut down, and allowed to drain to a low point 150 ft. south of the station, forming a lagoon. Visitors have never noticed the presence of this lagoon by reason of odors emanating from it.

Explanation of Inoffensive Sludge

Since we had precisely the same sludge experience during the past season that we had in 1919, and one that differs so radically from that in other cities, we have attempted to explain the mystery by a combination of circumstances.

First, we have a sewage that is comparatively dilute, amounting to more than twice the average water consumption. Thus the medium is provided by which many of the finely divided organic solids can be carried off in the effluent.

Secondly, the presence of tarry oils has always been noticed in the sludge. These are discharged in alleged small amounts by the local gas works. The antiseptic action of these light oils has long been recognized.

Thirdly, a large proportion of the sludge is made up of pulpy wastes, discharged into the sewer by a local paper mill. This material is practically inert and forms the fibrous mat which facilitates the drying and burning of the sludge. Samples of this dry sludge had a beat value of 7,000 B. T. U.

The ability of the sludge to "set up" when it is not periodically agitated was again manifested about the first of October, 1920. Instead of forming at the bottom of the well as before, several yards of the sludge formed a huge plug within the flare well, which threatened to put us out of business for a short time. Probing rods, long handled shovels, and 1½-in. pipes lashed to the superstructure and extending down into the sludge well were used from the surface of the tank in an effort to break up the plug, but without success.

It was broken up only after decanting off the upper 10 ft. of sewage in the tank, which allowed the plug to drop down within the well where it had a tendency to flatten out, spreading over the tank bottom. A 1¼-in. hose stream now helped in breaking up the mass. On refilling the tank with sewage, the plug came up again but much smaller in size. This was repeated three times before the plug entirely disappeared. After being broken up this sludge would appear in chunks rather than reverting to the homogeneous, viscous fluid from which it formed.

Conclusion

In concluding, it must be admitted that from the Grand Rapids standpoint with a sludge promising so little difficulty to handle, the high concentration is very desirable, especially where an almost unlimited space for sludge beds can be provided. There are 130 acres in the tract selected for the site of the permanent plant—fairly well isolated from the city.

There are several points still to be settled before final recommendations can be made. While much depends on the results of next season's experiments, the Dorr clarifier, in the opinion of the speaker, has great possibilities. Compared with the Dortmund tank it has given practically the same sedimentation efficiency, and delivered much more concentrated sludge for at least six months in the year with but half the excavation required for the Dortmund. A strong point for the clarifier is the emulsifying and concentrating effect imparted to the sludge by the rotation of the mechanism. Over against these advantages are the greater depreciation in Dorr superstructure and mechanism and the greater expert attention required for the successful operation of a plant of this type.

It is difficult, however, to imagine a plant the size of the future Grand Rapids plant, without a competent operating personnel. Inasmuch as the day is passing when engineers claimed great results for plants that operated themselves, possibly the last disadvantage cited is not as great as it seems.

The city has expended $63,000 to date for sewage disposal purposes, of which $30,000 has been applied toward the purchase of land for the permanent site; $13,000 represents the city's investment in building and equipment of the sewage testing station, and the balance covers operation and other expense incidental to sewage disposal studies since April, 1917.

Messrs. Hoad & Decker, of Ann Arbor, were the designers of the original Dortmund tank and testing station. During the past six months the Dorr Company organization has taken an active interest and co-operated greatly with the city in conducting its experiments.

The foregoing discussion is the major portion of a paper by Mr. Adams before the 1921 meeting of the Illinois Engineering Society.

USING ASPHALTIC CONCRETE FOR RESURFACING WORN OUT PAVEMENTS

By W. E. Baldry, City Engineer, City Hall, Topeka, Kans.

(Editor's Note:—Pavements of different types have been laid in the large cities of Kansas since about 1895. Most of the pavements laid between 1895 and 1910 were either brick or cobble stone, with some sheet asphalt. The use of asphaltic concrete as a resurfacing material for pavements which have become unsuitable for present-day traffic is discussed in the following paper which was presented by Mr. Baldry before the recent annual meeting of the Kansas Engineering Society.)

The Cobble Stone Pavements

A general practice in the laying of cobble stone paving was to prepare the subgrade to the cross-section desired, and after spreading 2 or 3 ins. of sand, begin the laying of the cobble stones. These stones were of variable widths and depths and were laid with no particular care to secure smooth surface as we now consider it, but were finished with a roller drawn by teams or possibly power, and closed with a sand filler. These pavements have probably served their purpose very well, for as a general thing they have supported the traffic upon them and given a good foothold for the horses drawing heavy loads over them; they have also been capable of a fair degree of cleanliness. Under the years of traffic, however, these pavements have tended to become more rough rather than smoother, and the joints between the stones being large, there has been a tendency for the filling material to wash away, especially when laid upon any grade, with the result that today such pavements are good for but one thing, and that is to keep traffic out of the mud. These pavements have, under the action of traffic, become firmly bedded into the subgrade, and even present truck traffic does not show appreciable movement of the blocks, though the tractive effort necessary to overcome the irregularities of surface is considerable, and the desire of the traveling public at present is that these pavements shall be restored to a smooth surface, more than that they shall be replaced altogether. The problem, then, becomes the selection of a surfacing material, using the present pavement as a foundation or base.

Early Brick Pavements

The general practice in the laying of brick pavements in the early days was by what is known as two-course work, using a sand filler. In this work, after the preparation of the subgrade, a sand layer of 1 or 2 ins. was spread, and upon this was laid a course of brick flatwise. This first course was usually of what were known as No. 2 bricks, being from the sides and ends of the kilns. Over this first course was spread another layer of sand of from 2 to 3 ins., and upon this a layer of No. 1 bricks on edge were placed, over which was again spread sand and the whole rolled with team, hand or power rollers. This type of paving was at once far more sightly than the cobble stone paving, was reasonably smooth, and met the conditions of traffic in the residence districts especially well, but did not support the heavy traffic as well as the cobble stone paving. With time the filler material was washed away, the same as with the cobble stone paving, and the action of traffic chipped the bricks some, which, by the way, were not as hard and tough as our present good paving brick, until now the pavements have become worn and rough, though still passable. The lower courses have become bedded in the subgrade, in some instances to a solid foundation, while in other cases present traffic has cut through both courses and piled the pavement into crests and troughs, or pot holes.

Repaving Problems

It is the purpose of this paper to present a method of returning pavements of the types above mentioned to usefulness under the present day traffic. There are several considerations in looking upon this problem: First, many of these cities have no legal means of compelling the re-pavement of these streets. Our state laws at present give ample means for securing new paving, but little or no recourse for the compelling of the repavement of streets unless a petition is received from the property liable for the cost of the work. In many cities conditions have changed, business has moved from where it was some years ago, property values have fallen, and the streets are left in a general state of bad repair and in some cases well nigh impassable. The city authorities may desire to place these streets in a creditable condition, yet they are unable to unless at the expense of the city at large. Some cities have decided to spend a part of their street maintenance funds to accomplish these ends, which is to make as much mileage passable as possible rather than as much yardage as possible.

A second consideration of this problem is that much of this early type of paving was laid with excessive crowning of the streets, which practice is not in keeping with the necessities of today. A means of cutting out some of this excess crown is very desirable in the consideration of the repaving of the streets.

A third consideration of the problem is the using of just as much of the present paving as can be done without harm to the new work, thereby cutting down the cost and perhaps hastening the completion of the work.

It is believed that the use of bituminous materials for the restoration of these pavements to meet the requirements of present day traffic is of sufficient merit to warrant a presentation of some methods of proceedure.

Bituminous Resurfacing Methods

In general, there are two methods of accomplishing desirable results in the study of this problem. Briefly, one method is to lay strips of additional material over the worn brick paving of such widths as to accommodate traffic, placing it down the center of the street, leaving the sides of the pavement for a distance of some 6, 8 or 10 ft. out from the curbing which is usually in much better shape than the center, undisturbed. On streets without street car tracks, it will be found that a strip of 16 ft. widths will meet the requirements very nicely, and on streets with car tracks, a strip of about 8 ft. in width on each side of the track will be found to take care of the traffic. In passing, it is suggested that where these strips are laid on streets with car tracks, the side of the strip next to the car track should be at least 3 ft. from the rail. This scheme might properly be called a temporary one, as it cannot possibly give the service as supplied by the second method.

A WORN-OUT PAVEMENT ON TOPEKA AVE., TOPEKA, KANS., AFTER FULL RESURFACING WITH TEXACO ASPHALTIC CONCRETE.
Street Resurfaced in 1917, Photograph Taken Jan. 11, 1921.

The second method carries with it the covering of the entire pavement from curb to curb, the building of new concrete gutters to create shoulders to which to tie the new paving, and the correction of such irregularities of the old paving as shall be necessary to present a first-class job when finished.

Strip Paving

To consider the first suggested method, that of applying only a strip down the main traveled portion of a street, there are two types of construction to be considered. One method is to prepare the old paving as will be given later under the second method, and to apply the new wearing surface without any protection of the edges.

When this is done the edge will have to be tapered off in order that traffic may successfully turn on and off of these strips when passing other vehicles. In doing this, the tapering must be done short and sharp. In some of the earlier work this tapering was done in a distance of about 18 ins., gradually feathering out the edge to a knife edge. Experience has shown that here is where the first failure will take place for the new wearing surface has not the thickness to withstand the traffic, especially heavy hauling with iron tires. The practice of one engineer now is to make this taper at an angle of about 45 deg., it being considered that the inconvenience to the traffic is less than the damage to the strips, where a long taper is made.

Another method, and a better one, we believe, to employ where it has been decided to lay strips rather than to cover the entire surface of the old paving, is to take out the top course of brick along the edge of the proposed strip, and to construct here a concrete shoulder which shall have a vertical edge of at least 2 ins. on the strip side, and be tapered off as desired to the level of the old brick paving on the curb side. Such a construction will guarantee the position of the strip and require it to wear out rather than ravel out, but attention will have to be paid in this type of construction to these headers, that they may be able to withstand the tearing action of the wheels as they shall mount the strips from their position on the old brick paving.

Consider a strip laid, say 8 ft. wide along car tracks. Coal wagons, with a 4-in. iron tire loaded with four tons of coal passing over this strip will concentrate over an area of about 15 ins. width with each wheel, and there will be no variation from this track to amount to much. This coal haul will be probably heaviest in the summer season. If now the strip has been laid without headers, the tendency of this traffic will be to cause a slow flowing of the strip material eventually causing a cutting through of the same, after which the strip is of little more value than the original rough pavement. If now a header is provided, this may be overcome and the strip made to wear its allotted time. One may observe in Topeka many blocks of this strip work, and down in the bottoms where the heavy coal hauls are made to the western part of the city one may see where this traffic has sheared off these strips, leaving the center of the strip in good condition. However, proper care and watchfulness may be exercised and as these worn places appear, they may be repaired, and this maintenance may compare favorably with the cost of building headers, but it is desired to call attention to what may be expected rather than to analyze cost data.

The laying of strips of such widths as funds will permit without headers may be done in such a way as will pay in comfort and ease of operation for the traveling public, and where a city has worn pavements which it is unable to repave through lack of a petition from the property owners, the city is justified in spending its street funds to lay these strips over these worn pavements, and it is well to call engineers' attention to this possibility of reconstruction rather than for a city to put up with a condition over which it has no control. The city may hear criticism that in laying these strips at the general expense of the city, it is granting special benefits to the property abutting upon such improvements, and it undoubtedly is, but under conditions as above stated, it is justified.

Resurfacing Full Width of Old Pavement.

If now petitions can be secured for the resurfacing of a worn pavement from curb to curb, we offer the following method of procedure, which has in mind the permanent reconstruction of the street. This is our second method of construction and should be employed where a first-class job is desired.

The first matter for consideration in adopting this method of resurfacing is to look to the curbs or gutters.

It will often be found that where this older type of paving was laid, sandstone curbs were built and the paving extended to the curbs, also it will be found at times that cobble stone gutters were laid with brick paving. Under this condition the cobble stone gutters should be removed, and the curbing left in place if desired, or a new combination curb and gutter built. The old flow line of the gutter should be held, but the outer edge of the new gutter next to the paving, should be elevated so as to form a shoulder at least 2 ins. above the old paving, thereby providing for a 2-inch new wearing surface at this point. By making these new gutters of 24 or 30-in. width, this additional 2-inch pitch in the gutter will not be found to be harmful. If there is already in place a combination curb and gutter which it is not desired to disturb, the old paving next to the concrete gutter may be removed and a strip of additional gutter built which will form the desired shoulder for the new wearing surface; this will probably make the gutter somewhat wider than common practice, but it need not be detrimental to the life of the improvement if carefully done, and be much cheaper than the removal of the present curb and gutter and the construction of a new combination curb and gutter which would provide the same advantages.

Leveling Off Old Pavement

After the construction of the new gutter is completed, a gang should start up the street again, taking care of all the potholes, ridges or sunken places, requiring especial attention. In doing this work, care should be used not to disturb any of the bottom courses of the paving. In two course brick paving the top course may be removed and readjusted if need be, but the bottom course should not be disturbed. If the bottom course has to be disturbed, a regular concrete base should be provided, and brought up to the grade of the wearing surface without binder course.

In this connection, attention might profitably be called to the tieing in of an improvement of this kind with adjoining streets already paved. Where two-course brick paving is being covered, the upper course is removed, and the 4-in. space provided is filled with 2 ins. of binder material and 2 ins. of new wearing surface, making a smooth junction with the adjoining pavements. Where cobble stone paving is being covered, the stones must be removed and concrete base put in to proper grade, or the adjoining paving raised to the new level, whichever is the cheapest accomplished. General depression should not be disturbed, but should be built up with binder material to the new grade, less the thickness of the wearing surface. Where the old pavement has been piled into ridges, or corn rows, a heavy tandem roller might be used to good effect to re-establish conditions, but if the ridges are firm, though uneven, it is best to leave them alone and to build up the quarters so that they may be properly covered with the new paving. In working out a job of this kind, it will be found that careful watching of the progress of the work, and the ability of the engineer to see how the finished product will look, is essential to success.

Making Ready for Binder Coat

The next step after leveling off of the old paving is the preparation of it for the reception of the binder coat. The first thing is the thorough sweeping of the street with a wire broom, removing all loose material on the surface, but making no effort to remove all of the old sand filler material. It might be well to call attention to one pertinent fact essential to the wearing qualities of the new paving; that is, in brooming the old paving, enough of the old sand filler material should be removed to give the asphaltic concrete a good grip upon the old paving, for this old paving is smooth, and without this clinch, the new paving will have nothing to hold it in place. In general the old filler material should be swept away until there is about ½ in. of it removed from the pavement surface.

After the sweeping, the next step is to apply a thin coating over this old paving to settle the dust and prepare for the reception of the binder coat. For this work a barrel, a good stirring stick and some common watering pots are brought upon the work. Asphalt of about 54 penetration is heated to a liquid state, and to this is added domestic distillate in the proportion of about 40% distillate and 60% asphalt, the ratio being varied somewhat with the weather conditions. With dry hot weather, the above ratio will make a good workable combination, the distillate will evaporate in about 24 hours, leaving the asphalt. After this mixing of the asphalt and distillate, the liquid is poured into the sprinklers and a man started at ordinary walking gait to sprinkle it over the entire old paving, the idea being to lay this coat as thin as possible, merely a paint coat. In about 24 hours it should be dry and ready for the binder coat. As a test to see if the paint coat is dry enough to proceed with the work, press the thumb against the surface of the old paving, and upon removal the thumb should show no perceptible stain.

The Binder Coat

The idea of a binder coat is to fill up all the depressions in the old paving, and to build up a new even cross section upon which to lay the final wearing surface. It has been found sufficient to provide for a 1-in. binder coat in the contract, using more or less thickness as circumstances require. This binder coat is what is known as a close binder, and is made up of stone ranging from ¾ in. down to ¼ in., three sand gradings, stone dust and asphalt. The proportions used in making this binder will vary with the material at hand, very much as Portland cement concrete materials are varied to produce a concrete suitable for the work at hand. The stone dust mentioned may be replaced by any inert material of 150 to 200-mesh, meeting the specifications for fineness, and is often a percentage of Portland cement. This binder coat must be so mixed as to remain firm after laying, show no signs of disintegration under the action of wagons or trucks bringing in the wearing surface over it, and yet must be porous enough to permit of the perfect welding of the top surface material to it; especially it must show no evidence of excess asphalt, or greasy spots.

The Materials to be Used

In general, and as a guide from which to deviate towards the perfect mix which alone can be determined after a sieve analysis of the available materials for the aggregate has been made we should suggest the following from which the actual percentage of the various materials used may be computed.

In a batch mix of 5,100 lbs, we should start with a mix about as follows: Asphalt cement, 225 lbs.; filler material, 450 lbs.; sand, all grades, 1,425 lbs., and stone between ¾ in. and ¼ in., 3,000 lbs. This mixture is produced in a regular plant built for the purpose of making asphaltic concrete, and should be delivered on the work at about 275 deg. F. This binder must be raked and rolled with a heavy tandem roller and when finished, should present the street of the grade and cross-section desired, less the thickness of the wearing surface.

After the binder coat is laid for about a day's run of the plant, the gang is turned back and the wearing surface is spread. This wearing surface of asphaltic concrete, should be not less than 2 ins. thick in any place, either when laid in strips or when covering the entire street from curb to curb, and the difference between this thickness and the actual material necessary to bring the new pavement to the grade desired from the surface of the old pavement, represents the thickness of the binder coat.

It is not thought necessary to enter into the discussion of the making of asphaltic concrete in this paper, the intent being to show what preparation of the old surface is necessary before laying the final wearing surface. The mistake has been made of using no binder coat, the reconstruction proceeding with the use of asphaltic concrete only of variable depths according to the condition of the old pavements. This practice should not be encouraged for it has been found that to be the most successful, the actual wearing surface should not exceed 2-ins. in thickness, and where additional depth is necessary, it should be made with a binder mix. By such a procedure, better rolling of the hot materials on the lower strata is secured, and the binder coat containing less asphalt than the new wearing surface, will afford less liability of creeping of the new paving. There is also to be considered the less cost of the binder material as compared to the cost of surface material.

After such a procedure as above indicated, if the old pavement is firm there is no particular reason why any and all traffic should not return to the use of the street, though sometimes after such treatment the street is restricted to the use of pleasure vehicles only. Such an action should properly belong to the pleasure of the local government.

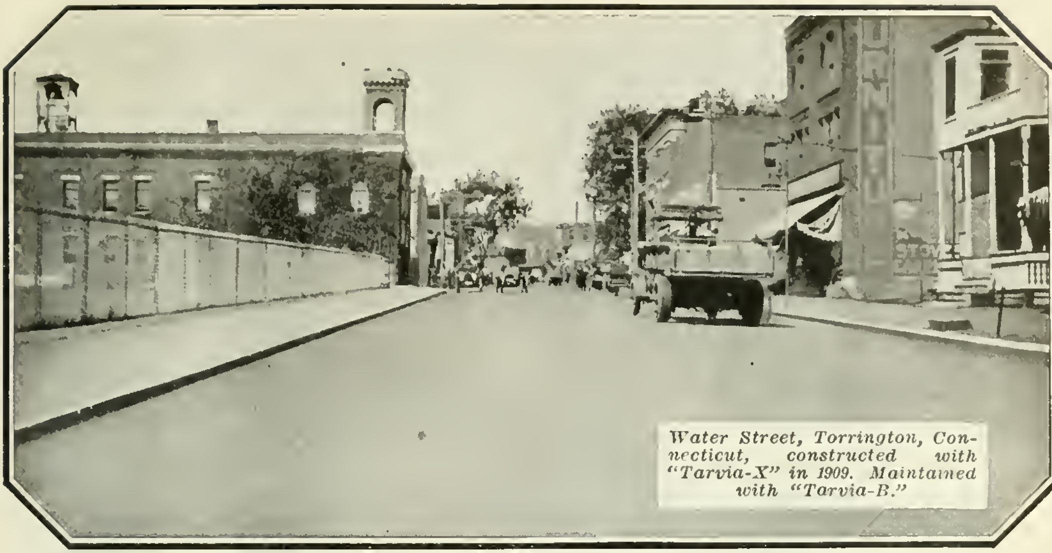
As to the cost of the procedure here described as compared with removing the old surface, laying a concrete base, and new 2-inch wearing surface, we should say roughly, it can be done for a third to one-half of the cost of new paving. This is the item which will appeal to the taxpayers perhaps more than any other, and it is one of the items which renders this type of reconstruction worthy of consideration by engineers, while another item is the rapidity with which it may be accomplished.

TYPES OF HIGHWAY PAVEMENTS IN TENNESSEE

By C. H. Olmstead, District Engineer, Tennessee Department of Highways, 327 Seventh Ave., North, Nashville, Tenn.

Tennessee is divided geographically into three divisions, east, middle and west. This division being a natural one, has become accepted practice in political and legislative affairs. These divisions, aside from their geographical designation, vary greatly in their topography and geology. East Tennessee has its mountains, Middle Tennesseee, its hills, valleys, river and creek bottoms, and West Tennessee has its low flat lands. The Tennessee river is the dividing line.

From the standpoint of highway materials, rock abounds in East and Middle Tennessee, while West Tennessee has none. East Tennessee has some good sand, mainly around Chattanooga; Middle Tennessee has only the Cumberland River sand, as the Tennessee River sands and nearly all creek sands are not suitable for extensive highway work. West Tennessee has good sand. Excellent chert abounds in many counties in Middle Ten-



Water Street, Torrington, Connecticut, constructed with "Tarvia-X" in 1909. Maintained with "Tarvia-B."

A Tarvia pavement—ten years old and still new—

THE Tarvia road above is Water Street, Torrington, Connecticut.

This street was constructed with "Tarvia-X" as a binder in 1909, and for three years thereafter required no maintenance whatever. Since then it has been kept in tip-top shape by an occasional inexpensive treatment of "Tarvia-B." It is an excellent example of the durability of a properly maintained Tarvia pavement.

Torrington is a busy manufacturing town where there is plenty of heavy traffic, and its satisfactory experience with Tarvia may be taken as typical. Whenever Tarvia is given a fair trial it invariably makes good. And the fact that towns which once begin to use it continue using it in increasing quantities year after year, is the finest kind of endorsement it could have.

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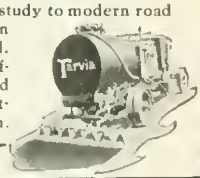

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nessee. This material makes a road superior to waterbound macadam, and more easily maintained. While Tennessee has many fine clay deposits, there is little paving brick manufactured, owing to the lack of base material and cost of hauling.

On account of the abundance of good rock, mainly limestone, we have a preponderance of pavements of the macadam type under construction at this time. Tennessee now has under construction:

100.68 miles of waterbound macadam;
160.43 miles of bituminous macadam;
38.85 miles of chert roads.

Owing to the distribution of sand and stone, concrete pavement is being constructed only in Hamilton and McMinn counties, where both are available; 4.37 miles has been constructed, and 24.65 miles are under construction.

In West Tennessee, bituminous macadam and bituminous concrete on a macadam base are being constructed.

Owing to the availability of rock asphalt in Kentucky, this material has come into use in East and Middle Tennessee, where 46.57 miles are under construction, rock asphalt being laid on a macadam base. Bituminous macadam and rock asphalt have been laid on a two-course macadam base, 6 ins. thick, but a modified Telford base 8 ins. thick is now being used. The modified Telford base is made of field or quarry rock, laid in shingle fashion, with the longest dimensions at right angles to the center line of the road and napped in place.

The bulk of the highway construction is being done on a contract basis, but force account work on a day labor basis is being done on three macadam projects, aggregating 16.77 miles. One concrete highway project, 10.14 miles, is being constructed by county forces, under supervision of engineers of the State Highway Department, at fixed unit prices, making it essentially a contract job, with the county as the contractor.

The Federal-aid construction is carried on upon a basis of the federal government paying one-half, the state and county paying one-half.

The Federal-aid program for 1921 calls for the construction of 271.75 miles of highways, surfaced with the various types and having an estimated cost of $8,575,900 and bridges at an estimated cost of $370,000.

INTERNATIONAL ASSOCIATION OF STREET CLEANING OFFICIALS SUCCESSFULLY LAUNCHED

On the invitation of W. J. Galligan, Assistant Superintendent of Streets, in the city of Chicago, 44 street cleaning officials from 28 United States and Canadian cities met in Chicago on October 7 and 8, 1920, and organized the International Association of Street Cleaning Officials. The objects of the association, as stated in the constitution adopted, are: "The acquisition of knowledge relating to the cleaning of streets and the dissemination of this knowledge among the members of this association, with the view of improving the service and reducing the cost, and the establishment and maintenance of the spirit of fraternity among its members."

Membership

Members are of four classes—active, associate, honorary and life. Active membership is limited to superintendents of street cleaning departments in municipalities and towns of the United States and Canada, and "other persons having charge of or connected with municipal street cleaning departments." Membership of active members is continuous, when once elected, whether they continue in employ of their various municipalities or not. Associate members are "manufacturers of and dealers in appliances relating to the interests kindred to the association."

Officers

Officers are President, Vice-President, Secretary, Treasurer, and a board of governors of five members. The members of the board of governors are chosen one from each of six districts, the United States being divided into five and the Dominion of Canada forming the sixth, except that none is chosen from that district from which the President is elected. Officers elected for the coming year are as follows:

President, W. J. Galligan, Assistant Superintendent of Streets, Chicago, Ill.; Vice-President, Theodore Eichhorn, Superintendent of Streets, Erie, Pa.; Secretary, A. M. Anderson, 1340 Old Colony Bldg., Chicago, Ill.; Treasurer, Robert W. Waddell, City Engineer, Kansas City, Mo.; Board of Governors, Abraham Swan, Jr., Engineer of Streets, Trenton, N. J.; J. W. Motte, Director of Public Works, Savannah, Ga.; F. W. Doane, City Engineer, Halifax, Nova Scotia; W. B. Lowry, Manager of Parks and Improvements, Denver, Colo., and Peter J. Owen, Superintendent of Streets, San Francisco, Calif.

WATER WORKS SECTION

PROGRESSIVE LOSS OF RESIDUAL PRESSURES IN A WATER WORKS SYSTEM

By Waldo S. Coulter, Consulting Engineer, 115 Liberty Street, New York City.

It is not uncommon to encounter communities where a notable loss of residual pressures throughout the water works system has been progressively brought about by an unusually large and rapid increase of domestic and industrial consumption.

Notable increases in industrial consumption, in particular, operate to hasten the process. The loss first becomes noticeable in connection with fire protection service. Whereas, at first the hydrant pressure alone may have been sufficient for fighting fires, lessened residual pressures and discharge will finally bring about the use of pumpers. At a later stage, unless corrected, losses will proceed to a point where they will be forcibly brought to the attention of the consumers by the failure of water to flow from taps on the upper floors of buildings in the higher portion of the city.

This may first occur during a time of unusually heavy consumption, such as a period of extremely cold weather, when the general opening of taps to prevent the freezing of pipes, may bring about a simultaneous failure of the supply on upper floors over a large portion of the city, and cause a vigorous public demand for improvement.

Experience at Bayonne, N. J.

Something of the sort occurred in the city of Bayonne, N. J., during the unusually cold weather in January, 1918. The writer conducted an investigation for the city at that time, and the general situation disclosed may be of interest. It may be stated that these conditions have since been removed by the installation of additional trunk lines to the city and the construction of a booster station at the point where they connect with the distribution system.

Bayonne is located on a long, narrow peninsula located between Newark Bay and Upper New York Bay, and has a population of about 65,000. The trunk lines enter the distribution system near the upper end of the peninsula and the main arteries of the latter extend longitudinally toward its point, with frequent ample cross-connections.

Since 1910, Bayonne has developed industrially with great rapidity, and is now the home of some of the country's largest industries. Most of these are located toward the point of the peninsula.

By 1918 the average daily consumption had reached 10¼ million gallons, having doubled during the preceding seven years. At the time the trunk lines were first connected to the system, 1894, the average daily consumption was less than 2½ million gallons, and the distribution system was of comparatively limited extent.

The pressure at the entrance to the distribution system was then 45 lbs., which was, as such matters were looked upon at that time, considered sufficient.

While the distribution system was, and is, in general, well designed, and arranged to avoid unreasonable losses of pressure by friction, there was a constantly increasing and legitimate diminution of residual pressures throughout the system. These progressive pressure losses arose from the increased flow through the pipes consequent on the rapid growth of population and manufacturing industries, causing increased friction losses and lower residual pressures. The lengthening of the piping by extensions contributed to further increase the friction losses. As the friction loss varies approximately as the square of the velocity of flow, if the velocity in a given pipe be doubled, the friction loss is quadrupled. When, therefore, a marked deficiency of residual pressure asserts itself in a system, associated with a rapid and continuous increase in the rate of flow, intolerable conditions are speedily precipitated.

Great Friction Losses

The peninsula upon which Bayonne is situated is comparatively level, without marked variations that might offset friction losses in the pipes. The residual pressures throughout the city were therefore chiefly dependent on the pressure communicated to the distribution system at the point where it was joined by the trunk lines. Any distribution system is, of course, entitled to certain legitimate losses of pressure. After such losses have been deducted from the initial pressure there should remain residual pressures and flows sufficient, not only for domestic and manufacturing purposes, but to afford ample fire protection throughout the system. The sum of the legitimate net losses (taking the topography into consideration) and the required maximum residual pressure for domestic and fire flows, equals the pressure that should be provided at the inlet to the distribution system. Computations showed that this initial pressure should have been, in 1918, about 70 lbs., instead of 45 lbs. The difficulties were increased owing to the fact that friction losses in the trunk lines, coincident with increased flows, rendered it impossible to maintain even 45 lbs. at the inlet to the distributing system.

Whereas, in earlier years, the hydrant pressure alone was frequently used to fight fires, for some time before 1918 the residual pressures had been reduced so low that a stream could be projected, with hydrant pressure, only 10 ft. or thereabouts from the nozzle.

The effects of this continuous diminution of residual pressures first became very noticeable to citizens in 1915, which would appear to indicate that prior to that time the pressure had not been reduced to a point where domestic consumers were seriously inconvenienced, although test data of the insurance bodies show that markedly deficient fire pressures were of longer standing.

War Industries Increase Loads on Large Mains

In addition to the rapidly increasing consumption of Bayonne, other important causes originated during 1917 to increase the load on the trunk lines. Where the latter passed through the Newark meadows on the way to the city, great war industries had sprung up, for which no other source of water existed. The draft upon the trunk lines by these industries increased from 100,000 gals. per day in July, 1917, to 1,800,000 gals. per day in January, 1918, with every prospect of a continued rapid increase during 1918. Adding the average daily consumption of the city for the latter portion of 1917 to the average daily consumption of these meadow consumers for January, 1918, with a deduction of 300,000 from the latter to allow for abnormal cold weather consumption during that month, gave a grand total of 11¾ million gals. per day, with the prospect of an increase in rate of from 1,000,000 to 2,000,000 gals. per day during the year 1918.

Additional Trunk Lines and Booster Station Installed

This pyramiding of consumption culminated in a complete collapse brought about by the abnormal consumption associated with the period of extremely cold weather in January, 1918. This circumstance but somewhat hastened the day of reckoning, which was not far distant in any event.

The objectionable conditions have since been removed by the construction of additional trunk lines and the installation of a booster station.

PUBLICITY IN UTILITY SALES

By W. Malcolm Lowry, of Henrici-Lowry Engineering Co., Consulting Engineers, 222 Commerce Trust Bldg., Kansas City, Mo.

Correct and constructive publicity has done much to relieve the unfortunate criticism relative to many of our large commercial institutions. The apparent frankness of these corporations through their publicity departments has convinced the general public that the cost of their commodities has been fairly, even if not correctly, determined.

The thing that will engender better feeling and help the general attitude of the citizens toward the rates charged by the local utilities, either municipally or privately owned, is publicity.

The recent convention of Building Managers held in a northern city developed the sentiment that even that profession was not properly understood and should undertake to explain to its clients the make-up of their rental rates. This publicity will show how each item of expense is justified and a complete analysis of the rates charged in each building.

Information Mailed With Monthly Bills

Public utilities should be equally frank. Each month when the statement is mailed a little insert could be enclosed setting forth just one item of percentage cost. Each month should show the new items as well as the recapitulation of previous ones. The entire analysis should be prepared in advance so that the percentage would be complete with the final exhibit; but by continuing the story over several months, the interest of the patrons would be retained.

These exhibits could show that of each 1,000 gals. of water pumped a certain stated percentage was chargeable to coal, another to plant salaries, another to outside employes, another to executives, another to new hydrants or machinery, another to plant distribution, plant maintenance and so on through many classifications. This would be a very inexpensive way to advertise the plant operations and would have a tendency to solidify the confidence of the public in the local plant.

To Prospective Customers.

To prospective customers the entire analysis could be forwarded at the beginning of the campaign for new accounts, and be followed with educational propaganda. The basis of meter unit could be explained showing how charges are computed. No manager should presume that his customers understand the technical points. The schedule of sliding charges for service would not complicate the analysis because the percentage could be kept proportionate, and the system generally explained.

Small sectional pictures of the inside of the plant would be interesting as well as constructive. In these days when so many of the schools provide science courses for women, it is pleasing to note their added interest in matters of daily life and its necessities. The women customers would be glad to learn more of the elementary details pertaining to the manufacture of electricity which is used to heat their percolator or iron as well as the means of purifying the water served on the table.

Simple instructions could be set forth in connection with thawing out water pipes or the dangers of amateur wiring of fixtures.

Value of Sustained Effort in Publicity

It is not of so much importance just what is covered in the matter of publicity as it is to keep continually in close touch with the consumer and prospective customer and show that there is an interest in their account other than the monthly collection of the rate.

Some of the states require that the fire underwriters furnish each customer a complete analysis showing the manner in which each separate rate is compiled. This has done much to relieve the antagonistic attitude of the insuring public. It also furnishes a basis for improvements which mean a saving to the customers. This would have the same tendency with all other lines of industry.

In some cities this could not be handled without some explanation in reference to certain commodities consumed. At some locations the increased freight charges have added heavily to all purchases, especially fuel. This increase would not apply to all plants alike, but could easily be justified by complete detailing the present rates and would at least be interesting to the consumer. Comparisons of other plants could be occasionally made.

The newspapers could also be pressed into service. In one city the tax assessor is even advertising when and where the returns can be made. If the assessor has found it advisable to advertise although his customers are in no wise subject to competitive service, why should a utility imagine its customers are any less human?

The entire matter should be carried out without any partisan spirit and should be based on the theory that all employees are either on civil service or are the best talent available for their particular duty.

Criticism is too frequently destructive without any constructive suggestions.

Encouraging Public Confidence

Too much thought is given to making customers purchase the manufactured product without encouraging his confidence in the article.

Many of the plants now use some method of advertising at irregular intervals, but if a constructive and consecutive program were outlined upon an inexpensive basis, it would result in stimulating a comparison of plants upon a rated basis and would be an economical saving to the ultimate consumer.

Courtesy in service is naturally expected and should be insisted upon by all executives.

Proper care should be used in the manufacture and delivery of all commodities, be it water or electricity.

Reasonable performance of the machinery is to be required.

These are natural details to expect. What are the details that you would appreciate were you on the outside of the plant and entirely unfamiliar with ordinary routine? There are many things you would like to find out. So it is with many of your customers, and a little data carefully and accurately prepared and presented in a concise manner will increase the output of your plant.

This is the day when customers desire to have a little interest in a plant or an institution more than they pay for. They believe in the safety of the national bank, but they also enjoy having the president of their selected institution come out and shake hands and show a little evidence of being an interested friend and not altogether a cold but successful financier.

A utility can build up the same support through friendly publicity.

The possibilities for this campaign are legion, and judging from efforts already put forth local managers are endeavoring to get on a more friendly basis with their customers.

This is the age of co-operation.

THE VALUE OF MUNICIPAL UTILITIES TO A COMMUNITY

By John F. Druar, of Druar and Milinowski, Consulting Engineers, 512 Globe Bldg., St. Paul, Minn.

(Editor's Note: Mr. Druar has contributed to this journal before and we are pleased to announce that articles from him on water supply, sewerage and paving subjects will appear in future issues.)

The crying need of cities of the third and fourth class and villages and towns throughout the country is a careful, prudent and economical development of their public utilities.

By public utilities, I mean the water supply and distribution, the sanitary and storm sewers, disposal of municipal and trade wastes, road and street improvements, sidewalks, curbs and gutters, pavements, electric lights, central steam heating systems, telephones, transportation, parks, lakes, and, in fact, anything that could be included in city planning.

Heretofore not enough attention has been given to the development of a municipality. Most small cities, "like Topsy," have "just growed."

Factors Arresting Development of Small Towns

Jim Smith thinks one thing, Bill Jones another. Perhaps they never get together, but Smith goes out and buys a patent disposal tank, puts it in his yard and equips his house with a modern inside toilet with a well and pneumatic water supply costing from $500 to $1,000. Smith, on the other hand, wants the village to take care of both water and sewer. He mentions the fact to the local council and Brown, a retired farmer, at once takes exception to any forward movement. He feels that what he had on the farm is good enough for him in town. There are a number of Browns and a number of Smiths. The Joneses are in the minority and proceed to talk for a municipal system. They win over a few Smiths and Browns; enough to get the village council started and the council proceeds to guess as to how much such a system will cost.

Guessing at the Cost

Right here is the place for them to engage a first-class engineer, one who has had experience in municipal work, to make a report on the project, which will crystallize public thought. Sometimes this is done. At other times, price, not reputation based on long successful practice, is the only consideration that is given to the selection of the engineer and the difference of 1% in the cost of engineering may mean the securing of inferior engineering services, which may result in a final cost of the improvement several thousand dollars in excess of what it ought to be; and the design may be poor. Again they may proceed as far as the bond issue without the advice of an engineer, only to find that they have not secured enough money for the project. Or, through want of proper explanation to the people, the bond issue may fail to carry.

Let us assume that an average city or village of, say 1,000 inhabitants, is desirous of securing municipal improvements. The town now has a number of houses with plumbing, pressure tanks and wells all on the premises, thus affording sewers and water to a few. Some one starts agitation for a water system and there are several informal discussions that lead nowhere because reliable information is lacking on which to base them. The banker or other business man suggests having an engineer come to address a public meeting and correspondence is taken up. Some engineers will visit the village and do a little development work just to start the proposition on the right track. Others from the outset will demand the guarantee of a fee. This demand may mean that the council or committee will abandon the movement for the time being and forget about the advantages.

Missionary Work by the Engineer

A good municipal engineer recognizes the need of a little missionary work and he will therefore visit the village even at his own expense and do what he can toward helping the community, of course, expecting that if anything is done, he will secure the work.

The village, on the other hand, should be careful not to engage an engineer who has not had a great deal of experience in municipal engineering. Many a poor piece of work is done because of inexperience.

An Impossible Fee

Some times the cheapness of an inferior engineer appeals to the council, and they will actually engage a man who proposes to draw plans and supervise the work and keep a resident engineer in attendance at all times for 2½ or 3% of the cost of the work. It cannot be done. The percentage asked points out the fact that the engineer does not know the cost of the work. Again some young engineer comes on, just out of college, with no practical experience, and becomes a self-styled consulting engineer over night. He puts out a shingle, engages in practice and perhaps secures work, possibly important work. He is at sea as to costs and many other matters. If the work goes in well it is because of luck only and generally the cost will be excessive.

A Fair Fee

A good standard fee for work of $40,000 or more, requiring survey, tests, plans and details, careful special specifications, bidding forms and attendance at the letting, would be 3% of the cost of the work and such fee should cover report, estimates and attendance at a mass meeting to explain how the money will be spent, so that the citizens may know the general plan, the benefits derived and the approximate cost to the individual property owner. If this method is closely followed the results are good, the bond issue carries, plans are drawn and the work let. Sometimes there may be a pool and it is the duty of the engineer, through his experience, to sit in judgment and to guide the council by his past experience as to whether the bids should be rejected or the work let to the lowest responsible bidder. This is the point where experience counts.

The Measure of Experience

An engineer is born and not made. You can pile technical training on a man for years, but unless he has a vivid, well-controlled imagination, a knack of knowing how to do things and unless this is backed by five to ten years of practical diversified construction and field experience in responsible charge of men and construction, he is not the engineer for the work. He has, of course, to make a start some time, but is not particularly reliable for his first, say 25 jobs. By this I mean he finds mistakes in his own plans, sees where they could be bettered after the work has been performed and where the costs could have been cut by other methods. In other words, he is going through the experimental stage. After considerable experience material men and patent appliances which have not been thoroughly tested no longer interest him and he takes no chances, trusting that the work will be lucky. He finds himself and becomes as reliable as the Western Union clock, provided he does not step out of his province and attempt too big a program. He has found that honesty is the best policy, that good work builds a good reputation, and that one job done well gives him added work.

When the Contract is Let

Now, when the work is let, the engineer makes an additional charge for general supervision of not less than 2%, which fee will allow him to be generous with his time and attend special meetings for explanation and discussion, and allow him to visit the work to see that the resident engineer is performing his duty.

The engineer, for the sum of $250 or $300 a month will put a special resident engineer in the field to have actual supervision over the contractor and see that the proper materials and quantities are used.

I rather favor having the contractor figure on reimbursing the village for this service and suggest that the sum of $250 or $300 a month (depending on the grade of the engineer and his duties) be deducted from his contract price of the work for each month spent in construction. This then causes the contractor to supply his materials and equipment and use his best efforts to complete the contract.

The Contractor

Unfortunately some contractors are not as well equipped for the work as others, and while I have known contractors to finish a $60,000 water job in two months, I have known others to dally along for a year on a $40,000 job, losing money for the city as well as for all others concerned. Therefore, in putting a penalty of this sort on the contractor, I know he will give personal attention to the work in hand and better service will be obtained all the way through. The contractor bidding on the work should be familiar with it and have successfully completed work of similar nature.

Much trouble is saved by clear plans and specifications, and if these are adequate no argument ensues, and this makes for a general good feeling and rapidity of construction.

The cost of municipal improvements is not large. One can be up-to-date in his municipality and have all the comforts of life, for less than it costs to exist without such improvements. This has probably never occurred to him, but it is a fact.

The citizen wants an automobile and is up-to-date in that way. He thinks nothing of spending for pleasure, but a slight tax for water, sewer, or pavement —no! He is opposed to it as much as if it were on a par with the Boston Tea Party. He feels like inaugurating such a party to protest. When will the American people wake up? Last year all over the United States $700,000,000 was spent for education, an absolute necessity, and $22,000,000,000 was spent for pleasure by the American people!

Cost of Residential Water and Sewerage

The citizen should think in terms of improvements for his community. I will take water and sewer first. The private individual builds a new house. I shall leave out the plumbing in the house, for each can have his own taste gratified in that respect. A bath room with all appliances can be equipped for $75 up and would include a kitchen sink and roughing in the plumbing. What is the first cost to an individual of putting in his own well, pump and storage tank? I shall assume that electricity is available for motive power. The least cost for a well, pump and pressure system installed would be approximately $300. Then there is the cost of a cess-pool or septic tank in the yard. This and the connections would cost at least $200, making the minimum for sewer and water for inside toilet and conveniences $500. This is to say nothing of interest on the investment, the cost of repairs and replacements, etc.

Now, with an out-house in the back yard, there is the first cost to build and paint of not less than $75. It costs about $10 each time it is cleaned, which may be once or more often a year. All are familiar with the conditions of visiting this place daily in all kinds of weather and in sickness and in health. Can anyone see how people have put up with it for so long a time?

Suppose the citizen has a well; perhaps a shallow one. If so, the pump and well cost from $75 to $100, and he or his wife (usually friend wife) pumps and carries the water every day in all kinds of weather, running the chance of catching cold, or slipping and injuring herself in the winter. He runs a good chance of having his well contaminated by his own or his neighbor's out-house and neither one of these utilities, that cost him at least $150, for both, and at least $10 a year to keep in a clean condition and in repair, is worth the expense and trouble in comparison with the actual cost of an up-to-date sewer and water system laid in the streets for all time. The useful life of a cast-iron water main is at least 80 years, and that of the vitrified sewer equally as long.

Suppose a town of 1,000 wants sewer and water, and that the town is not too widely scattered and the digging conditions are average. It has been my experience that water and sewers can be fittingly installed, first, to give a plentiful supply of pure, clean, wholesome water, suitably stored in such volume as to be wholly adequate for fire and domestic service. Then the street mains would be installed in each street of such size as to be adequate for the future increase of population. The pumping equipment and pump house would be neat and serviceable. The citizen would gain by such an installation wonderful advantages, some of which are as follows:

Advantages from Public Systems

Betterment of public health, the promotion of cleanliness, the larger use of water for cleaning, sprinkling and garden work. The main advantage from the standpoint of economy is the big saving afforded the entire community by the reduction of insurance rates. The reduction varies from 15 to 50% on the annual premium. With such a system and a volunteer fire force one can have a stream of water on a burning house in from 2 to 5 minutes, thus saving valuable and unreplaceable property to the owner, village, state and nation. One must realize that he or the nation are absolutely powerless to recover burned or destroyed property.

To do away with the out-house, the menace to public health, through becoming the breeding place of flies, the distribution point of unhealthful odors, the backing through the soil to your well of filth, it is only necessary to install a system of sewers to obtain permanent relief, at no further expense than the first cost, if a village happens to be on a stream of water of sufficient size to allow the free discharge of the sewage. If, however, there is only a small stream a disposal tank would have to be installed and then there would be a small yearly cost to the village for pumping the sludge two or three times a year.

To Dwellers in Small Towns

Now prepare to be severely shocked:

Whether you have spent several hundred dollars putting in your own system, or whether you have one of the out-house variety, you have spent more on these conveniences than was necessary and you have no results. Bear in mind that in co-operation or union there is strength, and when a community clubs together for the purpose of water and sewer it can usually be accomplished for the small cost of $150 per 50 ft. of frontage and this is based on the actual present cost on the date of Feb. 1, 1921.

Now, who is there that will resist this small expenditure and fight against improvements? If you are not fixed to pay for this service in cash, you may, at your option, have from 5 to 10 years to pay for it, as provided by law in most states.

Think what it means to your community at large. If you decide on improvements a bond issue naturally follows, money comes to your town and you are bringing something to your community. The only money that leaves the town is what it costs for material, freight, contractor's profit, and your community absorbs small repairs, local supplies, board and room money spent by the people employed on the work, and, I may say, that mostly local labor is used.

There is no economy in waiting and putting off either of these improvements. Disease and death follow in the wake of the outhouse and old well in the yard. Is your town to continue to be a place to avoid as lacking the commonly recognized necessary conveniences, or is it to be a cleanly, sanitary upgrowing community which will be attractive to the prospective citizen?

WELDING CRACKED PUMP CYLINDER BY THERMIT PROCESS

The accompanying illustrations show how an unusual welding repair was recently made on a large cast steel water cylinder of a steam pump operated by the city of East Liverpool (Ohio) water works.

The casting had developed a crack of about 20 ins. in length. An attempt was made to repair it by oxy-acetylene welding, but a crack again developed as a result of contraction strains and the cylinder was then welded by the thermit process.

In welding the casting, the broken sections were lined up, leaving a small gap between them, to provide space for the thermit steel later to enter. Yellow pattern wax was then inserted in the space and a mold formed around the wax. A preheating torch was then directed into the mold for the purpose of drying it out, burning out the pattern wax and pre-

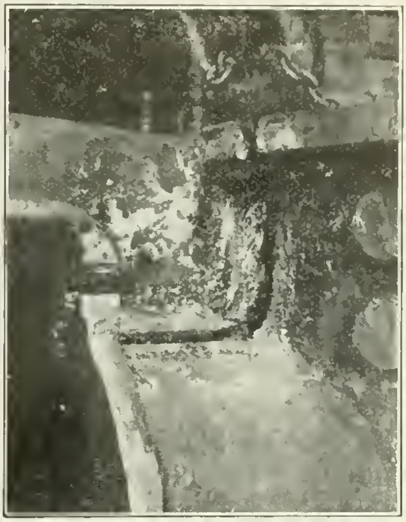


FIG. 1. GAP CUT OUT AT FRACTURE OF DEFECTIVE CYLINDER PREPARATORY TO WELDING.

heating the sections to be welded. Finally, when the sections were heated sufficiently for welding, a charge of thermit (which is a mixture of iron oxide and aluminum) was ignited in a crucible suspended over the mold. The chemical re-

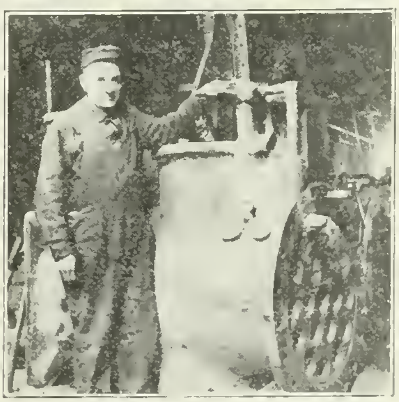


FIG. 2. WELDED CYLINDER BEFORE REMOVING CAST WELDED METAL.

action was started at the extremely high temperature of about 5,000 deg. F., during which the aluminum combined with the oxygen of the iron oxide to form aluminum oxide or slag in a highly superheated molten state, while the iron was set free and produced as liquid steel. The reaction required only about 35 secs., at the end of which time the liquid steel which had been precipitated to the bottom of the crucible, was tapped into the mold, and amalgamated thoroughly with the broken surfaces of the two sections.

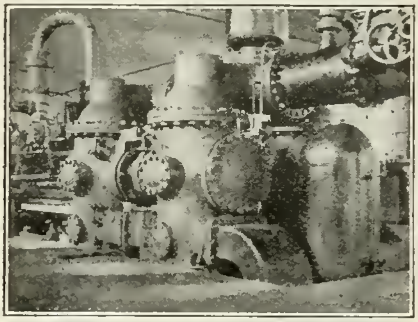


FIG. 3. STEAM PUMP IN WHICH WELDED CYLINDER OPERATED.

The metal of the weld was allowed to cool slowly, after which the molding material was removed, the excess metal cut off, and the welded cylinder returned to service.

Figure 3 shows a view of the pump after the welded casting had been replaced in operation and was giving perfect satisfaction while being operated constantly under a pressure of about 130 lbs. per sq. in., pumping filtered water up to a reservoir.

MODERN PRACTICE IN SUPPLYING WATER TO ISOLATED RESIDENCES

By G. C. Blalock, Asst. Prof. of Electrical Engineering, Purdue University, Lafayette, Ind.

The greatest objection to residence in isolated districts or dwellings is removed when modern conveniences in the way of light, water supply and sewage disposal are made available. Dependable electric generating and storage equipment is now available in small units for light and power service; also electric companies are beginning to see the possibilities in rural distribution. This makes possible the automatic pressure water system; numerous types and capacities of which are now to be had at moderate cost. An abundance of water makes practicable modern plumbing and sewage disposal apparatus, which also is now within reach of men of moderate incomes. So, with quick and efficient methods of travel and communication at hand, remote residence has lost its terrors and isolation becomes a thing of the past.

Great Variety of Residence Water Systems

The number and variety of residence water systems now being manufactured is truly amazing, when one considers how short the time has been since the well sweep and the rope pulley were the accepted means for elevating water on the farm. For less than the price of our most popular make of automobile the average farmer can have a reliable and adequate water supply—the equipment for which is simple, easily cared for and capable of giving years of service at very reasonable operating expense.

The demand for information concerning these systems has led recently to an investigation and study of available types and their characteristics by members of the Engineering Experiment Station Staff of Purdue University. The Farm Mechanics Department has co-operated with the Electrical Engineering School in making tests of complete electrically-driven equipments as well as their driving motors, and various dealers and manufacturers have generously loaned samples of their product for this purpose; deriving an indirect benefit from the publicity given this latest addition to modern farm equipment.

The elevated tank storage formerly used with hand, windmill or power pumps has given way to the hydro-pneumatic tank and this in turn is now being reduced in many cases to small capacities, or eliminated entirely so far as water storage is concerned. Residence systems of this kind are commonly sold as complete units and, particularly in the smaller capacity systems, are assembled with a view to cutting the required floor space to a minimum. They may be obtained with gasoline engine drive or electric motor drive, but the latter arrangement is the more popular where electricity is available, because of the automatic feature. The engine-driven system can easily be made self-stopping, but cannot well be made self-starting.

Pump Capacities

The reciprocating, suction-lift type of pump is most frequently encountered in this section of the country. The smallest practicable capacity appears to be 100 gals. per hour, requiring a ¼ h.p. motor and commonly assembled with a tank of not exceeding 50 gals. capacity. The

pressure operated switch then automatically maintains the tank pressure between certain limits; starting the motor when the lower limit has been reached, and stopping it when the pressure has attained the upper limit. This capacity of pump is sufficient for soft water supply in the average household and finds frequent application for this purpose in cities, where it appears to be superseding the hydraulic pump operated from city water pressure. It is, however, too low in capacity to be used for general water supply in any but the smallest families, and where no stock watering or lawn sprinkling is involved.

For more general purposes similar outfits are available in capacities ranging from 180, 250 and 300 gals. per hour, with motors of ¼ to ½ h.p. to those for large farms, estates and institutions having capacities of 1,000 to 1,500 gals. per hour and requiring motors of 1½ to 2 h.p. The needs of the average farmer will probably be well provided for by systems having capacities of 360 to 720 gals. per hour, requiring motor capacity of ½ to 1 h.p.; 360 gals. per hour, or 6 gals. per min. is sufficient to supply a single line of ordinary ¾-in. garden hose.

Tank Capacities

The tank supplied with each outfit will depend upon individual requirements. The larger tanks offer some degree of protection against interruption due to break-down of pumping equipment, but their greatest advantage lies in the reserve afforded by them for fire protection. It should be noted, however, that a tank used in this way has a water capacity only about 2/3 of its total capacity and that not all of the stored water is available at a useful working pressure. It is evident, therefore, that a tank large enough to afford any considerable measure of protection will add very materially to the cost of the outfit. The present trend seems to be toward reduction of the tank to a capacity only large enough to provide the necessary elasticity for the system and guard against unnecessary operation of the pump from reduction in pressure by leaky fixtures. This throws more responsibility upon the pumping equipment but results in a more compact and less expensive installation.

The same general features pertain to the deep-well as to the shallow well outfits except that the deep-well pump cylinder must be placed in the well and requires therefore that the pumping head be placed directly over the well; eliminating the flexibility as to arrangement of apparatus which is incident to the suction lift systems. The power required in the driving motor for a given capacity and tank pressure becomes correspondingly greater, of course, as the depth to water increases.

Pneumatic Systems

The second type of water system in general use is the purely pneumatic system, in which the tank is used for storage of compressed air; the air doing the actual pumping. The motor drives an air compressor and automatically maintains the pressure in the tank between fixed limits. An air line is carried to a pump, operating on the pulsometer principle, which is located beneath the permanent water level in the well. The pump operates and elevates water only when the pressure in the water line is reduced, as by the opening of a faucet. As regards capacity of the system about the same condition holds here as in the hydropneumatic system. Unless a tank of considerable size is provided the capacity of the system to meet a sustained demand depends upon capacity of compressor and driving motor. For satisfactory operation on the farm, therefore, the compressor should be able to supply air at a rate corresponding to at least a 6 gal. per min. output of water from a ¾-in. hose line.

A Modified Rotary Pump

A third type of shallow well pump, adapted to residence systems, has recently been placed on the market and is reputed to be meeting with a fair degree of success. Its operation is based upon a modified rotary-pump principle, but the rotor consists of one instead of two moving parts. Direct-conected to its driving motor and mounted alongside a very small pressure tank a system is formed which for simplicity and compactness could hardly be excelled. Its chief disadvantage lies in the fact that it is not self-priming and requires a well-fitted suction line and foot-valve for successful use with an automatic system.

The type of motor supplied with these outfits depends, of course, upon the nature of the available power.

Electric Motors

Motors are available for the ordinary commercial voltages and frequencies and for the 32-volt farm lighting units. For direct current operation the type usually supplied is the compound wound motor, because of the necessity for a high starting torque in displacement pump operation. No difficulty need be experienced with this motor provided it is kept free

from dirt and moisture. For alternating current operation the single phase lighting circuits are commonly used, and for this reason the simplest, most rugged types of a.c. motors are not available. The single phase induction motor must have an auxiliary starting device of some kind and this starting device is sometimes the source of much trouble, annoyance and expense, particularly in locations where the voltage may at times be considerably below normal.

The two types of a.c. motors commonly used are known as split-phase and repulsion-induction motors, because of the starting devices employed. The split-phase type can be depended upon to give good service where conditions are always normal or where the deviations are relatively slight, but the repulsion-start type is the more rugged and, as a power station man recently expressed it, has more "pep." The starting current required by the repulsion type motor is usually about three times normal current, while that required by the split-phase type is five to six times normal. This heavy starting current is supposed to last only for one or two seconds, but conditions may readily be such as to prolong this heavy demand to such an extent that fuses are blown or the windings injured. The former is annoying while the latter is both annoying and expensive. Despite its advantages, however, the repulsion start type of motor has not been generally adopted for this application because of its considerably greater first cost.

Test Data

Tests made on several displacement pump, compression tank outfits of 100 to 200 gal. per hour capacity showed overall efficencies of 15 to 25% under normal operating conditions, with 17.5% as a fair average. The efficiency increased with pressure but the pump is likely to operate at a reduced pressure for a large percentage of its total operating time. Motor efficiencies varied from 40 to 60%; with 50% as a fair average. Thus the pump efficiency in this type and size of outfit may be expected to average about 35%. These efficiencies result in a pumping duty of 2.1 to 1.25 kw.-hrs. per thousand gals. per 100 ft. head, with 1.8 as a fair average. Considering the capacities of these units this figure compares very favorably with the average for the smaller city pumping units over the state.

Watt-hour meters installed in several residences using compression tank systems for soft water supply to bath-room, kitchen and laundry revealed a maximum consumption of 0.75 kw.-hr. and an average of 0.45 kw.-hr. per person per month. So it is evident that at prevailing rates 1 ct. per day for electric energy is sufficient to provide an abundant supply of soft water for the average city family. For general water supply, however, where lawn sprinkling, stock watering, etc., are involved, the requirements are much greater and the cost correspondingly higher.

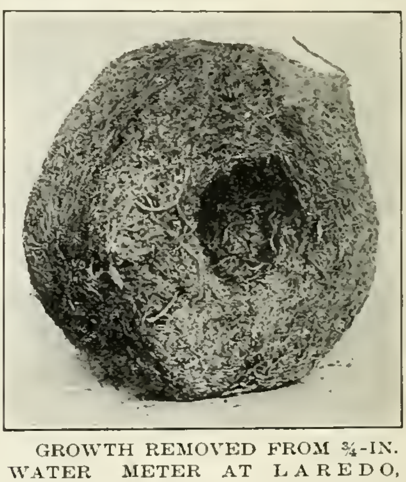
Judging by the above figures on energy consumption the soft water requirements for a family of five people would be met by a pumpage of 1,250 to 1,500 gals. per month, while for the general water supply on a farm supplied with modern plumbing and sewage disposal arrangements, involving the same number of people and 15 to 25 head of stock, besides sprinkling and car-washing facilities, a pumpage of 750 to 1,000 gals. per day would be required. But the rapidity with which farms are being equipped with these systems indicates that the up-to-date farmer considers that the advantages far outweigh the costs.

The foregoing paper, by Professor Blalock, was presented at the 1921 meeting of the Indiana Egnineering Society.

ODD GROWTH IN A WATER METER

To the Editor:

We are sending you a very curious mass of roots recently removed from a ¾-in. Trident water meter. This unique growth evidently resulted from a seed which



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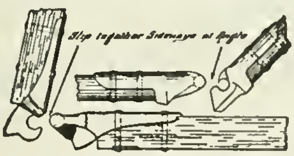

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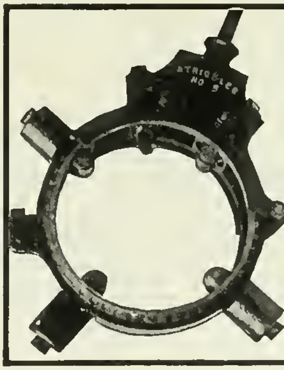

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Los Angeles, Cal.	339 Citizens National Bank Building

found ingress through the small line and then developed afterwards in the water chamber of the meter. (A picture of the growth is shown herewith.)

This was found floating, in a spongy mass, just below the gear train, but it did not interfere, apparently, with the operation of the meter. A broken shaft in the gear train led to the discovery of this curiosity.

This is so unique an indication of what water meters are sometimes required to put up with that we thought perhaps the readers of Municipal and County Engineering would be interested in it.

Very truly yours,

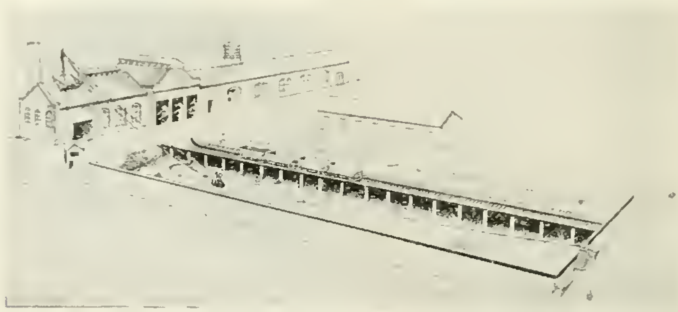
F. A. Matthes, Manager
Laredo Water Co.

Laredo, Tex., Jan. 7, 1921.

NEW METHOD OF MOVING STORED COAL

A new method of reclaiming coal from storage that appears to be suitable for many central station and municipal electric light and water plants has been adopted by the Indianapolis Light and Heat Co., Indianapolis, Ind.

A Sauerman dragline cableway excavator, ordinarily thought of as a machine for gravel handling and earth-moving operations, is successfully employed at the Indianapolis power plant to handle 500 tons of coal per day from the concrete storage pit to a hopper built into the roof above the bunkers. One man controls the entire operation of loading the bucket, conveying and dumping. The total span of the cableway is 550 ft. The bucket holds about two tons of coal and averages 30 trips per hour. The installation is illustrated herewith.



SAUERMAN DRAGLINE CABLEWAY EXCAVATOR USED BY AN INDIANAPOLIS POWER PLANT IN HANDLING STORED COAL.

PHILADELPHIA EXHUMES $70,000 WORTH OF CAST IRON PIPE

(Editor's Note:—The following item appeared in the Philadelphia, Pa., Inquirer of Dec. 26, 1920. For verification we sent it to Mr. Carleton E. Davis, Chief of the Bureau of Water, and he advises that it is correct. Referring to a picture of the pipe, he says the pipes removed are in perfect condition and a photograph would not show anything. The item follows:)

The city has saved $70,000 by digging up an abandoned pipe line and laying it in another location as a means of water supply, reports of Carleton E. Davis, Chief of the Water Bureau, to Director Caven, of the Department of Public Works, showed last week. The saving is on cast iron main 48 ins. in diameter.

The pipe was laid in 1888 between the old Spring Garden Pumping Station and the East Park Reservoir. It consists of four separate lines, and as Spring Garden Pumping Station, near the Girard avenue bridge over the Schuylkill river, was abandoned ten or twelve years ago, the pipes have been unused since that time. It was discovered that they are in good condition and after being cleaned and relaid will have an effective life over an indefinite period.

It was decided to put these pipes to use in relieving conditions in the lower end of West Philadelphia, where the population has increased rapidly and the demand for water has outgrown the existing facilities.

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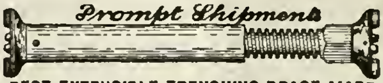

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Construction News and Equipment

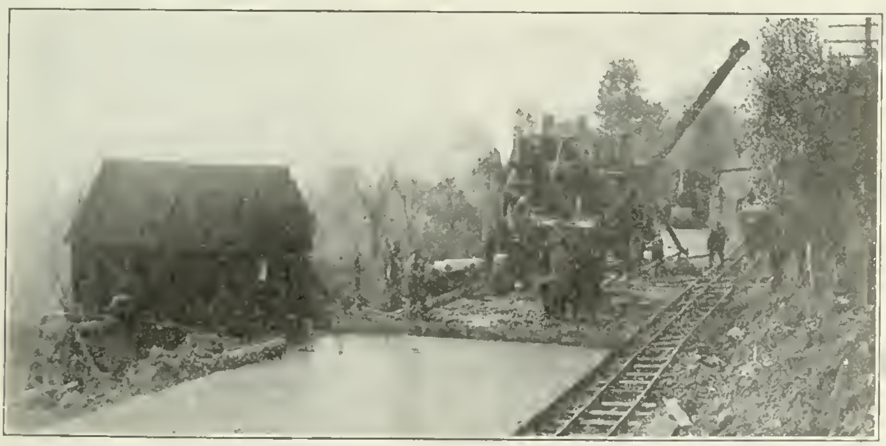
CONSTRUCTION METHODS AND EQUIPMENT USED ON THE McMULLEN HIGHWAY NEAR CUMBERLAND, MARYLAND

By John N. Mackall, Chairman and Chief Engineer, Maryland State Roads Commission, Garrett Bldg., Baltimore, Md.

The construction of the McMullen Highway, running from Cumberland, Maryland, to the plant of the American Cellulose Company, 3.8 miles away, is of interest principally because of the difficult work encountered ,and of the equipment used. On the 3.8 miles of road, the excavation, almost entirely of shale, amounted to 95,410 cu. yds. Some of the cuts were as deep as 40 ft., and some of the fills as deep as 50 ft.

Three steam shovels were used in the cuts, and for the short hauls, an industrial railway was used, and for the longer hauls, horses and wagons. The large cuts were entirely of shale, so that it was necessary to shoot them in advance of the shovel. However, by using large and frequent charges of black powder, no difficulty was encountered in removing the material. One of the three shovels had a multipedal drag, and demonstrated its great superiority over the other shovels. It required no pit men, and was, of course, never off the track, never out of line and always ready to dig.

Robert Station, on the Baltimore & Ohio Railroad, was about midway of the job, and at this point, spur tracks were laid on a trestle, so that stone, sand and screenings could be unloaded by gravity. A cement house, large enough to hold a freight car, was built over the tracks, so that all cement could be unloaded indoors under any weather conditions. Space was provided for 2,000 tons of stone and 1,000 tons of sand which could be unloaded by gravity, and the batch boxes on the industrial railway used to transport this material to the mixer were loaded with a clam-shell bucket. The same crane or clam-shell could be used to repile the material after it was dumped from the cars, though this was never found necessary, due primarily to the shortage of cars for any form of transportation. The track was standard 24-lb. rail, 24-in. gauge, with plank ties. These plank ties were found much more satisfactory than steel ties, because they were wider, flat on the bottom, countersunk bolts being used to attach the rails to them, which permitted the track being laid to the finished concrete much earlier than it would have been possible with steel ties. After five days the track was shifted over on the concrete road. This expedited the work materially in that



CONSTRUCTING AN 18-FT. CONCRETE ROADWAY WITH AN INDUSTRIAL RAILWAY FOR HAULING MATERIALS TO MIXER, McMULLEN (MD.) HIGHWAY.

the track required no attention after it was moved up on the concrete, whereas it naturally required constant attention while it was placed on the shoulder.

Grades as steep as 6% were encountered, and it was found that the Plymouth engine used to pull the batch boxes could not handle these grades, and it was necessary to use a truck in addition to help up the heavy load. The batch boxes, on arriving at the concrete mixer, were dumped with the crane into the skip, and then from the skip to the mixer. This was found much more satisfactory than dumping the batch boxes directly into the mixer through the chute, because it distributed the load as it came into the mixer, and threw no undue loads on the mixer at any time.

With the amount of capital invested in plant and equipment, the progress of the work was not great. Some of this was caused by labor shortage, and some by the shortage of material. With a 21 cu. ft. Koehring paving mixer, for 1, 2, 4 mix, 18 ft. wide roadway, 6 and 8 ins. thick, the average for a number of days on which concrete was actually mixed was a little less than 190 ft. per day during 1919, and 170 ft. per day in 1920.

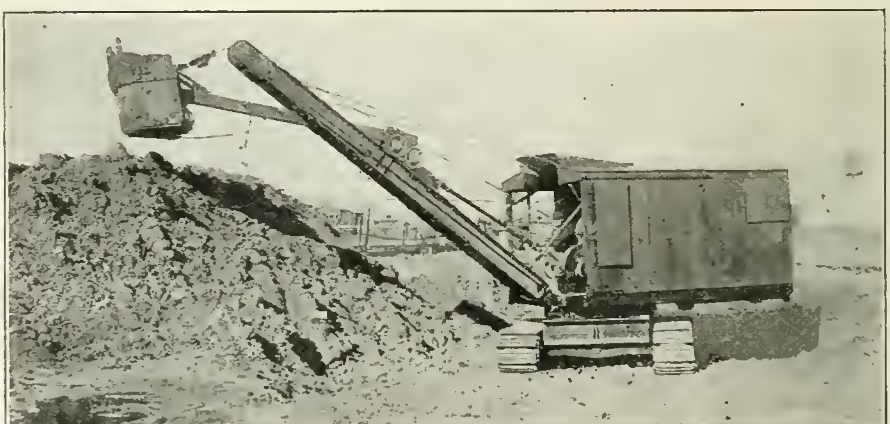
ONE OF THREE STEAM SHOVELS EXCAVATING MATERIAL FOR A 40-FT. FILL 250 FT. LONG, ON McMULLEN (MD.) HIGHWAY.

R. G. Collins, Jr., was the contractor on the work, and L. T. Downey was district engineer for the State Roads Commission, under whose direction the work was done.

THE NEW AUSTIN GASOLINE SHOVEL

The new Austin Model 6-T gasoline shovel is illustrated herewith.

This is not a makeshift adaptation of the steam shovel idea, but an entirely new



THE NEW AUSTIN GASOLINE SHOVEL.

The Paver of Low Mixing Cost

EVERY second of time saving means money saving—profit making on a paving job. The paver that is lowest in cubic yard mixing cost is the cheapest mixer. Any other is costly.

Extra Yardage Built in

Koehring mixers *are designed* to give the lowest mixing cost. Centralized control —the many automatic actions found only on Koehrings enable the operator to maintain that day after day speed of operation which means a big season's extra yardage.

Heavy Duty Construction

Heavy duty construction is but another term for dependability—and dependability pays a big extra profit in trouble-free continuous operation—which means lowest mixing cost.

Koehring mixed concrete is dominant strength concrete.

Write for Koehring Paver Details

Koehring low mix cost—dependability—can't be wished into a mixer. It must be built in. It is built into Koehrings. Investigate. Write for details of Koehring pavers.

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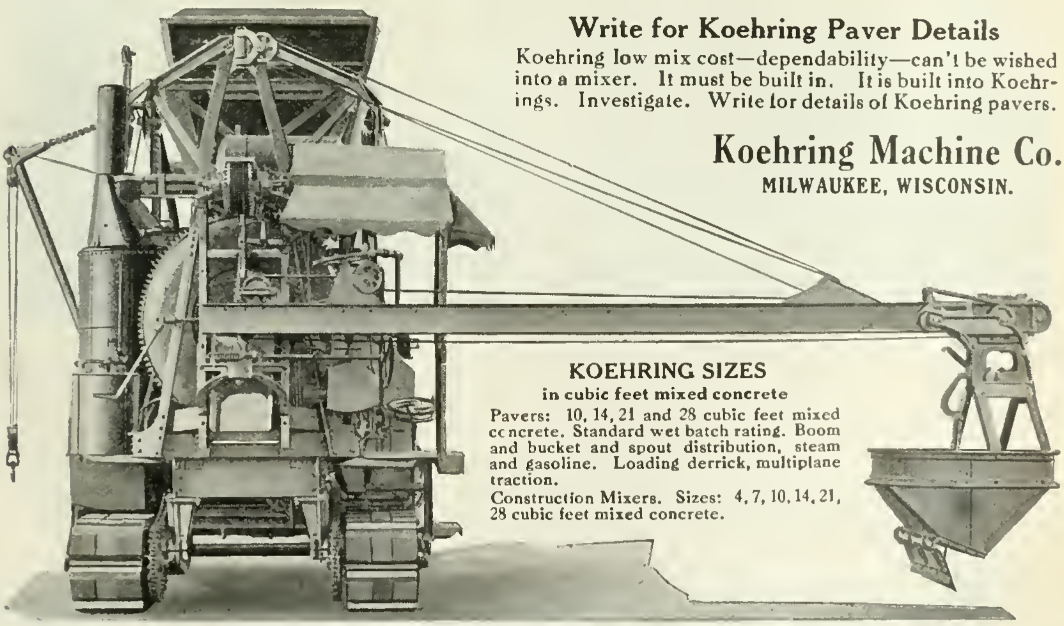

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Pavers: 10, 14, 21 and 28 cubic feet mixed concrete. Standard wet batch rating. Boom and bucket and spout distribution, steam and gasoline. Loading derrick, multiplane traction.
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design, built "from the ground up" for gasoline operation.

Patented air-controlled clutches enable operators to manipulate the principal operations with ease, effectually removing the Austin 6-T from the hand-clutch, "man-killer" class. The cushion-drive clutches of swinging and crowding devices satisfactorily insure the necessary overlapping of operations. All operations may be quickly reversed at any time. The swinging machinery and hoisting drum are locked by means of automatic brakes when the power is shut off.

The increased earning power of the Austin 6-T shovel is apparent in the following exclusive features: Ease of control (not a man-killer); overlapping of crowd, swing and hoist; three-lever digging control; cushion-drive swing and crowd; automatic locking of swing and hoist; "slam the dipper" door (a clean dipper); power boom hoist; quick replacement of clutch bands; interchangeable clutch parts; complete accessibility.

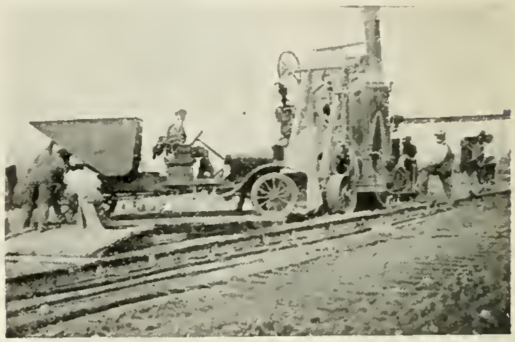
CONTRACTOR SAVES $25,000 ON PAVING PLANT THEN ESTABLISHES NEW RECORD

R. P. Johnston, Superintendent of the Arthur McMullen Co., 149 Broadway, New York City, saved just $25,000 by careful planning of his paving plant on their contract for a reinforced concrete road near Siegfried, Pa.

SMITH SIMPLEX PAVING MIXER, SIZE 21-E ON CONCRETE ROAD JOB.

Not only was this important saving made, but the efficiency of his economical plant made it possible to establish a new production record for reinforced road work. On Oct. 18, 1920, in 9½ hours, working time, with a Smith 21-E boom and bucket paving mixer, the McMullen crew laid 576 lin. ft. of 18-ft. reinforced road, average thickness 7 1/3 ins.

The contract calls for 28,800 ft. of reinforced concrete road, 18 ft. wide, 8 ins. thick at the center, 6 ins. thick at the shoulder, or an average of 7 1/3 ins. The reinforcement is wire mesh, 25 lbs. to the square yard, placed 2 ins. below the surface. This specification requires practically two courses of concrete and naturally requires much more time than a non-reinforced road. Taking this into consideration, the 576-ft. record in 9½ hours, or 121 sq. yds. per hour, is remarkable.



LIGHT TRUCKS TURNED ON A SIMPLE TURN-TABLE.

The proportion is 1:2:3, with 1¼-minute mix, operated under the batch meter, as per Pennsylvania specifications.

In planning his paving plant for this contract Mr. Johnston found that it would cost approximately $35,000 to install an adequate industrial railway system, as compared with an investment of only $10,000 in haulage equipment, including seven 1-ton dump body motor trucks. By

LIGHT TRUCKS WITH LEE BODIES DUMP AGGREGATE DIRECTLY INTO MIXER SKIP. WHEN PAVER MOVES TURN-TABLE IS MOVED WITH A TRUCK.

placing his cement at convenient intervals along the roadway and hauling the sand and crushed stone for about a mile by these trucks, maximum results were obtained in a very simple manner.

The efficiency of the McMullen plant is further emphasized by the fact that the entire payroll, including every man on the job from loading bins to the road, on the 576-ft. record day, was only $331.71. This means that the labor cost per square yard was only 28 cts., which is remarkably low for this class of work.

The 1-ton dump body trucks haul the sand and crushed stone from the material bins, about a mile from the road work. The trucks are run onto a simply designed turntable which is kept just in front of the loading skip of the Smith paver. When the truck is turned the load is dumped and the cement added. This all has been planned so that there is no lost motion. The turntable is moved whenever the paver moves, merely by hooking it to one of the trucks and dragging it over the roadbed. This takes only a few seconds to replace the turntable, and it is usually not necessary to make a move more often than once for every 20 lin. ft. of road laid.

The Arthur McMullen Company has found that it pays to plan the entire paving plant carefully for both economy and efficiency.

WHAT IS THE OBJECTIVE IN A CONSTRUCTION CONTRACT?

By F. A. Wells, Vice-President and Treasurer, Wells Brothers Construction Co., Monadnock Block, Chicago, Ill.

(Editor's Note: This paper, by Mr. Wells, presented at the 1921 meeting of the Associated General Contractors of America, while pertaining directly to building construction, develops a viewpoint of interest to engineers and engineering contractors also.)

What is the best form of building construction contract? Is there a "best" form, taking into consideration the interests of all directly concerned?

Certainly there are forms of contract which any reputable architect, engineer or owner ought not ask a general contractor to sign. The government of the United States (unless it has altered its form recently), is the most notorious violator of equity in this matter. The postoffice in New Orleans was delayed 28 months by the government in order to make changes to suit altered conditions necessary to operation. The delay cost the general contractor many thousands of dollars. The Supreme Court, acknowledging the equity of the claim, said in its decision, that it could do nothing, its hands being tied because the form of contract, while unfair and inequitable, had been signed by the contractor.

The Real Objective

What, then, is the real objective in a construction contract?

1st: Is it to get a building for an owner at less than cost?

2nd: Is it to hedge a contractor about with such conditions that all incentive is taken from him, but that of trying to avoid the unfair conditions?

3rd: Is it to bind him by general and broad clauses to agree to do the impossible, and thus acknowledge before he starts the work of construction that he need not be treated as a man, but watched like a culprit?

4th: Is it to give the tricky, unreasonable contractor a chance to twist every clause in its interpretation so that he may avoid responsibility and increase profits?

5th: Is it to give the responsible contractor an opportunity to make the largest possible profit rather than produce a building for the owner at the most reasonable price? or

6th: Should the contract be of such equitable form that it will call out all that is best in the contractor and his organization and produce that co-operation between owner, architect, engineer and contractor, which can only result in a successful piece of construction as to economy in both time and money?

Contractor Responds to Confidence

I believe that a builder will demonstrate the most skill, integrity and efficiency when the owner, architect and engineer will trust him and express their confidence in a fixed fee form of contract.

I know this to be true in the case of our own company. We have operated exclusively on this basis for the past four years. We favor it so strongly that we take every opportunity to talk about it. There is something solid about the idea. It is not to be exhausted in a few words —the reason is, perhaps, that it is a step in evolution in form and method.

Mutual Confidence the Ideal Relationship

The Associated General Contractors should do more than merely watch the evolution of building contracts and the methods of building contractors. They do not evolve themselves. The association can furnish the power to push energetically towards those forms which will draw out of the building fraternity the best there is in it. Many architects and engineers will unquestionably help to promote the more general use of the fixed fee building contract, but that will not be enough. We, as an association, are striving for higher ideals among our membership and fraternity. I know of no means whereby ideals can be uplifted so certainly as by having the owners trust us. When our association stands clearly for the skill, integrity and responsibility of the building industry, our members will have the confidence of the public as never before. The ideal relationship of architect, engineer, owner and contractor will then be possible, founded upon mutual confidence, and resulting in complete co-operation to produce the best structure.

Owners do not trust the contractor under a lump sum contract. They do not even trust him not to go "broke"—they exact a bond against that contingency.

Some Architects Have Adopted Flat Fee Basis

Architects have always been trusted, being employed on a professional service basis. The great majority of them merit that trust, yet some among them have turned to a flat fee basis of remuneration in the belief that owners have greater confidence in their singleness of purpose under that plan. The temptation under the percentage fee plan to make the building cost a maximum is a real factor in the minds of many owners when making their decision. How much trust would an owner put in an architect who named a sum at which he would design and produce a certain building, taking as profit all the difference between actual cost and the named figure?

Architecture has been maintained as a profession, due in no small measure to the basis of charge for services rendered. Construction work, on the other hand, has been commercialized. Its doors have been opened so wide that the capable and responsible contractor has been put in competition with the careless, incapable and sometimes dishonest one, and the responsible bidder is often offered the contract at the irresponsible one's price.

Advantages of Fixed Fee Contract

Under the fixed fee contract method of engaging the builder all this is avoided, and the reputation, experience and responsibility of the builder will receive its just recognition.

By the latter method, building construction becomes a profession; but not where the spirit of trust is lacking, not where the owner, his architect and engineer are constantly watching that the contractor does not gouge by inferior work or by an unconscionable price for extras and changes; not where the interests of owner and contractor are diametrically opposed so that a decision in favor of one must of necessity be unfavorable to the other. Rather does it become a profession when owner and architect seek a responsible builder of known integrity and entrust the work to him, satisfied that the builder will exercise all the skill and integrity of his organization to make a creditable building, on time and at the least possible cost commensurate with quality.

Shall we not accept the suggestion of some leading architects who have gone from percentage fee to fixed fee for the architect's services in order to win more owner confidence? Will not the owner and all who serve him be benefited by changing from the lump sum form of contract for construction to the fixed fee basis of remuneration for the builder's services? In our opinion, the building industry will make its greatest advance when we seek the confidence of owner, architect and engineer, and then justify that confidence.

This, then, is why I plead for the fixed fee form of contract. I believe it accomplishes the two most important objectives:

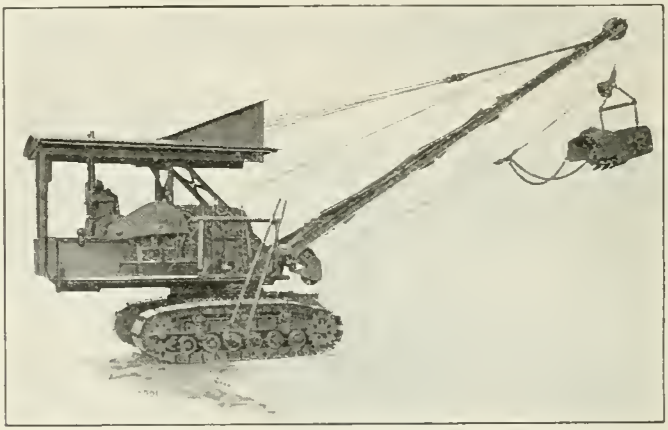
First: It will attract to the construction industry men of integrity, capability and responsibility. When this has been fully accomplished, the second objective will be realized.

Second: It will produce for owner, architect and engineer the best possible building for the least possible cost in the shortest period of time commensurate with quality; all made possible because the builder shares their interests under the fixed fee form of contract.

The objective of the Associated General Contractors must be to place general contracting as a whole on the highest possible plane of responsibility. We must not be the three-ball depository of the gains of the "artful dodger," but the national banks of integrity and ability to which owners can come with confidence when they need to draw upon our services.

NEW P. & H. EXCAVATOR CRANE

As a further development of its excavating machinery, and as an addition to P. & H. Excavator-Cranes, the Pawling & Harnischfeger Co., of Milwaukee, has brought out its No. 206 machine, which is a heavy duty, large capacity excavator of the full tractor type. As on the 205 crane, the corduroy traction consists of 20-in. wide cast steel treads. The sprockets which are placed on 9-ft. centers, are of manganese steel, bronze brushed, and adjustable to take up wear. The short turning radius gives it extreme ease of handling, a complete turn in twice its width being possible. Because no leading wheels are used, as on 205, this crane has a still larger radius of operation, getting into locations and



THE NEW P. & H. EXCAVATOR—CRANE NO. 206.

over uncertain soil as rapidly as the now famous tanks did in Europe.

Two traction speeds are provided, one for moving from one location to another over roads or good earth surface, and a lower speed to be used when soft or extremely hilly surfaces are encountered, and when coming out of deep ditches. The power plant consists of a 4-cylinder Waukesha heavy duty motor, 50 h.p., Warner Vacuum feed, so that fuel is supplied the engine regardless of position of the crane; and a storage tank carried below at rear sufficient to provide for about 20 hours' continuous operation. For use with a ¾-yd. bucket, a 30-ft. boom of braced structural steel is furnished, or a 38-ft. boom for a ½-yd. bucket—drag line or clam shell. Backfiller, lifting magnet, or slings may replace the bucket for filling or material handling duties.

All operating levers are located convenient for one operator on the right side, as shown in the accompanying illustration, giving him complete control of all movements and operations.

Contracts Awarded

ROADS AND STREETS.

Ala., Lauderdale—Wm. T. Taylor Constr. Co. awarded contract by State Hwy. Dept. to construct 12 miles of road in Lauderdale county, at $156,885.

Ala., Montgomery—W. T. Taylor Constr. Co., Wilsonville, awarded contract for grading and installing draing. structs. on 18.2 miles F. A. Proj. 88, 24 ft. wide, at $126,814.

Ark., Springdale—Mayme Bros., Oklahoma City, awarded contract for construction work in Road Dist. No. 5, Benton county, at $194,000.

Ark., Bentonville—A. A. Davis Contracting Co., Oklahoma City, awarded contract by Benton Co. Commrs. Rd. Impvt. Dist. No. 6 for construction of 30.31 miles of road, including steel bridges, at $127,387.

Cal., San Diego—Geo. R. Daley, 440 McNeece Bldg., San Diego, awarded contract for paving with concrete 4.73 miles county highway between Escondido and San Marcos, at $112,681.

Cal., Santa Ana—Steele Finley, Santa Ana, awarded contract for resurfacing 9 miles Garden Grove avenue, West Fifth street, Anaheim, Cypress and Anaheim Olive roads, 2-in. asphalt, at $75,248.

Colo., La Junta—G. A. Dalgren, West Third street, awarded contract for paving roads in Paving District No. 1, at $122,272.

Fla., Titusville—Snyder, Mott & Co., West Palm Beach, Fla., awarded contract to construct 19-mile (Rd. and Bridge Dist. Cocoa Beach); ojus rock and asph. treat.; $170,000 available.

Ga., Athens—Hagedorn Constr. Co., Montgomery, Ala., awarded contract to construct concrete pavements on Danielsville-Athens and Lexington-Athens Rd.; 5.44 miles, concrete with stone aggregate; $160,000.

Ia., Sibley—J. S. McLaughlin & Sons, Mankato, Minn., awarded contract for 80,000 yards paving, at $350,000.

S. C., Rock Hill—Ely Constr. Co., Augusta, Ga., awarded contract to pave streets; 130,000 sq. yds. sheet asphalt on concrete base; 90,000 1 in. ft. curb and gutter; $100,000.

Kans., Columbus—Koss Constr. Co., 2818 Fifth street, Des Moines, Ia., awarded contract for paving 2.95 miles Joplin and Galena roads, F. A. Proj. 71, Sec. A, 18 ft. wide, conc., at $138,580.

Kans., Columbus—Joplin and Salina Road Comm. awarded contract for improving and building bridges on 2.95 mi. Sec. A, Spring Valley, at $139,-580.

La., Arcadia—Smith Bros., Alexandria, La., awarded contract to construct 70 miles gravel road; $1,500,000 available.

La., New Orleans—State Hwy. Dept. let contracts for building 5.21 miles Tallulah-St. Joseph Hwy., Sec. A, Madison Parish, to S. K. Jones, 1252 Herbert avenue, Memphis, Tenn., at $34,968; 21.11 mi. Rayville-Monroe Hwy., Sec. A-1, Richland Parish, to J. M. Bass & Co., Hazelhurst, Miss., at $18,558; 13.26 mi. Rayville-Winnaboro Hwy., Sec. C, Richland Parish, to A. E. Perry, Colfax, at $158,471; 17.37 mi. Arcadia-Shreveport and Arcadia-Ruston

Hwys., Bionville Parish, to W. H. Smith, Alexandria, at $331,903.

Mich., Lansing—L. W. Edison, Rogers, Mich., and Traverse H. Duvall, Bain, Mich., awarded contracts by State Hwy. Dept., at total of $133,312.

Mich., Lansing—Beaverton Constr. Co., Beaverton, Road 18-14, Midland county, awarded contr. for grading and draining structs., 2,038 miles, at $13,054; Hiland Fuller, Big Rapids Rd. 24-3, Newaygo county, B-gravel base, 16 ft., 3,006, at $15,-998; J. Albert Swanson, Leroy, Rd. 63-2, Oscola county, C-slag gravel road, at $43,200; Lake Co. Rd. Comn., Baldwin, Rd. 63-3A, Lake county, stocking gravel, at $11,616; Ann Arbor Asph. Constr. Co., Ann Arbor, Rd. 65-3B, Livingston county, B-gravel road, 5.625 miles, at $71,778.

Minn., Duluth—D. H. Clough & Co. awarded contract for paving and improving Superior street, Twenty-third to Thirty-ninth streets, at $257,023.

Mo., Greenville—Wayne County Court, Greenville, awarded contract by State Hwy. Dept. for building 14.38 mi., Sec. A, Piedmont-Marble Hill Rd., F. A. P. 129, Wayne county, at $146,072.

Miss., Canton—B. F. Stroud, Durant, Miss., awarded contract for construction of important link in Jefferson Davis National Hwy. through Madison county, 9.8 miles. Work will cost approx. $75,000.

Mont., Whitehall—T. T. Black awarded contract for grading road through Cottonwood Canyon, at $80,000.

N. J., Belvidere—Masterton Constr. Corp., 15 East Fortieth street, N. Y. City, awarded contract for grading Hope-Blairstown road, Hope and Blairstown townships, at $109,365.

N. M., Clovis—Clark & Henery Constr. Co., Hearst Bldg., San Francisco, awarded contract for paving portion of 5 city streets with 5-in. Warrenite-Bitulithic, at $180,440.

N. M., Santa Fe—State Hwy. Comn. let contract for constructing 17.98 mi., Road F. A. P. 22, Gaudaloupe county, and 13.825 mi., F. A. P. 28, Grant county, to LaRoe, Palestine, Texas, at $132,401, and $214,090, respectively; 8.747 mi. rd., F. A. P. 23, De Baca county, and 15.981 mi. rd., F. A. P. 43, Torrance county, to J. V. Stryker Constr. Co., Denver, at $13,673 and $19,853, respectively.

N. C., Kinston—West Constr. Co., Chattanooga, Tenn., awarded contract to construct hard surface roadway; $2,000,000 work involved; $700,000 available.

N. C., Newton—Geo. R. Martin, Salisbury, N. C., awarded contract for impvt. of streets; hard conc. surface; 40,000 sq. yds., curb and gutter; $100,000 available.

O., Canton—Stark County let following contracts: Paving 2.75 mile Massillon-Orville Rd., 15 ft. wide, brick and gravel base, macadam shoulder and asphalt filler, to E. Vogt, Massillon, at $126,112; 2 mi. Sec. B, Hartville-Marlboro Rd., 16 ft. wide, macad. with asph. binder, to P. Christianson, 1355 Yale avenue, N. W., Canton, at $70,155; 1.04 mi. Canal-Fulton-N. Lawrence Rd., 14 ft. wide, brick on gravel base, slag shoulder and asph. filler, to W. G. Myers, Canton, at $49,872; 1.69 mi. Sec. A, Marlboro-Hartville Rd., 16 ft. wide, brick with slag base, tar filler and conc. curb, to G. Hadley, Salem at $99,253; 1 mi. Strausberg-Beach City Rd., 14 ft. wide, brick with comb. conc. base and curb, to Wise Bros. Co., Canton, at $24,000.

O., Columbus—R. B. Sheridan, 600 Grand Theatre Bldg., awarded contract for paving 2.02 miles Sec. P, Columbus-Sandusky Rd., 50 ft. wide, Franklin county, brick, at $238,943.

O., Columbus—State Hwy. Dept. let contracts for grading, building bridges and culverts and paving roads as follows: Williams Co., Sec. "Stryker" Bryan-Wauseon Rd., 1.393 mi., bitum. conc., to A. Langenderfer, Toledo, at $104,197; Wyandotte Co., Sec. "L," Marion-Upper Sandusky Rd., 3.56 miles, asph., conc. or conc. base, to H. P. Streicher Co., 310 Terminal Bldg., Toledo, at $175,997.

O., Columbus—Brown & Cook, Lancaster, O., awarded contract for improvements in Muskingum county, on Sec. F-1, Zanesville-New Lexington Rd., 3.15, at $174,991.

O., Dayton—G. Hoolihan awarded contract for paving 1.7 miles Troy Pike-Vandalia southward, at $90,881.

Okla., Claremore—Stanton & Ammerman, Leavenworth, Kans., awarded contract for paving, curbing and guttering Districts 4 and 7, involving 70,000 sq. yds. asph. conc., at about $400,000.

Okla., Eufaula—A. A. Davis, Oklahoma City, Okla., awarded contract to construct 23 miles Jefferson Hwy. through McIntosh county; gravel; at $354,427.

Okla., Idabel—S. B. McCartney, Valiant, awarded contract for 11.8 miles graded earth road, F. A. Proj. No. 2, at $117,000.

Okla., Oklahoma City—State Hwy. Dept. let following road contracts: Western Pvg. Co., $128,747, Sec. A, s. of Normal Rd. to Cleveland county line; Allen & Harrison, $165,033, 1st sec. east from Oklahoma City; $154,725, Sec. C, M. A. Swatek & Co.; $138,793, Sec. D; construction will be carried on in spring and summer.

Okla., Tulsa—Max J. Cunningham awarded contract for remainder of the "Big Four" paving contract. Contract calls for approx. 4 miles concrete surfaced highway 9 miles southwest of Tulsa, on Bixby Rd., at cost of $103,399.

Okla., Tulsa—Standard Paving Co. and Parker-Washington Paving Co. awarded contracts to resurface First street, east and west of Main, at $100,000.

Okla., Oklahoma City—A. A. Davis & Co., Oklahoma City, awarded contract for grading, constructing drainage structs. and gravel surfacing on Jefferson Hwy. through McIntosh county, about 21 miles, at $356,000.

S. C., Rock Hill—Ely Constr. Co. awarded contract for paving various streets, 3-in. sheet asph. on 5-in. concrete base, at $100,000.

S. D., Hot Springs—W. H. Butler, Sturgis, awarded contract by St. Hwy. Dept. for grading, draining and graveling 5.509 mi. Hot Springs-Oelrichs Rd., 36 ft. wide, F. A. P. 59, Fall River county, at $137,508.

S. D., Rapid City—Peterson, Shirley & Gunther, 1217 Woodmen of the World Bldg., Omaha, Neb., for grading and constructing draing. structs. on Custer-Hermosa-Rapid City Rd., 36 ft. wide, F. A. P. 70, Custer county, at $71,300.

Tenn., Nashville—T. L. Peters & Co., Knoxville, awarded contract for paving and building 2 bridges on 12.76 miles State Hwy. between Knoxville and Loudon county line, rock asph., F. A. P. 41, Knox county, at $434,999; 15.38 miles State Hwy. between Fayetteville and Bedford county line, asph. macadam, F. A. P. 50 Lincoln county to B. Williams, 821 Broad street, Nashville, at $488,831.

Tex., Canadian—Hemphill Co. let contract for grading, surfacing and draining 13.44 miles State Hwy. 4 from here to Lipscomb county line, 16 ft. wide, to J. F. Hamer, Stop 6, Interurban, Ft. Worth, at $90,530; including 10 per cent for engrg. and contingencies.

Tex., Dallas—Texas Bitulithic Co. awarded contract for paving Junius street-College avenue to Fitzhugh avenue, at $94,602.

Tex., El Paso—Lee-Moor Contg. Co., Two Republic Bldg., awarded contract for 12.6 miles, Hwy. No. 1 (Fabens Road), bitum. conc. paving, at $380,-903.

Tex., Hillsboro—Brown & Root, Taylor, awarded contract for grading, surfacing with gravel and constructing draing. structs. on Irene-Mertens and Irene-Corsicana Rds., in Irene Special Rd. Dist. No. 8, at $64,270.

Tex., Jasper—H. F. Bland awarded contract for hard surfacing roads; $135,000 available.

Tex., San Antonio—Southwest Bitulithic Co. and Uvalde Co. awarded contracts for 51,000 sq. yds. paving at est. cost of $163,198.

Tex., San Antonio—Paul W. Lane awarded contract to pave streets here, at $5,670; Southern Bitulithic Co. and Uvalde Rock Asph. Co. awarded contracts to pave streets (51,100 sq. yds.), at $163,-198.

Tex., Seguin—Paul Schriever awarded contract to construct draing. structs. on Highway No. 3, at $71,883.

Wash., Aberdeen—Grays Harbor Constr. Co. Aberdeen, awarded contract for widening fill from 24-32 ft. on Simpson avenue and paving 21 blocks Simpson and Park avenues, 36 ft. wide, at $136,740.

Wash., Seattle—Jahn & Bressi awarded contract for paving on Nickerson street, at $84,092.

Wash., Seattle—D. H. Traphagen, Walker Bldg., awarded contract for clearing, grading, curbing and bldg. walks on Wilson Ave., et al; also grading and curbing W. 59th St., et al, at $90,293 and $16,-176, respectively; J. B. Cavello, Seattle, contract for curbing, paving and bldg. walks on 33rd Ave. S., et al, at $25,647.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

AUTOCAR TRUCK USED BY O'BRIEN BROS. (MARTINEZ, CALIF.) ON CONSTRUCTION OF PAVEMENT CONSISTING OF TWO 8-FT. CONCRETE STRIPS SEPARATED BY 4 FT. OF MACADAM.

Motor Truck Operation and Accounting LXVII

NEW MOTOR TRUCK EQUIPMENT FOR ROAD BUILDERS

The motor truck manufacturers are working in close cooperation with road builders in the development of motor equipment for use on road construction operations, in respect, particularly, to trucks with batch dump bodies for hauling either aggregate or mixed concrete. Some recent examples of such developments are here presented.

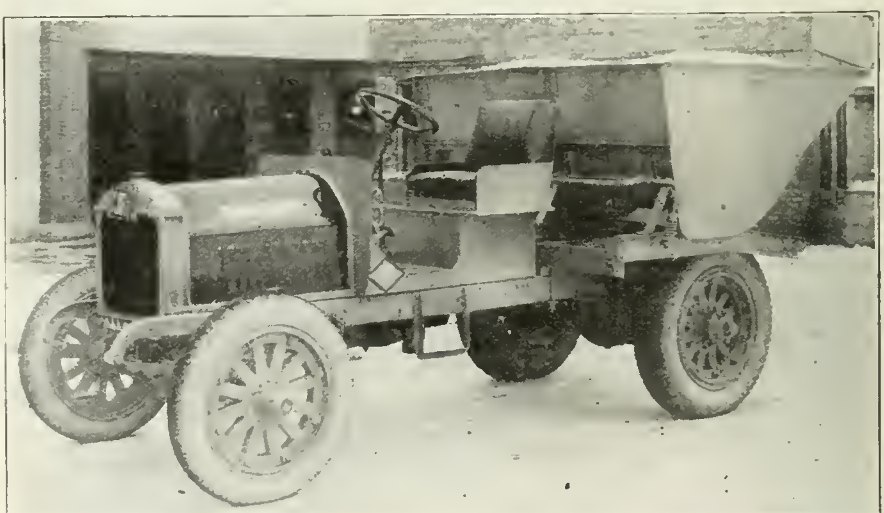
The Diamond T Contractors' Special

The R. F. Conway Co., the widely-known road and street contracting firm of Chicago, has purchased ten Diamond T Contractors' Special trucks of the type illustrated herewith. The Conway Co. tested out this type of truck on a strip of road near Morris, Illinois, last fall, and the job which was exhibited by the Diamond T Motor Car Co., of Chicago, at the recent Good Roads Show in Chicago was the identical truck which was used for their demonstration.

The Contractors' Special has been specially designed for handling road building materials and actual tests have proven that it shows a saving of 25 to 50% over the older conventional methods of distributing sand, gravel, crushed rock and cement, where equipment used varied from 1 to 5-ton units. It is equipped with dual end-dump hoppers constructed of No. 10 gauge steel throughout, each having a capacity of 1 cu. yd., giving a total load capacity of 5,000 to 6,000 lbs. The exceptionally short wheelbase enables it to turn easily on an 18-ft. sub-grade. It is fitted with pneumatic cord tires, 34x5 front, 40x8 rear, which allows operation on soft ground and particularly protects sub-grades from being broken down.

The construction design is unusually sturdy, compact and rigid. Auxiliary springs carried on each frame member and resting on spring box prevents spring rebound and relieve sidesway when only one hopper is filled. There is also a coil spring connecting the hopper control chain with the forward frame member which absorbs dumping shock.

The motor is a heavy duty truck motor 4-in. bore x 5¼-in. stroke, developing 43 h. p. The carburetor has been equipped with an air strainer to prevent dust from entering the combustion chamber and scoring the cylinders and bearings. The hoppers dump by gravity upon release of



THE DIAMOND T. CONTRACTORS' SPECIAL.
Equipped with Lee Dual End-Dump Bodies of 1 Cu. Yd. Capacity, Each. Turns Easily on 18-Ft. Subgrade. Has Pneumatic Tires to Protect Finished Subgrade Against Rutting.

trip bar allowing instant and complete scavenging of either wet or dry mix.

This truck can be used not only as a construction unit, but is considered by contractors as an ideal job for maintenance and repair, the dual hoppers permitting distribution of load at several repair points. The interest which it created at the Good Roads Show is indicative, it is believed, of the important part it will play in the 1921 road building program.

The Diamond T Motor Car Co. has put a special representative on the road to figure with contractors who are interested in this type of equipment.

The Kissel Dual Hopper Road Builder

For hauling from gravel pit, or other source of aggregate supply, to mixer, the dual hopper dump body truck is said to have advantages over all other types of equipment that have been tried out for this work.

Previously, it was necessary to have trucks bring the gravel and sand to the stock piles, from whence the material was hauled, usually, by wheelbarrows to the mixers. The number of men required for this work varied, but it was not unusual to see a dozen men handling the wheelbarrows.

This Kissel Dual Hopper Dump Truck, made by the Kissel Motor Car Co., Hartford, Wis., entirely replaces these men and there is no handling necessary from the time the material leaves the stone crusher until it is dumped into the hopper of the mixer. The driver of the truck is all that is necessary.

The chassis, built with a 116-in. wheelbase, operating on a turn-table, turns on an 18-ft. road. The driver of the truck does not leave his seat, but simply drives on to the turn-table, which leaves the rear wheel on the ground and through which the driver is able to effect the turning. After the turn is made, the driver simply backs the truck off the turn-table to the hopper and dumps one of the hoppers into the loading skip of the mixer. While this batch is being mixed, he brings the other hopper directly over the skip of the mixer for the unloading of the second batch. No time is wasted and the mixer can be kept going as fast as it can mix the batches. At no time is it necessary for the driver to leave his seat.

The Kissel Special Tail-Gate Spread Regulator

For gravel road building the Kissel engineers have worked out a Heavy Duty type of truck with dump body and hoist and load spread regulator which requires only the driver of a truck for operation.

THE KISSEL DUAL HOPPER ROAD BUILDER WITH LEE BODIES.

The truck is brought alongside the stone crusher and gravel is first filled in from the gravel hopper, the proportion of sand and gravel usually being one to one, the sand being filled in on top.

After the truck is driven to the place on the road where the sand is to be spread, the driver raises the dump body by pulling a lever under the seat. When the dump body is raised he shifts to first speed, and at the time of letting in the clutch pulls a lever opening the end gates and slowly drives ahead in first speed.

The thickness of the layer which he wishes to spread on the road is deter-

mined by the speed of the truck and the size of the opening of the end gates, which can be regulated to any desired opening. The gravel, being at the bottom and having less rolling resistance than the sand, slides out of the body first, so that the gravel is spread on the ground with the sand covering.

Contractors, road builders, county highway commissioners and others in charge of road construction or maintenance work very frequently, and to their advantage, consult with the Kissel Contractors' Division for practical information and help. This Division has solved many problems for local authorities and is as much interested in helping owners get the most out of present equipment as in supplying new trucks.

The Federal Road Builders' Truck

The road builder wants units that will speed the materials from the central mixing or storage plants, the material pile or quarry, to the slab and carry the greatest number of batches per day at the minimum cost per ton mile.

The Federal Road Builders' Truck, made by the Federal Motor Truck Co., Detroit, Mich., has been thoroughly tested over varying distances and on different jobs. It has demonstrated that it has the mobility, speed, and time-saving requisites for the hurry-up job of road construction. It is of the dual hopper type.

It has proved that it can haul more batches per day than a 5-ton truck with single large dumping body. It has shown that it is capable of hauling for practically one-half the cost per ton mile of 1-ton trucks, and one-half the cost per square yard of pavement of the 1-ton single batch haulers.

In fact, every contractor who has witnessed the performance and seen the figures on the operation of the Federal Road Builder has given unqualified approval of it.

Equipment of this type delivered wet mix on a recent road job at one-half the cost per unit of pavement of 1-ton trucks with one-batch bodies. On this job the cost was 21.7 cts. per ton mile or 14.9 cts. per sq. yd. of finished pavement. The truck averaged 74.7 miles per day for one month and hauled more batches per day than 5-ton trucks. This special 2½-ton Federal Road Builder, equipped with two-batch Lee gravity end dump bodies is made by the Federal Motor Truck Co., of Detroit, Mich.

FACTS AND FIGURES ON TRUCK PERFORMANCES ON HIGHWAY WORK

Three 3½-Ton Garfords Replace 15 Two-Horse Teams in Road Work

"Highway construction is hard grinding work. It takes a well-built truck to stand the heavy loads and bad going," says Mr. J. M. Pierson, of the J. M. Pierson Company, Inc., 1622 West End Ave., Chicago Heights, Ill.

"In October, 1919, I traded in two lighter cars toward two 3½-ton Garfords. They made good from the start. The Garford's short wheel base enables it to get into the short turn places so frequently in road building. Its strong side frames offer a good margin of safety over the strain on the dump body while in the lift. In June, 1920, I purchased outright a third 3½-ton Garford.

"These three Garfords are used exclusively for hauling stone, sand, and cement on road work. Most of the time they run over new grades and new cut stone—jolting and lurching, under a constant strain. The work is so hard that I get only about two-thirds the guaranteed tire mileage. I don't expect any adjustment on my tires, and couldn't get it in the way I have to use them.

"Our fleet operates on a schedule that keeps the material coming along as fast as it can be used. If a driver isn't back on time, I ask him why, and want a good reason. It's up to us to keep the concrete mixer busy.

"From October to June we were working on the Dixie Highway just south of here. The winter months cut down our operating days considerably, because the weather was too bad for the contractor to work his crew. Our trucks were always ready to go. The following table shows we made good mileage when we worked. All three Garfords were doing identically the same work.

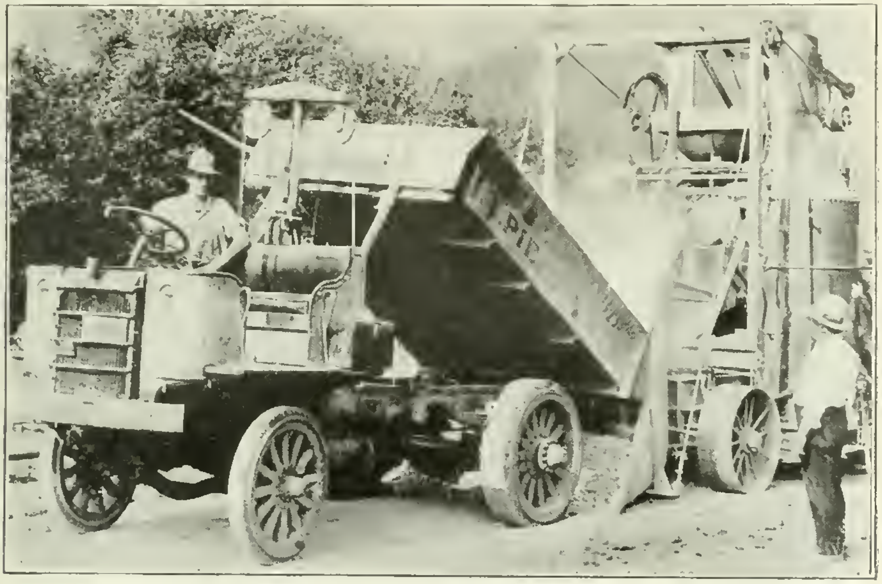
Month 1919-20	Days worked	Miles per day	Miles in month
October	17	75	1,275
November ...	22	75	1,650
December ...	15	40	600
January	15	40	600
February	15	40	600
March	20	54	1.080
April	25	96	2,400
May	25	96	2,400
June	11	96	1,056

"The high mileage made in April, May, and June was due to the fact that the contractor was behind with his work.

Material ordered by freight had been held up by the railroad strike. If that section of the Dixie Highway wasn't finished on time, it would seriously inconvenience car and truck owner and the general public. For 50 days we made two round trips daily hauling cement from Buffington, Indiana (near Gary), to Chicago Heights.

"On this work each truck carried 120 sacks of cement, weighing 96 lbs. each. This made a total load of 11,520 lbs., which is an overload of 2¼ tons. As a rule I don't believe in overloading, but it is frequently necessary in our work. This material is needed, we have to get it through at any cost.

"Our costs on the Dixie Highway job are good examples. As we had no breakdowns or layups because of trouble, the costs on the three trucks were practically the same. I'm using the National Standard System as a basis. In the 165 days, each truck traveled 11,660 miles, an average of 70.66 miles per day. It cost $30.57 per day to operate. This is probably $2 higher than it would be if we could have worked more days in December, January, and February. There was no actual repair, but my estimate for maintenance and repair for the eight months would be $540.



GARFORD 3½-TON TRUCK WITH PARTITIONED BODY DUMPING CONCRETING MATERIAL DIRECT TO MIXER LOADING SKIP.

was an emergency. The contractor had to have the material. He couldn't get it any other way. The roads were good, and the Garfords had no trouble. The section was done on time.

"At present we're hauling for street building contractors here in Chicago Heights. This is a short haul of about one mile from loading chute to job. For this work I've partitioned my truck body into five compartments, each holding a 1-ton mix of cement sand, and stone. By dumping the compartments one at a time into the mixer I save a lot of rehandling. This releases 18 men for other work.

"Necessarily my operating costs are always high. That is inevitable in this kind of work. Bad roads and heavy loads use up tires, gas, and oil. Part of the loading gang, as well as the driver, must be charged against each truck. When

"Those 96 mile days in April, May, and June cost me 43 cts. per mile. That was $41.28 per day for the two round trips—17 cts. per sack for the cement. Freight would have been considerably cheaper, but the railroads were tied up. The contractor had to have the material, and was willing to pay the price. I know my costs, and base my charges on actual cost plus a fair profit.

"We have our own garage and maintain our own trucks. We regularly employ a mechanic, who goes over all trucks every night. He tightens up bolts, oils up, and inspects the machines externally. He is paid $50 a week—$30 during the four months, December to March. This charge is distributed equally against the five trucks—$10 a month each. Such regular care gives the trucks a longer life, and insures us against sudden accidents. Small troubles are discovered and attended to before they can become serious.

"We never employed horses on this work because they would cost too much. It would take five 2-horse teams at $15 per team per day, to do what I'm doing with one 3½-ton Garford truck. That's $75 per day for hauling. There'd be $16.20 per day for shovelers to load and unload. That's a total of $91.20 per day, against the truck cost of $30.578—a daily saving of $60.62 per truck. But if we had to haul with horses we'd have to cut out the long trips and get more material by freight."

Use of Autocar Trucks on Road Work

Specific information on the performance of Autocars on road work is given herewith. The Autocar Co. (Ardmore, Pa.) has been making rather a close study of this important field during the past six months and has concluded that the transportation end of highway construction is the most promising point at which a contractor can expect to accomplish economies.

A significant development during the 1920 season was that various contractors were able to figure on a surprisingly low basis and these same contractors completed their jobs in record time. Investigation will show that in almost every such case the contractor had evolved an improved system of hauling by which he eliminated the labor of many men, speeded up the work, and insured a more correct and exact mixture in every batch.

Further investigation reveals that a number of these successful contractors used Autocar trucks to haul the dry mixture from the loading hoppers, usually located at a railway siding, direct to the mixer. We have known of these hauls which were more than 6 miles each way. In this way all dumping of crushed stone and sand on the sub-grade was eliminated and one contractor estimated that he had cut out the expense of 16 day laborers who had been handling wheelbarrows, shoveling material, etc.

The reason for the success of the standard Autocar trucks in this line of work has been because of the unusually short wheelbase (only 97 ins.), which enables them to work and turn easily in the cramped places which always prevail on such jobs. They are able to get in, dump the load into the skip of the mixer and get away quickly wihout blocking the approach of the next truck. When equipped with pneumatic tires the unusual light weight of the Autocar chassis has made it possible for these trucks to haul loads of material over the sub-grade without seriously cutting it up.

The accompanying pictures show how the Weldon Contracting Company, of Westfield, N. J., used two Autocars in laying 1¼ miles of concrete road on the Lincoln Highway at Rahway, N. J. They were equipped with dump bodies and division boards.

AUTOCAR TRUCK USED BY WELDON CONTRACTING COMPANY, (WESTFIELD, N .J.) ON ROAD WORK.

Specially constructed buckets were used on this job. They were filled with a 1 yd. mix of sand and stone and then dumped into the truck, one bucket full on each side of the division board.

The trucks dumped the load directly into the skip of the mixer where the cement was added from bags. The truck pulled forward while the skip was elevated, and backed up again to dump the second compartment of the load.

By this method the Weldon Contracting Company averaged to lay daily, from 6,600 to 8,250 cu. ft. of concrete road, 29½ ft. wide by 9¼ ins. average thickness.

Weller Construction Company, of Washington, D. C., have been Autocar users for several years, and were among the first to apply these trucks to highway work. They, of course, use their trucks for all kinds of general hauling in connection with their various jobs, but on route No. 127, section No. 3, of the Baltimore-York Pike, a Pennsylvania Highway concrete job, they worked out last summer, an interesting method of hauling their material with Autocars direct from their loading hoppers to the mixer.

Instead of using the extra low Autocar

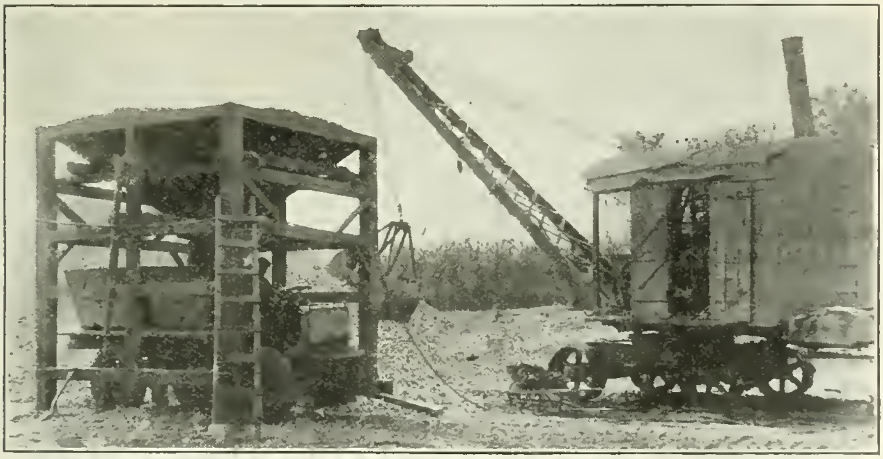
rotary dump bodies, they had their trucks equipped with platform bodies and oversize pneumatic tires, and hauled the material in steel batch buckets.

Their sand, stone, and cement was brought in by railroad and at that point was hoisted into the loading hoppers by means of a clam shell bucket. They ran their trucks under the loading hoppers and deposited in the batch box a measured quantity of sand and stone. The truck then ran to a freight car from which the proper amount of cement was thrown on to the load in bags. From there the trucks took the load direct to the mixer, this haul averaging from 3 to 4 miles, part of the way over grades as high as 6 and 8 per cent.

inating some heavy grades and sharp turns. The length of this Franklin Canyon Highway job is 9 miles.

It had been specified that this highway should be built in two 8-ft. strips with a 4-ft. macadam space between. The object for this design was to prevent the concrete from cracking and to keep vehicles on the proper side of the highway.

When the work was started, 15 large trucks were put on the job, but it was soon found that they were poorly adapted to the work because of the narrow concrete road which made it impossible for them to turn between the header boards without backing. This also made it necessary for each large truck to run out the entire length of the header boards be-



AUTOCAR TRUCK WITH PLATFORM BODY FOR HAULING STEEL BATCH BOXES FOR WELLER CONSTRUCTION COMPANY, WASHINGTON, D. C.

At the mixer the batch buckets were lifted from the trucks by a power hoist attached to the mixer, and were dumped by hand into the loading skip. After the batch bucket had been emptied it was swung back on to the truck which quickly returned for a new load.

The Weller Company found that 10 Autocar trucks kept the mixer supplied and that they had no difficulty in laying from 350 to 500 ft. of road a day.

O'Brien Bros., contractors, of Martinez, Calif., had a road job last summer on which the short wheelbase of the Autocar was especially advantageous.

This road is called the Franklin Canyon Highway, and connects Martinez, Calif., with the Coast Highway, at Pinole, Calif., reducing the distance between Martinez and Bay Cities by 5 miles, and also elim-

fore another truck could even approach the mixer with its load. The result was that the 7 men who were stationed at the mixer were frequently idle owing to lack of material. O'Brien Bros. quickly recognized that a short wheelbase truck would meet their requirements, and bought two Autocars and hired two others. These four trucks were able to eliminate entirely, the 15 large trucks and in the end the Franklin Canyon Highway was laid in record time. The reason for this was that these trucks, because of their short wheelbase handiness, could approach the mixer quickly, dump the load, swing sideways over the header boards, and allow another truck to approach and repeat the process. The mixer, therefore, was kept constantly busy, and the amount of road laid daily, steadily increased.

EDITORIALS

SPEED THE READJUSTMENT

The readjustment period, to use a term all will accept without precise definition, is unpleasant, we believe, to everybody. If this is true the sooner it is over with the better for us all. If, then, the process can be accelerated, by all means let it be done. Feeling that frankness of discussion will speed readjustment and hasten the return of stable conditions we hope there will be very frank, fearless and straight forward consideration of the wage question at once.

Wages, in many lines, were greatly increased during the war. Many laborers are still drawing the war wage while food and clothing are cheaper than they were when the wage was fixed. Rents remain high; in fact they are higher than ever and getting higher. Some argue that although food and clothing are down rents are going up and that therefore the laboring man must not be asked to accept lower wages until rents come down.

It is very doubtful if rents will come down until they are forced down by an increase in the supply of houses. And the supply of houses will not be greatly increased at the present cost of construction. Landlords can afford to maintain the deadlock, but tenants cannot. Wages must come down, they must come down substantially and they must come down very soon if the present state of affairs is to change for the better. This will start construction on a great scale, will provide employment for labor at a fair wage, will correct the housing situation and stabilize business in general. Labor did not take the first cut; it was not asked to do so. It was taken, however, by nearly all other classes, including farmers, manufacturers, jobbers, wholesalers, retailers, etc. It is now labor's turn. Wages are too high now if they were substantially raised during the war. Workmen who asked and received increased wages because of advancing living costs must now accept decreased wages because of receding living costs.

The high cost of labor is halting the building program. If anyone says the cost of material is equally responsible for the failure of the construction program to get under way on a great scale, let him remember that the cost of labor is a very great part of the cost of most materials of construction. Reduce labor prices substantially and a corresponding reduction in material prices will quickly follow. We dare say such a development would be most welcome to the producers of materials who are thoroughly tired of inaction at fancy prices.

Many skilled workmen are also tired of a fancy rating without income. Numerous carpenters have written to Chicago newspapers, for example, saying they would much prefer working at reduced wages to their present condition of a nominal wage of $1.25 per hour, but without any work or income.

The housing question is no doubt the most acute problem of the day. Landlords now have the advantage held by tenants ten years ago. At that time landlords were giving fifteen months' rent at the price of twelve. Now conditions have so far changed that the tenant must pay any price asked.

There are only two possible solutions of the housing problem. Either large numbers of people must go back to the country or more city homes must be built. The first solution may be dismissed as highly improbable as once the American tastes urban joys rural life no longer attracts him. Relief can come only from the building of more homes and this waits on the building trade unionist. It is his move. By accepting a substantial wage cut right now he can save himself and others a great deal of needless and fruitless anxiety.

OUR NEW SIZE WELL RECEIVED

It was anticipated that the readoption of the size now being employed by this magazine would prove popular with readers. In fact, as previously stated, it was largely at the verbal suggestions of readers that the publishers decided to return to the size used for a period of 25 years. Although general approval was anticipated it has, nevertheless, been gratifying to receive numerous letters from readers in all parts of the country who have congratulated us on the change in size.

A magazine is made to be read and anything whatsoever that increases its appeal to the reader correspondingly increases its usefulness, enhances its artistic success and increases its value to its patrons. The central thought in all the letters of commendation we have received is that the present size invites reader attention because of its concession to the known habits and requirements of the busy men for whom it is published. Thus, a prominent chief engineer of a state highway department has congratulated us on the change, saying the new size is much more convenient than the old, especially for anyone who has to find time at odd moments to read the magazine. He finds the present size very convenient for carrying in the pocket or traveling bag.

CIVIC TOUR OF EUROPE

Some of our readers in the municipal service will undoubtedly be much interested to learn of the civic tour of Europe which is to be conducted this summer. Those who do not wish to go will be glad to learn that impressions gained during the tour will be reported for publication in Municipal and County Engineering.

Although there will naturally be a good deal of pleasurable sight-seeing, the tour is not merely a pleasure junket. The tour is planned primarily for city and town planners, housing experts, city officials and social engineers. The executive head of the party is Dr. John Nolen, town and city planner, of Cambridge, Mass. All the great nations of western and central Europe will be visited. Readers may obtain complete information by addressing Jacob L. Crane, Jr., Robinson Hall, Harvard University, Cambridge, Mass.

THE OTHER KIND OF LOYALTY

We hear much of loyalty. Young men are taught loyalty to their superiors. It is wholesome to consider, for a moment, that there is such a thing, also, as loyalty to one's subordinates. Recently a prominent engineer pointed out that in expecting loyalty to themselves executives should not fail to practice loyalty to their subordinates.

Another very prominent engineer recently remarked that: "It is relatively easy to stay up in the air with generalities and obtain the enthusiastic endorsement of every one, but the whole face of the earth is covered with 'toes,' some of which are trod upon when you try to bring these generalities down to the solid ground of actual application."

Thus encouraged we may, we trust, with propriety again suggest that if engineers are to advance as a group in their earning power, relative to the rest of the community, it must be a case of "all for one and one for all." The men at the top who, in past years and in some cases, considered it a part of their jobs to hold down their subordinates were, at the same time, very effectually holding down themselves. The fortunes of the man at the top are firmly linked to those of the man at the bottom, and anything which holds down the earnings of the man at the bottom produces the same effect on the man at the top.

May we relate a story which is not too closely related to the foregoing?

Many years ago we read a book about the Chicago stockyards. It wasn't much of a book, perhaps; in fact its title has long since been forgotten and its contents as well with the exception of a rather melancholy incident connected with the fortunes of a strawberry roan steer. This story we recall in great detail even to the inconsequential fact that this trick steer responded to the name of Phil. The usefulness of this bovine Judas consisted of leading the day's receipts within reach of the hammer. Just before he reached that point in the runway where evil befell his followers he stepped to one side into a stall made and provided for that purpose, and from which he returned to rest and refreshment at the close of the day's occupations. It is related that he waxed fat on the job and was something of a favorite. But the melancholy feature of the story, and the recollection of it causes us distress, was that one day when Phil reached the haven of refuge he found it boarded up and was gently nudged forward in the runway. His philosophical reflections at this unexpected turn were cut short by a tap at the base of his horns with a ten pound hammer.

SUB-GRADE INVESTIGATION ON BATES EXPERIMENTAL ROAD

By H. F. Clemmer, Testing Engineer, Illinois Division of Highways, State House, Springfield, Ill.

The object of the subgrade investigation as carried on in connection with the Bates Experimental Road was twofold. First, information was desired as to the uniformity of the subgrade under each of the 63 sections comprising the road so that proper comparisons of the resistance of the various types of surfaces could be had and, secondly, an excellent opportunity was afforded by which valuable data on subgrade conditions including expansion, contraction, bearing power and moisture content, so essential for the comprehensive designs of roads, could be had.

This investigation includes determination of moisture content of soil as well as observations with pressure cells, subgrade testing cylinders, and static and impact bearing power determinators. In addition to the above, the effect of subgrade conditions upon the elevation of the road surface are being studied by means of precise levels.

Sub-Grade Testing Cylinders

The subgrade testing cylinder as shown by Fig. 1 consists of a 1½x1¼-in. black iron reducer (A), a short length of 1¼-in. black iron pipe (B), a 1½-in. counter sunk black iron plug (C), a special ¼x 1¼-in. brass bearing plug (D), a short sleeve of 1-in. black iron pipe (E) and a ½x1¼-in. brass disk (F). Plug (C) is flush with top of the pavement and plug (D) rests freely on the subgrade. The length of the pipe (B) and sleeve (E) vary with the thickness of the pavement in which the cylinders are used.

When it is desired to install testing cylinders in a concrete pavement, at the time of the construction of the pavement, wooden cylinders 3 ins. in diameter and about ½-in. less in length than the thickness of the pavement are set in place before the concrete is poured. After tamping and finishing of surface have been completed the testing cylinders are substituted for the wooden ones, having the concrete tamped firmly around them, with their tops flush with the top of the pavement.

Installation of these cylinders in bituminous concrete and brick pavements can be effected with the use of the Calyx core drill after completion of the pavement. Considerable care must be exercised when grouting around cylinders so that proper contact with adjacent pavement can be had.

The brass bearing plug (D) follows the downward movement of the pavement and the upward movement of the subgrade so that any separation between the subgrade and the bottom of the pavement due either to rutting caused by traffic or occasioned by moisture or frost conditions can be learned by measurements taken from this plug.

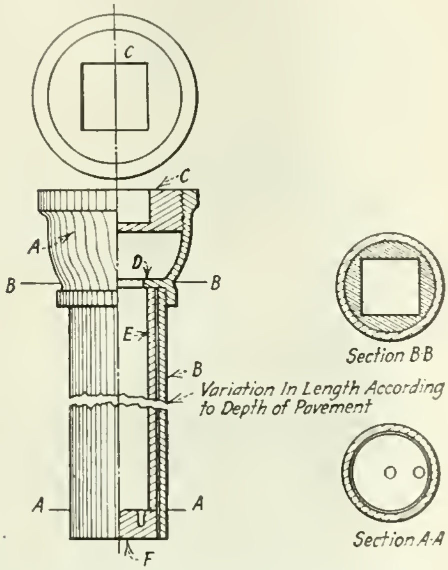


FIG. 1. TYPICAL SUBGRADE TESTING CYLINDERS AS USED ON BATES EXPERIMENTAL ROAD.

The device for reading the change in position of the bearing plug in relation to the pavement is shown in Fig. 2. This device consists of an Ames dial fastened in a support (A) which rests on the stationary brass disc (D) and a rod (B) which fits into a small circular depression in the center of the bearing plug (F).

The difference between initial readings taken as soon as possible after testing cylinders are placed and readings taken at subsequent times shows any change in position between the subgrade and the pavement.

These bearing plugs can also be used to obtain data on bearing power of subgrade by loading them with the plunger of the static bearing power determinator.

By removing the brass bearing plug and iron sleeve, these cylinders afford an excellent means of obtaining subgrade samples for moisture content determination. Also the brass bearing plugs in the cylinders give excellent points for securing precise levels so that the amount of heaving or settling of pavement can be determined.

The testing cylinders are set in rows of three and five across the pavement, the rows being 25 ft. apart. When five cylinders are set in a row they are spaced in the center, at the quarter points and 18 ins. from the edges, and when three are used the ones at the quarter points are omitted.

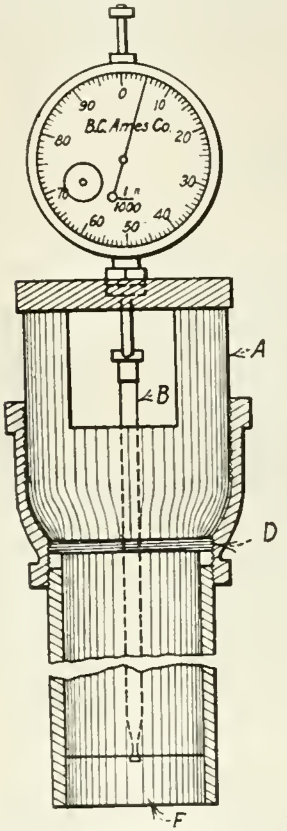


FIG. 2. READING SECTIONS OF SUBGRADE TESTING CYLINDERS.

HOW SEWERS ARE DESIGNED IN NEW YORK CITY

By S. D. Bleich, Assistant Division Engineer, Office of the Transit Construction Commissioner, 49 Lafayette St., New York, N. Y.

(Editor's Note.—The present article on sewer design as practiced in the office of the Transit Construction Commissioner was prepared in carrying on studies of the rearrangement of sewers on account of subway railroads for Greater New York City. Our readers will be interested in it, largely for the reason that it explains the different methods which are in use in designing sewers in the various Boroughs of the City of New York. This article is preliminary to a series of articles describing office practice, standard and special details of sewers which will be published in Municipal and County Engineering.)

The general rearrangement of sewers to fit in with the subway line, requires a broad and comprehensive treatment somewhat analogous to fixing the line and grade of the railroad itself. An intimate knowledge of fundamental principles together with a mature judgment are required for this study of sewer adjustment. The determination of sewer sizes and grades can be obtained by definite and prescribed methods or formulas, but the ability to adjust the sewers to the subway cannot be taught; experience with the actual problems together with natural and acquired engineering ability are requisite. In what follows, the rules used for computing sewer sizes and grades will be outlined; the structural sewer details will then be given and finally both typical and special interesting sewer arrangements and features will be described.

The determination of sewer sizes consists of two operations: (1) Estimate of the discharge or run-off and (2) the computation of the sewer size having sufficient capacity for the discharge.

Discharge Computations

The discharge may be either ordinary dry-weather flow consisting of sewage, water waste, and ground water infiltration or storm flow or both combined. Most of the sewers in New York City are of the combined type taking care of both storm flow and sewage. In such cases, it is generally sufficient to compute the storm flow only as the sewage flow comprises as a rule a negligible proportion of the combined flow. Where the sewage flow may be an appreciable amount, as in downtown districts, it is also computed; and the sewer capacity is made sufficient for both flows combined.

In special instances, it becomes imperative to make careful computation of the sewage flow and its variations, as in inverted siphons, overflows, and separate sewers. Separate sewers are used for sewage only, whereas storm drains are used for storm flow only.

Computations of Sewage Flow

The amount of sewage flow is taken equal to water consumption plus the infiltration from the ground into the sewer. From data given in the Report of Commission of Additional Water Supply, the following constants were deduced:

Character of Drainage District	Population per Zone	Water Consumption, cu. ft. per sec. per acre
Large hotels, high class residence	66-96	.023
East Side Tenements	550	.032 to .050
High Class Apartments	176	.020 to .028
Office Buildings, waterfront—Total	496	.064
Medium Class Apartments	224	.034

A check computation on the above constants may be obtained in the following manner: Estimate the total floor area of the buildings of the district, either for present or future development; the water consumption is approximately a constant of 350 gals. per day per 1,000 sq. ft. of floor area.

Seepage or infiltration depends on ground conditions and tightness of the sewer construction, and is a very variable quantity. The leakage into the sewer decreases as a rule with the age of the sewer, as the cracks and joints become gradually tightened with finer particles, 50,000 to 100,000 gals. per day per mile of sewer is probably a good range for infiltration for the average vitrified pipe or masonry sewer. In very wet ground with mediocre sewer construction, the infiltration may approach 1,000,000 gals. per day per mile. In practice, the infiltration itself is not computed. A liberal value is taken for the sewage constant which is presumed to include infiltration.

The maximum rate of sewage or dry-weather flow including infiltration is taken 3/2 times the average and the minimum 2/3 the average. As an illustration a drainage area in a district of office buildings, the average sewage flow in the absence of other data would be approximately 0.07 cu. ft. per second per acre; the maximum 0.105 and the minimum 0.047 cu. ft. per second per acre.

Storm Discharge

To standardize run-off computations for the new sewers which have to be provided in the subway contracts, the practices of the Sewer Bureaus of the various Boroughs have been ascertained and it has been endeavored to adopt their methods, provided they did not involve considerably increased expense on account of being recently adopted for improving the sewerage system. The problem of readjusting sewers is to replace the old and undisturbed sewerage system with a modified system which would be equally efficient. This, of course, is followed in a reasonable manner with proper regard for the interests of the City and railroad.

The methods in use in the various Boroughs are different in each. They, however, can be reduced to two: (1) the empirical method and (2) the so-called rational method.

The empirical method consists in the use of a formula arrived at from observation on actual storm discharges in sewers, without representing any logical relation between the various factors in the formula. Although such a formula has no rational validity and in many respects is objectionable, it is considered by some as yielding results as satisfactory as can be obtained at the present stage of our knowledge of the subject.

The Borough of Brooklyn uses the empirical method with McMath's formula:

$$Q = CRA^{4/5} S^{1/5},$$

in which R represents the rainfall rate factor and is taken as 3 ins. per hour; A is the drainage area in acres; S is the average slope in feet per 1,000 ft. of the ground or sewers in the drainage area; C is the run-off factor, which for a built-up territory is taken at 0.75.

The rational method is used in the Boroughs of Manhattan and the Bronx. The run-off is taken equal to the product of the run-off factor, rainfall intensity for the drainage area, and the drainage area. It is represented by

$$Q = C R A,$$

in which C is the run-off constant, which is generally less than unity, depending on many conditions and principally on the degree of imperviousness of the area; R is the rainfall rate in inches per hour, taken from an empirical formula showing the relation between it and the time of concentration, t in minutes for the drainage area; A is the drainage area in acres.

In the Bronx the following formula is used:

$$R = \frac{120}{t + 20}$$

with C=0.75 for built-up areas.

The rainfall formula approximates the "2-year rainfall curve." It gives the average rainfall intensity for any duration of rainfall in minutes and for an extensive period this intensity will not be exceeded on the average more than once in two years.

For Manhattan Borough, the New York or Hering formula appears to have been used, although not definitely adopted. This is an empirical formula similar to McMath's, having slightly different exponents. It is

$$Q = C R A^{0.833} S^{0.27}$$

with C R equal to 1.62. As the results of this formula roughly approximate those of McMath's formula, the latter is used with C=0.90 instead of 0.75 for Brooklyn. In addition, the rational method described for the Bronx is used and the larger run-off by these two methods is used.

McMath's formula is readily solved by Diagram No. 1. It gives the results for

$$\frac{Q}{CR} = A^{4/5} S^{1/5}$$

by inspection. With a drainage area of A equals 120 acres, and a general slope of ground or sewers of 0.3 per cent. the value of this equation is 57.

For Brooklyn, C R equals 0.75×3, or 2.25. The run-off is 2.25×57=128 cu. ft. per second. For Manhattan, C R equals 0.9×3, or 2.7, and the run-off is 2.7×57=154 cu. ft. per second. In actual work, the results for various locations are recorded in tabular form, and a slide-rule, together with the diagram, enables the run-off to be obtained very rapidly.

The rational or time-element method is as follows:

The time of concentration characteristic of the drainage shed is computed from a sewer map. A time of entry from the most remote point to the sewer is actually approximated or taken as 5 minutes. The time of flow along each sewer leading to the point at which the Q is to be obtained is computed. The results of their time are added to give the time of run-off of flow from the most remote point, or the time of concentration.

If this time is 20 minutes, then

$$R = \frac{120}{t + 20} = \frac{120}{20 + 20} = 3 \text{ ins. per hour.}$$

With a drainage area of 80 acres, and C=0.75, the run-off is

$$Q = 0.75 \times 3 \times 80. = 180. \text{ cu. ft. per second.}$$

In most cases no additional allowance is made for the dry-weather flow in obtaining the combined discharge. Where, however, the dry-weather flow may be considerable, as in the down-town districts, it should also be computed and added to the storm flow, to obtain the run-off.

In using McMath's formula, the following values for C, known as the ratio of imperviousness, are to be used:

90% for the business districts of Manhattan;

80% for the residential districts of Manhattan;

85% for the business districts of Brooklyn;

75% for the more densely populated residential parts of the Bronx, Brooklyn, Queens and Richmond Boroughs.

70% to 50% for the sparsely settled or suburban districts in the Bronx, Brooklyn, Queens and Richmond Boroughs.

Due consideration must be given to possible future development and growth.

Recently the Manhattan Bureau of Sewers had made studies for improving its sewerage system. In this conection it adopted the rational or time-element method, excepting that the "10-year rainfall formula" $R = \frac{150}{t + 15}$ is used with C=0.60. A minimum value of 10 minutes is taken for t, and no allowance is made for dry-weather flow.

Time Distributions of Excessive Rainfalls

As a matter of interest and value, the distribution of rainfall intensities throughout a period of years is given. Although the so-called "2-year" formula gives the rainfall intensities, which are not exceeded on the average more than once in two years, there have been periods of three, four, and even nine years during which such intensities have not been reached. For t=20 minutes,

$$R = \frac{120}{t + 20} = 3 \text{ ins. per hour.}$$

This rate for 20 minutes was equaled or exceeded in the following rainfalls:

Date	Max. rate for 20 minutes	Interval between rainfalls
Oct. 11, 1871	3.18	
July 26, 1875	3.81	3.79 years
Aug. 5, 1878	6.93	3.02 years
May 22, 1881	3.57	2.80 years
Aug. 22, 1884	3.18	3.25 years
Aug. 20, 1893	4.35	9.00 years
May 24, 1897	3.03	3.76 years
July 28, 1902	4.20	5.18 years
Aug. 5, 1902	4.05	0.02 years
Aug. 19, 1904	3.21	2.04 years
July 31, 1910	3.21	5.95 years
May 30, 1912	3.21	1.83 years
July 28, 1913	3.93	1.16 years
Sept. 4, 1913	6.00	0.19 years
Oct. 1, 1913	3.45	0.08 years

In 1902 there were two rainfalls of this severity within 7 days, and in 1913 three such storms within 2 months and 3 days. Then, again, there were eight storms having intervals between them of over three years. The average interval for 45 years for a 3-in. rate for 20 minutes is three years instead of two years.

The distribution for the "10-year rainfall" is still more erratic. For a 20-minute interval $R = \frac{120}{t + 15} = 4.3$ ins. per hour. This was equaled or exceeded in the following rainfalls:

Date	Max. rate for 20 minutes	Interval between rainfalls
Aug. 5, 1878	6.93	
Aug. 20, 1893	4.35	15.04 years
July 28, 1902	4.20	8.77 years
Sept. 4, 1913	6.00	11.10 years

Two intervals between these storms exceed ten years and one is slightly below 10 years.

The short analysis is intended to give an insight into the character of rainfalls for which the sewers are designed and the frequency and time distribution of these rainfalls.

Sewer Sizes

In the foregoing the methods of estimating the discharge or Q which the sewers or drains will have to take care of are given. It now remains to obtain the sewer size for the computed discharge.

In general, sewers are designed to flow full for the computed run-off. In some cases economy is secured by adopting a

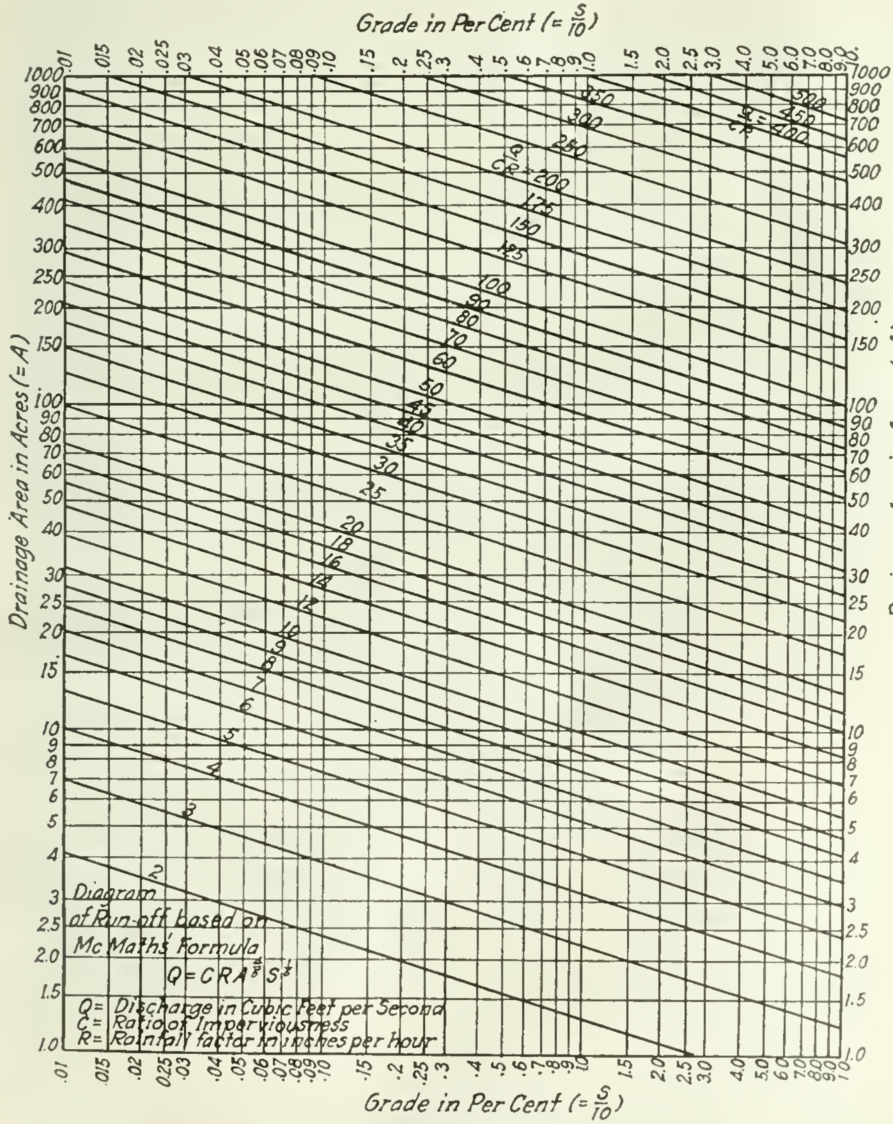


DIAGRAM NO. 1.

section, which has its soffit or inside of roof above the top of water surface for maximum flow.

Hazen-Williams' formula:

$$v = C r^{0.63} S^{0.54} S^{-0.04}$$

and $Q = AV$

are used to obtain the sewer sizes.

v=velocity of flow in feet per second;

c=co-efficient, depending on the physical character of the sewer or drain;

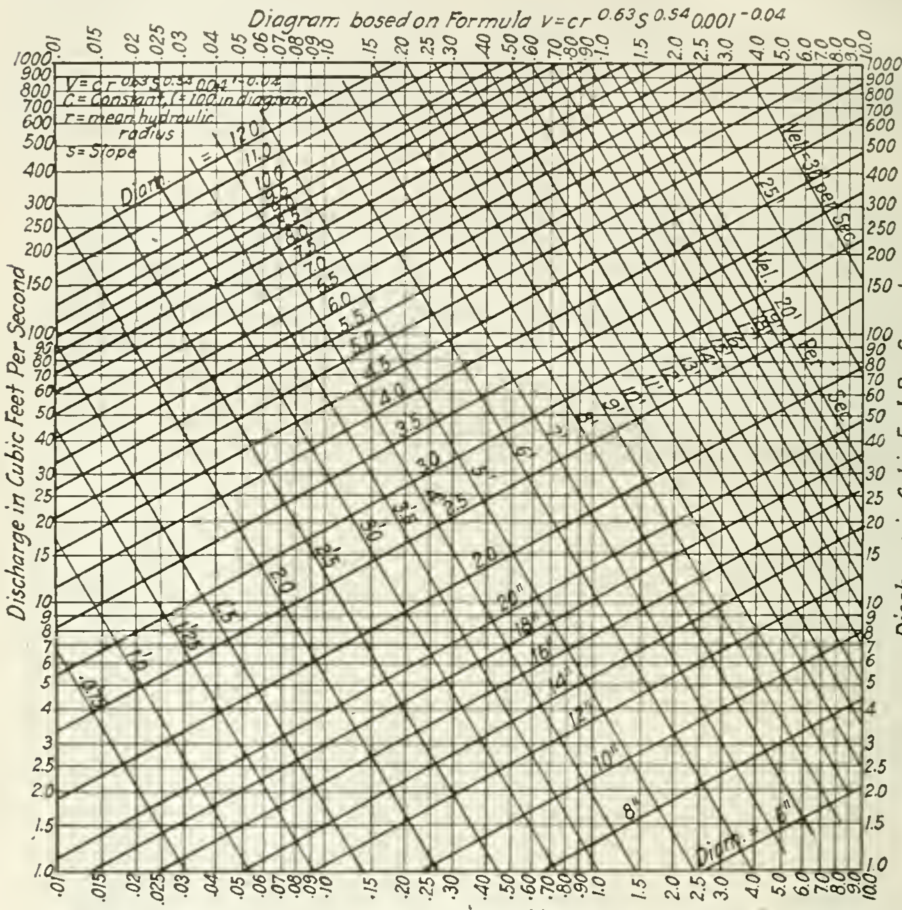
r=mean hydraulic radius, or the ratio of the wetted area and the wetted perimeter;

S=slope in feet per thousand;

Q=discharge in cubic feet per second; and

A=cross-sectional area of wetted area in square feet.

The Diagram No. 2 of the Hazen-Wil-



The diagram is based on Hazen-Williams Formula for c = 100. For any other value of c, the velocity and discharge obtained from diagram are to be modified by the radio of c and 100

Values of "c"			
Class of Pipe	c	Class of Pipe	c
Very best Cast Iron Pipe	140	Brick Sewers	100
Good New " " "	130	Vitrified Pipe	110
Tuberculated " " "	110-80	Masonry Conduits, smooth and clean	140
New Riveted Steel Pipe	110	" " slime coated	130
Lead, brass, tin, and glass pipe	140-120	" " ordinary good work	120
Smooth Wooden Pipe	120		

DIAGRAM NO. 2.

liams' formula facilitates calculation for circular sewers. It presents at a glance the relation between the diameter, velocity, slope and capacity.

To illustrate the use of this diagram let it be required to find the size of a circular brick sewer, flowing full for a discharge of 150 cu. ft. per second, at a grade of 0.75 per cent.

The intersection of an interpolated ordinate at 0.75% with the 150. discharge line, gives a diameter of about 4 ft. 4 ins. and a velocity of 10 ft. per second.

The diagram gives the circular section required for C=100. Where special sections are desirable, such as egg-shaped or horseshoe, they shall have the same hydraulic capacity as the circular section. When a sewer having a value for C which is different than 100, the diagram can be used by modifying the value of Q in the direct ratio of C to 100.

If in the preceding example the masonry were rough, so that C would be equal to 140, then the diagram should be used with $Q=150\times\frac{140}{100}=210$. The intersection of Q=210 and grade =0.75% gives the necessary diameter of circular sewer of nearly 5 ft. The velocity of flow must be obtained between the actual Q of 150 and a diameter of 5 ft., which is 7.5 ft. per second.

The standard egg-shaped section has a height of 3/2 the width. Its required size is obtained from the circular sewer having the same discharge by the relation:

Horizontal diameter of egg sewer=0.84 ×circular diameter.

The invert gradients are determined by local conditions, such as surface grade, elevation of sewers, which have to be connected, elevation of outlet, sub-surface and subway structures. It is also desirable to fix the grades to obtain a well-balanced system of sizes and velocities. Cost may also be a determining element in selecting the grade.

Although the invert elevation and grades of the sewers are recorded on the drawings, their sizes are obtained for the hydraulic grades and discharges. In most cases the hydraulic grade is the same as the invert grade.

Losses due to curves and changes of sections are estimated and are compensated, if possible, by increasing the grade of the curves or the transformers to make up such losses. Loss of head in bends in excess of that of straight pipe measured along tangents for a central angle of 90 deg. equals $Kv^{2.25}$ in which v is the velocity of flow in feet per second and K is a factor depending for its value on the radius of bend. For a radius of 5 ft. K is .0023; for 15 ft., .0048; for 25 ft., .0065, and for 40 ft., .0077.

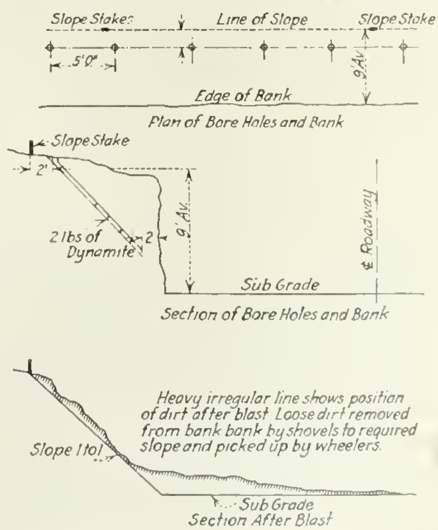
As an illustration, take a 4-ft. circular sewer at a 0.2 per cent. grade. A portion of this sewer is on a curve with a 15-ft. radius. The velocity of this sewer flowing full with c=100 is about 4.3 ft. per second. Then $v^{2.25}=2.7$; $K=.0048$; $Kv^{2.25}=.013$ ft. for a 90-deg. curve. For a 60-deg. curve the correction is 60/90×.013=.009 ft. To overcome curve resistance and maintain the same capacity as on the tangent, the sewer must be given a grade for the curved portion of 0.2 per cent. plus .009 ft., or a total of .04 ft. in the length of curve of 15.71 ft., which is an actual grade for the curve of about 0.25 per cent.

USING EXPLOSIVES IN SLOPING BANKS TO NEW GRADE ON OLD ROAD CUT

By John N. Bohannon, County and Project Engineer, Washington County, Sandersville, Ga.

On Sept. 23, 1920, the writer, in company with Mr. W. B. Alford, agricultural representative of the duPont Powder Company, demonstrated the economy of sloping banks on federal aid work, by the use of explosives.

The section of bank selected was a hard,



SKETCH SHOWING HOW CHARGES OF DYNAMITE WERE PLACED.

VIEWS SHOWING USE OF EXPLOSIVES FOR SLOPING ROAD BANKS.
Left: Left Bank Immediately After Blasting. Right: Slope Complete on Right Bank.

dry sand-elay, in which the old grade was cut with the banks vertical, thus making plowing impossible in this extremely hard material. The new grade was some 4 ft. deeper, and was also lowered with the banks vertical, making a total bank which averaged approximately 9 ft. high.

THE BLAST.

Herewith is a diagram showing the method of placing the charges of duPont 40% Red Cross Extra Dynamite. There is given also a cost record of a section of the most difficult work, and a comparison of the cost by blasting, and the cost of like work by the pick and shovel method; also where the banks can be plowed and finished with pick and shovel.

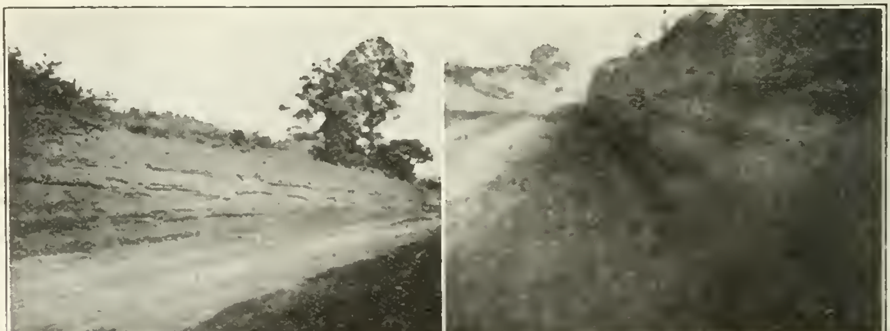
Accompanying pictures show the bank before blasting, the blast, and after blasting.

Where clearing and grubbing are necessary, there is a still greater saving possible by the dynamite method.

In addition, Washington County, at this

BEGINNING THE CUT.

time, was very short of convicts, making it impossible to keep the banks sloped behind the wheelers; or, on the other hand, necessitating the stopping of wheelers sufficiently long to give the required number of men to slope these banks. By using dynamite only a small force is necessary to do the work required, and wheeling can continue without interruption.



USE OF EXPLOSIVES IN RESLOPING ROAD BANKS.
Left: Left Bank, Cut Complete. Right: Right Bank, Cut Complete.

Cost Data

31 holes at 14.8 cts. (2 convicts boring holes, 5 ft. deep, with soil augers, 15 hrs. at 15 cts. per hour.)		$ 4.50
62 lbs. dynamite R. C. E. 40 per cent. at $23.25 per 100 lbs., ton lots		14.42
31 electric caps, at 9 cts. with soil augers, 15 hrs. at 15 cts.		2.79
31 holes, loading, at 2.4 cts. per hole		.75
		$22.46
300 cu. yds. moved by pick and shovel previous, without blasting		.668
Wheeling, 500 ft.		.20
		.868
232.5 cu. yds. dirt moved with dynamite	.096	
Trimming with shovels, per cu. yd	.12	
Wheeling 500 ft., per cu. yd.	.20	
		.416
Saving		.452

Where soil conditions and banks are not too steep and suitable for plowing, the following costs would prevail: (Earth moving costs, except where using dynamite, are taken direct from county records.)

250 cu. yds. moved by plowing and trimming with shovels at	.24
Wheeling 500 ft., per cu. yd.	.20
	.440
232.5 cu. yds. blasting and trimming with shovels	.416
Saving	$ 0.024

THE ECONOMY OF EARLY CONTRACT AWARDS

By C. D. Franks, District Engineer, Portland Cement Association, 11 S. Meridian St., Indianapolis, Ind.

(Editor's Note: This summary of the reasons why construction contracts should be awarded early in the year, as presented by Mr. Franks before the Indiana Engineering Society, is the most forceful, concise and convincing statement on the subject we have seen. He shows that the interests of the general public and of the construction industry are identical in this highly important matter.)

We had a period of depression after the armistice and we are again going through the same experience. For a year or more, up to a few months ago, the conduct of business resembled an obstacle race. For over a year the railway service was demoralized, all production low, labor scarce and inefficient, strikes frequent, material hard to secure and high in price. Everybody wanted to do things, but it was difficult to get them done.

For the last several weeks business has had a clear way before it. Now railroad service is much improved, production is good, labor plentiful and more efficient, strikes infrequent, materials easy to secure and lower in price. It is easy to get things done, but nobody wants to do them.

Contracts awarded for road and other work during the six month period ending December, 1920, have in their price been influenced by the many handicaps surrounding such work—handicaps such as deliveries of material, naturally leading the contractor to figure on only a percentage of the normal day's output. Labor having been scarce and high in price, this situation was naturally allowed for. The possibility of increased prices had its effect in the contract price. All of these things which would tend to handicap prompt and efficient handling of a particular job naturally were figured in, and liberally so.

Will the Breaks Favor the Contractor?

Now the contractors can, in general, figure on better railroad service, adequate supply of materials, plenty of labor—more efficient and at lower prices—and a somewhat lower cost of materials. In other words, based on what has happened at recent lettings, the contractor's frame of mind is just the reverse of what it was when he figured work during the latter part of the year 1920. In other words he is figuring on the breaks being in his favor rather than against him. It is logical to assume, therefore, that he is going to make a more attractive bid now for work than has prevailed in contracts made within the past six months.

Building conditions now are much the same as when the armistice was signed. Because of the interference as previously mentioned, there is a large accumulation of work waiting to be done; yet everybody interested in construction work is adopting a waiting attitude. If it is continued, a turmoil may result similar to that experienced through the last half of 1919 and nearly all of 1920, resulting in no one accomplishing what he starts to accomplish in 1921, because of late contract awards, heavy demand all at once for materials, transportation, labor and equipment, all of which will result in higher prices later in the year. In other words bids submitted now will be more attractive than bids taken during the past season or bids which may be taken when the present general depression is over and business is again upon the up grade. An increased demand for labor, materials and railroad service will naturally be taken into consideration by the contractor.

Do This Year's Work This Year.

There is now voted and available for expenditure on road construction alone, many millions of dollars. The expenditure of this money will probably take place during the next five years. Past experience in the award of public work would indicate that the wisest expenditure of these funds can be effected by having awards made early each year for approximately that amount of work which can be completed in one year by the contractors available. It is reasonable to expect that over a period of five years or more the cost of doing work on such a basis will be as low or lower than will be the cost if an attempt is made to award contracts only when the prices for labor, materials, etc., are at a low point. From our experience of 1919 and 1920 it is evident that when a great deal of work is held up and awards not made until near the end of the construction season, much of the actual construction goes over until the next season, thus throwing the whole organization out of balance and unduly upsetting the entire program. There is no question but that the difficulties experienced in the road building industry during 1920 are to a large measure the result of late buying of all commodities in 1919 and late awarding of road and street contracts in 1919. Had much of this work been awarded early in 1919 and completed in that year I feel sure we would not have had the many difficulties experienced in 1920, insofar as road and street construction are concerned. Then, too, there was much dissatisfaction during the winter of 1919-1920 because of work started on certain sections of road during 1919 which, because of delayed letting, it was not possible to finish during that year. Sections of road left unfinished during the winter and spring of 1920 produced a great deal of discomfort and loss of money to those required to use such roads.

Railroad Situation Now Favorable to Construction Requirements.

Many people are too complacent about the railroad situation. Undoubtedly railroad service has improved greatly through increased efficiency in operation, but the roads are not now called upon to do what they were called upon to do through the last year. Business in general has slowed down and farmers are holding back their products from the market. Business in general is sure, sooner or later, to revive and the farmer to send his stored products to market. When both or either of these things occur the railroads will again have more than they are able to do. If everybody wants to do construction work at that time, which means the shipment of materials, the result will naturally be increased contract prices and disappointment because of delays. Now is the time to award contracts for public work. Let the contractor have time to store some material, perfect his organization and let the material and machinery industries know now what will be expected of them for this year in construction work.

At a time like this when owners, contractors and others may be discouraged from undertaking new projects, the fact should be given prominence that all effort, whether it be in the form of money, credits, materials, labor, transportation or what not, that goes into construction work, unlike that going into work of many other kinds, is not consumed. Effort expended throughout the country on many things that are consumed might well go into construction work, where the materials and labor and other things involved are not consumed, but transformed into houses, industrial buildings, improved highways, water-power development and other valuable improvements that form additions to the permanent, taxable wealth of the country as well as tools for the production of additional wealth.

A Minimum of Obstacles Now.

If construction work is needed and if such work will add to the permanent wealth of the individual and the country at large, it should be carried on when not subjected to interferences that have been present almost continuously since our entry into the war and which may again be present later. There is now and will be plenty of cement to supply the country's needs, as long as transportation and other conditions permit cement mills to operate reasonably near full capacity and to ship the finished product.

"Economy" is the watchword, but all are aware that there is a shortage of houses. Rents will remain high until there are enough houses to supply the demand. Houses are not the only things needed; construction work of other kinds must go ahead, notably highway and railroad improvements. Economy in construction means early contract awards.

MAKING AN INTENSIVE STUDY OF THE SUB-GRADE

By H. G. Shirley, Secretary, Federal Highway Council, 1311 G Street, Northwest, Washington, D. C.

The crying need in highway design, as far as that need can be seen at the present time, is to build a road that will have uniform strength, so as to carry a specific load over its entire length without danger to its structure. We all know that on gravel and other stable soils with a high bearing power a thick surfacing will not be required; whereas on soils consisting of clay and adobe a very much thicker surfacing will be required to carry the same load at certain seasons of the year. Why, then, should we persist in laying the same thickness of surfacing over the clay and adobe soils that we lay over gravel and other more stable materials? Millions are being wasted annually in placing a greater thickness of material in places where it is not needed, and in other places where a greater thickness is required, in not putting down a sufficient depth. The consequence is that in the place where there is not a sufficient depth of material the surfacing will go to pieces under the load, thereby causing enormous expense for its reconstruction.

Relation Between Failures and Bearing Power of Soils

It may be of interest at this point to note that the failures that occur on the soils of a high bearing power run about 17 per cent., whereas under the same climatic and traffic conditions, with the same thickness of surfacing, made of identically the same materials, on soils of low bearing power, such as clay and adobe, the failures ran up to 70 per cent. On very stable gravel and sandy soils the failures ran down as low as 2 to 3 per cent, and they were likely due to workmanship and not to foundations.

From this it can be seen that the uniform distribution of the material over the subgrade was an absolute mistake. In sections it could have been made thinner, and over the weak clay and adobe sections it should have been made thicker. Of course, this would not have shown up if heavy traffic had not gone over these highways, for we all realize that almost any kind of surfacing would be capable of carrying a large volume of baby carriage traffic. If the highway is to be built to serve the community, and be a means for transportation, then it must be built of sufficient strength to carry, in an economic way, the commerce of the section it serves.

The Two Greatest Problems

The writer believes the two most important problems of highway transportation and construction that face the country at the present time are the determination of the weight of the moving wheel load that can be carried and the bearing power of the different types of soils of the sub-grade. When these two factors have been determined, plus a reasonable percentage for impact due to speed, then we can proceed to design the surfacing with a reasonable assurance that it will carry the load that has been specified without breaking down in many places and costing the public a large amount of money to repair annually.

Mr. Thomas H. MacDonald, Chief of the Bureau of Public Roads, and Mr. Goldbeck, Testing Engineer, fully appreciate the great importance of this problem, and are devoting a great deal of energy and time to its solution. The Bureau has under investigation many important features bearing on this subject, and is doing most excellent work. It is only through such a channel that we can look for this problem to be solved quickly, and it is the duty of those interested in highway construction and highway transportation, and the general public, to assist in every way this investigation, and to see that the Bureau of Roads is supplied with sufficient funds to carry on this work expeditiously.

The Sub-Grade Committee of the Federal Highway Council is cooperating to the extent of its ability with the Bureau of Roads and the leading universities and colleges of the country, as well as many of the State Highway Departments and testing laboratories, in an effort to stir up as much interest as possible on this subject. By working together the problem can be approached from many angles and a most satisfactory solution arrived at speedily.

Outline of Problems Taken Up

The outlines of the problems being taken up by the Problem Committees of the Council are as follows:

Problem 1. Securing of samples of the sub-grade materials at points where the failures have occurred, and samples where failures have not occurred in the same vicinity under similar conditions.

Problem 2. Developing field tests for bearing power of soils.

Problem 3. Making studies in drainage, using experimental sections of roads.

Problem 4. A study of chemical methods of sub-grade treatment for increasing bearing value or preventing absorption.

Problem 5. A study of mechanical methods of sub-grade treatment.

Problem 6. A study of freezing and thawing on the volume and on the supporting properties of soils.

Problem 7. A study of the effect of moisture on the volume changes in soils.

Problem 8. A study of the transmission of pressure transmitted to the sub-grade, through different thicknesses and different types of surfacing.

Problem 9. A study to ascertain the practical classification of sub-grade materials.

Problem 10. Special Problems.

Many Experiments Necessary

The method of procedure has been outlined by each Problem Committee so that the members of the entire committee, and those who are making similar tests in other institutions and laboratories, will have a direct line of investigation. It is hoped that the results secured from these investigations will be in such shape that they can be checked up and a final conclusion arrived at. However, it is absolutely essential that a great number of experiments should be carried out, both in the field and in the laboratories. Instruments will have to be made to test the bearing power of the different types of soils; drainage systems will have to be designed to keep water from getting to the sub-grade, rather than taking it away after it once gets there; and mechanical and chemical treatment will have to be undertaken to see which methods will give the best results under certain conditions.

Taking Samples

The samples taken should be a cubic foot in volume and to be taken directly under the failure, if possible, also all accompanying data giving the general topography of the surrounding sections, drainage conditions, type and character of workmanship used in building the roadway, photographs of the failure, and the general conditions surrounding, as well as a full description of the traffic passing over the road. Samples are also to be taken in the near vicinity, under similar conditions, from a section of the road that has withstood traffic, with all the accompanying data given as above. These samples will be tested to determine their behavior and bearing value under many conditions—first, the amount of water contained in the soil, when samples are taken, and also the volume of water when it has been saturated, the change in volume due to the varying amounts of water; change in volume due to freezing and thawing; void spaces in the soil; the rate and extent of percolation through the soil; the rate and extent of capillarity, both horizontal and vertical; organic matter in the soil, and its bearing power under the different quantities of water; its analysis as to fineness and its classification.

These, along with many other characteristics of the soil, are being studied and determined.

Improved Handling of Sub-Grade Problem Near at Hand

The intricate classification of soils and their behavior under heat, cold and moisture, seems to have a deterring effect and be very discouraging to many, but the complications and unknown quantities that will have to be met makes the work only that much more interesting. When the problem has once been solved, the writer feels that the conclusions will be so thoroughly worked out that the subject will be solved for all time to come. With the experiments being carried on by the Bureau of Roads, the different universities and laboratories of the country, we can feel assured that an improvement in the sub-grade conditions will be arrived at in the very near future, and that it will not be many years before a really satisfactory solution will be found. One that can be used with economy, and with assurance that a road constructed in accordance therewith will support the load specified, and the bearing power of the sub-grade no longer will be an unknown factor.

Information Inspector Must Have

Not until these problems have been solved so that an inspector on the road can make a test of the sub-grade material and determine its bearing power and the kind of surfacing that should be used, will the problem be satisfactorily solved. The writer looks forward to the time when some simple test will determine the bearing power of the soil, and an inspector can look on his blue-prints and tell the type and character of surfacing that should be used on that particular kind of soil; or he will be able to turn to his specifications and see the treatment necessary to bring the soil up to a certain bearing power. He will then immediately know how to proceed with the construction of the road in order that it may have a uniform strength throughout its entire length at all seasons of the year and be capable of carrying a specified wheel load without danger of destruction.

If the engineering skill and ability of

this country can be directed to this great problem, the writer has no fear but that it will be solved, and properly so. It is with this idea in view that he is attempting to arouse his brother engineers to a sense of their responsibility. There are no engineering problems that have affected the welfare of the people of this country, and the world materially, that have not been solved by the engineers most satisfactorily when once presented to them, and the writer feels that if the engineers of the country will make a study of this problem and find how it affects the life and cost of the highways, they will devote a great deal more time and thought to its solution. When this is done there is no question but that some solution will be found very speedily, and that the road building of the country will be put on a scientific basis rather than on a hit-or-miss plan. He trusts that he has outlined in this article, in a brief way, a few ideas that will bring to the minds of those interested the necessity for proceeding with this investigation and finding a reasonable solution at once.

The Sub-Grade Committee of tne Federal Highway Council is anxious to cooperate with the State Highway Departments and all the leading laboratories and universities throughout the country in an effort to throw as much light on this subject as possible, and it asks cooperation in collecting all the data that can be secured looking to that end.

The foregoing paper by Mr. Shirley was presented at the 1921 meeting of the American Road Builders' Association.

RELATIONS BETWEEN LAND SURVEYORS AND ENGINEERS

By W. D. Jones, Land Surveyor and Civil Engineer, Sec. Bd. of Examiners of Land Surveyors, Cook County, 8 S. Dearborn St., Chicago..

(Editor's Note: Engineers will be interested in the viewpoint here developed by a prominent land surveyor. Engineers are agreed that men should not practice as engineers unless properly qualified to do so and it develops that land surveyors entertain somewhat similar ideas about their line of work. This paper by Mr. Jones was received with much interest by the Indiana Engineering Society.)

In the "Act in relation to Land Surveyors" passed by the 51st General Assembly of Illinois, Section 3, reads as follows:

"The definition of the words 'Land Surveyor' shall, for the purposes of this Act, be held to be a person who for a consideration establishes one or more corners or boundaries of any tract or lot of land and executes and issues plats thereof signed by himself as a surveyor."

In the proposed bill (for Indiana) which is up for discussion by the Inveyors" passed by the 51st General Assembly of Illinois, Section 3, reads as follows:

"Land surveying as covered by this Act refers only to surveys for determination of areas or for the establishment of land boundaries and the subdivision and platting of land."

The word survey as it is used today, when not used in connection with the word land, seems to mean any kind of an investigation ranging from a survey to determine how many apples are in storage in any certain town, to a survey to determine how much water power can be developed from a certain water-shed.

The Land Surveyor's Not Inconsiderable Job

Land Surveying might perhaps be defined as the art of determining what the man who worked 25, 50 or 100 and more years ago, did and did wrong. It is certainly not the art of determining what the surveyor who worked 100 years ago should have done. Any professional engineer knows what should have been done, but the land surveyor must find out and prove what the ancient surveyor did do. He must prove it so conclusively that no other land surveyor or layman can successfully dispute him. He must do this notwithstanding the fact that most, if not all the original monuments have been destroyed by time. He must do it notwithstanding the fact that hardly any two miles seem to have been measured with the same chain. He should and he usually does know the working habits of the man who surveyed 100 years before him.

Straight lines the land surveyor must run and accurate measurements he must make, but these are only a small part, frequently the least important part, of his task in finding the location of an old corner. He must have a legal mind and act as a judge. He must find and examine witnesses that have no tongue and yet speak much more truth to him than the witnesses who present themselves and make much noise.

The land surveyor is often called upon to tell what is meant by an old deed that says what it does not mean; to take a description that will not close and make it close. Why must he make it close? Because the fact that a description is faulty, does not deprive an owner of his property, and if the land surveyor cannot tell a man what he owns—who can? The court? Yes, but without the expert testimony of one, two, three or more land surveyors, who may agree or disagree, the court cannot decide.

The land surveyor has never had the proper respect from the engineer or from the general public. Pehaps that is because it took so much less care and ability to make the original mistakes in the surveys which created the townships, sections and subdivisions, than it does to find out what those original mistakes were.

Where Was That Stake Set 100 Years Ago?

It takes a great deal of training, work, experience, care, thought, and considerable judgment and ability to be able to tell where a stake that was set 25, 50 or 100 years ago, actually was located, and that is the task of the land surveyor today.

Other things being equal it is best accomplished by a man familiar with local conditions. Surely it is not the task for the man who has devoted his efforts to other lines of engineering and not to land surveying. Ability to build a bridge, a tunnel, a railroad, a sewer or a water power plant does not prove ability to find a lost property corner. Surely the restoration of property corner monuments is important enough to be done only by those who, by reason of experience, know how to place the monument where the corners actually are. No man should be licensed to make a land survey simply because he is a good engineer or a good architect.

In a small town the engineer is an architect, engineer and a land surveyor, he works at all three and knows pretty well how to do all three because he has had experience in all three. But in the large city, where property values are high, and property lines more important, the engineer and architect usually confine themselves to engineering and architecture and do not attempt to make land surveys.

Some Pertinent Questions

The last part of Section 17 of the proposed Indiana bill reads as follows: "Nothing in this Act shall be construed as prohibiting registered professional engineers from making land surveys." Why not add, "Nothing in this Act shall be construed as prohibiting a land surveyor from practicing professional engineering? Why not provide that a lawyer or an abstractor, or a real estate agent may practice land surveying?

One of the strongest arguments for the act is the determination of "property rights," yet, you would license men to restore property lines who do not know how to do so. If an engineer knows how to make land surveys then register him also as a land surveyor; but would you refuse to register an expert engineer as a professional engineer because he did not know how to make land surveys?

License Law Suggestions

May I suggest that you provide that an applicant may be registered as a professional engineer and land surveyor or as a land surveyor or professional engineer, but that his right to be registered as a professional engineer shall be passed upon by the professional engineer members of the board and that his right to be registered as a land surveyor shall be passed upon by the land surveyor members of the board; that the professional engineer shall not make surveys herein defined as land surveys but may make any other kind of surveys; that the land surveyor may make any kind of surveys but may not do professional engineering unless also registered as a professional engineer.

THE SIGNIFICANCE OF LOCAL CONDITIONS IN THE DESIGN OF BRICK PAVEMENTS

By Maurice B. Greenough, Secretary National Paving Brick Manufacturers' Association, Engineers Bldg., Cleveland, Ohio.

(Editor's Note: This statement is often made in connection with engineering designs: "There is no hard and fast rule; it all depends on local conditions." There is little help, indeed, in that statement to the average or relatively inexperienced engineer. Practically speaking, the variety of local conditions is not infinite. Much good comes from a study made to evaluate local conditions, to some degree, and to recommend construction procedure for each condition so recognized. In this paper, before the Illinois Society of Engineers, Mr. Greenough presents the guiding principles to be followed in determining the best types of brick pavement designs for certain local conditions.)

We hear and read repeatedly that "local conditions" need to be reckoned with in the design and construction of pavements. Now, constant repetition emphasizes some thoughts and adds clarity to their meaning scope or application, in practical ways. To the contrary, there are numer-

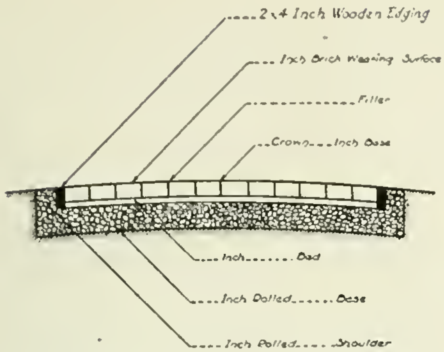


FIG. 1. THIS CROSS-SECTION SHOWS THE USUAL FORM OF ROLLED-BASE BRICK PAVEMENT FOR COUNTY ROADS.

The Wooden Edging May be Allowed to Remain in Place After the Pavement is Built, or it May be Removed. The Filler used for this Type is Customarily a Flexible One (Bituminous Material or sand); the Bedding, Sand or a Similar Material; and the Base Broken Stone, Gravel or Crushed Slag Bound with Screenings of the Particular Material Used, or Bituminous Material.

ous excellent propositions that are made increasingly vague by continual reiteration. It is much to be feared that the term "local conditions," as used in paving engineering, falls into the latter class. The more the expression is used the less real meaning it conveys.

Experience has, with all of us, very much to do with our conception of what "local conditions" denotes. Accordingly, we may have concluded that problems associated with financing improvements are of paramount importance, or perhaps those of location or traffic or subsoil and foundation, or any one of several phases of the question.

The Illusive "Standard" Type.

The fact remains that each of us reads

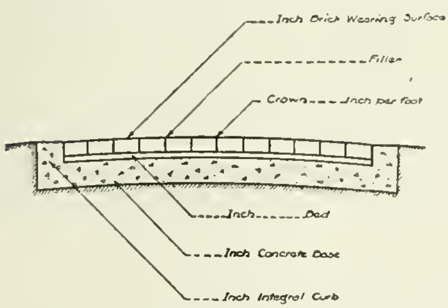


FIG. 2. THIS IS A SPECIMEN CROSS-SECTION OF A BRICK PAVEMENT, ON A CONCRETE BASE, FOR COUNTY HIGHWAYS.

Bituminous Material or Sand Would be Used as the Filler, and, for the Bedding, Sand or a Like Material.

into our conception of "local conditions" a meaning that harmonizes with our own experience. There has been no procedure, established by professional custom or agreement, that constitutes a well-rounded guide for the identification and solution of such matters. That such a statement can be made is unfortunate, but not surprising.

Let us recall for a moment that not so long ago efforts were being made to create "standard" types of paving that could be used universally, with as much economy in one place as another. All this effort, if it had any justification, must have rested upon one assumption, and no other, that conditions found surrounding each and every proposed paving project, likewise were standardized. As well attempt to equip all men with the same size and kind of shoe. As feet vary, so do all the details of different paving projects.

When adherence to "standard" types prevailed the adoption of any paving type,

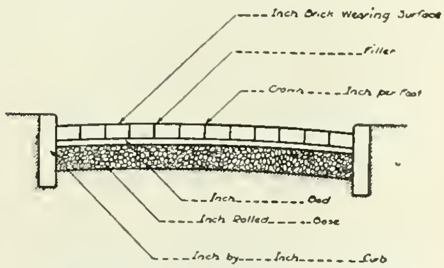


FIG. 3. AN ADAPTION OF THE ROLLED-BASE TYPE OF BRICK PAVEMENT IN CITY STREET CONSTRUCTION.

other than so-called standard, could be had only by proving conclusively that the "standard" type could not meet the situation. The burden of proof had to be assembled to support the negative of the proposition.

There could have been but one outcome for street and highway building if the pursuit of the (now-recognized) illusive "standard" had continued. That would have been the failure of so large a proportion of paving improvements that taxpaying citizens would have turned away from such things. They would have denied themselves the benefits of paved thoroughfares because of the price, in waste and inefficiency, they would have been compelled to pay.

True Designing.

Happily, the trend of engineering practice today in paving design is away from the use of "standard" types of paving and toward the selection of forms of paving, of all kinds, that best satisfy the requirements of the particular project for which paving is being chosen. This indicates that, however seductive might have been the appeal of uniform treatment for all paving improvements, it could not prevail against the conservative engineering thought which would build structures suitable to the needs of given situations. If one may gauge the progress of engineering sentiment and classify it while yet it is in a state of change, one would say:

First—That eventually as much care, in proportion to the nature of the work, will be bestowed upon the examination of a proposed paving project, in securing the fundamental data necessary for economic designing, as would be exercised in securing facts for the design of bridge piers or high building foundations.

Second—That where two or more pavements as designed and built happen to be similar in all respects, then it will be because the basic situations surrounding each of them likewise happen to call for the same treatment.

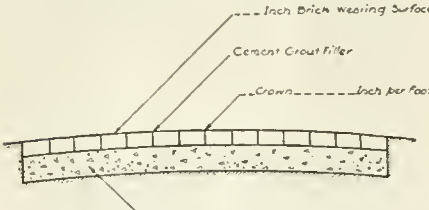


FIG. 4. THIS IS A TYPICAL CROSS-SECTION OF THE MONOLITHIC BRICK PAVEMENT FOR COUNTY ROADS. THE BRICK ARE BEDDED IN THE GREEN CONCRETE BASE.

In Comparing the Dimensions of this Type of Brick Pavement with Other Types, the Depth Considered is the Combined Depth of Brick and Base.

Brick Pavements Analyzed.

Admittedly, the design of pavements by the method of assembling all pertinent data, and the selection of a type based upon the consideration of all the available resources, imposes a volume of work upon the designing engineer larger than alleged "designing" by the adoption of some "standard." But we believe that whatever additional effort is required to be put forth more than justifies itself to engineers who would use public money to the best advantage.

Let us now consider the possibilities of brick pavements as to the available types of construction. A brick pavement is a composite structure. It has three elements: Wearing surface, bedding and foundation.

The relation between these several elements is most clearly defined, and the necessary data for design assembled, by beginning the analysis with the foundation.

The Foundation.

By foundation we mean the natural soil underlying the pavement plus the artificial base, if such proves to be required. The two must be studied as one element. Where the natural soil is high in the properties ascribed as essential in upholding the pavement structure, namely well-drained and therefore probably stable, less requirements are exacted from an artificial support. Conversely, where the natural soil seems unsuitable for the performance of its proper functions, one of two courses is open to the designer.

He may take steps to improve the character of the sub-soil or he may throw all the burden of pavement support upon the artificial base.

The comparative values of the alternate methods may, we believe, be summed up thus: If the sub-soil is favorable to the performance of its functions, then the burden of supporting the pavement, and its loads, is thrown upon the natural earth. The artificial base primarily serves as a medium for the transmitting of loads and forces from the wearing surface to the natural foundation where they are fitly disposed of. On the other hand, if the sub-soil is not capable of rendering proper service, then all the capacity for pavement support, and everything which that entails, must be provided for in the artificial base.

As a matter of practical record, we have had sufficient evidence presented to us in the recent past (and doubtless we shall have more in the future) to show that recourse to this last procedure results only in waste and inefficient pavement construction. We must then build our pavement bases as bridges, and the cost of such construction as would accomplish what is intended, would be prohibitive, even if it had the justification of good sense. We know that in the long run it is cheaper to improve deficient sub-soils, once and for all, than it is to repair broken down pavements. Of the two methods, the first is obviously the more to be desired.

Let the foregoing discussion serve to establish the need of a most thorough sub-soil study in each case of brick pavement design. The strong and weak characteristics of the soil will be disclosed thereby which will guide the selection, and the proportioning, of the artificial support. By this method, we establish whether or not an artificial base is needed, and if so, substantially how much of a given kind of base is required to meet the situation.

With this general analysis in mind, it is now opportune to point out the fact that there are many forms of artificial bases adequate, under proper conditions, for brick pavements, for example, concrete, hardened or green; rolled stone, gravel or slag, screenings or bituminous bound; and worn macadam or concrete pavements. A selection from these bases is available for any project under consideration. And the speaker would re-emphasize an opinion already expressed: That he believes that single projects may, in time, be under-laid with several types of bases according to the nature of the natural foundation.

With brief reference to the fact that there are many cases where no artificial base is required, let us dismiss the question of the base and proceed to a discussion of the bedding.

The Bedding.

In this element of a brick pavement, we have the medium that serves, like the artificial base under proper conditions, to transmit loads and forces, and probably to absorb a certain amount of them, fractional of the total at the most. The bedding likewise is a construction expedient, to furnish, as the name implies, a convenient resting place for each brick so that its position is consistently secure with reference to other brick, and likewise with reference to surface elevation. The bedding is a means of securing a smooth surface.

Experience shows that the bedding is an important factor to be considered in brick pavement design. Foundation may be studied and base selected (and subsequently built) with the greatest skill and economic good judgment. But if the bedding is not in proper accord with the rest of the structure, a successful pavement may not be had. The controlling consideration is the composition of the filler between the brick.

If the filler is of a kind, like asphalt or sand, that permits slight movements or readjustments, under traffic, of any single brick without reference to a change in position of any other brick, then the bedding must likewise permit this movement. If, on the other hand, the filler is cement grout, and the movement is of the surface acting as a slab, then the bedding must likewise be of a character to act similarly, over an area equivalent to the affected area of the wearing surface.

The general practice of engineers today is to use sand and similar materials in conjunction with bituminous and sand fillers. Where the filler is cement grout, one of two methods may be followed. The bedding may become one with the base, as when the brick are laid in green concrete, or a cement-sand bed may be used.

Thus the distinction is drawn between "flexible" and "rigid" brick pavements. As to the effect on the artificial base, it may be said that the use of cement grout filler predicates the adoption of a concrete base and thus creates a "rigid" type of pavement, while many other bases, in addition to concrete, are available for the "flexible" types. To none, by any means, may be awarded a place as "standard."

Some Fundamental Principles.

If the terms "flexible" and "rigid" do not convey an adequate picture of the distinctions in type involved, let it be said that, with the former, the wearing surface is relieved, in some measure, of the load-supporting function. In the case

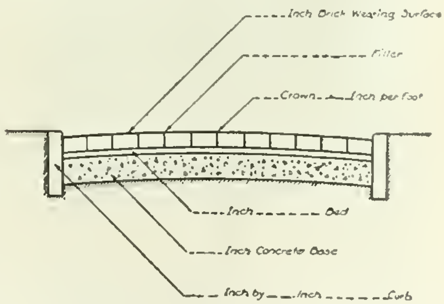


FIG. 5. THIS IS A WELL-KNOWN FORM OF BRICK PAVEMENT, ON A CONCRETE BASE, FOR CITY STREETS.

With an Asphalt Filler, for Example, the Bedding Would be of Sand, or a Similar Material. If the Filler is Cement Grout, then the Bedding Should be a Cement-Sand Composition, and Longitudinal Expansion Cushions Should be Allowed for Against Each Curb. The Depth of Cushion Should be the Combined Depth of Brick, Bedding and Base.

of the latter, the wearing-surface, bedding and foundation, united as they are in a solid slab, must of necessity, share each in some measure at least, in the structural reactions of the pavement as a whole. And the assertion may be ventured that, with the "flexible" type of pavement, less base compared with the "rigid" is needed, if loads are properly transmitted to suitable sub-soils.

The development of the practice of using brick 3 ins. deep, with a "flexible" filler, rests upon the above distinctions. And so we find, in most instances, brick of the 4-in. depth used in the rigid types of construction. But the fundamental principles already mentioned as involved in the competency of sub-soil support are identical in application to the two types. The better the support from the sub-soil, the less of artificial provision for its needs to be made, in the structural assembly of the pavement. And of course that means more economical designing, and hand in hand with better designing, the conservation of funds thus effected, and more efficient service from the pavements when built.

We believe that it is self-evident that if there is any virtue in our analysis, types of construction of brick pavements are not lightly to be selected. We must bear in mind that the chief attainment sought is the maintenance of the wearing surface of the pavement (every pave-

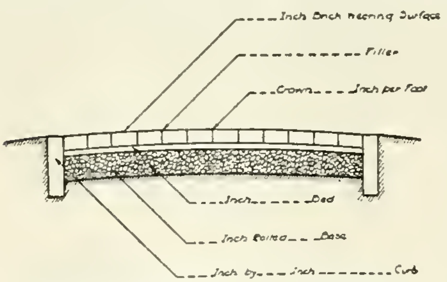


FIG. 6. SHOWING A COMBINATION OF ROLLED BASE AND SEPARATE CURBING FOR COUNTY ROAD BRICK PAVING.

ment) in a normal position for the performance of its service. We are not vitally concerned with how this is accomplished provided it is done.

We need wearing surfaces for our pavements which possess endurance in proportion to all possible future demands of traffic. Correctly built brick pavements are enduring under traffic and the brick themselves are practically immune to the disintegrating influences of natural forces like water and frost. The principles of good designing might therefore be laid down about as follows:

First—Let the sub-soil be studied exhaustively and its probable behavior catalogued, from one end of the project to the other.

Second—Let the nature and proportions of the artificial base be determined only after the filler to be used has been settled upon. Also, after a painstaking search for, and selection of, the materials which will, at the least cost, insure the satisfactory performance of the requirements of the base. Maximum serviceability at minimum cost.

Third—Let us not be hesitant at including more than one type of construction in a single improvement project, if conditions found indicate the wisdom of doing so.

Fourth—Let every step in this preliminary study and search for fundamentals be made a matter of accurate public record in every detail.

Fifth—And finally let us build with that exactitude and care which will impart to the completed structure all the service-quality which is the inherent property of each and every material entering it.

Actual Study

And now, has all this discussion a practical bearing upon pavement design? We believe it has. If, instead of assuming, broadly and without *detailed* study, that a particular form of brick (or any other pavement) will answer the purpose for every paving project, and then saying that "local conditions" may perhaps *modify* the choice, we study all such conditions and evolve the best type we can in each instance, no one, we believe, will deny that progress will have been made in connecting up type of construction and service. That means better paving for the taxpayers' money. Our chief objection to the thoughtless use of the expression "local conditions," and none will gainsay the prevailing, if diminishing, prevalence of the custom, is that it leads directly to loose thinking and still looser designing. What we need most is an appreciation, not of *comparative* "local conditions," but of *absolute* local conditions. Paving types selected in this attitude of mind will meet their service-requirements because they are built for the conditions as and where they exist and not for some location fifty miles away.

CONCRETE VIADUCT ADDS VALUABLE BUSINESS BLOCK TO KNOXVILLE, TENN.

By Carlos C. Campbell, Publicity Secretary, Knoxville Board of Commerce, Knoxville, Tenn.

Transforming a business block from a row of shooting galleries, cheap photograph shops and second-hand stores to a block of first class retail houses is the feat accomplished by the new reinforced concrete viaduct recently completed in Knoxville, Tenn. This new viaduct also provides a more direct connection between the main business section of the city and the business district now being developed north of the southern Railway lines, and facilitates the handling of traffic over Gay Street, the leading business street of the city.

Replaces Steel Truss Bridge

The new concrete viaduct replaces the former steel truss bridge across the railroad tracks, which ended at Jackson Avenue with a grade of 6½ per cent. It passes over Jackson Avenue and extends to Vine Avenue on a grade of only 1 per cent. Because of the former excessive grade, desirable retail stores had been kept out of that block of Gay Street. One large retail furniture house was the only exception in over fifteen years, and it soon moved to a better location. The building it vacated stood empty until it was occupied by a clothing manufacturer.

Creates New Business Block

The old buildings on the west side of this block were only one and two stories high. The new viaduct ran just a few feet below the roofs of the one-story buildings. Eight of these old structures have already been razed and new and attractive buildings, three and more stories high, are taking their places. Other buildings are planned, and the entire block will soon be filled with modern structures. The buildings on the east side of the street were three, four and five stories high. These were converted into valuable retail buildings by changing the floor levels to that of the new street level. The extension of the viaduct and the elimination of the steep grade has added another good business block and has helped to relieve the congestion.

Design Features

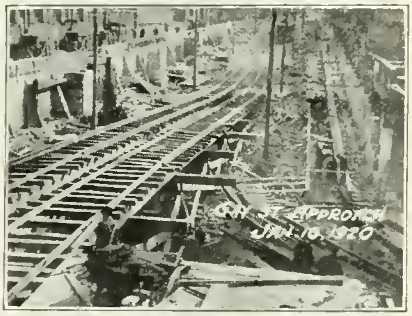
The viaduct is of the girder type, with spans varying in length from 19 to 38 feet in order to accommodate the railroad track lay-out. The bents supporting the spans consist of five columns, resting on heavy reinforced concrete footings extending the full width of the bridge.

Foundations

Foundations of the columns across the railroad yards rest directly on hard natural clay. Those on the south end, near Jackson Avenue, as well as the foundations of the Jackson Avenue and Gay Street approaches, are supported by Raymond reinforced concrete piles. The pile foundations were necessary because the site was formerly a swamp. Raymond concrete piles are the cast-in-place type. A steel casing was driven into the ground by means of a collapsible steel core, after which the core was withdrawn and the casing filled with concrete. The cores were driven by a 2,000-lb. steam hammer until the average of the last few blows did not exceed ¼-in. Pile lengths vary from 20 to 40 feet, and the thickness varies from an average of 18 inches at the top to 6 inches at the bottom. The total number of piles driven was 327, and the time required was six weeks. This portion of the work was executed by the Raymond Concrete Pile Co. of New York, owners of the Raymond patents. This work attracted general public interest, and large crowds frequently gathered to watch the process.

Approach Fill

The Gay Street approach consists of a fill of sand and gravel, made between two concrete retaining walls of the buttress type, which were built directly on the curb line of the old street. This fill contains 8,500 cu. yds. of sand and gravel, and is covered by an 8-in. base of concrete on which asphalt paving is laid. This fill was made by dumping the sand and gravel from side-dump cars on the street railway track and washing the material into place by a 4-in. hose. The car tracks were raised 1 ft. at a time as the filling progressed, and street railway traffic was not interrupted at any time.



VIEW SHOWING WHERE THE FILL WAS MADE ON GAY STREET, KNOXVILLE, BETWEEN VINE AND JACKSON AVENUES.

At the Left is Seen the Retaining Wall, While at the Right the Reinforced Concrete Piles Have Just Been Driven. After the Retaining Wall on That Side Was Completed, the Street Was Filled With Sand and Gravel, the Street Car Tracks Being Raised as the Fill Was Made. There Was no Interruption to Street Car Traffic During the Entire Construction. A Heavy Concrete Pavement Was Placed Over the Fill as Soon as it Was Completed.

Lighting System

The lighting system of the viaduct is unusual, in that the concrete light standards supporting the 200-Watt lamps are entirely outside the sidewalks, leaving the curb lines entirely unobstructed. These light standards were especially designed for this work, and are made of pink granite. They will outlast any form of steel pole, which in time would be eaten away by rust and the gases from the railroad engines. Ducts carrying the lighting wires and the conduits of two telephone companies, the Western Union Telegraph Co. and the local gas company are out of sight below the floor of the viaduct. All overhead wires, excepting trolley wires, crossing the railroad at this point, have been removed.

VIEW OF NEW GAY STREET VIADUCT AT KNOXVILLE, TENN.

The construction of this viaduct was financed by a bond issue voted by the taxpayers of Knoxville in a special election. The total cost of the viaduct was $390,300.

Personnel

The design was made by W. B. Crenshaw, assisted by H. M. Ferrin, both Knoxville engineers. The contract was awarded to M. C. Monday, a widely-known contractor of Knoxville. The construction was carried on under the direction of L. W. Frierson, of Knoxville.

HOW TO MAINTAIN STREETS IN THE AVERAGE CITY

By Harlan H. Edwards, City Engineer, City Hall, Danville, Ill.

(Editor's Note: Mr. Edwards has been a frequent contributor to Municipal and County Engineering and our readers are familiar with the practical character of his articles. In the present paper, presented before the Illinois Society of Engineers, he gave some very valuable, specific suggestions, which have demonstrated their worth in practice, on the maintenance of street pavements of various types.)

Street maintenance in our small cities is a task of no less importance than in our large cities. In fact, such work in cities under 50,000 is likely to be made more difficult than that in the larger cities, by the petty jealousies of some of its citizens. Its superintendence calls for the services of an engineer, a diplomat, and one with an unlimited amount of patience and courage, to direct and prosecute the work successfully. It is only too often that druggists, merchants of various sorts, or plain politicians are appointed to these offices, to the obvious detriment of the work.

The maintenance of our streets includes the care of dirt roads, as well as the repair of pavements. It includes the constant attention which bituminous and stone roads require, as well as the repair of holes or breaks which might occur in our brick or concrete roads. It includes the opening and replacement of all pavements as well as the constant control of street car track maintenance, and it finally includes the continual checking up on the condition of all grade crossings lying within the corporate limits. Not one of these items can be slighted or neglected.

Maintenance of Earth Streets.

The maintenance of dirt streets requires the judicious use of a light blade grader, the road drag or one of its combinations in the form of the road planer or one of the various makes of road machines. If the district is not well equipped with storm sewers, the services of a "handy man" are required to clean out the waterways and build new culverts, crossings over gutters, etc. There is little difference between the maintenance of dirt streets and country roads other than taking care of the drainage which, of course, is much more complicated in towns, owing to the frequent street and alley crossings. The use of the blade grader early in the spring, to shape up such roads as have become badly rutted and pushed out of shape by winter and spring traffic, followed by a system of patrol maintenance with a light drag, is probably the best combination for this work. In order to accomplish this, an outfit consisting of one man and a one-horse wagon, together with a light drag, pick, shovel, hammer and saw, responsible for a district totaling about five or six miles of road, has proved to be the most economical. Of course it is useless to attempt to keep dirt streets in boulevard shape in continuous wet weather, but the continuous use of such an outfit as this will do much toward keeping the streets in passable shape and improving them quickly after the wet period is over.

Oiling Streets.

The use of a coating of asphaltic road oil has proved a great aid in waterproofing the road surface, and when it is used it should be applied after the road has been put in good condition. If the road has not been properly shaped and dragged, the use of oil will only make conditions worse.

The maintenance of street pavements is occasioned by the formation of chuck holes or breaks, due to the general wear of traffic, by the opening of pavements for connections or repairs to underground pipes or cables, and by the damage from poorly constructed and maintained street car tracks. Of all these items probably the last two have been the greatest cause of the shortening the life of pavements.

Maintenance of Bituminous Pavements.

Methods of repair of pavements made necessary by general wear vary with the type of pavement used. The surface of bituminous pavements can be kept in good shape by the frequent use of surface treatments, using either a thin asphaltic product or a coal tar product applied under pressure by tank wagons. For the ordinary revitalizing of our asphalt or tar-bound streets, we have found "Tarvia B" applied cold, about 1/4 to 3/8 gal. per sq. yd., to be very economical and easy of application. A number of our pavements had cracked badly and had acquired a tendency to ravel out easily, with the formation of small chuck holes following soon after. These chuck holes were first cleaned out, then patched with a bituminous concrete mixture 2 ins. thick, consisting of 3/4-in. crushed stone, sand and "Tarvia K. P." mixed in the prportions of 6 yds. stone, 2 yds. sand and one 50-gal. barrel "Tarvia K. P." Two paint coat applications of "Tarvia B," about one day apart, covered lightly with coarse sand or stone chips, have put these pavements in shape so that they will be able to withstand traffic for several years longer without additional care.

Most of our troubles with brick pavements have been the replacing of a few brick here and there, the tops of which had been crushed off as a result of improper penetration of cement grout filler and the subsequent expansion due to increase of temperature, or the replacement of the worn down patches of soft brick in our older pavements. Generally speaking, our brick pavements have given us from 25 to 30 years of service, with practically no maintenance and many of these pavements are still in exceptionally good condition, and give indications of many more years' use.

Resurfacing Brick Streets With Brick.

Much has been said of resurfacing old brick pavements with asphaltic or tar concrete, but where paving brick may be had for a reasonable price, the old brick pavements may be resurfaced by the removal of the old brick, the leveling of the sand cushion and the laying of a new 3-in. vertical fiber asphalt-filled brick pavement at a cost which will not greatly exceed that of the bituminous surfacing and will furnish a wearing surface much more foolproof and longer lived. In cities where asphaltic pavements are the rule, rather than the exception, this may not be exactly true on account of the cheapness of the asphaltic material and the availability of experienced repairmen, but in many of our smaller cities, where the mileage of brick streets constitutes the greater proportion of the entire mileage of paved streets, the cost of a bituminous surface is somewhat higher, owing to the higher cost of the mixture laid down on the street and to the necessity of shipping in a mixing plant to handle the work. Where this type of surface is laid, it must have continuous maintenance from the time it is laid and probably after a service of from 8 to 12 years, it will require a surface treatment at least once every three years.

In 1919 we rebuilt an old two-course brick street about two blocks long at a cost of $2.98 per sq. yd., not including excavation. The old brick wearing surface and the sand cushion were removed, a 3-in. layer of concrete mixed 1 to 6 was placed on top of the old lower course of brick, a new sand cushion placed on this and a 4-in. asphalt-filled brick pavement formed the wearing surface. The brick were of the straight wire-cut variety, laid as closely together as possible and rolled to a smooth even surface. Asphalt filler was then applied by pouring cans, filling every joint from the top to the bottom. It might be well to state at this time that besides this work we have laid pavements with either the straight wire-cut brick or the vertical fiber brick with no lugs, on five other streets, a total of nearly two miles of this type of pavement and have experienced no trouble whatever from lack of penetration of the asphalt filler. In most of this work the filler was poured on and "squeegeed" into the joints.

Protecting Pavements Against Trench Settlement.

The greatest source of uneven surfaces resulting in chuck holes has been improperly backfiled trenches under the pavements. On this account municipal control of the replacement of pavements over openings made in the streets for various purposes has become absolutely necessary. More trouble has been experienced and more pavements have been ruined from this cause than from any other. Formerly openings could be made in the pavements by any one, the dirt thrown back loosely, the broken concrete piled on top of that, the sand cushion laid and a new brick surface laid and grouted. This, of course, was bound to settle, and it formed a very dangerous hole in the pavement. The replacement of these sunken portions of pavement still form a considerable amount of our yearly maintenance. Several years ago, however, a new method of control was adopted, making it necessary that city forces replace the dirt and the pavement, using a concrete base about 1 ft. thick and extending 1 ft. on solid ground on al sides of the trench. Since this has been adopted no trouble has been experienced from settlement. An improvement on this type of handling the work is contemplated, however, consisting of the use of the precast 8-in. concrete slabs in sections about 4 ft. long and 2 ft. wide, reinforced with ½-in. steel rods placed 6 ins. on centers and 2 ins. from the bottom of the slab. As many of these slabs will be used as necessary to cover the trench completely, and they will be grouted in place thoroughly. It is hoped that the adoption of this form of concrete base will save time and will permit the replacement of pavements in cold weather when it would be impossible to lay new concrete in the street.

The Equipment Required.

The equipment necessary to handle all this work is simple. A 1-ton truck, preferably equipped with a dump body, is sufficient to handle the material for the average small city. Along with this a small concrete mixer and an asphalt heating kettle, together costing not over $500, are necessary items. A few men, including a foreman and two or three workmen, form the nucleus of a gang sufficient to keep the streets in good repair the year round. These three or four men are enough in the winter months and may be supplemented in the summer by additional men, using the regular men as straw bosses. The small tool equipment, of course, consists of the necessary shovels, spades, scoops, picks, mattocks, posthole diggers, axes and saws of various sizes, together with hammers for brick work and carpenter work and several 50-ft. sections of rope of various sizes. Such an equipment, supplemented by other small items when needed, will enable the men to handle almost any situation from the removal of large trees to the laying of good-sized sections of pavement or the building of a small bridge if necessary.

Protecting Pavements on Car Track Streets.

Street car tracks are another source of trouble on paved streets and if their sphere of influence is not curbed the rest of the street is often ruined. Where stone or gravel ballast is used for street car tracks the most pronounced destruction is found, for the wave motion of the street railway track under the effect of the moving loads tends greatly to disturb the adjacent pavement. Where T-rails are used the wheels of wagons and trucks, when turning out of the track, exert a strong leverage on the paving surface and grind or loosen whatever paving materials are in the way. If the paving is loosened it is not long before the effects of water and additional motion of the car tracks disturb the pavement for a considerable distance adjacent to the tracks.

Under most franchises the maintenance of the pavement between and adjacent to the railway tracks is taken care of by the street railway companies. If the costs run much higher than the maintenance of the pavement on the rest of the street, however, the result is that the least possible work is done. It falls upon the street superintendent, therefore, to keep after the street car companies and demand careful and substantial paving repairs along and between the tracks.

In some cities the street railway companies have adopted a new type of construction for their track, wherein steel ties are used, embedded in concrete with a minimum of 9 ins. of concrete beneath the rail. This has gone far to cut down destruction caused by loose tracks, as is seen very strikingly in Chicago Heights, Ills. In this city street car tracks on two streets were laid during the same year and had the same type of surface, but one used a substantial concrete base under the ties, while the other used stone ballast. At the present time the first named pavement is in perfect condition, while the other is very rough with many of the bricks along the rail considerably loosened or entirely gone. Such track construction as this may be cheaper initially, but is much more expensive for the railroad companies to maintain.

Isolating Car Tracks From the Pavement Proper.

Wherever the flexible type of construction of street railway tracks is used, however, it is practically impossible to eliminate the bad effects of the moving track and it is, therefore, necessary, if the adjoining pavement is to be protected, to isolate the street railway track completely from the paving on each side. This matter is one which has been given great thought by many capable engineers. Several designs have been made which accomplish their purpose admirably. In all these designs the concrete header or subcurb is used, extending down just outside the ends of the ties to a point several inches below the bottom of the street railway track ballast. On some pavements, such as concrete, wood block, or granite block, this subcurb can be easily extended to the surface of the pavement, while it is hard to accomplish this without the use of a different paving material in the case of asphalt or brick with a soft filler. Even these, however, can be built with the line of separation extending to the surface of the pavement if a metal paving guard is installed in the concrete base, so that the long side of the guard extends up as a retainer through the sand cushion to within about ½-in. of the surface of the brick pavement or to the surface of the asphalt pavement.

Advantages of the Subcurb or Header.

The advantages of using the header or subcurb are several. It affords ample protection from poor track work and from the lesser movement of well constructed track, thereby reducing the worries of the street repair gang and confining the damage to the unit in which it originates. It allows tracks to be repaired, or torn up and relaid without causing damage to the abutting pavement. Repaving of the track space will be done more quickly, for the two curbs will be at the proper street level, thereby serving as a paving line during such work. This type of construction along street railway tracks is now being used by many of our most progressive cities. The expense is not great when the benefits to be gained are considered. It is the opinion of many, however, that the cost of the header curb should be borne by the street railway company, inasmuch as it is necessitated by the presence of their track in the street.

Pavement on Railroad Crossings.

The pavement within and along street railway tracks, however, is not the only source of trouble. The portion of streets lying within the right-of-way of railroads at grade crossings is oftentimes the most dangerous portion of the street if not properly taken care of. The question of maintenance of the pavement in this portion of the street is one which has occupied the attention of railway and highway engineers for many years. Many different types of surfaces have been tried with the usual reversion to the old form of plank crossing. No other section of the highway must meet conditions as severe as those imposed upon the pavement adjacent to and between the rails of a grade crossing. Demands made on it are two-fold. It must fulfill the need of highway traffic and at the same time conform to the railroad requirements. As a part of the highway, built to carry modern motor truck traffic, the pavement must be of sufficient strength to carry the loads and withstand the impact caused by the wheels of heavily-laden trucks. The surface must be as durable as the highway of which it is an important link. From the traffic point of view any pavement which will produce a smooth even surface at the same level as the bearing surface of the rail is highly desirable. A crossing free from nails, which might cause punctures or penetrate horses' hoofs, and free from jagged splinters of sharp stones which might cut tires, is much needed. Railroad operation, on the other hand, requires that crossings permit trains to pass over them without shock, danger or undue noise. Railroad maintenance demands easy access to the ties and rails and that the crossing pavement be economicaly repaired and replaced.

The growth, weight and volume of traffic during the past few years has made the old type of timber crossings obsolete. Newer types of pavements for this purpose have been evolved by experiment, yet the experimental stage is not over. One type consists of reinforced concrete slabs precast and set into place. Another type consists of crushed stone maintained with stone chips. Still another type is the bituminous concrete surface held in place near the rails by paving guards or the bases of old rails laid on their side. This latter type of pavement seems to have given good service, where it has been used, although its period of service to date has not been great.

Railway maintenance men often neglect their grade crossings and leave them in very rough condition. The result is either broken springs on trucks or stalled motors on the track, either of which is dangerous. It is necessary, therefore, for the street superintendent frequently to jog up the memory of the maintenance men and to see that they keep at all times an adequate supply of materials at each crossing to maintain it in good shape.

Good streets can not be produced by any method, however, with insufficient funds. The financing of street maintenance work is a problem which has concerned city officials, especially during the last few years. We have seen the increased cost of labor and materials eat up our available funds and leave us with only a portion of the much needed work completed. Appropriations from the general fund, together with the money derived from the road and bridge taxes became entirely insufficient to handle the work. In many cities, therefore, the motor vehicle tax was adopted as a method of securing additional funds for the repair of streets. In some cities it has been contested vigorously, but where the ordinance was properly drawn up it was upheld by the courts. An additional source of revenue has been taken up by some cities in the form of a tax of about one-half cent per gallon on gasoline sales. This is said to produce a very satisfactory revenue, and has the advantage of hitting the hardest those who use the streets most. Of course this does not reach the horsedrawn vehicle owners, but since the amount of this type of traffic has greatly decreased in our cities, this inequality of taxation would not amount to much. It is hoped, however, that the economic readjustment through which we are now passing will bring prices back to a reasonable level, and thus enable us to maintain our streets at the right standard.

RESOLUTIONS ADOPTED AT GOOD ROADS CONGRESS

Among the resolutions adopted at the Eleventh American Good Roads Congress, held in Chicago Feb. 8-12, which show the trend of advanced thinking among highway workers, were the following:

Urging the Interstate Commerce Commission and the railroads immediately to grant a reduction of 25 per cent in freight rates on road building materials for use in constructing public highways.

Urging material producers and contractors to reduce the cost of materials and operation to a point that will permit an immediate start in the development of the greatest road-building era in American history.

Protesting against the killing of more than 5,000 and the injury of more than 14,000 persons on the highways of the country during the past four years, condemning reckless speeding and demanding better policing of the highways, better construction and inspection of bridges and better means of preventing grade-crossing accidents.

Urging that state highway departments be divorced from politics and that the salaries of highway engineers be increased so as to make possible the employment by highway departments of the most competent engineers and their retention in the public service.

Recommending that the United States become a member without delay of the International Road Congress and instructing the executive committee of the American Road Builders' Association to secure the passage by Congress at Washington of such legislation as may be necessary to that end.

Urging Congress to pass without delay the bill, now pending in the House of Representatives after having passed the Senate, which authorizes the immediate allotment by the government of one hundred million dollars as Federal aid to road projects for the year ending June 30, 1922.

Recommending the application of Federal aid to the construction of interstate highways as a step toward the ultimate formation of a great national highways system.

VALUABLE TRADE LITERATURE

Reflecting the activity in the municipal and county fields some exceptionally interesting and valuable trade literature is being issued at this time. We present, herewith, very brief reviews of some of this literature which has been brought to our attention:

Cableway Excavators and Power Scrapers—Three new booklets are being circulated by Sauerman Brothers, 1142 Monadnock Block, Chicago, with reference to their Dragline Cableway Excavators and their Power Scrapers. Pamphlet No. 14 gives data on the dragline cableway excavator method of excavating and conveying sand and gravel, and is illustrated with views of typical installations. Pamphlet No. 12 describes the latest developments in the use of mechanical drag scrapers for handling gravel from the hillsides and explains the adaptability of power scrapers for small pits. Pamphlet No. 11 illustrates practical solutions of various storage problems by use of scrapers and dragline cableways, some of this information being published in this pamphlet for the first time. The pamphlet pertains particularly to the handling of coal from storage in connection with power plant operation.

Tarvia Roads—Three new Tarvia booklets have just come from the press bearing the following titles: "How A Tarvia Macadam Roadway is Constructed," "Tarvia Pavements," "Tarvia Preserves Roads and Prevents Dust." The first named has a self-defining title and is a complete illustrated description of the recognized procedure in constructing a Tarvia Macadam roadway. The second named booklet shows, step by step in actual photographs, the construction of a Tarvia pavement. The third booklet is a discussion of the nature and advantages of Tarvia as a material for highway construction and maintenance.

How American Cities Are Paved—This is a circular issued by the Asphalt Association, 25 West 43rd Street, New York City, compiled from reports of city engineers from 196 cities. Tables and diagrams are presented to show the amount of pavements of the various types in these cities.

Steel Forms—Better steel forms for concrete road construction, curb and gutter work, sidewalks, culverts, fence posts, walls and foundations are illustrated and described in Bulletin No. 36 issued by the Lakewood Engineering Co., of Cleveland. The Lakewood-Hotchkiss line of forms is described. The booklet shows the application of the complete line. This method of construction is particularly interesting as by its use better concrete and perfect expansion joints are practically certain.

Texaco Asphalt Macadam—This booklet tells how to build asphalt macadam roads and is issued by the Asphalt Sales Department of the Texas Co., 17 Battery Place, New York City. It gives a short discussion of the entire subject. It gives the procedure in the construction of Texaco Asphalt Macadam roads, starting with the foundation and discussing the process step by step to the finished pavement. Cross sections are shown to illustrate the work as it progresses and there are several photographs of actual construction views shown.

New Pavements at Half the Cost—This is an interesting booklet just issued by the Barber Asphalt Paving Co., Land Title Building, Philadelphia, Pa. It deals with the re-construction of worn out pavements by resurfacing them with native lake asphalts. Procedure is illustrated and described.

Better Roads for Maricopa County, Ariz.—This is an attractively printed and illustrated booklet published by the Lakewood Engineering Co., of Cleveland, describing the 280-mile road job, in the county named, which was handled by the Twohy Brothers' contracting organization. The booklet consists largely of pictures.

Webster Method—This monthly periodical is issued by the Webster Manufacturing Co., 4500 Cortland Street, Chicago. It contains a great deal of valuable information in each issue pertaining to Webster power house equipment, with special reference to coal and ash conveying machinery for use in the water works and other municipal power plants and in similar installations.

WATER WORKS SECTION

DESIGN OF MILL AND WORKSHOP FOR MINNEAPOLIS FILTER PLANT

By W. N. Jones, Engineer in Charge, City Hall, Minneapolis, Minn.

It has been the writer's experience that on almost all construction jobs, of whatever magnitude, very little attention is paid to the construction plant layout and the important part this plays in the economy of construction. This lack of attention is more pronounced on jobs done by the states or municipalities, when using force account, than on contract jobs, but even the contractor is very likely to overlook the many advantages secured by an adequate construction plant manned by the proper men.

The Workshop

One of the most important parts of a construction plant, on work of any magnitude, is the workshop, or mill. This workshop should contain all the necessary machinery and equipment for the working of the wood and steel or iron that is necessary on the job and the making of all the necessary repairs to the tools and equipment. The structure should not be too elaborate, but it should be ample to take care of all the needs and sufficiently strong and weather-proof to carry the machinery and protect the workers from the elements, for unless this is done, the shop will shake itself to pieces or the workmen will fail to give the best of service. Therefore, the following brief description and the accompanying sketches are offered for what they may be worth. It is not claimed that the workshop as shown is the last word in design but it has admirably answered the purpose for a number of years and is a great improvement over all others that it has been the writer's fortune to observe under actual working conditions.

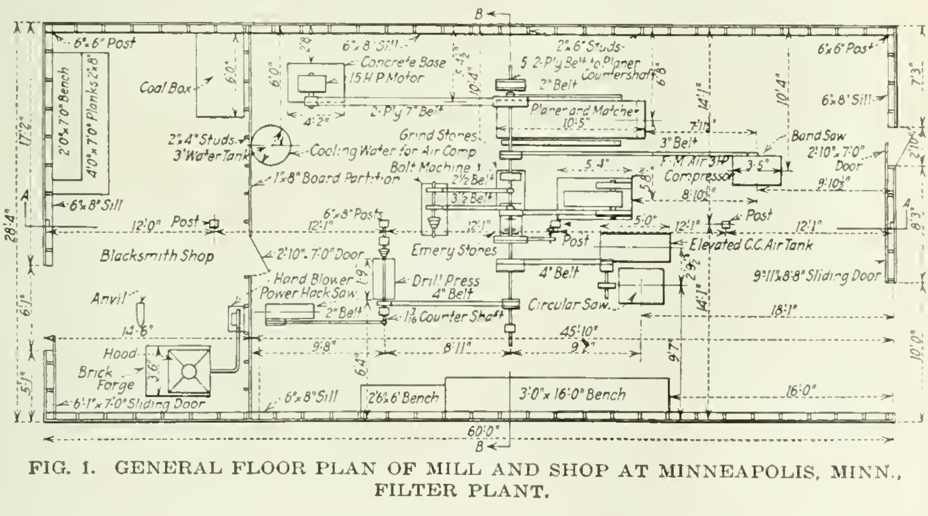


FIG. 1. GENERAL FLOOR PLAN OF MILL AND SHOP AT MINNEAPOLIS, MINN., FILTER PLANT.

This shop was designed and built early in the spring of 1911, and with the exception of two years has been in constant operation ever since. During this period it has never been necessary to shut down for repairs and many times the shop was in continual operation day and night for weeks at a time. Not only was all the ordinary work done therein, but at times, certain articles were manufactured which were necessary in carrying on the work or which it was found could be done there more quickly and as cheap as at private works.

At no time was it inadequate to meet the needs although the construction crew

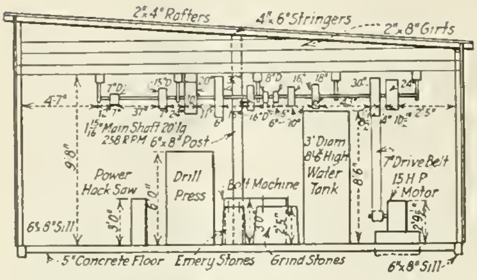


FIG. 2. CROSS SECTION THROUGH B-B OF FIG. 1.

ran as high as 500 men at one time, and it required but 5 men to run the shop even when the construction crews were at their maximum.

The Equipment

As will be noted by the sketches, the building, including the blacksmith shop, is 60 ft. 6 ins. by 28 ft. 4 ins. in plan and contains the following equipment:

1 24-in planer and matcher.

1 26-in. band-saw with all the necessary saw blades.

1 14-in. circular saw table with both crosscut and rip saws.

1 40 cu. ft. per min. under 80 lbs. pressure air compressor.

2 10-in. emery wheels.

2 24-in. grind stones.

1 No. 20 Champion drill press with drills from 3/32 to 1½ in.

1 bolt and pipe threading machine with bolt dies and taps from ¼ to 1½ in., and pipe dies from ¼ to 2 in.

1 12-in. power hack saw.

All are driven by a 15-h. p. electric motor.

In addition to the above there is the blacksmith shop containing a forge and blower, an anvil, two blacksmith vises and a workbench. The main shop also contains two prentice vises, three pipe vises, all the necessary benches and tables and all the small tools that one needs to carry on the work.

From past experience, it is believed that the shop as shown will answer all the needs on jobs of a considerable magnitude, and that only two improvements could be made in the equipment. First, a lathe with an 18-in. swing would come in very handy, although a smaller lathe could be used and, second, a machine for heading up bolts would more than pay for itself, especially upon work similar to that for which the shop was designed.

The lighting in the shop is not the best, as the windows are too small and a great improvement could be made by using or making the windows just twice their present size, or by the use of skylights where the layout would permit.

THE BASIS FOR EXTENSION OF WATER MAINS

By Dow R. Gwinn, President and Manager, The Terre Haute Water Works Co., 634 Cherry St., Terre Haute, Ind.

The extension of water mains is always a problem, and in the past years it has been a serious one. Previous to the great war cast iron pipe was delivered f.o.b. Terre Haute for $22; in October, 1920, the price was $77.60. Fire hydrants, valves, special castings and valve boxes are also very much higher in price. Common labor costs twice as much as formerly.

It costs a little over $1.80 per foot to furnish and lay 6-in. Class B cast iron pipe at present price—$64 per ton. On this basis the cost of an extension for a block of say 365 ft., including the fire hydrant, valves, valve boxes and 6-in. tee, is $829. If it is necessary to cut into a main and insert a special for a connection, the cost would be greater.

A Cost Item Sometimes Overlooked

It may not be out of place to say that in estimating cost of pipe laying, the cost of connecting with existing mains is sometimes overlooked. It is expensive to shut off a main, cut a piece out of it, pump out the water that is in the main, insert a special, cut a piece of pipe to close the gap, put on a sleeve, and make four lead joints. It sometimes happens

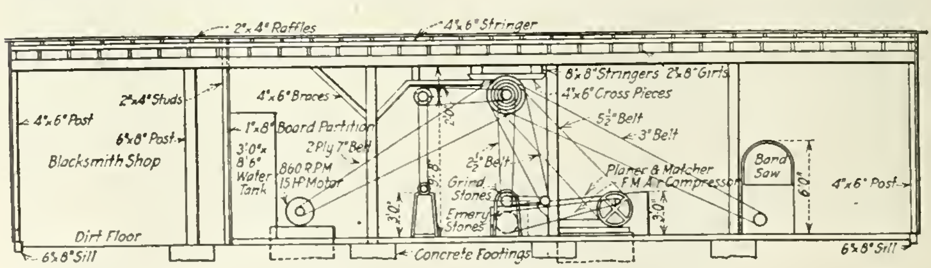


FIG. 3. CROSS SECTION THROUGH A-A OF FIGURE 1.

in Terre Haute that the water from the pipe softens the earth so that there is a caving of the banks. A number of valve stems have been broken while the workmen were trying to get the water off so that the cut could be made.

However, for present purposes, we will estimate a block of 6-in. pipe at $829.

Assuming that the extension is needed and that the water department or company can finance the improvement, the next question would be: what additional income should the department or company receive? In the writer's opinion, the income should be the same regardless of whether the water works belong to a municipality or company. A municipally owned plant should be conducted on business principles and should charge for fire hydrants and they should be paid for out of the general fund.

Rate of Return.

The Indiana Public Service Commission allows Water Companies a rate of return of 8 per cent and 1 per cent for depreciation. Assuming that the cost of operation and taxes are 10 per cent of the valuation, the charge against an extension of a block of 6-in. pipe with one fire hydrant should be 19 per cent of $829, or $157 per annum. At first blush this may strike some as being rather high. But analyze the statement and it will be found that $157 is not too high.

What about the rate of return on the rest of the plant? What good would the extension be without a water supply, pumps, boilers, filters, housings and reservoirs? The extension should pay its proportionate cost or rate of return on the main plant. Something should be added for return on these items.

In many cases it would be necessary to put in 8-in. or larger pipe. If 8-in., the cost for a block, including hydrant, valves, etc., would be $1,000. In that case, the income should be $190 per annum. If 12-in. pipe, it would be considerably higher and someone must pay on this investment and also sufficient to cover proportionate cost of operation. The average water department or company does not have a special fund to cover such costs and it would not be fair to load them on the existing consumers.

We have gotten the wrong viewpoint on the cost of a water supply. We have been satisfied with, or at least have accepted a return much lower than the manufacturer or merchant receives.

It was Leonard Metcalf who said:

"When we stop to reflect upon the life of the community, it seems to me that we must admit that the water supply is of fundamental importance. There is no other service of a public nature which is so supremely important to the life of the community as the water supply. Moreover, there is no other service which is so cheap, even at present day prices, as the water supply."

The writer recalls a rent of $200 for fire hydrants at a plant where he was employed in the "eighties." Since then water service has been wonderfully improved and the cost reduced. Then we pumped natural river water, now we pump it twice, coagulate, settle, filter and chlorinate it.

Extensions in Partially Built-Up Districts

To return to the subject, How is the $157 or $190 to be paid? It should be paid by those who are benefited. There are two kinds of extensions, one where there are houses where water supply is needed at once, and another in virgin territory which a real estate owner wants to develop and sell off in lots.

First, let us consider an extension inside the city where some houses have been built. On an average city block of 365 ft., after deducting the street, there would be say 14 42-ft. lots. It would seem only fair and reasonable that there should be, say, six houses on the 14 lots; that each of those should guarantee a $1.50 minimum monthly rate (about 5c per day) for a period of five years. Then if the city would pay $50 a year for the fire hydrant, there would be an annual income of $158.

If the extension required 8-in. pipe (60 per cent of the mains in Terre Haute are 8-in. and larger), then the six prospective consumers should guarantee $1.75 minimum per month and the hydrant rental should be $60 per annum. This would mean an income of $186 per annum, if all the consumers kept up their payments.

To protect the department or company, contracts should be made with owners instead of renters and the service pipe should be laid from the curb into the houses and at least a faucet connected in the kitchen before the main was laid.

Extensions Made in Undeveloped Districts

Second, where extensions are desired for the development of real estate so that lots may be sold, such extensions are for the benefit of the landowner and he should pay the cost, and be reimbursed by the water department or company when the income from the water consumers and hydrant rental on such extensions is equal to the rate of return (on the original cost) allowed by the Indiana Public Service Commission plus depreciation and the proportionate cost of operation and taxes.

Recommended Form of Contract with Land Company

The following is a form of contract which is recommended where such extensions are made:

THIS AGREEMENT MADE AND ENTERED INTO this...................., by and between...................., hereinafter for brevity called the Water Company, and the...................., hereinafter for brevity called the Land Company, witnesseth:

I.

The Land Company is the owner of that certain tract or body of land extending from ....

....

and is desirous of having water mains extended from the Water Company's existing system of water mains into and in the streets in said tract as the same have been platted by said Land Company; and the Water Company is willing to make such extensions for the Land Company for the consideration and upon the terms and conditions hereinafter set forth.

II.

The proposed extension will be made by the Water Company upon the orders in writing of the Land Company after the said streets have been brought to grade by the Land Company. Provided, however, orders for extensions for the current year.............shall be limited to

....

....

III.

Orders for extensions shall be limited to the tract or body of land and its boundary streets, as specified in Article I of this agreement. Provided, that orders for any calendar year after.............shall not exceed four thousand (4,000) feet of mains, unless otherwise mutually agreed by the parties.

IV.

The Water Company will purchase all materials and employ all labor necessary for the proposed extensions, including the installation of service connections and meters, and shall have full charge and control of all the work contemplated hereby. The Water Company will keep a true record and account of the cost of each extension, which record shall at all reasonable times be subject to inspection by the Land Company.

V.

When the work of any extension is completed, the Water Company will notify the Land Company thereof in writing, and in such notice state the cost thereof, and the Land Company will within ten (10) days of receipt of such notice pay to the Water Company such costs in cash. Provided, however, the cost of service connections and meters will be kept separately and payment therefor made to the Water Company by the Land Company in amounts of approximately two hundred (200) dollars as the same accrue.

VI.

All mains, service connections, and meters hereby contemplated, for which the Land Company shall pay as herein contemplated, shall remain the property of the Land Company until the Water Company shall reimburse the Land Company without interest the aggregate sums so paid by the Land Company.

VII.

The Water Company agrees that whenever, and as its net earnings on the basis fixed by the Public Service Commission for determining and allowing net earnings (proportionate operating expenses, taxes and depreciation being deducted from the gross earnings from extensions made for the Land Company), for a period of one year for water and service on any extension, shall be equal to 8 per cent. on the money sc paid by the Land Company to the Water Company, representing the cost of such extensions, meters, and service connections thereto, as provided in Article V, that it will reimburse the Land Company for such payments, without interest; thereupon the ownership of such extensions, meters and service connections to curb shall pass to the Water Company.

VIII.

It is agreed and understood, however, that for all purposes of operation by the Water Company of its general Water Works Plant at and in the City of ...., the Water Company shall have the right to use water mains, service connections, meters, and all other equipment installed under this agreement, and to collect and retain all money for water and service furnished by the Water Company through or by means of such mains, service connections, meters, etc., in all respects as if the Water Company were the owner thereof and as if the same constituted a part of the general Water Works Plant and system of the Water Company. Provided, however, that the Water Company will, at the end of each calendar year until the final reimbursement by it to the Land Company as contemplated hereunder render a statement to the Land Company of all such collections so made by it.

IX.

For all the purposes of this agreement, the Water Company shall be the sole judge of the sizes and kinds of mains and other materials to be used in the work contemplated hereby, and shall have full direction and control of the installation thereof.

X.

All water and service supplied by the Water Company hereunder will be furnished and supplied at and upon its standard schedule of rates now in force and as fixed by the Public Service Commission of Indiana, subject, however, to such changes or modifications thereof as may from time to time be made by the Public Service Commission.

XI.

This agreement, though tentatively signed and executed by the parties, shall not be binding upon the parties unless approved by the Public Service Commission of Indiana, or approved as lawful by the counsel of the Public Service Commission.

IN WITNESS WHEREOF, the parties have executed this agreement in duplicate the day and year aforesaid.

Features of the Contract

The form of contract provides that the landowner will be reimbursed for the cost of the extension, but without interest. The income from the consumers and also any hydrant rental belongs to the department or company for service rendered. The plan enables the landowner to improve his property and make it attractive to prospective buyers at the cost of the main pipes, meters and service pipes to curb line.

He is not required to make an investment for pumps, boilers and filters. He does not have the responsibility of operating a water plant; he gets the benefit of the same prices for material that the department or company enjoys.

The cost of the water pipes, etc., are a part of the development, like sidewalks, grading and trees, except that if good judgment has been used in selecting the land and the lots are sold at profitable prices in a reasonable period, the owner may be reimbursed for that portion of his investment for water mains. Incidentally, the cost of all improvements are added to the price of lots when they are sold.

In conclusion, it should be stated that a community cannot grow and prosper unless its utilities are prosperous; their interests are closely related, and what hurts one ultimately injures both. To be prosperous, a utility must have adequate rates which will produce sufficient earnings to make its securities attractive to the investor.

The foregoing paper by Mr. Gwinn was presented at the 1921 meeting of the Indiana Sanitary and Water Supply Association.

COST KEEPING ON CONSTRUCTION WORK

By F. H. Austin, Currie Engineering Co., Webster City, Iowa.

Good engineering requires that designs not only insure that structures will fill the purpose for which they were intended, but that the design finally decided upon will be the most economical one, and the estimating ability of the engineer is often the deciding factor between two designs, said Mr. Austin in addressing the 1921 meeting of the Iowa Engineering Society.

The subject of Cost Keeping on Construction Work is one in which every engineer must be vitally interested; is one which presents many difficulties to be overcome and it is only by exercising the greatest of care that we will be able to keep off the rocks.

Of what real value to the engineer is a knowledge of the cost of construction? There is no argument but which will admit that it is of some value, but the point is: what trouble and expense is an engineer justified in taking to obtain this information?

Influence of Cost Data on Engineering Estimate.

Possibly the greatest value of cost data is as an aid in preparing an estimate of cost. Some engineers argue that by closely following lettings and observing the bids received that they are able to make estimates that will come close to the low bid received. They also claim that there is usually some bidder who is governed to a large extent by the engineer's estimate, and consequently the estimate, even though inaccurate, will not be far from some of the bids.

The object of an Engineer's Estimate of Cost should not necessarily be to approximate the low bid, but rather to be of such amount that would allow a responsible and informed contractor to fulfill the terms of the contract and with a fair margin of profit.

If an engineer's estimate of cost is based on accurate cost data of sufficient volume, such that individual cost datum, which may be somewhat in error, will not materially affect the total, will he not have more confidence in his estimate and consequently will not the estimate be of vastly more value to his client?

Take for example the case of a town council receiving bids on a sewerage system. Suppose the council has asked for an estimate of cost and that the low bid is some 15% to 20% above the estimate. Is it not one of the most valuable items of engineering service to the town for the engineer to be able to say with conviction that the bids are too high and that the town can save money by having another letting? Or suppose the low bid is considerably below the estimate. Is it not the engineer's duty to himself, the bidder, and the town to advise the council that the work cannot be reconstructed for the amount bid, that the contractor will lose money or throw up the job to his bondsman, with the subsequent trouble and delay, and that the town is very likely to get an inferior piece of work? True it is that an engineer often does give this advice, but it is often with some misgivings and fear that his estimate has been made on not too sound data and formulae.

Using Cost Data for Comparing Designs

Another item of the value of cost data is in the comparison of different designs. I recall an instance of this in one of my own designs for a tile outlet of a large drainage district. The design was completed, sizes, lengths, and depths, and I was well satisfied with the design in general. There was being used some 2½ miles of pipe ranging in size from 30 to 39 ins., at a depth of from 8 to 14 ft. About one-half mile from the lower end there was a portion of the line which had considerable fall. By starting a new grade line from the upper end and using steeper grades and smaller sizes it was possible to save some $6,000 to $8,000 dollars although the average and maximum depths were considerably greater. At least the two estimates of costs so indicated.

Another instance of this kind occurred in the design of a sewerage system for a town of about 1,500 population. The slope of the town was such that the obvious thing to do was to carry the entire town north and east to a small creek. The design was so worked out, pumping the southwestern part of the town situated in a hollow. Later on a possible gravity outlet for this part of the town was investigated and while apparently not feasible, the comparison of cost estimates favored the gravity outlet by some $10,000 to $12,000.

In such cases as these, and they are encountered every day in designing, the ability of the engineer in comparing the relative costs of different designs is certainly invaluable to his client.

Data Necessary for Careful Estimating

The cost data necessary for careful estimating may be divided in four divisions: materials, labor, overhead and local conditions.

Take for example the cost of a sewage treatment plant. The cost of materials will include the cost of concrete materials, form lumber, sheating, bracing, reinforcing, brick, filter sand and stone, sewer pipe, cast iron pipe, valves, pumps, siphons, doors and windows, and a great number of odds and ends of different kinds of materials.

It is relatively easy to obtain reliable cost data on most of these items, and a careful estimate should take into account most of these items separately, although some of them could be grouped.

This information can be obtained from the manufacturers, or I believe that most contractors would show their bills for materials if the proposition was put to them in the proper light. Freight and shrinkage, of course, should be taken into account in arriving at the cost of materials.

The cost of labor will include the cost of excavation, forming, mixing and pouring concrete, placing reinforcing, removing forms, laying brickwork, setting doors and windows, cast iron pipe, valves, pumps, forming embankments, seeding, sodding, placing sand and stone, laying pipe, hauling, etc.

It is evident that it would be almost impossible and certainly not feasible to arrive at cost data on all of these different items and some of them must be grouped.

It is essential to obtain the items of labor cost in terms of man-hours, differentiating between skilled and common laterms of money as has often been done. bor, machine-hours ,and ton-mile haulage in place of obtaining the information in

The cost of overhead is perhaps more difficult to arrive at and will contain such items as office expense, superintendence, depreciation on machinery and equipment, repairs, losses of small equipment, such as: tools, jacks, cement sacks, etc.; bonds, interest on investment and borrowed capital, insurance of different kinds, discounts on bonds, cleaning up, moving and many items of general expense connected with the contracting business.

This cost can probably be best ascertained by making friends with the contractor and assuring him that the individual information will not become public property. I am sure that most of the reliable contractors will see the advantage of contributing cost information, in that the chance of their being able to obtain work at a fair price so often depends on a fair estimate of cost by the engineer.

The local conditions that will affect the cost of construction will include, site conditions, proximity of work to suitable materials, class of local labor and teams available, local housing and boarding conditions, forms of amusements and entertainments tending to keep labor contented.

If we should analyze the factors of cost on some other class of work we might find that some of the individual items of cost would be considerably different.

The matter of efficient handling of the work and whether or not the contractor has time and labor saving equipment should be noted and recorded in any method of cost keeping that is to be of value.

Actual Cost Comparison as Kept by Engineer and Contractor

I wish, as an example, to give an actual comparison between the cost of a sewer job as determined by cost-keeping reports to the engineer, and the cost as determined by the contractor's cost records.

	Engineer	Contractor
Materials	$7,625.55	$9,779.19
Labor	9,574.50	9,838.51
Use of machines	6,500.00	6,254.90
Overhead	5,119.21	5,570.32
Total	$28,819.26	$31,439.92

In the foregoing comparison the engineer's costs were made as follows:

Materials, from unit prices as quoted at the time of letting; labor, from the cost reports as returned by the resident engineer using the actual rates of pay; overhead, calculated as a percentage of the materials and labor costs using a percentage based on the contractor's figures, which in this case amounted to about 21.6%. In this particular instance the contractor rented the machines and the per diem charges for these machines were used in determining the amount for the use of machines under the engineer's cost.

These figures indicate that the engineer's cost fell short of the contractor's cost by about 9%. The greater part of this difference was in the materials item and it is evident that in this particular instance more care should have been taken in ascertaining the amounts of the different materials used.

The most satisfactory way to obtain sufficient data to be of real value is through the Engineering Society. The Society through its organization could do much toward bringing about a better spirit of co-operation between the contractor and the engineer in the matter of cost information, and would be attempting something worth while if it could collect such information so that it would be available to the engineering profession.

FEATURES OF NEW WATER PURIFICATION PLANT AT HARTSHORNE, OKLAHOMA

By V. V. Long, Consulting Engineer, 1300 Colcord Bldg., Oklahoma City, Okla.

The cities of Hartshorne and Haileyville, Oklahoma, take their water supply from a 250,000 gal. surface storage reservoir, created by a masonry dam across a valley two miles south of Hartshorne. The tributary drainage area is mostly mountainous. There are a few farms in the narrow valley. The creek feeding the reservoir ceases to flow during dry seasons.

The population of both cities is estimated at 7,500. This is a coal mining district. The water supply has been ample, but during the dry summer months has had an offensive odor. Water was pumped direct from the reservoir to the cities without treatment of any kind.

Tests made by the State Board of Health Laboratories in 1918 and 1919 showed the water to be unsafe for domestic use. Bacteria counts per cc. as high as 3,000 were obtained.

In August, 1919, the city retained V. V. Long & Co., consulting engineers, of Oklahoma City, to make investigations and recommendations as to improvements needed to secure a water suitable and safe for domestic consumption; $25,000 was available for improvements.

A heavy growth of vegetation was found around the edge of the reservoir, with large areas of shallow water. The organic matter in the water was high.

No algae were found by microscopical examination at the time of investigation late in August, yet the writer was of the opinion that they had been present earlier in the season.

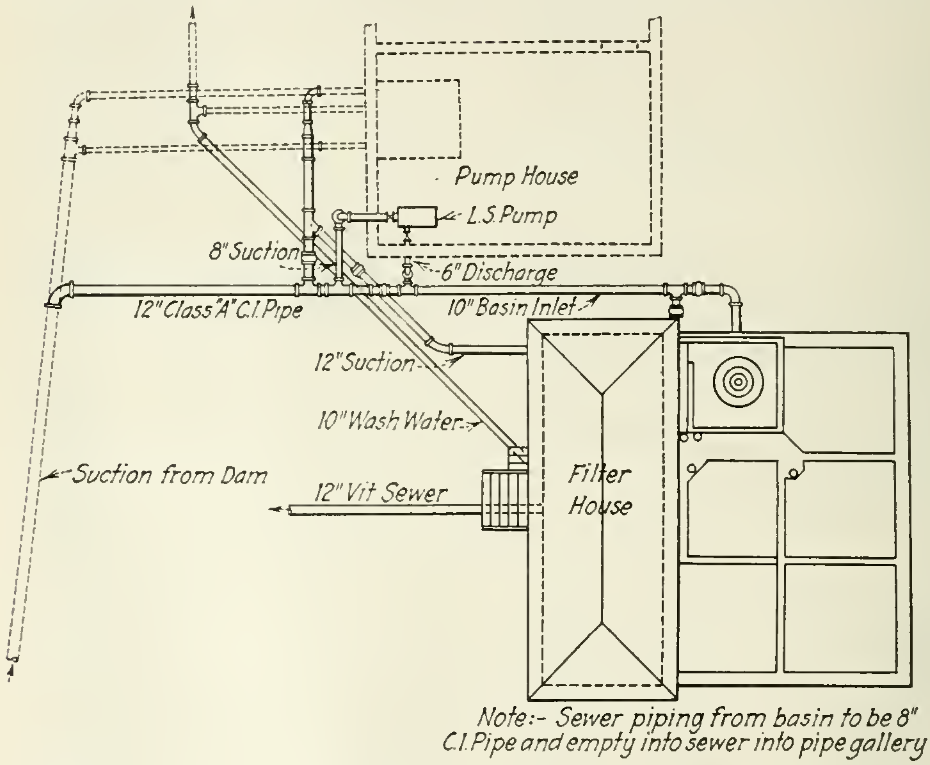
It was recommended that a water purification plant with an aerator for the raw water, be installed, that the weeds, brush and undergrowth around the edge of the reservoir, be cut and burned regularly and that the reservoir be treated with copper sulphate under the direction of the State Board of Health during the summer months.

equipment includes a dry feed chemical machine, aerator, agitator, and liquid chlorinator.

The Aerator

The aerator consists of horizontal, circular steel trays around the influent pipe to the basins. The water passes from the aerator to the agitator. When it is not necessary to use the aerator, water will flow by gravity from the reservoir to the agitator.

Alum is used as coagulent and is fed at the entrance to the agitator. The agitator consists of vertical wood baffles



GENERAL LAYOUT OF WATER PURIFICATION PLANT AT HARTSHORNE, OKLAHOMA.

Short Retention Period

Under the direction of the consulting engineers, a 500,000 gal. per day water purification plant was built. Due to the large storage capacity of the reservoir, thus assuring a high degree of sedimentation, only a 2½-hour retention period was figured for the coagulating basins. Two filter units were installed with connections so that others can be added. The clearwell is below the filters and pipe gallery. Reinforced concrete was used for the basins, filters and clearwell. A brick filter house covers the filters. Pittsburg Filter Equipment was used. The and mixing is obtained with only a ten-minute agitation period.

A manual control liquid chlorinator feeds liquid chlorine to the pump suction from the clearwell.

Copper sulphate was applied to the reservoir to good advantage during the past summer.

The construction work was done by N. S. Sherman, Machine & Iron Works, of Oklahoma City. The plant was placed in operation November 24th. Approximately 300,000 gals. is being used per day.

(Continued on Page 126)

MUELLER LEAD FLANGE WORK

The simplicity with which lead flange connections can be made by the *MUELLER* method and *MUELLER* goods is here illustrated. Note how the pipe withstands four full twists without injury to the joint. Note the knurled feature that makes the *MUELLER* leak-proof and non-loosening joint. *MUELLER* Ground Key Curb Cock E-565 is shown—one of many patterns.

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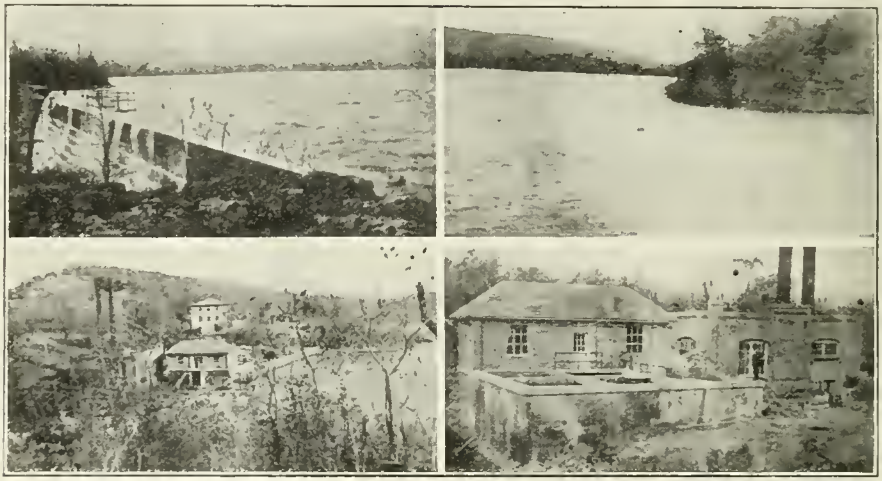
(Continued from Page 124)

Results of Test

A test Dec. 10, 1920, showed the following results:

Source	Bacteria Per cc.	Gas. 10 cc. Sample
Reservoir	480	Positive
Basin effluent	120	Positive
Filter No. 1, effluent	40	Negative
Filter No. 2, effluent	20	Negative
Alkalinity filtered water	45	P. P. M.
Total solids	70	P. P. M.



VIEW OF DAM, RESERVOIR AND WATER PURIFICATION PLANT AT HARTSHORNE, OKLAHOMA.
Top: Dam and Reservoir-Vegetation Around Reservoir Edge. Bottom: Filter Plant and Pumping Station —The 500,000 G. P. D. Filter Plant.

During the test an alum feed of two grains per gallon was used. The action in the coagulating basins justified the short retention period.

RELATION OF ZONING TO WORK OF CITY ENGINEER

By Edward S. Rankin, Engineer in Charge, Bureau of Sewers, City Hall, Newark, N. J.

The latest municipal activity, the zoning of cities, a movement which is growing rapidly in favor throughout the country, has been advocated chiefly on account of its effect in stabilizing property values and to a somewhat less extent as a health measure. There is no question but that these two reasons alone are ample justification for stringent laws governing the height of buildings, the location of residence and industrial districts, and the percentage of lot area permissible for building purposes. Our citizens should be protected in their inherent right to light and air, and our homes from the possibility of a noise or nuisance producing industry on the adjoining lot.

But there is another feature of the movement which is the subject of this article, a feature which does not seem to have received the recognition to which it is entitled, and which should be of peculiar interest to municipal engineers.

Zoning Removes Uncertainties

In a city in which a stringent zoning ordinance is in force the element of chance in the engineer's work is largely eliminated and decided economies effected, whether it be in the laying out of streets or in their paving, sewering or water supply, for it is obvious that with the assurance that a given section of the city will be occupied by a certain definite class and size of buildings the engineer can much more intelligently design the public works necessary to properly serve that section.

In the final report of the New York Commission on Building Districts and Restrictions, Mr. Nelson P. Lewis has this to say in regard to the opening of streets in undeveloped territory: "One of the serious problems confronting my office in passing upon street plans has been the need of providing what may be an excessive width of streets where land is cheap, for fear that the building of a new transportation line, putting the land in close touch with the business center, will result in an intense development by apart-

(Continued on Page 128)

(*Continued from Page* 126)

ment houses, so that we have been obliged to guard against conditions which formerly prevailed on the east side of Manhattan and to insist upon a minimum street width which is more than the real need of the territory if reasonably restricted. If such development were confined, for instance, to two or three-story houses, or in some cases to detached houses, we would not have been obliged to impose upon the property owners the cost of acquiring and then improving streets of greater capacity than they would need if there were some sane, reasonable plan for preventing over-intensive development."

In another part of the report the same author says: "This city has suffered tremendous losses by the inflexibility of its street system, which instead of controlling a subdivision has been controlled by the habit of creating lots 100 ft. deep lying between streets 200 ft. apart, and great enterprises, finding themselves hemmed in by rigid street systems, have been obliged to find new sites on the New Jersey meadows."

With a zoning ordinance in effect a street system can be laid out with streets of such width and such distances apart as best to serve the use to which the land will be put, and with the assurance that such use will be permanent. Parks and playgrounds can also be located where they will permanently be of the greatest service to the greatest number.

Relation of Zoning to Paving Problem

Perhaps the most obvious effect which zoning will have on public improvements will be in its relation to the paving problem.

In an industrial district durability and strength to carry the heaviest traffic will be the first consideration, while smoothness with an absence of noise will govern the selection of a pavement for a residence district. Of course, these features are given consideration without a zoning ordinance, but there is no assurance that the character of the district will not change and the pavement become unsuitable. The writer has in mind a street in his own city paved a few years ago with telford. The street was well built up at the time with moderate sized one and two-family detached houses, but adjoining a new railroad spur. Almost immediately following the paving of the street factories began to appear, attracted by the railroad, with the result that inside of a year the pavement was sadly in need of repair, and soon had to be replaced with more durable material. Had the street been restricted by a zoning ordinance to its original character, the pavement would have served every purpose for a number of years, or had it been definitely placed in an industrial district the mistake of laying a telford pavement would never have been made.

The effect of zoning on sewer design, with the substitution of known factors for estimates based on the judgment of the engineer, is very marked. For most of the remarks on this phase of the subject I am indebted to an article by Mr. W. W. Horner in the report of the City Plan Commission of St. Louis for 1919.

Effect of Zoning on Sewerage

The three factors governing the cost of sewers, length, depth and size, are all affected by the character of the district to be sewered. In a small house, residence district, all streets must have sewers, and, following the modern custom, connections laid to the curb for each lot approximately 25 ft. in width. For apartment houses, residences restricted to large lots, business or light manufacturing districts, the connections may be placed farther apart, while for heavy industries one or two to a block are sufficient, and in some blocks even main sewers may be unnecessary.

One and two-family houses and industrial buildings usually have cellars not to exceed 4 to 5 ft. in depth below the curb, hence a shallow sewer will serve every purpose, while apartment houses, and particularly commercial buildings, require much deeper sewers.

The necessary size of a sanitary sewer, omitting the factor of grade, being governed entirely by the number of people served, can be determined very accurately, knowing the permissible height of buildings and the proportion of building to lot area, and particularly when, as is the case with the Newark ordinance, the maximum number of families allowed per acre is specified.

In estimating the required size for combined and storm sewers by the so-called rational method, the uncertain but important factor of impervious area becomes a known quantity. As is well known, this factor may vary from 100 per cent. for entirely built-up areas down to 30 per cent. or even less in suburban districts.

Without definite restrictions it is necessary to estimate the possible maximum length, depth and size for all parts of a city alike, but with a zoning ordinance in effect each section can be treated separately and sewers built properly to sewer

(*Continued on Page* 130)

(*Continued from Page 128*)

such section alone. Mr. Horner estimates that from 10 to 15 per cent. of the cost of the St. Louis sewers could have been saved had a definite plan for the development of the areas been adopted when the system was designed.

With the exception of the factor of depth, similar remarks would apply to the water distribution system.

It would appear, therefore, that the municipal engineer should be one of the foremost advocates of the zoning of our cities.

The foregoing paper by Mr. Rankin was presented at the 1920 annual convention of the American Society for Municipal Improvements.

HYDRO-ELECTRIC ENGINEERING FIRM INCORPORATES

The Fargo Engineering Company, 212 West Cortland Street, Jackson, Mich., has filed articles of incorporation, with a capital stock of $50,000, all paid in. The officers are Wm. G. Fargo, president; Horace S. Hunt, vice president; Rolla G. England, secretary-treasurer.

This company is a consulting engineer firm which has been active in water power, steam power and general industrial work in the Middle West for 20 years. It is the outgrowth of an engineering office opened by Wm. G. Fargo in 1890.

In 1895, for the late W. A. Foote, Mr. Fargo began water power investigations, and, with his associates, has planned and supervised the construction of 20 important water power plants and 10 steam plants for the companies which Mr. Foote promoted or acquired, including the Consumers' Power Company and the Grand Rapids-Muskegon Power Company.

Fargo Engineering Company has also been engineers for four large water power installations, besides steam plant work, for the Indiana & Michigan Electric Co., of South Bend, Ind.; several steam and water power plants in Wisconsin for the American Public Utilities Company, and some 40 other power plants in various parts of the country.

Of Mr. Fargo's associates, Mr. England has been with the organization since 1899, Mr. Hunt since 1905 and Mr. Streiff since 1910.

At present the company has engineering work under way in various parts of the United States from Maine to Nebraska, also in Canada. It has recently completed an investigation for the Hydro-Electric Commission of the State of South Dakota, in connection with a series of dams proposed to be built by that State on the Missouri river, totaling 400,000 horse power. This project involves the building of 664 miles of primary transmission lines and upwards of 600 miles of secondary high-tension lines, besides the lower voltage distributing systems. The first dam will cost about $9,000,000 and the transmission line required with it about $8,000,000 more.

STREET LIGHTING EXTENSION AT SALT LAKE CITY

A contract has just been given to the Utah Power & Light Company by Salt Lake City for an extensive addition to the city's ornamental street lighting system which, when executed, will give Salt Lake the distinction of being the best lighted city of its size in the world.

The contract calls for 112 standards each carrying three General Electric Company's ornamental luminous arc lamps. The Union Metal Manufacturing Co., Canton, Ohio, will furnish the standards which will envelop the present trolley poles and carry two lamps below the trolley wire and one above. The total cost of the installation will be approximately $100,000.

Of special significance is the fact that the extension to the lighting system was brought about directly as the result of the success attending the first installation.

Salt Lake City will now have 182 lighting standards with 546 luminous arc lamps, giving a total candle power of 819,000 on less than two miles of streets, which is approximately 90 c.p. per foot of street lighted.

The second installation is interesting proof that after three years' trial of the intensive whiteway the business men of Salt Lake have decided that it is a good investment and worthy of extension.

A NON-FREEZING EXPLOSIVE

A new explosive that cannot freeze is announced by the Atlas Powder Co. of Philadelphia, Pa. Briefly, the qualifications claimed for this new explosive are: (1) Five grades for every blasting requirement; (2) cannot freeze at any temperature; (3) withstands the heat of summer; (4) its stability avoids premature explosions (nothing weaker than a No. 6 Blasting Cap should be used to detonate it); (5) will not cause headaches to those who use and handle it; (6) made in all standard size cartridges.

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Construction News and Equipment

HOW A PORTABLE MIXING PLANT WAS USED TO SOLVE A CONSTRUCTION PROBLEM

When constructing the 6½ miles of 12 duct subway between Union and Passaic, New Jersey, and the 2¼ miles of 24 duct subway between Jersey City and Newark, New Jersey, the New York Telephone Co. was confronted with problems which compelled some radical changes in equipment.

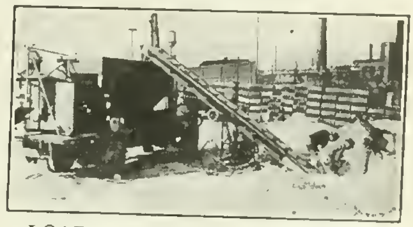
The construction of the subways was of multiple duct tile with a concrete foundation and concrete top protection, and all manholes were built entirely of concrete.

The road on the Union-Passaic job being very narrow and lined with swamps on both sides, the mixing of this concrete would have necessitated the building of platforms in the swamps for the mixer and material about 500 ft., apart and at a very high cost.

A concrete mixing plant mounted on a motor truck was the answer.

The outfit consisted of a power batch concrete mixer mounted on a 7-ton Packard motor truck, which was also equipped with two gravity hoppers, one for sand and the other for stone, in addition to a tank for water.

The materials for the concrete were gathered at a convenient place on the job and the sand and stone loaded into the hoppers by a Portable Machinery Co. Scoop Conveyor, as shown in one of the illustrations. Bags of cement were also



LOADING AGGREGATE HOPPERS MOUNTED ON MOTOR TRUCK WITH PORTABLE SCOOP CONVEYOR.

put on board and, fully loaded, the outfit carried material sufficient for 5 yds. of concrete.

The power mixer was fed by a laborer on the truck shoveling sand and stone from openings at the bottom of the gravity hoppers. The concrete was poured directly into the truck or manhole excava-

CONCRETE MIXER, TWO GRAVITY AGGREGATE HOPPERS AND WATER TANK, MOUNTED ON 7-TON PACKARD TRUCK FOR CONCRETING TELEPHONE CONDUIT IN NEW JERSEY.

tions by means of a spout. The truck driver, with a little practice, found it possible to regulate the forward movement of the truck to give the required thickness to the concrete in the truck so that little hand spreading was necessary. The saving of this equipment on this job was great.

On the Jersey City-Newark job, although it was possible to mix the concrete in the usual way at stations along the trench, the use of the portable mixing plant was found to be about 25 per cent cheaper than the fixed concrete mixing stations and the dumping of the concrete into the trench and manhole excavations from wheelbarrows.

IOWA ROAD CONTRACTOR PROSPERS WITH GOOD EQUIPMENT

Robert Henkel a few years ago was building concrete sidewalks in Mason City, Iowa. He had a bunch of wheelbarrows, some shovels and small tools and a small mixer. He knew how to handle cement and built good sidewalks. Having served an apprenticeship at this job, he turned bridge builder and did good work there. When Cerro Gordo county, after trying out short stretches of concrete roads for several years, got her hands on the first federal aid allotment of dollar for dollar money that came to Iowa and let a contract for four miles of concrete paving in one batch, Henkle sat up and took notice. "If Cerro Gordo county is going to build concrete roads, why shouldn't I build them or at least part of them?"

When after completing the four mile stretch, Cerro Gordo saw more federal money set apart for Iowa she again was standing in line and even before other progressive counties had made application for their share, had the money cinched, her plans and specifications ready and three contracts let. Henkel had one of the contracts, only it was The Henkel Construction Company now, with Henkel, Jr., as part of the company, says the Service Bulletin of the Iowa Highway Commission.

Henkel's contract was for 7½ miles of the East and West road through the county, the Old North Iowa Pike, now known as the National Parks Highway, also part of the Pershing Way. The contract called for one course concrete pavement, 18 feet wide, 8-in. thick at the center and 7-in. thick at the edges. The mix was to be 1-2-3½.

With the contract in hand the next thing was to plan the equipment and develop the organization with which to do the work. Henkel, Jr., had spent an entire season in Illinois on road construction jobs with the special purpose of studying different methods of construction in use by the large firms building roads there.

The old-fashioned wheelbarrow outfit with materials dumped on the roadway went into the discard. The balance between the central proportioning and the central mixing plant swung in favor of the central proportioning plant with the mixing done in one continuous operation without the intervening delay caused by hauling the wet mix. With the central proportioning plant settled upon, came the question of transportation. Should it be by individual trucks or the industrial railway; and the industrial railway won. This required quite a complete rail road layout of five miles of track and switches, three 6-ton locomotives, 30 two-box trucks, 80 wooden batch boxes with hinged bottoms and minor railway equipment necessary to operate the line.

The Milwaukee line parallels the North Iowa Pike for the entire distance of the paving contract. At a point about half way out the company established a switch and there the proportioning plant was established. A cement storage house was built. The tunnel system of loading the cars was determined upon. A long shed was built over the industrial track. Over and above this shed the sand and gravel was piled as it was unloaded from the Milwaukee freight cars. The trains of Western industrial trucks and batch boxes were run under the shed or into the tunnel, as it is called, and in short order every box had its proper amount of sand and gravel, ready for the short journey to the cement sheds where the stop was even shorter before the run to the construction crew. A crane operator, two men on the aggregate pile, three cement men and one car cleaner, completed the loading crew.

The paving equipment consisted of the Koehring 21-E four bag mixer and the Lakewood finishing machine. The mixer was equipped with a crane for lifting the batch boxes off the trucks and swinging them over the mixer skip. A crane man and three helpers spotted the cars, handled the boxes, dumped the materials, reloaded the boxes and pushed the cars out of the way for the next. There were a mixer engineer, a mixer foreman and two spreaders.

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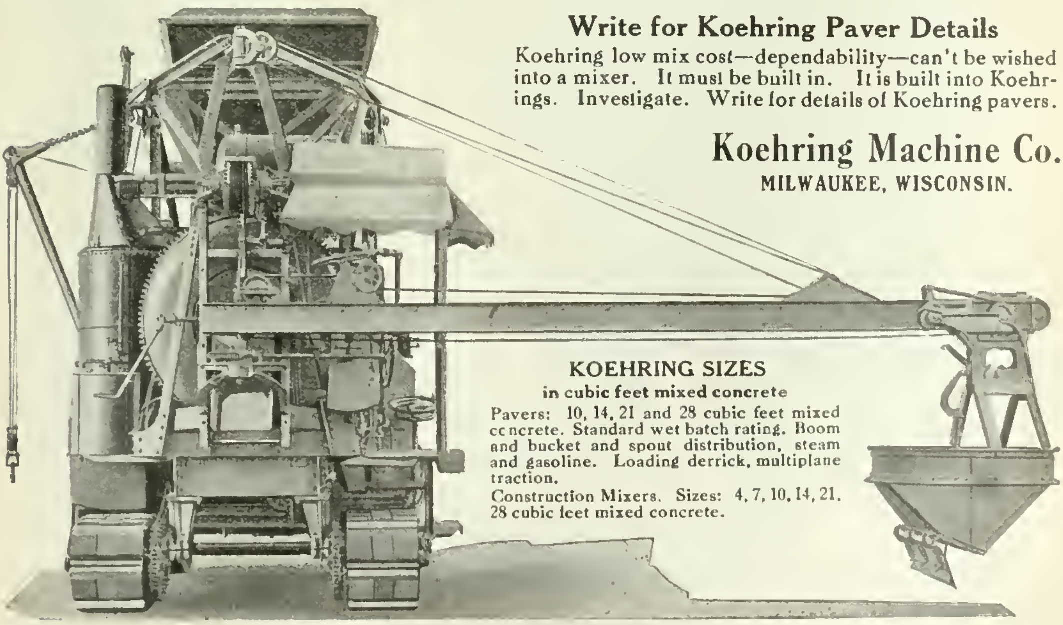

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With the Lakewood machine there was the operator who looked after the machine and the various finishing jobs. Two additional men looked after the water supply, covering of the freshly laid concrete and other odd jobs.

The grading work was completed well in advance and a good shoulder built for the railway track. A subgrading machine immediately ahead of the mixer trued up the excavation for the concrete slab and there was little or no trouble on this score at the mixer. The subgrade was usually as perfect as the traffic surface of the concrete slab. There was no loss of material filling up depressions and no danger of weakening of the slab where the subgrade was high and the inspector off the job for an instant.

With a plentiful supply of materials the equipment and the crew averaged between 400 and 500 ft. of concrete per day. But there was not always a sufficient supply of material. There were many weeks when two or three days each were entirely lost because of lack of materials and this within a few miles of the large gravel pits and cement factories at Mason City, the source of the material supply.

The Henkel road building plant was well balanced. Henkel acted as foreman himself. Every part of the work was well coordinated with every other part. There were just enough men and just enough equipment in each phase of the work. With good weather and plenty of material, each branch of the outfit kept its part of the work up so that there was no unnecessary delay. There was no hurry or confusion. Each man had his work and had time enough to do it. Moreover he did it and he did it when it should have been done for Henkel was there to see that he did.

One noticeable feature of the work of the outfit on the occasion of two visits was the clean and perfect condition of the subgrade for three or four hundred feet ahead of the mixer. The surface was as true as a floor and seemed to be swept almost as clean. The entire 7½ mile job was worked with one layout of the track.

The proportioning plant was about midway of the distance, the longest haul being at the start, something over four miles. The shoulders were well built and the track well laid, so that there was little trouble from wrecks and delays on the track.

That it pays to equip fully and completely and to have a well organized and well coordinated force, is shown by Mr. Henkel's experience. He stated that he was able by carefully balancing and adjusting his outfit to save an average of $32 per day over what he had estimated before starting work to be his daily average.

The Henkel plant was inspected frequently during the 1920 season by other contractors and by men who contemplate outfitting for road building. Both father and son were well pleased with their plant and feel that the careful study they gave before adopting the central proportioning and industrial railway systems returned them good dividends. And Henkel is not alone among the Iowans who have taken to the road building game and equipped with the best of them for the work to be done. Three or four other Iowa firms that got under way for the first time in 1920, bid fair to set examples to the older contracting firms who invaded Iowa from neighboring states at the beginning of the season just past when Iowa made her start at the improvement of the primary road system.

CUTTING DOWN THE LABOR COST ON CONSTRUCTION

By Samuel G. Kuhlen, Austin Machinery Corporation, Railway Exchange Bldg., Chicago, Ill.

Contractors are not immune from the one bane common to all industries, that of "leaks" through misuse and waste of time and energy. Masters of efficiency have not yet succeeded in completely eradicating this drain on profits from any line of business, and there are few lines which offer so many obstacles to thorough-going efficiency as contracting.

Since labor is, perhaps, the contractor's largest single cost item, great care should be used in its conservation. As a general rule, however, it receives scant attention. Many men are still employed for work which can be much more economically handled by machinery.

Paving, for instance, affords striking examples of inconsistency. Few contractors would even think of mixing concrete by hand. No, indeed, nothing short of the largest and fastest machines would answer for this important duty, or how could bids be figured to win? Yet the majority of contractors still use hand labor for all the remaining operations, in spite of the fact that perfected machinery is now available which tamps, strikes off and finishes, combining these three operations in one and doing it as fast as the mixer can lay down the

batches. If contracts can be won without this extra efficiency, is that sufficient ground for rejecting it? If the added profits are not attractive, why bid at all?

Idle paving machines are another serious drain on profits. Large amounts are often lost on one contract by keeping fast machines of generous capacity, together with their crews, waiting for batch materials. This can be avoided by the use of narrow-gauge gasoline locomotives and batch cars.

Equally wasteful is the widespread practice of filling ditches by hand instead of using a backfiller. As with paving, so here, machines are universally used for the first operation, that of digging, while the equally important work of replacing the earth is usually still done with slow expensive hand labor. This is too often complicated by leaving the backfilling to be done at some future time. In the meanwhile the ground freezes or forms into a solid mass, requiring an extra force of men with picks to break it up before it can be shoveled. Then, too, contracts are not paid in full until they are completed, adding one more "leak" to the extra cost of hand-breaking and filling.

Many contracts fail to return proportionate profits because of worn out or antiquated equipment. The temptation to squeeze the last dollar out of an investment is quite natural, but the time inevitably comes when excessive repairs or capacity limitations spell the doom of this class of inefficiency. The poorly equipped contractor can not hope to compete successfully with his more progressive rival. If he figures to make a profit on his costly methods he is sure to lose contracts and if he figures to win contracts he will as surely forfeit his earnings in their execution.

Right now, at the beginning of the greatest road-building and construction era, is the time to check up on equipment and fill the gaps between efficiency and inefficiency.

THE NEW LAKEWOOD-HOTCHKISS ROAD FORM

After three years' development work a new steel form for concrete road construction has been developed by the Lakewood Engineering Company, Cleveland. The new Lakewood-Hotchkiss form is designed to meet all the requirements of modern road construction.

Lakewood-Hotchkiss blue annealed, high carbon steel road forms are furnished in sections 10 ft. long, and in the heights for road thicknesses of 5, 6, 7, 8 or 9 ins.

The distinguishing feature of the design is that a somewhat lighter metal has been used for the main section of the form, but this section has been reinforced by stiffening members, advantageously placed. Each 10-ft. section has the top flange supported at five intermediate points by a heavy stiffening iron.

This principle is the same as is used in bridge design, where light members are riveted together to form a strong truss, rather than using one solid heavy section of sufficient strength to carry the load.

The forms also are different in that electric spot welding is used in addition to riveting to fasten the various members of the form together. The form has a bottom flange 4 ins. wide, giving a large

THREE STAKE POCKETS AND TWO INTERMEDIATE BRACES TO EACH 10 FT. SECTION GIVE STRONG, RIGID SUPPORT TO THE NEW LAKEWOOD-HOTCHKISS ROAD FORM.

bearing area on the ground. The top flange is 2¼ ins. wide, which is ample as a rail for the finishing or subgrade machines. The turndown section of the top is 1¾ ins. deep, making for unusual strength at this point.

The forms are staked to the ground with three stakes to each 10-ft. section. The stake pockets have elliptical holes, giving considerable leeway when driving the stake, so that it does not disturb the alignment of the forms. After the stake has been driven until its head is about an inch and a half below the top of the form, so that the stakes will not interfere with the finishing machine wheels, the form is clamped to the stake by a heavy wedge member sliding in the stake pocket. This wedge is heavy enough to allow driving with a sledge hammer. It has a quarter-inch bearing on the stake, and can not become bent or rapidly worn. These wedges may, however, be easily replaced when worn. They are held in the pockets and can not become lost on the job.

The forms are built so that any section

may be removed from a line of forms set up to allow passage of trucks or other contractors' tools. There is an extra heavy slide, at the joint, which holds the forms in alignment, both laterally and vertically, and assures a smooth joint between the forms over which the finishing machines may run. These slides are extra heavy, and so located as to be accessible for driving with hand hammer when setting up or taking down the forms. It is to be noted that the top of this slide accurately fits into the channel shaped head of the road form. It can be definitely stated there will be no opening of the forms at the joints because of the careful working out of the details of this locking device.

There are no rivets in the top flange of the form to get worn and loose under the wheels of the finisher or subgrader.

The sections of form are made from steel especially milled to size for each height of form. The rolled edges of the top and bottom flanges are so smooth that a man can not cut his fingers while handling the form. It is the form with the velvet edge.

CONTRACTING AS A PROFESSION

By F. C. Young, Mem. Am. Soc. C. E., of Moore-Young Construction Co., Waterloo, Ia.

The occupation of applying labor and machinery to raw materials for the production of structures has always appealed to the writer as a most interesting calling. The fact that we are so engaged is not the result of accident or chance but of a life-long ambition and directed effort. A study recently made of the financial results of a season's operations in contracting led the writer to a further consideration and analysis of the elements entering into the business. We are led to the conclusion that contracting is a profession. While this is not a new viewpoint for us it is one perhaps not generally recognized. Hence the occasion for this discussion, said Mr. Young, in addressing the 1921 meeting of the Iowa Engineering Society.

We find from the dictionary that a profession is a calling, other than those purely commercial, mechanical, or agricultural, to which one devotes one's self and in which one employs some special knowledge. It would seem that the only argument necessary to establish that contracting is a profession is to prove that it is more than a purely commercial calling. Before discussing the special knowledge which a contractor employs and which we believe makes the calling a profession, let us consider what a contracting business consists of from a purely commercial standpoint.

Of What Does the Contractor's Business Consist?

Let us consider a season's business of what might be a typical contractor's experience. Mr. Contractor, we will call him, is operating a one-man organization, that is, one of the size that one man can not only direct, but attend to the general executive details personally. By this we mean specifically that he does his own bidding, buying, and directs the construction operations in considerable detail himself. Being in the paving business this means that he has from two to three crews in the field, capable of laying from one to two hundred thousand yards of paving per year. This means on present prices anywhere from one-half to one million dollars per year. The season's business for 1920 consisted of the construction of 140,000 sq. yds. of paving at a total value of $568,000.

System of Accounting

Before going into the analysis which we propose it will be necessary to explain briefly the system of accounting which Mr. Contractor employs. He uses a double entry journal and ledger in which he keeps an account with each contract. All labor and material and all expenses whatsoever incident to the construction of any contract are charged to that contract. This includes liability insurance, interest on money used on that contract, discount that may become incident to the sale of bonds on certificates and small tools that may be considered as consumed on the job. All large articles of equipment which last more than one job are carried in an equipment account.

What Becomes of Contractor's Money

Under this system of accounting the season's operation under discussion shows a job profit of $83,000, or 58½ cts. per sq. yd. of paving, or 14½% of the volume of business. Immediately, we anticipate, you will say this is a generous profit, but let us analyze farther. We find a general overhead expense of some $10,000 consisting of office, traveling, and general expense incident to the business and not charged directly to any specific contract. This amounts to 7 cts. per sq. yd. of paving or 2% of the volume of business. This we believe to be a very low overhead and one which could not be attained in anything but a one-man organization.

Again we find that the depreciation charged off on equipment amounted to $16,000, or 11½ cts. per sq. yd. of paving, or 3% of the volume of business. This item we believe to be reasonable also, and it is, in fact, made as nearly as possible in accordance with the instructions of the government with respect to income tax returns; that is, that every article of equipment may be depreciated annually an amount equal to its actual cost divided by its probable life. In this connection the government rules that this depreciation in every case must be based on original cost and not on market price and that no loss can be charged off due to a reduction of the market unless the loss be actually incurred by the sale of the equipment. It can readily be seen, in this connection, that every contractor is facing a loss on equipment, during the falling market which we seem to be facing; a loss which he cannot charge off on his showing. In other words he will be compelled to pay an income tax on a false showing or on a paper profit which does not exist.

May we be allowed to digress at this point to say that we have observed that the government's requirements in the matter of accounting for the purpose of income returns which apply to practically every man, woman and child in the United States earning more than a common laborer's wage, have been, and are the means of a great amount of much needed education? A small-town banker recently made the statement that he believed that the amount of income tax which the farmers of his community had paid had been a good investment to them with respect to the knowledge of their own business which they had gained. He stated this applied not only to farmers, but to a great many small business men and contractors as well. May we be permitted to say that we believe that our schools, from the lower grades to the universities, have been and are lacking in instruction in elementary accounting and business methods?

To return to our subject, we now find that our job profit of 58½ cts. per sq. yd. is reduced to a final profit of 40 cts. by the general overhead and equipment depreciation. This 40 cts. amounts to 10% of the volume of business and is the paper profit on which an income tax return must be made.

We say "paper" profit for it exists on paper only. No charge has as yet been made for the personal or "professional" services, if you please, of Mr. Contractor himself. The business under discussion is a partnership and Mr. Contractor's partner contributes to the business a large part of the necessary financial credit necessary to conduct such a business. In so doing he devotes about one-half of his time to the work. Computing then the personal services of one man and one-half time for another at a salary equal only to that paid to the highest salaried foreman in this organization, plus the interest on the actual investment in the business we have an item of $11,000, or 8 cts. per sq. yd. of paving, or 2% of the business done. This leaves a real profit of 32 cts. per sq. yd., or 8% of the business done.

Still a very profitable business you say; yes, if Mr. Contractor had this amount in his pocket or to his credit in the bank. But where is it? Five of the 8% we find reinvested in equipment and therefore existing as an asset only in the shape of second-hand equipment. This leaves a cash profit of only 13 cts. per sq. yd. or 3% of the business done.

Still a fine salary, you say. Yes, perhaps so, if Mr. Wilson had managed to keep us out of war. But on an income return Mr. Contractor is compelled to pay our government a tax on something over three thousand dollars, leaving him a net cash profit of some six thousand dollars. In this connection we are informed that the State Highway Engineer of a neighboring state has made the statement that no road contractor in his state would be allowed to take work at a price that would yield him more than four thousand dollars for one outfit or six thousand for two. Our Mr. Iowa Contractor then comes within these requirements and yet road contractors are coming into our state from the state to which we refer with the assertion that we are getting better prices than they are able to get in their state. May it not be, therefore, that the State Engineer in question has failed to appreciate all the factors that enter into the conduct of a contracting business?

Should A Contractor Incorporate His Business?

It may now occur to you that Mr. Contractor should incorporate his business. He should by all means. A fair capitalization for a business of this size would be $100,000. On this basis we find that the income tax on the season's business in question would amount to something over seventeen thousand dollars or almost the entire cash profit. This seems, and we believe is, an injustice to a corporation of this character. The excessive tax would be due of course to the fact that the business done is nearly six times the invested capital. But Mr. Contractor could not afford to have an invested capital anywhere equal to his business turnover. It is much more economical to borrow at least 75% of the face of his contracts.

It would seem, perhaps, that Mr. Contractor should be allowed to incorporate as a personal service corporation and thereby be able to secure the advantages of a corporation, but still be allowed to make a tax return as an individual. This would not be allowed, however, under the rulings of the Internal Revenue Department. The statutory definition of a personal service corporation is one whose income can be ascribed primarily to the activities of the principal owners, who are themselves regularly engaged in the actual conduct of the business. But the rulings are that the employment of capital must be merely incidental and that profits from trading must not equal 50% of the gross income, and furthermore, that if the owners merely supervise or direct a force of employees the corporation is not a personal service corporation. We are barred then from this classification and it might be inferred in this connection that we have no justification for claiming to be rendering professional services.

Why the Contractor is a Professional Man.

This brings us back to our subject and we now wish to call attention to the extent to which we believe Mr. Contractor's calling is a profession. In the first place he has a technical education. He is the graduate of an engineering college. Not necessary, do you say? Not absolutely, to be sure, but highly desirable, we believe. The days of the old type of contractor are rapidly passing. We refer to the contractor who has come to be such largely through his political position and who uses his influence incident to such a position to secure contracts and to make a profit on the same at the expense, perhaps, of the public. We say this type is rapidly passing and it is a fact that a majority of the contractors who are today engaged in the line of work in which we are interested, in this territory at least, are technical men. They are engineers because of the close relation of the knowledge necessary to design and supervise construction to that necessary to the actual employment of the labor, machinery and materials to build it. This is becoming more and more true as the application of technical knowledge is becoming more and more recognized as necessary to proper and economical construction.

In addition to school education Mr. Contractor has experience in his chosen line. He has been out of school some ten years. The first few years were devoted partly to the practice of engineering and partly to construction work. Having in mind fitting himself to be a contractor he made a special study of methods of construction and their cost. Having reached the point where he thought he could with some degree of certainty estimate the cost of a piece of construction he established the necessary financial connections and made a start. Then through several years of effort, not always successful from a financial standpoint, Mr. Contractor has been gaining experience in his chosen calling. He has been bearing in mind always that his ultimate success depended upon his so conducting his business that his relations, not only financially, but professionally, must be such that he would gain a reputation and standing as a reputable contractor. He must, in short, become recognized as having the necessary experience, resources, organization, and knowledge to properly carry out a construction project. Has he any defensible claim that his calling is a profession?

Consider the Doctor.

By way of final comparison consider the doctor. Without any dispute the calling of a doctor is considered as one of the learned professions. Consider a doctor who has, we will say, been out of school ten years and who is now enjoying successful practice. What has made his calling a profession? He has technical education, some investment in equipment, some apprenticeship following his schooling, and then has, necessarily, spent several years gaining experience and building himself up a practice and reputation so that he will be recognized as one who can safely be intrusted with work in his line.

Is not contracting, as we have considered it, just as much of a profession as that of the doctor? Could the doctor, for instance, take the contractor's equipment and conduct his business? No, he could neither secure a contract, nor carry it out, much less make a profit. In other words, the tangible assets of the contractor, and they consist only of his equipment, would be of no more use to a doctor than would the surgical instruments of the doctor be to the contractor.

Hazards of Contracting

Again, to return to the commercial aspects of the contracting business, it must be remembered that it is the most hazardous of all enterprises. The government income returns show that for every dollar earned in the manufacturing industry, seven cents are lost; that for every dollar earned in the banking business, fourteen cents are lost; and that for every dollar earned in the construction business, twenty-five cents are lost. The contractor must, therefore, if he be successful, have initiative and executive ability to meet and overcome the uncertainties of the market, and of labor conditions, to a greater degree than is demanded in any other industry.

We conclude, therefore, that not only must the contractor employ the arts of salesmanship, financiering, and general business methods, but that he also must employ in a large measure special technical knowledge worthy of being classed as professional. Is he not entitled to a return commensurate with the professional knowledge used, and at least equal to that of any commercial enterprise of equal magnitude?

Contracts Awarded

ROADS AND STREETS.

Ala., Birmingham—H. N. Bowdry, awarded contract to pave 11th Ave., North; asph. on conc. base, at $83,090; J. T. Morgan Co., contract to pave 10th Court, at $81,316.

Ariz., Globe—McPeake, Burton & Brockman, 620 Security Bldg., Los Angeles, awarded for paving, curbing and bldg. walks on 7,000 ft. Broad St., at about $164,000.

Ark., Bentonville—A. A. Davis & Co., Okla. City, awarded contract for grading culverts and surfacing 30.31 miles hwy. in Road Impvt. Dist. No. 6, Benton Co., at $131,490; Campbell Bros., Kansas City, Mo., awarded contract for bridges at $9,783.

Cal., Carpinteria—Chas. T. Richardson, 525 E. Haley St., Santa Barbara, awarded contract for paving new Carpinteria Rd. with macadam, using materials from asph. mines near here, at $108,800.

Cal., El Centro—Geo. H. Oswald, 336 E. 58th St., Los Angeles, award. cont. for paving portion of Main St., at 34c sq. ft. for 5-in. Willite, 19c sq. ft. for 2-in. Willite and 90c ft. for curb; also contr. for paving portion of 4th St., at 34c sq. ft. for Willite and 90c for curb. Contr. involves abt. 220,000 sq. ft. paving.

Cal., Hollister—W. A. Dontanville, Petaluma, awarded contract for paving streets with conc., at $100,000.

Cal., San Diego—Bent Bros. Constr. Co., Central Bldg., Los Angeles, awad. contr. for paving with 5-in. conc., 16 ft. wide, rein. with wire mesh, San Julian Rd., No. 3-B, Ballena to Julian, 10.12 mi., at $262,831.

Cal., San Diego—G. R. Daley, McNeece Bldg., award. contr. for pacing 4.473 mi. hwy. betw. Escondido and San Marcos, at $112,881.

Colo., Rocky Ford—Strange-McGuire Paving Co., Fort Morgan, award. contr. for 21 blks. paving here, at $151,000.

Fla., Titusville—E. P. Maule, Miami, Fla., award. cont. to rebuild 28 mi. of road, Brevard Co., at $200,000.

Ill., Chicago—Bd. Local Impvts. let contracts for impvt. of portion Colfax Ave., to Calumet Coal & Trading Co., 9022 Commercial Ave., at $72,102; paving (a) portion Gary Pl., (b) Kedvale Ave., (c) S. Kirkpatrick Ave., (d) LeClaire Ave., (e) Wabania Ave., to R. F. Conway Co., 133 W. Washington St.; (a) $9,443, (b) $10,230, (c) $36,160, (d) $25,713, (e) $41,161; Montrose Ave., Central to Menard; Parkside Manor & Mango Aces., Montrose to Sunnyside Aves., to Am. Asph. Paving Co., 133 W. Washington St., at $78,784; portion of Grace St., to White Paving Co., 17 No. La Salle St., at $406,050.

Ill., Geneva—Contr. for road work in Kane Co. award. as follows: Sec. O-15d to Hans Jensen, St. Charles, Ill., at $27,941; Sec. P to Wilson A. Jaicks, Chicago, Ill., at $66,173; Sec. R, to Chas. E. Gentz

& Son. Elgin, Ill., at $135,913, 18 ft. Portland cem. conc. pavements.

Ill., Herrin—Peter Cardani, Marion, award. contr. for constr. of brick pavement on city streets, at $113,329.

Ind., Wabash—Pike Constr. Co., award. contr. for extension of Lafontaine Rd.; also constr. of Chippewa Road, at $241,526.

Minn., Mahnomen—M. W. Barnard & Son, 1817 Irving Ave., S. Minneapolis, award. contr. for grading at $115,673; Minneapolis Bridge Co. award. contr. for monolithic culverts, at $33,888 (contr. located at 1035 Met. Life Bldg., Minneapolis); P. H. Cramer, Crookston, Minn., award. contr. for portable culverts at $1.59 per ft. for FAP 117, 22 miles in length.

Mo., Caruthersville—State Hwy. Dept. let contr. to J. M. Elvaine and C. R. Pierce, Caruthersville, for bldg. 5.93 miles Kings Hwy., (Hayti Special Rd. Dist.), F. A. P. 35, Pemiscot Co., at total cost of $73,183.

Mo., Kansas City—D. T. Brosnahan, award. contr. for paving Main St., 33rd to 39th Streets, 3-in. vitr. brk. on 8-in. conc. base, at $99,925.

N. Y., Albany—Lane Constr. Co., Meridan, Conn., award. contr. for bldg. 5.03 mi. state rd. from Holland Patent to Frenchville, bitum. conc., at $338,968. Work involves 45,500 cu. yds. earth and 2,900 cu. yds. rock excav., 4,840 cu. yds. broken stone base, etc.

N. C., Hendersonville—Davidson-Grennell Co., West Palm Beach, Fla., award. contr. for street paving here. Contr. will entail expenditure of abt. a million dollars covering a period of perhaps one year. Type of pavement will be penetration asph. on 8-in. macad. base. Practically every street in Henderson will be paved.

N. C., Rutherfordton—Geer Wilson Co., award. contr. to pave streets; 2.2 miles, at $100,000.

N. C., Washington—Ligon, 2,000 Brookfield Ave., Baltimore, award. contr. to constr. 6,500 sq. yds. vitr. brick with asph. filler paving; 2.6 miles storm sewers, at $421,176.

N. C., Wilson—R. G. Lassiter & Co., Raleigh, award. contr. for grading, paving, etc. on various streets, Warrenite-Bitulithic on conc. base, at abt. $466,000.

O., Akron—Summit County let contr. for grading and paving 3.01 mi. Sects. A and B Rd., 49, to V. Olson Contg. Co., 507 Mahoning Bank Bldg., Youngstown, at $137,100; 3.89 mi. Sect. 4A and 4B Rds., 15 and 133, bitum. conc. on 6-in. conc. base and 7.78 mi. conc. curbing, to T. E. McShaffrey Constr. Co., 173 S. Forge St., at $196,850.

Okla., Ardmore—Maney Bros., Okla. City, award. contr. for 16 mi. gravel rd., Carter Co., at $340,000.

Okla., Idabel—S. B. McCartney, Valiant, award. contr. for bldg. 8.8 mi. earth rd. 18 ft. wide, F. A. P. 2, at $113,497.

Okla., Mangum—Roberts Bros. Constr. Co., Wichita Falls, Tex., award. contr. by Bd. of Commrs. for paving Street Impvt. Dist. No. 1, at $241,603.

Okla., Okla. City—Western Paving Co., 518 Terminal Bldg. award. contr. for paving 3 mi. rd. 18 ft. wide, F. A. P. 19 (bitum. conc.) at $128,747; 7 mi. conc. to Allan & Harrison, Okla., at $367,275; 3 mi. conc. to M. A. Swatek & Co., 412 Security Bldg., at $138,794.

Okla., Walters—Wichita Falls Paving Co., Wichita Falls, Tex., award. contr. for paving 93,000 sq. yds. paving, $520,000 available.

Okla., Waurika—Roberts Bros., Wichita Falls, Tex., award. contr. for paving various streets, involving 60,000 sq. yds. asph. conc., at abt. $225,000.

Ore., Salem—State Hwy. Comm. has award. contracts as follows: Pacific Bridge Co., 8.6 mi. bitum. paving, Monroe to Junction City, at $248,558; Blake, Compton Co., 6.3 mi. bitum. paving, Walker to Divide, at $178,540; Canyon Creek, Douglas Co., to Parker & Bonfield, Portland, at $13,159.50.

S. C., Bennettsville—Southern Paving Co., Chattanooga, Tenn., awarded contr. to constr. 70,000 sq. yds. pavement and 40,000 lin. ft. combination curb and gutter, at $500,000.

Tex., Eastland—Fleming-Stitzer Road Bldg. Co., award. contr. to constr. rds; bitum. macadam, at $4,500,000.

Tex., El Paso—El Paso Bitulithic Co., award. contr. to constr. 15.45 mi. conc. paved road on State Hwy. 33, the Alamogordo Rd.; 163,200 sq. yds. pavement, at $479,245.

Tex., Fort Worth—Womack Constr. Co., Fort Worth, award. contr. for impvt. of State Rd. No. 2, 13.36 mi. Work consists of constr. of drainage structs. and bridges; also roadbed complete, at $134,000.

Tex., Kaufman—Smith Bros. & Healy Constr. Co., Dallas Tex. award. contr. for 25.4 mi. F. A. Hwy. No. 40, at $149,343; also 60.03 mi. County Rd., at $372,999.

Tex., Seguin—P. Schriever, Seguin, award. contr. for bldg. rein. conc. draing. structs. on 19.1 mi. State Hwy. 3 from here west to Bexar Co. line, including 10 percent for engrg. and contingencies, at $79,072.

Tex., Houston—Griswold & Walling, award. contr. for graveling 18 mi. city streets at $179,053; Gulf Bitulithic Co. award. contr. for paving certain streets in city at total of $40,000. Streets include Avondale, Hopkins, Travis, Rush Sts. and Dallas Ave.

Va., Richmond—Spotsylvania Constr. Co., Spotsylvania, award. contr. for paving 7.26 mi. Proj. 46, Rappahannock Co., waterbound macadam, at $147,203.

Wash, Aberdeen—Aberdeen Paving Co., local, awarded contract for paving Simpson Ave., at $125,143.

Wash., Yakima—Yakima Paving Co., award. contr. for paving 17 blocks, or 33,000 yds., on N. 3rd St., et al at $112,827.65. A Bitulithic pavement on conc. base will be used.

Wis., Appleton—Gruenke Bros., Appleton, award. contr. for Appleton-Dale-Medina Rd., FAP 232, at $89,165.

Wis., Madison—State Hwy. Comn., let contr. for surfacing 1.14 mi. Dubuque-Platteville Rd., F. A. P. 100, Grant Co., to J. L. Burch, Monroe, at $14,089; surfacing 1 mi. Potosi-Dickeyville Rd., F. A. P. 208, Grant Co., to C. E. Rich & Co., Lancaster, at $28,628; 3.53 mi. Co. Line Rd., Dodge to Jefferson Cos., F. A. P. 72, to E. L. Bartlett, Watertown, at $141,914.

Wis., Manitowoc—Zandala Cement Co., Manitowoc, award. cont. for Sheboygan-Manitowoc Rd., FAP 255, at $122,769.

Wis., Milwaukee—Badger Constr. Co., award. contr. for paving with sheet asph. 13 streets in the 20th and 25th Wards, at $270,000.

Wis., Rhinelander—Brogan & Burns, Green Bay, award. contr. for surfacing 4.47 mi. Pelican-Grandon Rd., FAP 73, Forest Co., and 3.17 mi. Crandon-Laona Rd. FAP 155, Forest Co., at $34,228 and $34,126, respectively.

Wis., Washburn—J. R. MeLean, 1st Natl. Bank Bldg., Duluth, award. contr. for grading and graveling St. Hwy. No. 10, Ironwood to Moquah, at $124,000.

Wis., Waukesha—J. R. Griffith, Racine, award. contr. for impvt. of Oconomowoc-Nashotah Rd., Hwy. 19, at $136,824.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Los Angeles—Funk & Bunker, 417 E. 15th St., award. contr. for all work complete for constr. reinf. conc. pit for Mormon Isl. sewage pumping plant, at $19,725; Leo Miletich, 610 W. 54th St., award. contr. for constr. sewer in Victoria Ave., at $2,723.

Cal., Los Angeles—Mike Chutuk, 1506 Pleasant Ave., award. contr. for constr. vit. pipe sewer in Temple St. betw. Virgin and Vermont Aves., and 27 other streets in Temple Street sewer district, at $221,963.

Can., Toronto, Ont.—J. McKnight Constr. Co., 88 St. David St., award. contr. for bldg. 11,000 ft. vitr. tile san. sewers in various sts., in Danforth Dist., at $41,376.

Ont., Walkerton—Town will constr. by Day Labor under supervision of E. D. Bolton, Engr., Listowel, 9-in. cement tile sewers in Main St. Work will cost abt. $25,000.

Ont., Windsor—Merlo, Merlo & Ray, Walkerville, award. contr. for bldg. sewerage pumping station at Sandwich, at $14,407.

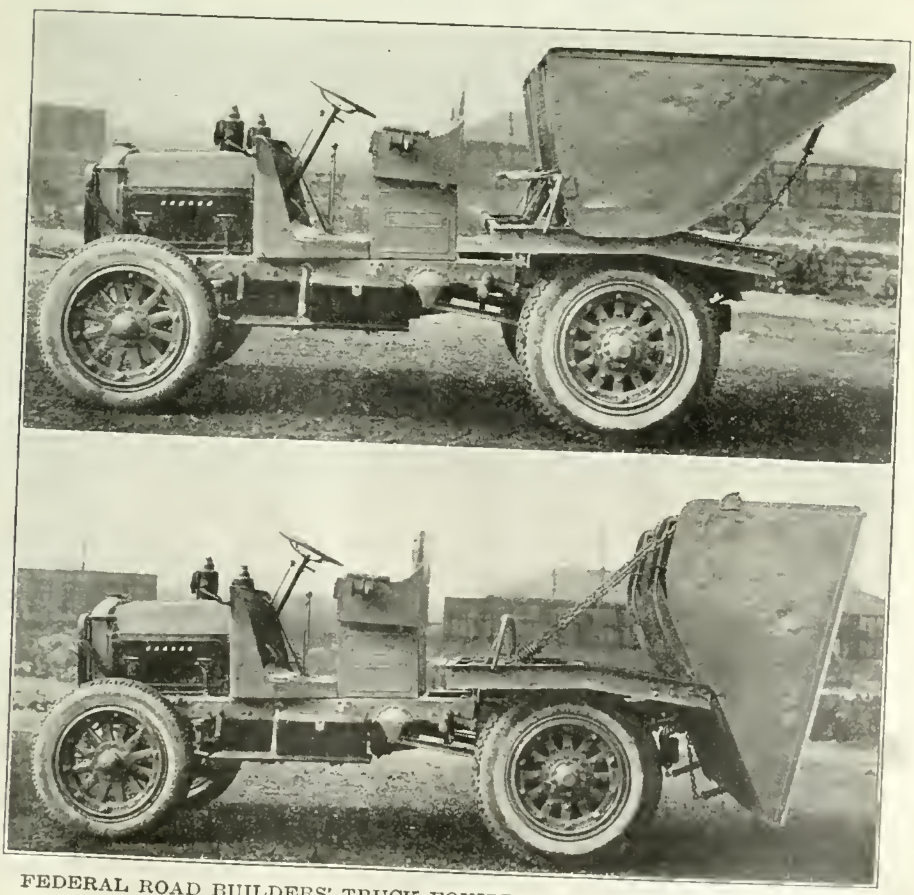
Ida., Boise—Morrison-Knudsen Co., award. contr. for extension of main sewer to prevent pollution of Farmers' Union canal, at $11,962. Bidders also promised to do the extra conc. work at $26 a cu. yd.

Ind., Indianapolis—City let contr. for laying 2,300 ft. 18-24-in. vitr. sewer in Merrill, Sand and California Sts., to Columbia Constr. Co., 2108 Columbia Ave., at $8.48 per lin. ft.

Mich., Detroit—R. D. Baker, award. contr. for constr. of Beniteay Ave., sewer arm, at $123,448.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



FEDERAL ROAD BUILDERS' TRUCK EQUIPPED WITH TWO BATCH LEE DUMP BODIES, IN RUNNING AND DUMPING POSITIONS.

Motor Truck Operation and Accounting LXVIII

Use of Trucks for Garbage Collection at South Pasadena, California.

The information here given on the use of motor trucks for garbage collection is from a letter to the editor by Mr. R. V. Orbison, City Manager of South Pasadena, California:

"The City of South Pasadena has a population of over 8,000, an area of 3½ sq. mi.; about 45 miles of traveled streets and approximately 2,500 residences.

"In the collection of garbage, the city was divided into three sections, and a twice-a-week collection is made from each district by the city. The business sections and the hotels receive a daily service.

"We are using a Bethlehem 1½-ton truck equipped with a 3-yd. dump body and a Woods hydraulic hoist. The crew consists of a driver and two pick-up men, and they average 20 miles of streets per day. As the garbage is kept in the rear of the premises, it necessitates the men walking farther, and consequently requires more time than where the garbage is placed on the parking. The pick-up men work very fast and it requires about six hours for each district.

"Based upon the past 8 months' records, the cost of collecting our garbage is as follows:

Salary	$2,840
Oil and gas	240
Tires	380
Repair	55
	$3,515
Less sale of garbage	1,073
	$2,442

Or $305 per month.

"This gives an average cost of 67c per truck mile, and 45c per capita per year.

"The truck driver has a key to the police boxes and calls in at different hours for complaint slips.

"There is no question in my mind but that the motor truck is indispensable in the collection of garbage. There are locations, however, where teams could be advantageously used by having a motor truck haul trailers to different sections of a city, collecting the garbage with the trailers drawn by teams and then collecting the loaded trailers with the truck."

Building Trucks to Meet Requirements

The strong truck companies do not manufacture trucks merely according to their own ideas of what the customer should want but spare no effort to learn just what the customer's requirements really are and then trucks are built to meet those requirements. Above the chassis there is room for great flexibility in design and in body design particularly the product of the truck manufacturer indicates how closely he keeps in touch with the changing and developing requirements of his customers in various lines of business.

To illustrate how a well-established truck manufacturing company goes about serving its clientele reference is here made to the practices of the Kissel Motor Car Co., Hartford, Wis., in rendering engineering service to road builders.

Kissel during the past 15 years has developed and perfected: First—proven types of motor truck hoist and dump equipments, dual hopper units, load spread regulators and other types of haulage units; Second—Kissel engineering service for contractors and road builders.

In designing and perfecting the Kissel "Heavy Duty Road Builder" with dump body and hydro hoist—the Kissel Dual Hopper Dump Body and other road construction units and equipment—Kissel employed knowledge gained by studying contractor's problems on the road—as well as with road builders and contractors who have visited the Kissel factories.

Kissel engineering service gives scientific attention to transportation requirements of contractors who are contemplating additional equipment, or who are planning additional investment in motor truck equipment. This service goes beyond truck building by building up profit for contractors—by supplying equipment that pays for itself in a short time.

The Kissel Motor Car Company's engineering division has for the past five years made a special study of the adaptability of the motor truck to good roads work. This study has not been superficial, nor has it been confined to one locality, but on the contrary the engineers'

KISSEL

DUAL HOPPER DUMP UNIT

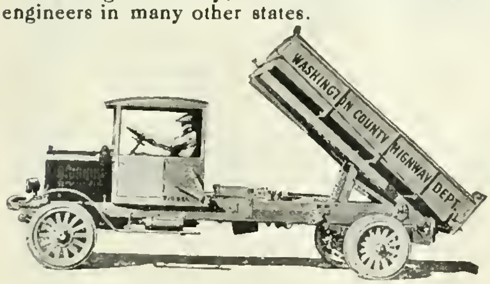
KISSEL Engineering Service to contractors comprises designing and building transportation units to fit particular requirements or individual needs, depending on type of work.

The above Kissel Dual Hopper Dump Unit is an example of a Kissel Unit supplied to a contractor who required special equipment to fit a specific purpose.

Result—this Kissel Dual Hopper Dump Unit, built with 116-inch wheelbase, eliminates rehandling of material by hauling direct to the mixer.

Kissel Heavy Duty Road Builder

shown below, is a Kissel Engineered Unit, designed and built for heavy work in gravel road building for the Wisconsin Highway Commission in Washington County, as well as contractors and engineers in many other states.



THE HUG TURN TABLE,

used in connection with concrete road work, turns the truck in a very short radius, to the mixer, without injuring the cross bed or disturbing the cross boards.

Further details regarding Kissel Engineering Service to Contractors, and road building equipment, can be had by addressing

KISSEL MOTOR CAR CO.
HARTFORD, WIS.

SPEED—ECONOMY—DEPENDABILITY

analyses have been from the ground up, taking in every grade of soil encountered in all parts of the United States.

The haulage, mixing and spreading of different kinds of road huuilding material—the obstacles road builders are constantly up against—all have been analyzed, studied and classified, and the 1921 Kissel road building equipment for gravel as well as for concrete work, ranging from the Dual Hopper job the Kissel Heavy Duty Road Building Truck, with exclusive body, loading and unloading equipment, is the result.

The Kissel Contractors and Good Roads Division

The increased demand for the Kissel "Heavy Duty" model, popularly known as the Kissel Road Builder, necessitated the formation at the Kissel factory of the Contractors' Division, formed for the express purpose of giving individual study to the peculiar haulage problems of contractors and county commissioners.

This division is composed of not only the Kissel Transportation Engineers, but the regular Kissel engineering corps, augmented by the Kissel Zone Distributors. It works with contractors and county commissioners who are either contemplating additional equipment or who are planning initial investments in motor truck equipment.

As an example of how this Contractors' Division works, the following excerpts from a plan sent to a western contractor are interesting:

"Regarding the cost and performance of Kissel Trucks on your 5½-mile job with three mixing stations:

"This job figures approximately 10,500 cu. yds. mixed material. The daily capacity of your mixer is 300 cu. yds. maximum, which, under ideal conditions, would mix the job in 35 days' time, barring delays for weather and breakdowns.

"The maximum hauling distance from any one mixing point is about 1 mile. Therefore, with the mixing time for 1 batch being 1 minute, a 1½ cu. yd. load would require 5 minutes' time. The speed of truck 12 miles per hour would require 15 minutes for a round trip. On this basis 4 trucks of 1½ cu. yd. capacity would be required to keep the mixer going steadily."

Then followed a table, listing the approximate cost of the Kissel truck equipment necessary to handle the foregoing job.

This cost table was made up of the price of the chassis, the dump body and hoist equipment and freight charges to destination. The sum total of these three items made up the initial truck investment, to which were added the following items:

1—Fixed Charges—which consisted of interest at 6%, depreciation for 5 years, taxes, license and insurance.

2—Maintenance Charges—consisting of such items as overhauling and repairing for the year, together with garage charges—the sum total representing the maintenance charges.

3—The Operating Charges consisted of estimated gasoline consumption for 310 days per year, lubricating oil consumption, wages of the driver and complete tire equipment for the full period. The sum total of these items represented the operating charges for the year.

The grand total of these initial investments—fixed charges, maintenance charges and operating charges—divided by the number of days the truck would operate each year, gave an operating cost of approximately $12 per day.

The plan then concluded with the following paragraph:

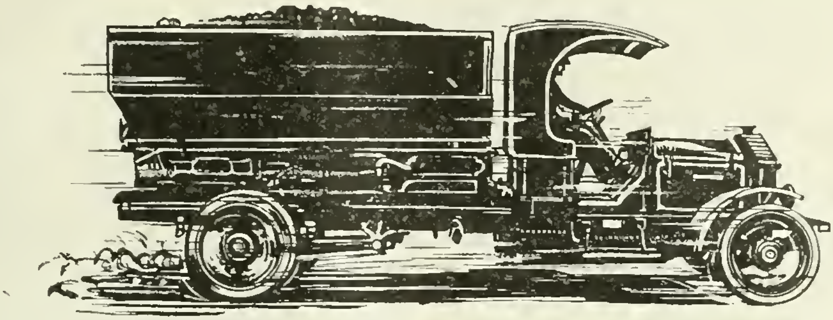
"The Kissel 'Freighter' should make a round trip on this job in 15 minutes, including loading time, and carry a 1½ cu. yd. load. At a cost of $12 per day, this will give you a unit cost of practically 15c per cu. yd. of concrete placed on the job by truck. Operation of four trucks for 35 days at $12 per day, the total cost of hauling the mixed concrete would be $1680."

Grading Contractor Changes from Horses to Trucks

The Carlin Grading Co., of San Francisco, have this to say in reference to their changing over from the use of horse-drawn to motor equipment on their grading work.

"For a great many years we operated entirely with horse-drawn equipment firmly believing that such equipment was essential to successful grading operation and in fact it was not without a struggle that we were finally convinced that motor equipment was necessary if we were to remain in business and successfully meet competition.

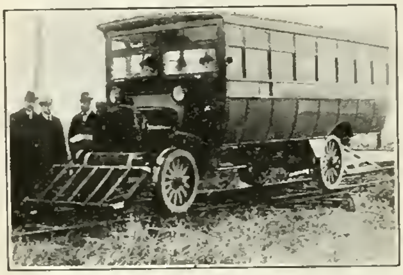
"We have had occasion at different times to rent trucks and a careful checking of their cost and efficiency as against our own horse-drawn equipment figured on a yardage basis finally convinced us. In September, 1919, we placed an order for two 5-ton Sterling chain driven, dual gear ratio dump trucks and operated them for three months under a careful cost system with the result that we immediately purchased three more and are now oper-



ating a fleet of five Sterling dump trucks, and have recently placed an order for three more. We are selling off all of our horses and wagon equipment, and will in the future handle all of our operations with motor equipment. In fact at the present time we are using in addition to our own trucks 18 hired trucks of various makes."

Truck Runs on a Steam Rail Road

The Winchester & Western Railroad has recently installed a passenger service which is unique, and it is predicted that it may revolutionize the passenger service on short line railroads.



SERVICE 2½-TON TRUCK, EQUIPPED TO CARRY 34 PASSENGERS, AS OPERATED ON THE WINCHESTER & WESTERN RAILROAD.

This railroad is now operating from Winchester, Va., to Wardensville, West Virginia. The car is a powerful gasoline motor truck. It is equipped with a body which seats 34 passengers comfortably, is well heated and electrically lighted.

This body is mounted on a 2½-ton Service motor truck. The wheels are the same as on regular Service trucks, but instead of rubber tires flanged iron tires are used, which are the same as those used for the pony truck wheels of the largest locomotives. The rims are about 1 in. thick.

The truck runs on schedule time, and is hauling almost capacity loads. It arrives at Winchester at 9:55 a. m. and leaves at 3:00 p. m. Passengers are enthusiastic over the new car, and prefer it to a regular passenger coach; there is no smoke, dust, or cinders, and but very little noise.

The Winchester & Western Railroad has already announced "theater special" runs for the truck every Wednesday and Saturday evening, and the car will be available for special trips to town on any special occasion which may warrant it.

Pierce-Arrow Bus Makes 2,000-Mile Trip Through Eastern Cities

To demonstrate the strides made in the development of the modern motor bus, a 2,000-mile tour of eastern cities is being made by a bus recently introduced by the Pierce-Arrow Motor Car Company. The bus. which seats 25 passengers and incorporates all the latest safety and comfort devices, is designed especially for the dual-valve two-ton chassis, which permits of a safe and economical speed of 23 miles an hour with a maximum of comfort for the passengers.

With the adoption of motor busses by a number of street railway systems as a means of augmenting their regular equipment, the public is taking an interest in the growth in usage of this type of passenger-carrying vehicle. The appearance of the Pierce-Arrow, therefore, is attracting widespread attention in the various cities through which it is passing on its tour.

"Traction authorities today regard the motor bus as a valuable ally," says Robert O. Patten, truck sales manager of the Pierce-Arrow company. "By running busses in streets paralleling street car lines, congestion in rush hours is avoided. Equally successful is their use in tapping newly developed sections, for it is a costly matter to acquire new streets cars, new trolley poles and wire, and new tracks at about $75,000 a mile. Then, too, the motor bus solves the problem of handling circus-day, ball-game and other unusual crowds.

"In cities where trolley companies have added motor busses to their equipment, experience has shown that the bus service is comparable in headway, speed, earnings and economy of operation to the trolley service."

The route being followed by the bus includes the following cities: Rochester, Syracuse, Utica and Albany, N. Y.; Springfield, Worcester and Boston, Mass.; Providence, R. I.; Hartford and New Haven, Conn.; New York City, Newark and Trenton, N. J.; and Philadelphia.

Three Eras of Transportation in India

The accompanying illustration shows one of the six Wichita 3½-ton trucks, manufactured by the Wichita Motors Company, Wichita Falls, Texas, hauling brick for Mackintosh Burn, Ltd., builders and contractors of Calcutta, India. To the left are the carts drawn by Indian buffalo which these trucks have since replaced, while above the truck are seen the natives with their baskets, which previously had been replaced by the ox carts. This illustration is interesting because it shows three eras of transportation in India.

Mackintosh Burn, Ltd., have been in

the building and contracting business at Calcutta for 15 years, and first relied upon man power to carry their building material. Each man would carry 100 lbs. of brick upon his head in the baskets shown laying at their feet in the picture, and when these men were replaced by the ox carts it was considered that great progress had been made toward more efficient and economical transportation. For a long time the oxen held sway, for it only took 1 driver and 4 men to load and unload the carts which did the same work that previously required 15 or 20 men.

It was when this builder and contractor placed the first Wichita trucks in service that he realized a still greater advance had been made in his transportation facilities and greater economy and efficiency had been effected. Because of the extremely slow speed of the buffalo team and the time required for unloading, it was found one Wichita dump truck could do the work of 20 carts. Because of the dumping feature of the truck body, no labor was required to unload the brick, and the only time the brick were handled was in the loading.

Each of the six Wichita 3½-ton trucks which Mackintosh Burn, Ltd., operate replaced 20 buffalo carts and 100 men, each of which in its day of supremacy had taken the jobs of 15 to 20 men. Today each truck is accomplishing the same results that were accomplished 15 years ago by three hundred men.

A common laborer in India is paid one rupee per day, which would amount to about 40 cts. of our money. A daily pay roll of $120 would be required to maintain a crew necessary to do the work of one truck, even at the extreme low wage of 40 cts. per man. The daily operating cost of each 3½-ton truck is approximately thirty-seven and one-half rupees ($15), and the large saving which the trucks effect accounts for Wichita trucks being used in 83 foreign countries.

Using Trucks to Haul Stone and Builders' Supplies

Gottron Bros., of Fremont, Ohio, operate of fleet of four 3½-ton Service trucks, equipped with dump bodies and hydraulic hoists, in hauling stone, builders' supplies and coal. The first Service truck is over four years old, and the fourth was delivered in September, 1920. Gottron Brothers operate their own quarries, where stone is blasted out and loaded on trucks, both by steam shovel and portable electric conveyor.

THREE ERAS OF TRANSPORTATION IN INDIA: FIRST, THE BASKET CARRIED ON THE LABORER'S HEAD; SECOND, THE OX CART, AND, FINALLY, THE MOTOR TRUCK.

This is a typical example of the savings effected by the use of trucks over horses. Before the trucks were put in operation, the most that six horses and 18 men could haul over the 200 yds. from the quarry to the crusher was from 15 to 18 tons of rock an hour. One Service truck and six men are now delivering 40 tons an hour to the crusher.

After being crushed the stone is divided into several sizes, ranging from the fine dust, which is used in making concrete, to sizes as large as 4 ins., which is used for road work.

These different sizes are put in separate bins, under which the trucks are run to get their loads, which is dropped right into the bodies. The biggest job that these trucks have, however, is hauling from the bins and quarries to the point where the stone is used by the contractor.

From the bottom of the quarry to the point where the trucks emerge at the top is a distance of about 200 ft., in which is a rise of 35 ft. Each truck must negotiate the grade anywhere up to 20 times a day. Crushed stone is hauled any distance from 1 to 13 miles.

Gottron Brothers figure that their four 3½-ton trucks average from 85 to 100 miles a day, for a 10-hour day, but they have made as high as 106 miles a day for a two weeks' period. This, however,

SERVICE 3½-TON TRUCK DUMPING STONE TO RIVER BARGE.

was when the trips were long and only four round trips were made a day, delivering to a job a little over 13 miles from the quarry.

In addition to the stone work, Gottron Brothers have a three or four year contract for hauling stone to Sandusky Bay for riff-raffing, or filling in swamp land to preserve it for duck shooting.

Stone for this work is taken from the quarries and hauled to the river, where it is loaded on huge barges and towed about 18 miles to the dumping ground. Each barge carries about 100 tons a trip.

The oldest of these four trucks, as stated, is over four years old. It is a 3½-tonner, and for four years has been hauling the regular load of 10,300 lbs. The entire expense for the four years has been less than $700, which included two repaintings and a general overhaul one winter when work was slack. And this in spite of an accident that happened when this truck, with its regular load, went over a 30-ft. embankment on the highway a little after midnight one night when it was doing day and night service, and turned over twice in rolling down the bank. In three hours' time it was "on its feet" and started right off. There was not a broken bolt, and the only damage that was done to the truck in any way was a cracked running board.

This truck, and another of the same capacity, were over three years old before there was any mechanical overhaul at all. This is an exceptional record, for, although scientifically cushioned, these trucks have been doing the very hardest kind of work, and were heavily overloaded on each trip.

Efforts to Handicap Large Capacity Trucks

The International Motor Co., New York City, has prepared an interesting review of recent legislative attacks on large capacity trucks in New York and of the attitude of various New York newspapers toward such restrictive legislation.

On Feb. 9, 1921, the newspapers in the leading cities of New York published news items announcing a law which had been proposed in the New York Legislature to place an excessive tax on motor trucks of 5-tons capacity or over. As the law was obviously designed entirely to eliminate these large capacity units, its proposal was looked upon by many as an excellent medium for determining the trend of public sentiment in this connection.

The proposal was, of course, defeated in its early stages and on March 1 its provisions had been amended so that restriction is directed only against vehicles over 7½-ton capacity. A special news dispatch from Albany dated Feb. 14th, and published in a large number of papers read as follows regarding the public reception of the proposal: "The announcement of legislative leaders that they intend to tax heavy motor trucks off the highways has aroused a state-wide protest from commercial, industrial and agricultural interests. They contend that no proposal presented to the legislature in years has been so reactionary in its effect."

Directly following the announcement of the proposal, the New York City newspapers gave editorial expression of their views on it, which, by the way, may well be considered as a concerted voice of public opinion. A brief glance at a few representative extracts from these editorials will therefore have particular interest.

The New York World.—"The Albany bill taxing motor trucks of five tons capacity and upward from $500 to $800 a year to drive them off the roads belongs to that large class of legislation inspired by guesswork rather than exact knowledge. It is lazy legislation.

"It is proper to tax vehicles for the maintenance of the roads—though the truck should not be asked to pay for the damage done by touring cars. It is proper to tax for proportion to weight, if the tax is not excessive. But to impose confessedly prohibitive taxes in advance of scientific study of the economics of the subject is to wrong producers and consumers by handicapping transportation developments to their common advantage."

The New York Tribune.—"The whole spirit in which this attack upon a great and growing means of cheapening communications is conceived is short-sighted and ill-advised. The prime effort of every State, of every legislature, should be to encourage the truck, to give it every chance to develop freely. Its limits of economy have by no means been reached.

"The full benefits of this new small unit of transportation cannot possibly be won if it is to be opposed and handicapped at every turn by short-sighted legislation. The broad attitude of the State should be to conform the roads to this new vehicle rather than to hamper its development and future by any arbitrary restriction of weight or size. As we build bridges to carry the big locomotives rather than to trim locomotives down to bridge capacity, so roads should be made to carry the trucks that can make the lowest rates."

The New York Herald—"It is waste of legislative breath to talk of driving heavy motor trucks off the State roads, whether with prohibitive taxes or whatever means; so long as there are votes and elections the agricultural and general industrial business of the State will never be deprived of the marvelous distributive facilities which have been built up in New York. Not only members of the legislature representing the farmers and small town manufacturers but members representing suburban communities served by the great department stores of the metropolitan centers will never listen to any proposal to put the essential trucks out of business by taking them off the State highways."

The New York Times—"It is against public policy to block the 'ship-by-truck' movement by a prohibitive tax, as the administration leaders at Albany threaten to do. Such an attempt is precisely on a level with that which the lawmakers made some years ago to banish the automobile by imposing impossible speed limits, and it is foredoomed to a similar failure.

"Already the motor truck has forced recognition as contributing to the speed, convenience, and economy of transportation. For wholesale merchants, 5-ton and 10-ton trucks make a considerable saving over all distances which the railways class as short hauls.

"What the motor truck calls for is combined regulation and accomodation, not a destructive tax."

The Brooklyn Eagle—"The proposal that the motor truck should be taxed out of existence is vicious and ought to be beaten at Albany. It is unjust to transportation interests that have become valuable to the people of the State and which can be made still more valuable in the future. It is unjust to a public which those transportation interests serve with a rapidity and facility not always assured by railway shipments.

"The influences opposing it (Shipping by Truck) at Albany are actuated by purely selfish and unworthy motives or they are ignorant of facts. In either case their effort deserves to fail."

Brooklyn Standard Union—"The reported purpose of the State to tax heavy motor trucks off the highways because they are so destructive to roads is an obviously ill-advised move. What should be done is to build the highways so that heavy trucking will not be harmful.

"The large motor truck has assumed a highly important place in the nation's freight transportation scheme and anything that curbs its usefulness is decidedly a step backward. Industry would be badly crippled if the Albany plan were generally adopted throughout the country.

"New York State cannot afford to approve any policy which turns back the wheels of progress, and this it would be doing if it yielded to the plan mentioned."

It is only natural that attempts of this kind will be made in other States either through misconception of facts or through deliberate self-interest, but no matter what their form, they cannot in any sense be permanent so long as the law of economics is sound.

EDITORIALS

OUR OFFICES CONSOLIDATED

For several years this magazine has maintained offices in Indianapolis and Chicago; the mechanical and business offices have been in the former city and the editorial and advertising offices in the latter. Effective May 1, 1921, all the departments will be consolidated at Indianapolis, where the magazine has always been printed.

This consolidation is in line with the spirit of the times, of course, and is made also in the interest of improved operating efficiency. Delays occasioned by the maintenance of the separated offices will be obviated by having the editorial and printing work done in the same publishing plant.

DEMANDING CONSTRUCTION

The public is impatient of delay in the general building program, the program that is to furnish the long desired and greatly needed new homes and highways, new public buildings and constructional works of every description. Pick up any newspaper, whether a small town weekly or a metropolitan daily, and the demand for construction will be found in both news and editorial columns. Construction news is the livest news of the day, and more often than not is being given first attention in the popular press.

So great is the demand for improved highways, for example, that the most influential newspaper in the Middle West is urging their immediate construction without regard to cost, taking the position that while economies on construction may be desirable, and, if obtainable, would be acceptable, construction should not be delayed because of the price consideration. The newspaper to which reference is made argues that a good road is cheap at any price and that no price concession at all likely to be secured would be worth as much to the community as a new road. The paper in mind is widely known for the range and brilliance of its editorial pronouncements, so it is particularly significant to note that it is publishing a strong, concise good roads editorial nearly every day.

People have been sold on the idea of improved highways for some time. It seems they are now fast reaching the point where they are not only willing, but anxious to pay for good, dependable highways.

All workers in the construction industry will rejoice with us that there is now such an insistent popular demand that construction move forward. All will join us in the expression of hope that any remaining obstacles to construction shall speedily be removed.

ROAD MAINTENANCE IMPERATIVE

Engineers, contractors and public officials were undoubtedly much pleased with the attention given the highway problem by President Harding in his message to Congress. Not only did he devote a substantial portion of his message to this subject, but he shows a very gratifying appreciation and knowledge of it. His insistence that highways be properly maintained is particularly praiseworthy and his demand that guarantees of adequate maintenance be made a condition precedent to the participation in federal aid is most commendable from every point of view.

Surely the importance of highway matters was never more strikingly emphasized than by his extended discussion of them in this message, which formulates his policy and plan for legislation affecting all domestic business and international relations as well. No other form of recognition is at all comparable with this. Old workers in the highway field will be much gratified to note the high plane of importance this work has now attained.

Not only are the President's ideas sound with respect to proper maintenance of improved highways, but the very greatest good will come from his calling attention to the subject. Man is a natural builder, but he must be taught, or forced, to maintain any finished structure. Stated in other words, the building instinct is universal, every child has it, but the will to maintain must be acquired and cultivated. The child builds castles and forts with his blocks and then goes away, leaving them in such state of order or disorder as they may be in when his attention is drawn elsewhere. The man builds a fine road, or other engineering structure, and assumes it will last forever without further attention, although there is no basis in experience for such assumption.

While the federal government can compel maintenance only on federal aid roads, such roads are intended to be exemplary in every way, and the example set in their proper maintenance will be emulated on all other roads.

FOR FORCE ACCOUNT WORK TO LEARN COSTS

In any year it is well for public officials to carry on some force account construction work to learn the true cost of such work. This will enable engineers to prepare cost estimates intelligently and will provide standards with which contractors' bids may be compared.

At this time, when prices are continually changing and it is exceedingly difficult for even the well-disposed to predict whether a contractor will get rich or go broke when awarded a contract at his own price, it is more than ever desirable that considerable force account work be carried on, under the direct charge of mature and experienced construction engineers, to evaluate construction costs. This may well be done on city, county and state jobs, not only this year, but each year until stability of prices has been restored.

Generally speaking, we believe that engineers long ago agreed that the contract system, with all its faults, is preferable to the force account system, for reasons often recited. The contract system is firmly established in theory, in practice and in basic law. There is no thought of abandoning that method of carrying on work. But the interest of all parties would now be served by adopting the suggestion that enough force account work be done so that engineers and public officials, as well as the general public, will have some guide to their judgment in passing on the fairness or unfairness of a contractor's bid. It is altogether too difficult even for the initiated to determine at present whether a contractor is "profiteering" or losing money.

We believe contractors will approve this suggestion, as it is made as much in their interest as for any other reason. It is undoubtedly true that the more force account work is carried on the more will the contract system be appreciated.

JUSTICE FOR PUBLIC UTILITIES

A remarkably effective presentation of the case of the privately owned public utility vs. adversity, intolerance, indifference, injustice, prejudice et al., appears in this issue under the title: Operating a Water Works Plant Under State Supervision. We hope every public official charged with the responsibility of dealing with such a utility will read and ponder the article, which, with admirable restraint, relates the story of the difficulties imposed by the war period, abetted by the indifferent or hostile attitude of the public toward the utilities in their darkest years.

Prior to the war the utilities were operating on a small margin of profit. If successful their earnings were limited by law; if unsuccessful they were "out of luck." They did not complain greatly, but worked hard, and, aided by the rapid urban development of the nation and the demand for modern conveniences, managed to get along fairly well. But when war sent sky high the price of everything the utilities must buy, such as labor and material, and taxes of all kinds were increased, their income remained stationary, or, at best, was grudgingly increased just enough by state commissions to prevent interruption to a vital public service. In other words, the utilities had no war profits whatsoever with which to offset advanced costs, as was the case in private industry. And all this time the utilities had to keep operating, for continuity of operation is the very essence of their function. They could not shut down entirely, or even partially, to await the return of favorable conditions before resuming full time operation, as so many private industries did and are still doing. To put it shortly, the utilities have been having a tough time of it.

That the utilities are to blame for public indifference will hardly be questioned. The managers have so long lived apart from their fellow-citizens that they scarcely could hope to be understood. Instead of seeking publicity in past years, they have practiced the suppression of even the technical news of their plants and practices, fearing or refusing to release any information whatever, even, in many instances, for publication in a technical journal, lest the information so released be turned against them. Public indifference and hostility are the direct results of such a policy of news suppression. Probably this fact is now appreciated, and if it is the utilities can still secure justice if they seek it in the right way, as recommended by the author of the article to which we have directed the reader's attention.

SPECIAL FEATURES OF IMHOFF TANK CONSTRUCTION

By George B. Gascoigne, Sanitary Engineer, in Charge Subdivision of Sewage Disposal, City Hall, Cleveland, Ohio

During the past two years it has been the privilege of the writer to design and supervise the construction of four sewage treatment plants, three of which comprise Imhoff tanks. These plants have varied in size and in many features of design, but it is the intent in this article to deal primarily with certain construction features common to such plants. Although the greater part of the information contained herein pertains to the treatment plant now under construction for the city of Cleveland at the Westerly site, the four plants previously mentioned may be listed as follows:

The Four Plants Considered

Hiram, Ohio—Population designed for, 900; plant comprises bar-gratings, two-story settling tank and open sludge-drying beds. Tank constructed in 8 ft. of hard shale, underlying 6 ft. of clay.

Vermilion, Ohio—Population designed for, 4,000; plant comprises bar-gratings, siphon beneath the Vermillion River, two-story settling tanks, disinfection equipment, open sludge-drying beds and buildings. Tanks constructed in soft silt in old river bed, necessitating coffer-dam work and continuous pumping.

Easterly Sewage Treatment Works, Cleveland, Ohio—Population designed for, 575,000; plant comprises bar-gratings, grit chambers, sluice gates, disinfection equipment, pumping equipment and buildings. Excavation in hard blue clay.

Westerly Sewage Treatment Works, Cleveland, Ohio—Population designed for, 288,000; plant comprises bar-gratings, grit-chambers, two-story settling tanks, disinfection equipment and buildings. Tanks constructed on lake front in clayey earth, necessitating coffer-dam work and continuous pumping. (See Fig. 1.)

Responsibility of Engineer.

As soon as the contract drawings for a sewage treatment works have been prepared, it is generally assumed that the duties and responsibilities of the engineer cease. As a matter of fact, however, if the engineer is to be held responsible for the successful completion and operation of the plant, he must keep in close touch with the work during its construction and be thoroughly familiar with conditions, especially as they pertain to the initial operation of the plant.

In the construction stage of the work innumerable questions relating to litigation proceedings, award of contracts, assessments, abandonment of work, selection of materials, foundation difficulties, additions and alterations, preparation of estimates, and other matters must be decided. It is practically impossible, sometimes, to obtain during the preparation of the original contract drawings, field information which will represent actual conditions. This is particularly

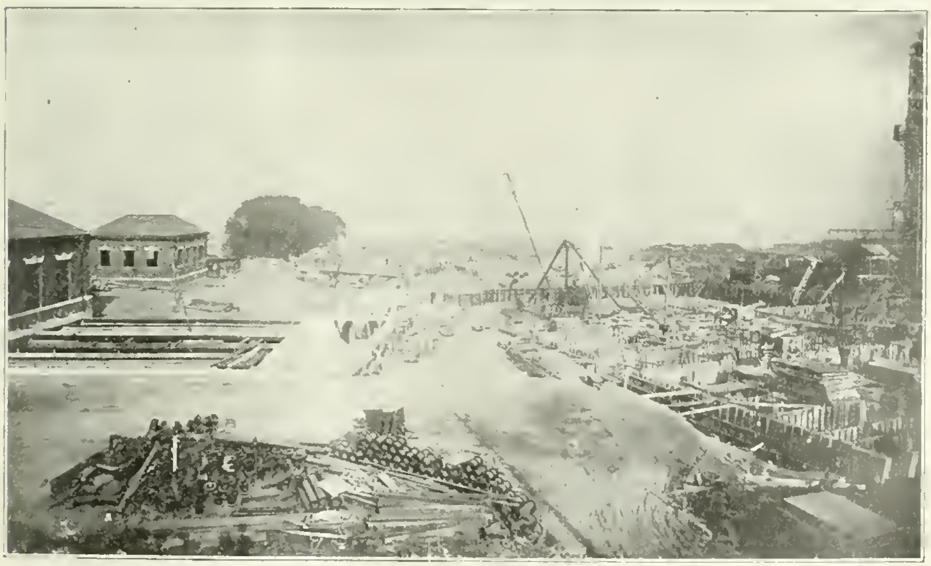


FIG. 1. GENERAL CONSTRUCTION VIEW OF WESTERLY SEWAGE TREATMENT WORKS AT CLEVELAND, OHIO.

true in the construction of large sewage works in which foundation difficulties are usually encountered. Since minor, and sometimes major changes in the contract drawings are thus made necessary, the engineer should be in close touch with the work, not only from the standpoint of protecting the interests of the owner, but of insuring the satisfactory completion of the work in accordance with the basis of design originally contemplated. There are various methods by which full responsibility for a project may be assumed by the engineer. The minimum requirements involve occasional visits during the construction period while the maximum may necessitate direct supervision by the engineer or his representative.

Necessity for Selection of Responsible Contractor

The construction of a complete sewage treatment plant can usually be divided into five general classes of work, as follows: Excavation, concrete, piping, buildings and parking. In the majority of cases it will be found that the excavation and concrete items represent from 75 to 90 per cent of the total work involved. It seems logical, therefore, in awarding contracts for the construction of sewage treatment works, that the contractor should be selected upon the basis of his ability to perform these particular items of the work in an efficient and economical manner. At the same time it should be appreciated that the minor work on such a project is important and very seldom is it possible to select a general contractor who is especially proficient in all these lines of work. The problem, therefore, becomes one of deciding between two procedures; namely, having a general contractor handle the entire work or dividing the work among a number of specialized contractors. From the standpoint of economy and of making progress, the writer has found it advisable in most instances to proceed in accordance with the former plan.

Other important factors for consideration in the selection of a responsible contractor are his financial resources, available construction equipment and the character and extent of his organization. Very often little is known about the contractor's organization, because in such specialized work, he, himself, has no accurate information upon this particular subject and must rely entirely upon his experience with work of an entirely different character.

Coffer-dam Construction

Since the construction of sewers is naturally the first step in the development of a sewerage project and since the least expense is involved when these sewers closely parallel the surface of the ground, very little consideration is given to the future need or the probable location of a sewage treatment works. Consequently it is usually necessary to locate sewage treatment plants near rivers or bodies of water and at such elevations that foundation conditions are exceptionally difficult. In fact it may be said that coffer-dam construction is usually required in building Imhoff tanks. Furthermore, it is frequently the case that the site selected does not provide suitable foundations for tank structures, a condition which requires costly construction and involves many changes in the details of the work.

Possibly the most important questions relating to coffer-dam construction pertain to the nature of the material encountered and the most suitable method for excavating within the coffer-dam. Undoubtedly the use of steel sheeting is the method most commonly used in cases where exceptionally difficult work is anticipated, but apparently only in a few cases does the contractor consider it advisable to submit prices which will permit the use of this material. When steel sheeting is used, however, many difficulties are usually eliminated and the additional expense is found justifiable both from the standpoint of the owner and that of the contractor.

Naturally there are various methods employed for bracing the sheeting in coffer-dam construction. A decision as to the best method is usually based upon the nature and extent of the operations which are to be carried on inside the enclosure. Should these operations require a clearance of considerable width, inside bracing is usually omitted. This condition is well illustrated in Fig. 2, which shows the type of construction used in building the Imhoff tanks for Cleveland's Westerly Sewage Treatment Works. The excavated material was removed from this enclosure by means of a drag-line excavator, having a 2-yd. bucket. The material was loaded into 12-yd. standard gauge side dump cars and hauled by a standard gauge locomotive to the several spoil areas about the plant site. This excavation was carried within 18 ins. of the finished grade, the remainder of the material being removed by hand and loaded into cars by means of a clam-shell bucket. In this maner the foundations for the tank structures were not disturbed since the material was removed only to the neat lines of the concrete work.

Testing Foundations

Soil conditions along the south shore of Lake Erie vary and to such an extent that in one location a suitable foundation may be secured, while within a very short distance from such a location conditions change entirely. It is unwise to place heavy foundations where ground is excavated along the lake front unless piles are used, although the exact location as well as the depth to which the foundation is carried and the type of loading govern to a large extent. For this reason a plan was adopted whereby the type of foundation to be used at the Westerly Sewage Treatment Works could be determined after the coffer-dam was constructed and the footings exposed. It was decided to show upon the contract drawings two schemes of foundations, one with and another without the use of piles. Furthermore, it was specified that soil tests be carried out as the excavation work progressed, the results of these tests to furnish data for a decision upon the type of foundation to be used.

Fig. 3 shows the method used in testing the soil and it may be of interest to describe the way the loads were applied. Attention is called to the depth of the tested area below the surrounding

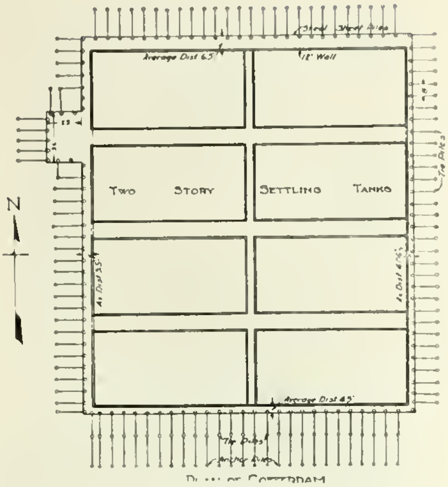


FIG. 2A. PLAN OF COFFERDAM.

area as being equal to the length of the longest side of the area tested. Bags containing iron ore and weighing 100 lbs. each were placed on the platform and used in obtaining the desired loading. The loads were applied in increments of 100 lbs. per sq. ft. and time intervals allowed for such duration as to note the cessation of movement. Loads were added until a value per square foot equivalent to the weight of the tanks when empty was reached. The loading was then stopped, but as soon as all settling movement had occurred, the load was again increased until its weight was equal to that of the tanks when filled with water. The loadings were stopped again, but were later increased, using the same time

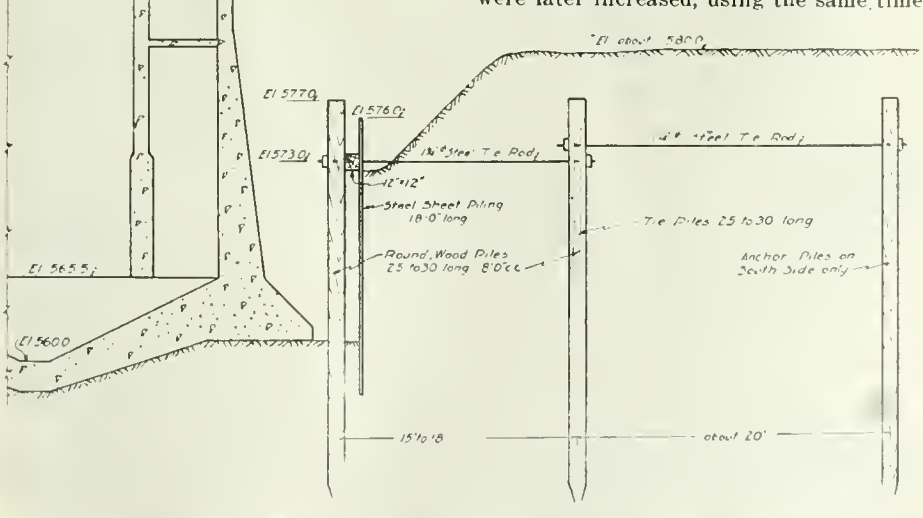



FIG. 2. COFFERDAM CONSTRUCTION, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO, SHOWING TYPICAL SECTION THROUGH TANKS AND COFFERDAM.

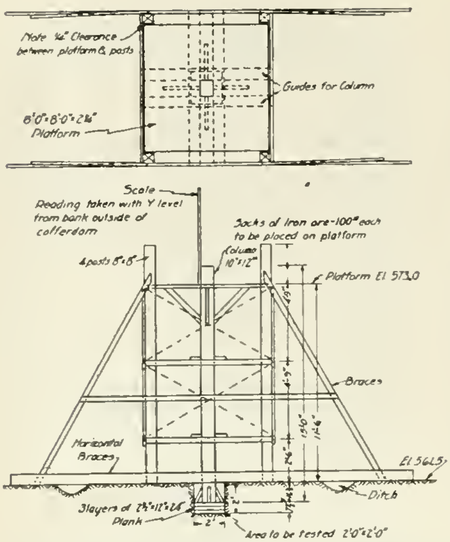


FIG 3. SHOWING LOADING PLATFORM FOR SOIL BEARING TESTS, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

intervals, until double the weight of the tanks when empty and full was reached. The loadings were then increased to three and four times the tank loads when empty and fully loaded. Finally the soil was loaded to what was considered failure or until the platform kept settling without the addition of loads and a total settlement of 7 or 8 ins. had been reached. Six loading tests were made within the 200 ft. sq. area and the results plotted as curves which showed the behavior of each test. From the curves the safe loading was determined as well as the amount of settlement which could be expected. In no case was a settlement less than ⅛ in. found with loads which would be imposed when the tanks were full. On the other hand what was termed as complete failure did not occur until loads approximately four times the full load were used.

Concrete Work

Probably the most interesting feature of the Westerly work to date is the method used in constructing the tank bottoms. Prior to the award of the contract and as soon as expedient thereafter, the program and methods of construction which were contemplated were discussed thoroughly. It was found that the contractor intended excavating the bottoms to the hoppered shape, placing the steel on small concrete blocks, wiring the wall steel to racks and pouring the concrete of such consistency as to stand on the slopes (1 on 2) without the use of inside forms.

The bottoms were found to consist of

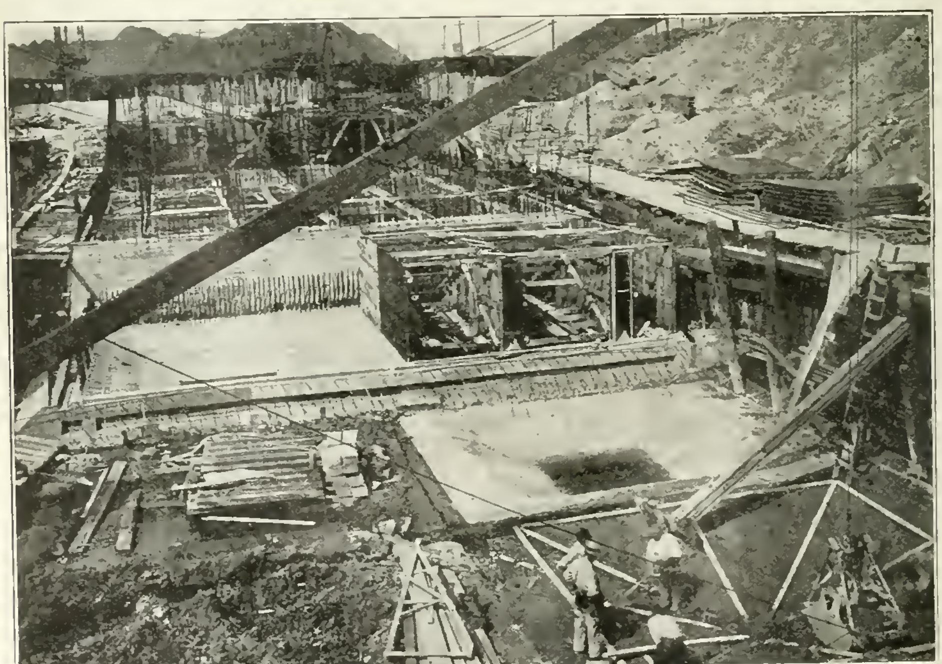


FIG. 4. METHOD OF CONSTRUCTING CONCRETE FLOOR OF IMHOFF TANKS IN WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

a rather heavy, yet firm, blue clay which when wet would make working in it almost impossible. It would "churn" up, cover the steel and seriously interfere with efficient labor. After considerable discussion it was decided to proceed with the concrete work of the hopper bottoms by excavating to a grade 2 ins. below the neat lines and place screed boards (2x4 in.) in the valleys of the hoppers along the middle of each side and around the top. A 2-in. layer or floor of concrete was then placed over the bottom and screeded down flush with boards. (See Fig. 4.) This layer of concrete was then given a chance to set before any attempt was made to work upon it. The floor steel was then readily placed, wired and supported off the floor with 2-in. concrete blocks. The steel in the upper portion of the hoppers was wired to inside forms instead of being supported on racks as may be seen in Figs. 5 and 6. The forms were then lowered into place and rested on concrete blocks 6 ins. by 12 ins. by 42 ins. and wedged to the proper elevation. The wall steel was then put in place and wired to a 2-in. by 4-in. strip along the edge of the hopper, the 2x4's being marked off for the correct spacing and bulkheads were then built and the concrete poured to a depth of about 2 ft. over the floor, to elevation 562.5. The blocking or wedges supporting the forms could then be removed without danger of settlement of the inside hopper form. The remainder of the concrete in the hopper was then poured.

The 2-in. working floor of concrete prevented the steel becoming covered with mud and enabled the steel men to work expeditiously since they were on a clean concrete floor instead of in mud. The inside forms gave a better wiring surface for placing the upper layer of steel than the racks and permitted the contractor to place the concrete and spade it more thoroughly by not having to make it as dry as would be necessary without forms. Also the forms provided a good support for the wall steel. The 2-in. floor insured getting clean concrete through the entire mass. The savings by the false floor method of construction were greatly to the advantage of the contractor and valuable to the city because of the quality of concrete and sureness in keeping the steel in place.

The concrete was mixed in a Lakewood outfit, a ¾-yd. mixer being used, and the receiving bins and distribution system having an eight-hour capacity of about 300 cu. yds. It was distributed by means of elevated steel chutes which terminated at the forms in a secondary hopper from which other chutes delivered it to the forms proper. The secondary hopper was built large enough to hold four or five batches and had openings on four sides so that the concrete could be

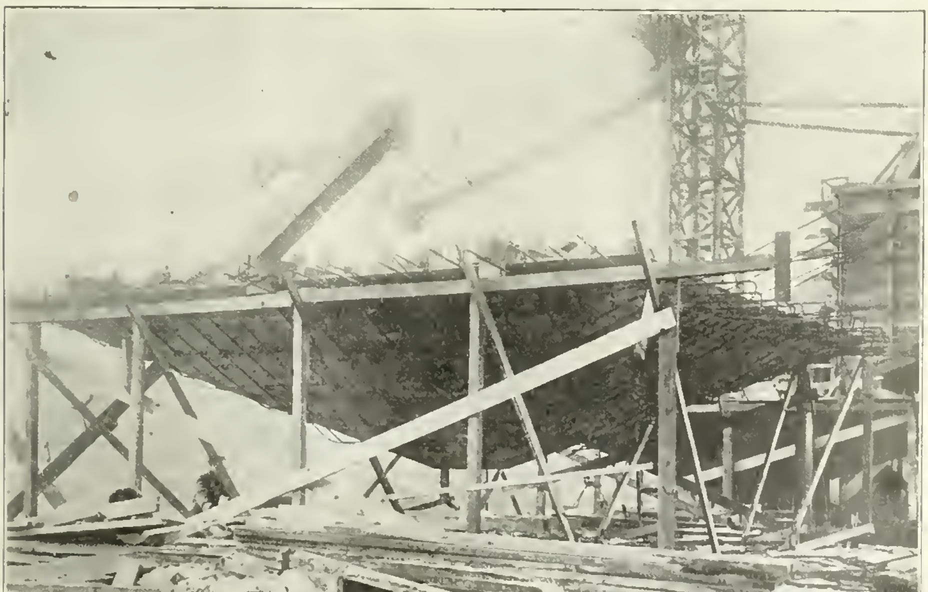


FIG. 5. RACKS FOR SUPPORTING STEEL IN IMHOFF TANK CONSTRUCTION, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

run in any direction by means of short wooden chutes. The mixing in the secondary hopper practically prevented poorly mixed or poorly proportioned concrete reaching the forms. Moving of chutes could be effected without stopping the mixer, because of the capacity of the secondary hopper and running the concrete into the forms in four places prevented it from setting up in one place while it was being poured in another. In pouring long walls, or more than one tank bottom, two or more secondary mixing hoppers were used, the only change required in the main or steel chutes being from one hopper to another.

Buildings and Parking.

It is observed that for some reason or other not enough attention has been given in the past to the necessity of buildings about a sewage treatment plant. Many times there are no buildings at all. These statements apply in particular to the smaller-sized plants where the need of them is great. On larger plants the buildings are complicated somewhat since they require plumbing, electrical wiring, heating systems and drainage. On the smaller plants the buildings are used normally as a storehouse for tools and a place to shelter the attendant in times of bad weather.

In keeping with the necessity and substantiality of the buildings is the upkeep and attractiveness of the surrounding grounds. The disrepute in which many sewage plants find themselves today can be traced to the bad appearance of the works. Money spent for parking purposes, such as walks, seeding, sodding and roadways, has usually been found to be justified and this is particularly true should the works lack isolation.

General

Mr. Robert Hoffman is commissioner of the Division of Engineering and Construction for the city of Cleveland, of which the Subdivision of Sewage Disposal is a part. The work of design and construction herein described is under the supervision of the writer. J. M. Heffelfinger and A. A. Burger are the resident engineers in immediate charge of construction, and the Masters and Mullen Construction Company and the American Construction Company, both of Cleveland, are the contractors for the Westerly and Easterly plants, respectively. J. D. Price was the resident engineer in immediate charge of construction and the American Construction Company was the contractor for the Vermilion Sewage Disposal Works. A. C. Schlobohm was the resident engineer in immediate charge of constructing the Hiram Sewage Disposal Plant, and the work was done by the owner upon the direct labor basis.

LETTING GRADING AND BRIDGE CONTRACTS ON ILLINOIS STATE BOND ISSUE ROADS

By C. M. Hathaway, District Engineer, Illinois State Division of Highways, Effingham, Ill.

For the year 1920 the Illinois State Division of Highways planned an extensive paving program on the sixty million dollar bond issue system, and it was in-

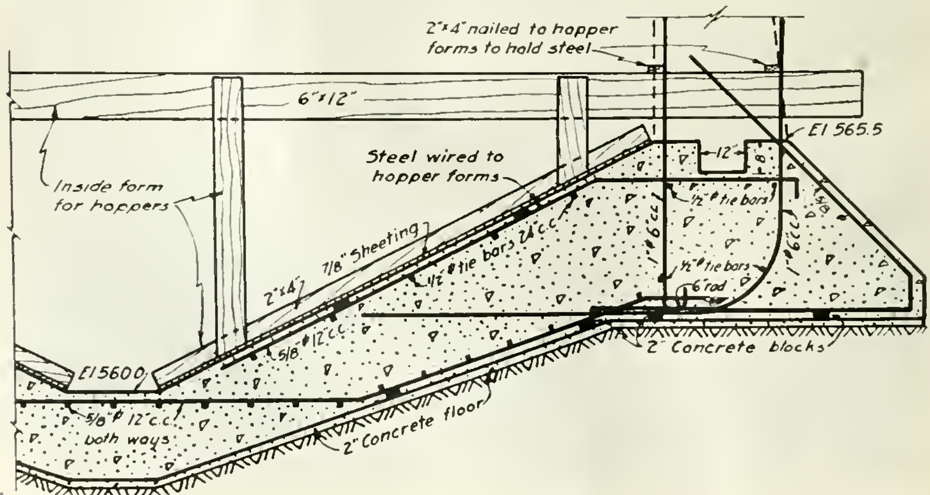


FIG. 6. METHOD OF CONSTRUCTION HOPPER BOTTOMS FOR TANKS, WESTERLY SEWAGE TREATMENT WORKS, CLEVELAND, OHIO.

tended to put under contract during the season 1,000 miles of paving work.

Because of the high prices then prevailing and the scarcity of cars and labor it became apparent after the first bids were received that paving work at a reasonable figure was out of question and it was, therefore, definitely decided that the anticipated program for the season of 1920 would have to be abandoned and that construction work with respect to paving would have to be confined almost entirely to completing existing contracts.

Earth Grading and Bridge Work in Advance of Paving

It was felt, however, that something could be accomplished by doing the earth grading in certain sections of the state, where there was involved a great amount of heavy grading and bridge work, confining this work specifically to those instances where it would be necessary for the heavy fills to settle at least a year before the pavement could be placed and where new alignment must be established and heavy grades reduced. The construction of bridges of long span is also somewhat of a drawback on a paving job and it was also decided that this work should be done in advance.

Definition of Grading Sections.

As a rule grading sections were considered as those where the earthwork ran higher than 6,000 cu. yds. per mile or where fills ran in excess of 3 ft. In some cases these sections were in continuous stretches 5 to 6 miles in length and in others broken sections comprising short fills or short stretches of rough country of one half- mile or more in length with the level ground between.

In placing the minimum limit at 6,000 cu yds. it was felt that when the yardage ran less than this it would not be economy to undertake the grading until the paving work was started.

Special Earth Road Section Designed.

A special earth road section designed to take into account work of this sort is shown by Fig. 1. Referring to this cross section it will be noted that the section used is such that the grade of the finished roadway is practically the same as that proposed for the finished pavement and as completed is such that when the paving work is undertaken it will require only the moving of such earth as may be necessary to place the slab without necessity of moving additional material from the ditches or side banks. In other words, an ordinary plow and grader should open up subgrade at small expense and on completion of the pavement the earth thus thrown out may be graded back against the pavement for the 6 ft. earth shoulder on each side. It is estimated that when the paving sections are completed there will be involved not to exceed 2,000 cu. yds. of earth work. As a general rule, bridges occur coincident with the heavy fills and at other points in the grading sections, although in some instances the construction of bridges was undertaken where there were no grading sections.

130 Miles of Heavy Grading and 84 Bridges

Following out this plan there was put under contract during 1920 130 miles of heavy grading and 84 bridges. Upon inviting bids for these several sections of work it was found that there were seemingly a sufficient number of grading contractors willing to take such work at a reasonable price, considering labor conditions and the same condition was also true with the bridge contracts.

The first contracts awarded showed some disposition on the part of contractors to be skeptical of conditions and the prices accordingly ranged somewhat higher than was at first anticipated. Further lettings, however, showed a marked decrease in bid prices and a more marked competition indicating that this class of work was very desirable and could be readily disposed of. This situation did not quite apply to the bridge work, since the bids on bridges were all uniformly higher than had been estimated, which evidently indicated that the bridge contracts were still being affected by existing uncertainties of labor, shipments of materials, etc. In no instance,

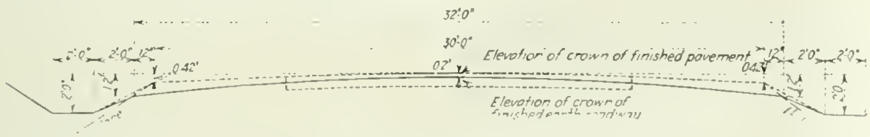


FIG. 1. SPECIAL EARTH ROAD SECTION FOR GRADING ROADS TO BE PAVED IN ILLINOIS.

Dotted Lines Indicate Original Pavement Cross Section. Solid Lines Indicate Cross Section to which Earth Roadway is to be Graded.

however, was there ever any lack of bidders on a section.

Selected Sections Well Scattered.

In selecting sections, the work was well scattered over the entire state with respect to location and railroad shipping points, and as construction proceeded it became plainly evident that the department had not figured unwisely in awarding the work which it did. With respect to bridges, the contractors were able to get desirable shipments of materials with practically no delay and were always able to secure the necessary labor, either from their regular gangs or locally. The grading contractors were especially well able to secure teams and labor and in numerous cases the supply of "subs" looking for work exceeded the demand.

The Plan An Unqualified Success

Although the first contracts were not let until about August 15 and from then on until October, nevertheless, in each case a surprisingly short time was taken to get under way, and of the 40 miles of grading and 53 bridges put under contract in the writer's territory, about 70% of the grading was entirely completed by cold weather and 20 of the bridges were entirely completed with 27 over 50% completed. As a result it is apparent that where all heavy grades were reduced, all relocations made, all poor alignments remedied, and all heavy fills made ready for an extensive paving program, the scheme has proved an unqualified success, this especially when one realizes the usual difficulty of the paving contractor in keeping ahead with heavy grading operations and the delays and financial loss due to omitting the paving over heavy fills and later moving back.

Exclusive Grading Men Attracted

In addition it attracted the exclusive grading men to the job with outfits adequate to handle dirt. It was especially noticeable that many men who habitually shunned the paving work were only too eager to handle a grading job. In other words it has attracted a new line of contractors, who had not previously shown an inclination to bid, men, too big to "sub" the grading work on an average paving job, who saw a large enough yardage to afford the utilization of their machinery and equipment to economic advantage to themselves and to the state.

Separating Bridge and Grading Contracts on Same Section

In connection with work of this sort there was instituted a practice which has been much discussed by members of the department and the experience which was gained therefrom may be of some value to the readers of Municipal and County Engineering, namely, the separation of bridge construction from grading even though the bridges were included in the limits of the grading section. Previous opinion had been that bridges and grading should, as a rule, be combined, since it was feared that having two contractors on one job might lead to numerous difficulties and be the cause of repeated controversy.

Contractors Favored Separation.

When the question of grading contracts came up, however, there were requests by both grading contractors and bridge contractors for this separation, since it is a well known fact that the grading contractor is usually equipped to handle grading work only, while the average bridge contractor is equipped to handle bridge work only.

Where one must overlap the other, it may result in two things: First, the grading contractor being unfamiliar with bridges naturally raises his prices on the bridge work to take into account his unfamiliarity with the work, while the bridge contractor, not familiar with grading work on a large scale and not equipped, is not in position to make a rational and economic bid on the grading work. Second, if let together the grading contractor may underestimate his bridge requirements and will "sub" this work to a less desirable man than the regularly qualified bridge contractor, while, on the other hand, the bridge man bidding on the basis of his knowledge of bridge work will give the grading operations secondary consideration. Therefore, after giving this matter consideration in the light of the numerous pleas for the separation of such contracts it was decided to separate grading and bridge sections wherever practical and where the bridge work was of sufficient magnitude to justify such a course. The grading contractor, however, was called upon to construct the usual small cross road culverts and private entrance culverts along the line of his grade since these particular culverts are always so numerous and so situated that it would be impracticable to separate them from the grading work.

Two Methods of Limiting Jurisdiction

Two schemes were tried, one, making a deduction from the grading contract about 100 ft. back from the face of each abutment of the bridge and specifying that the bridge contractor should make the fill within those limits, this to allow him storage and working room; second, requiring the grading contractor to make the entire fill up to the back of each abutment.

Special Specifications to Insure Co-operation

In order that there might be no confusion between the two contractors, special specifications were inserted in each instance, which specifications may be quoted in brief:

"Co-operation between the contractors. The contractor shall handle the work of this contract so as not to interfere with the operations or work of the contractor for the bridges not included in this contract and laying within or adjacent to this section and located at Stations .... on the contract designated as project No. .... The contractor hereby assumes all responsibility, financial or otherwise, for work not completed and accepted, and further agrees to protect the state from all damages or claims due to any inconvenience, delay or loss encountered by said contractor on account of the presence and operations of the contractor for the above mentioned bridges.

"The contractor for the above mentioned bridges will be required likewise to carry on his operations so as not to cause undue delay to the contractor for this section. Both contractors will be required to co-operate with each other, and in case of any dispute the decision of the engineer shall be final and binding upon both alike.

"Priority of work. The construction of the abutments for the bridge at station .... shall take precedence over any other work to be done under this contract and shall be completed as soon as possible after the award of the contract. The construction of the east abutment shall precede the construction of the west abutment.

"The construction of the abutments for the bridge at station .... shall take precedence over any work to be done on the bridges at stations .... and shall be completed as soon as possible after the award of the contract. The construction of the north abutment and backfill shall precede the construction of the south abutment."

It will be noted from the above specifications that the grading contractor is held responsible for the fill, while the bridge contractor is held responsible for certain definite operations in connection with construction of his abutments.

In addition to the "special provisions" the two successful contractors were called together before starting work and the entire proposition was discussed very carefully so that each would be familiar with the obligations and intentions of the other.

In the writer's district there were 22 individual sections on which the bridges were separated from the grading, although some were combination sections, and since practically all 22 sections were either completed or well under way by January 1, there was afforded a chance to study the working out of the method.

Contractors Do Not Clash.

The writer has watched this proposition with considerable interest and to date there has not been noted a single accountable difference between contractors. In one or two instances slight difficulties did arise, but the engineer always got the two contractors together and, after a careful analysis of conditions, there was effected a peaceable and satisfactory settlement.

In short, it would appear that no more trouble need be anticipated on a proposition of this sort than usually arises between a contractor and his "sub" under similar conditions. Each contractor seemed to realize his obligations and evidenced his willingness to accede to them.

With respect to omitting a small section of grading adjacent to the bridge for the benefit of the bridge contractor's working force, as contrasted with the proposition of having the grading contractor construct the entire fill, there did not seem to be a marked difference in either scheme, although observation at present tends to indicate that it is fully as desirable to let the grading contractor make the entire fill and thus relieve the bridge contractor of any grading work. At first, thought it may appear strange that this matter worked out as it did, yet it seems that the two contractors are able to work in such harmony that there is no apparent confusion and in several instances where the grading contractor had the work practically completed except the back fill at the abutments he made a private arrangement with the bridge contractor whereby the latter should complete the work and where the bridge contractor needed a small space for storage or plant, he made a similar arrangement. The latter scheme is now followed in new work.

Conclusion

In conclusion it would appear that the inference to be drawn from these last paragraphs is that better and more reliable contractors for their own specific lines of work can be obtained by following out the course just referred to and that, just as in the case of separating heavy grading from the paving, so also it would seem desirable from a practical and financial standpoint to separate all large bridge work from the grading.

In short, the 1920 experience along this line has shown a marked preference to continuance of the system of letting grading contracts strictly to grading men and bridge contracts strictly to bridge men.

ANALYSES AND PREPARATION OF HIGHWAY COST ESTIMATES

By H. J. Kuelling, Construction Engineer, Wisconsin Highway Commission, State House, Madison, Wis.

In view of the rapidly changing economic conditions in the past few years and the uncertainty as to future years, estimates have been giving, and are going to give, highway engineers considerable trouble. There has been and there will be great doubt as to whether or not bids should be accepted. The uncertainties have been very great in recent years, and largely against the contractor. Apparently there is a reversal coming and the uncertainties will now be against the states. This means that it is all the more urgent that proper estimates be made on highway work.

The question of estimating will be discussed in this paper from the standpoint of a state department and not from the standpoint of an individual, said Mr. Kuelling, in addressing the recent annual meeting of the American Association of State Highway Officials.

It is assumed by the writer that the economical type to be constructed has been previously selected. This statement is made because of the fact that in making estimates, factors are very often uncovered which warrant a change in type.

Collecting Local Information

Before any figures are made on an estimate, the engineer must carefully analyze all conditions surrounding the work. In other words, he must spend time in seeking out all local information relative to every feature of the work. This local information may pertain to availability of materials; freight rates; railroad accommodations, as to sidings and train service; camp sites; water supply for these camps; availability of supplies for this camp, whether they come from merchants or farmers; the soil conditions, whether or not they are conducive to a small weather loss; whether the sand is so soft that it will interfere with the movement of his equipment, such as wheelers, or wagons; the kind of clearing and grubbing he has, whether they are deep-rooted trees or flat-rooted; the type of marsh conditions, if there are any, whether it is possible to work horses or equipment on them; the kind of grades that may be encountered in the work, which will have a bearing on the hauling of materials, or the pumping of water; in fact, he must seek information on a great variety of subjects.

Information on Local Materials

In seeking knowledge of materials he must know the capabilities of commercial concerns to ship, whether they are in a position to get cars, whether they have the proper capacity to turn out the amount of material they are likely to contract for; whether their material is satisfactory; the business reputation of the concern, as to whether they will keep their word or not—that is, whether they will ship in accordance with promises, or whether they will ship to some one that comes along and offers them a higher price at a later date.

Seeking information on local materials, the engineer must be even more careful, as he must know the kind of materials available, the amount of it, especially if it is a gravel deposit, as these are likely to pinch out; he must know the cost of it, and he should have an option on it, so that one contractor, by getting this option, cannot bar others from bidding.

The mere investigation of present used materials is not sufficient, as there are many cases where materials are being hauled several miles when there is a sufficiently good supply within a very short distance from the job. Entirely new and unknown sources of supply can be found in any state by a painstaking materials department. The changes of the freight rates, if there are any new increases, should be balanced against the extra distance that local materials can be hauled.

After an engineer has obtained or been furnished with all this local color, he is still very much handicapped in making his estimate, unless he has had considerable experience in actual construction. He should know the best methods of carrying on the work, what equipment to use, whether it be a grading or surfacing job.

Do Some Work by Force Account to Learn Facts

With the amount of work that is being

done and will be done by every state in the Union, the simplest, most practical and only satisfactory way to get this cost information is for the various states to do some of their work by force account. The writer knows that some states cannot legally do this, but believes that provision should be made so that they may. It will be surprising to many to find out the items that crop up and that must be paid for on a construction job. Some things are hard for an engineer to realize unless he has been through the mill; things which he is likely to criticise the contractors for including in their estimates.

Wisconsin has taken this stand for years past and has done a very great amount of certain types of work by force account. Up until the time of federal construction this force account work was entirely in the hands of the county authorities and only under the general supervision of the state. Since the federal construction began, the state has undertaken a number of jobs by day labor, and, in fact, in 25 of the 71 counties during the past season part of the work has been done in this way. This does not mean that the majority, or even a large per cent., of the work is done by force account, but enough is done so that the state will have first-hand and absolute knowledge of costs.

Range of Force Account Jobs in Wisconsin

Owing to the variety of work and variety of conditions, there is required several force account jobs along different lines. For instance, on concrete road construction during the past season, one job was run by day labor where the material was dumped on the subgrade and handled by wheelbarrows. This material was shipped in from commercial plants to a special siding, transferred by a clam to side dump cars on an electric railway, which ran along the highway and dumped directly onto the subgrade. In another case a local pit was developed and the material hauled to the road by trucks; it was then mixed and placed, the mixer being loaded with wheelbarrows. In a third case a local pit was used, the concrete mixed at the pit, hauled in a mixed condition by industrial railway and placed on the subgrade with a large crane.

In grading operations one job was undertaken in a sandy soil; one in a gravelly soil; one in clay soil; still another in very stony ground. Some work was done by steam shovels and some by wheelers and fresnoes.

In a similar manner various kinds of gravel work were undertaken. Some with sandy gravel, some with clay gravel and some with gravel that would hardly be worthy of the name of gravel; in other words, it was really top soil.

With an accurate cost analysis of all this work at hand, we feel that we are in much better position to determine whether or not the bids submitted to us are satisfactory.

After progressing thus far in the making of an estimate, the writer believes that the states should have a regular system of making these estimates; in fact, he sees no reason why a committee from this organization could not develop a scheme, or schemes, for having all the states make their estimates in the same manner. This scheme, whatever it may be, should be after the same fashion, and, in fact, can well be the very same forms that a contractor should use. There is no reason why the drawing up of such estimate forms could not be partly done by the contractors, or in conjunction with them.

This scheme of having the contractors work with the engineers has been tried out during the past year in Wisconsin, with more or less success.

Form for Making Estimates

A year ago the Wisconsin State Highway Department called a two-day meeting of contractors, machinery men, material producers and the engineers of the state. A very open discussion was had regarding the relations of all parties concerned. At this meeting a committee was appointed and instructed to draw up a form for making estimates. This committee was composed of five contractors, elected by the vote of the contractors themselves, one man from the aggregate producers, one man from the machinery manufacturers, three men from the county construction departments, and two from the State Highway Department. This gave a committee of five engineers, five contractors and two others who were vitally interested in the meeting. This committee met for three different sessions and they were sessions at which work was done. The contractors, as a rule, were frank in their statements, and out of it grew an estimate form for one type of construction which seems to be fairly satisfactory to all concerned. No doubt it has many faults as yet, but it is a start in the right direction. This form is drawn up primarily for a concrete road job, but it can be very easily adjusted to other types of surfacing. The committee did not complete an outline for estimating grading work, but it is hoped that they will do so some time in the near future. They did, however, touch upon certain features of it.

There is perhaps more guessing done in making grading estimates than in any other kind of road work. There is a greater need for some satisfactory method for estimating grading costs than for most kinds of road work. Too often the average haul is not even known. A greater use of the mass diagram would be beneficial.

The attendance of this committee was was almost 100 per cent. and the meetings were lively, as many discussions arose. All points were finally amicably settled and the form is used quite freely throughout the state.

The Form as Developed

The form as developed is divided into 16 subdivisions, as follows: Cost of sidings; moving of equipment to the job; lost time of moving equipment; cement; fine aggregate; coarse aggregate; surfacing; camp loss; miscellaneous cost; contingencies; compensation and public liability insurance; bond cost; overhead; profit; charges for machinery and equipment. Each of these items is subdivided into as many divisions as were considered necessary by the committee. Most of these items are somewhat easy to determine, but others are not. Only a few will be discussed here.

Overhead

Overhead, the committee finally put on a percentage basis. For instance, in figuring a job the contractor or the engineer would have to estimate the per cent. of the manager's time that would be required for the job, and then charge up that per cent. of his yearly salary to the job. The same with regard to his office force, timekeepers, the expense of the manager, his office rent, supplies, etc.

Overhead also includes the corporation insurance, interest on the necessary working capital and any dues that might have to be paid to associations.

Profit

Under the item "Profit" I might say that the committee had a rather heated argument. Naturally the contractors were anxious to obtain as much profit as possible and have the state officials agree to certain percentages. This, however, we refused to do, and the per cent. of profit was left blank for the contractor to fill in as he desired. What we were seeking was primarily to get every one to make his estimate along the same line and then let the contractor be his own judge on whether or not he could get the job with certain profits added on.

Machinery and Equipment

In the last item, charges for machinery and equipment, the committee had perhaps the most interesting discussions. Charges for surfacing, machinery and equipment were worked out to certain percentages per mile of road constructed. For instance, under concrete pavers, we assume that the paver will build 30 miles of standard 18-ft. road, at the end of which time it would be completely used up. The same result was obtained if we assumed that it would build 24 miles and at the end of that time have a salvage value of 20 per cent. of the original cost. With the 30 miles noted above, and an average per year of 6 miles, the life of the mixer would be 5 years. Depreciation, therefore, in 5 years equals 100 per cent. Repairs in 5 years at 10 per cent. would equal 50 per cent. of the original cost. Interest, storage and insurance, 30 per cent. of the original cost, making a total of 180 per cent. of the total cost, to be spread over 30 miles, or 6 per cent. per mile. In other words, in figuring the charges for machinery, the contractor, if it was a standard 18-ft. road, would merely multiply the number of miles by 6 per cent. and take that per cent of the original cost of his paver as the amount to be charged to the particular job under estimation. In a similar manner the committee arrived at percentages for various types of equipment used in the surfacing work.

Grading and Hauling Equipment

The per cent. on grading and hauling equipment naturally could not be arranged by miles. It must be worked on a time basis, and cannot be as accurately determined as surfacing equipment, because of the greater variation in quantity and kind of excavation in different jobs. Final percentages have not as yet been arrived at by the committee for these types. The committee did state that including depreciation, interest on investment, storage, insurance and all repairs, but not including fuel, the percentage per operating day would vary from ¼ per cent. to ½ per cent. of the original cost, depending upon the kind of equipment.

There is no doubt that a continued use of this form will bring out points of weakness, but the writer believes it is a step in the right direction and that within a very few years standard forms of estimating will be in use for road work, and that there is no reason why these same forms cannot be used both by the contractors and by the engineers.

There is also no doubt that adjustments will have to be made for certain local conditions which are not covered. Where there is something to guide, there is no reason why the contractor and the engineer should not be a little more in harmony than they have been in some cases in the past.

Short cuts in estimating are needed and can be devised by state departments. Care should be taken, however, not to make these too short. No scheme will ever be devised or charts drawn so that a novice can make highway estimates. It is only by the use of brain and knowledge of conditions influencing costs that proper estimates can be made.

THE RELATION BETWEEN THE FLOOD FLOW OF STREAMS AND INTENSITY OF RAINFALL

By Harrison P. Eddy, of Metcalf & Eddy, Consulting Engineers, 14 Beacon St., Boston, Mass.

In the absence of definite information upon maximum rates of flood flow in streams it often becomes necessary in flood protection problems to make an estimate of the probable maximum flood flow based upon the probable maximum rates of rainfall for various durations; in other words, to apply what is known as the Rational Method of design of storm water channels, which is now a method commonly followed in design of storm water drains.

The whole of the rain which falls on the surface of the ground does not pass off into the brooks and streams. A portion of it enters the earth and becomes a part of the ground water; some is absorbed by vegetation, and some is returned to the atmosphere by evaporation. The proportion of the rainfall which runs off over the surface into the streams varies considerably due to changing conditions. Some of the rain which eventually reaches the streams does not run off quickly, but is retarded by vegetation, and by depressions in the surface of the ground. When the soil is dry it will absorb a much larger quantity of water than when it is water soaked, as just after a long rain. The character of the soil, whether of clay and of an impervious nature, or of gravel and sand and of a porous character, greatly affects the amount of water which runs off and also the rate of run-off. The presence of considerable rock increases the imperviousness of the surface.

With rains of high intensity covering periods of 24 hours or more, the rate of run-off is greater than in the case of short-time storms of similar intensity because the soil becomes more thoroughly water soaked, vegetation is drenched, the rate of evaporation is reduced and small depressions in the surface of the ground are no longer capable of retaining additional water.

There are comparatively few reliable measurements available showing the relation of the run-off to rainfall, especially

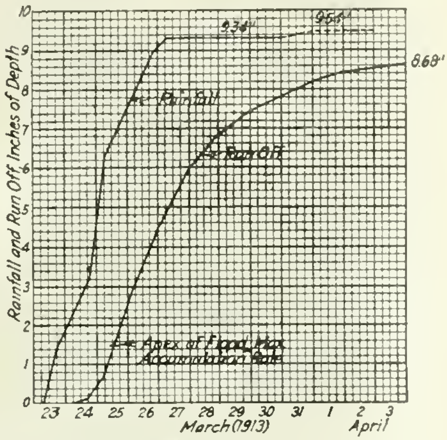


FIG. 1. ACCUMULATED RAINFALL ON THE SCIOTO WATERSHED AND THE ACCUMULATED RUN-OFF AT THE COLUMBUS STORAGE DAM.

Drainage Area, 1,050 Sq. Miles. Storm of March, 1913.

for rains of high intensity and long duration.

Some measurements have been made of the run-off from sewered areas, but these are of little value in estimating the run-off from a drainage area where the amount of impervious surface such as roofs and pavements is small compared with the proportion of the same in urban districts which are sewered. Records of this kind indicate rates of run-off as high as 85 percent of the rainfall for short storms of high intensity, and from that figure down to an average of perhaps 50 percent.

The best available records of run-off for a long-time storm of high intensity are those of the Scioto River near Columbus, Ohio, and the Miami River at Dayton, Ohio, for the storm and flood of March 23-27, 1913.

Scioto River Run-off

Data on the rainfall and run-off of the

Scioto River for the March 1913 storm are given in Report of Alvord and Burdick on Flood Protection for the City of Columbus, Ohio, September 15, 1913, pp. 50, 78, etc. and Mead's Hydrology, p. 568.

The amount and rates of rainfall were observed at a number of stations in and near the watershed, making it possible to compute the average rates of rainfall for the whole watershed with reasonable accuracy.

The run-off or river discharge was computed from the records of the depths of flow over the Columbus storage dam, a masonry dam of the overflow ogee type having a rounded crest. Experiments were available to determine the coefficient of discharge of such a dam with a fair degree of accuracy. The run-off was also corroborated by data on gage heights of the river at other points.

Fig. 1 shows the accumulated rainfall on the Scioto River watershed and the accumulated run-off at the dam.

The principal data are as follows:

Drainage area of Scioto River above Columbus storage dam* (U. S. G. S. revised), 1,050 sq. mi.

Average slope of Scioto River for 40 miles above Columbus and the junction with the Olentangy River, 4 ft. per mi.

River flows for 20 to 25 miles above Columbus through a rock gorge with steep sides 50 to 100 ft. in depth and from 500 to 4,000 ft. in bottom width. Bottom lands not fertile.

Large natural storage reservoir on upper part of watershed consisting of large area of level land receiving drainage from 100 sq. mi. of watershed and developed into market garden farms. Stored water during flood and for 3 weeks thereafter.

"The lower two-thirds of the watershed above Columbus, therefore, really contributed the water which created the crest of the flood at Columbus of such proportions." (Alvord and Burdick-Columbus Flood Protection Rept., 1915, p. 129.)

Rainfall on Scioto Watershed (Mar. 23-27, 1913), 94 hours, 9.34-ins.

Run-off of Scioto River at Dam (Mar. 23-April 3, 1913), 258 hours, 8.68-ins.

Ratio, 93 percent.

Rain began to fall about 6 a. m., Mar. 23.

River began to rise about 6 a. m. Mar. 24.

River began to rise rapidly about noon, Mar. 24.

Maximum flood rate in river occurred about noon, Mar. 28, following period of intense rain which began 18 hours earlier.

Period of concentration on river apparently about 30 hours at beginning of storm.

*Alvord and Burdick Rept. on Flood Relief for the Scioto Valley, 1916, p. 62.

Maximum 72 Hours—Rainfall 7 a. m., Mar. 23 to 7 a. m., Mar. 26, 8.08-ins.; Run-off 6 p. m., Mar. 24, to 6 p. m., Mar. 27, 5.52-ins.; period between beginning of rainfall and beginning of run-off as above equals 35 hrs.; ratio run-off to rainfall (run-off coefficient), 68.2 percent.

Maximum 48 Hours—Rainfall 7 a. m., Mar. 23 to 7 a. m., Mar. 25, 6.4-ins.; run-off 6 a. m., Mar. 25 to 6 a. m., Mar. 27, 4.2-ins.; period between beginning of rainfall and beginning of run-off as above, 47 hours; ratio run-off to rainfall (run-off coefficient), 65.7 percent.

Maximum 24 Hours—Rainfall 6 a. m., Mar. 24 to 6 a. m., Mar. 25, 4.1-ins.; run-off 6 a. m., Mar. 25 to 6 a. m., Mar. 26, 2.4-ins.; period between beginning of rainfall and beginning of run-off as above, 24 hrs.; ratio run-off to rainfall (run-off coefficient), 58.6 percent.

The maximum rate of discharge at the Columbus dam (Mar. 25) was 79,000 c. f. s., equivalent to 74.3 c. f. s. per sq. mi. This rate was maintained for about 3 hrs. It is equivalent to 0.267-ins. depth over the watershed per hour, and is 238 percent of the average rate of rainfall for the maximum 72 hours (0.112-in. per hr.)

The storm occurred at a time when the flow in the river was very small, being about 450 c. f. s. There was no snow on the watershed, the ground was water-soaked and practically frozen, the rate of evaporation was low and conditions in general were especially well suited to produce a large run-off.

Run-off Coefficient

From the above figures it is evident that for a storm of the length and intensity of this one (9.34-ins. rain in 94 hours), and other conditions favorable, a run-off of at least 68 to 70 percent may reasonably be expected. If there had been no storage on the Scioto, the run-off would have been greater. It is interesting to note that for shorter periods of time the run-off coefficient is less.

Miami River Run-off

Data regarding the rainfall of the storm of March 23-27, 1913, on the Miami River, Ohio, drainage area and the resulting flood run-off are given in Mead's Hydrology, 1919, p. 568; Miami Conservancy District, Report of Chief Engineer, Vol. I, 1916.

The average amount and rates of rainfall over the drainage area were computed from the observations at a number of stations in and near the watershed, apparently giving a very close estimate of the actual rainfall which caused the flood flow.

The run-off of the river was computed from an elaborate series of hydraulic measurements and computations based on the flood profile, river cross-sections and assumed coefficient of roughness as used in the Kutter formula and others. Corroborative results were obtained at a number of stations, which led the engineers of the Miami Conservancy District to believe that the computed discharge rates were reasonably accurate. It is doubtful if the records of run-off of the Miami are as accurate as those of the Scioto, due to the difference in conditions and possibilities of accurate measurement.

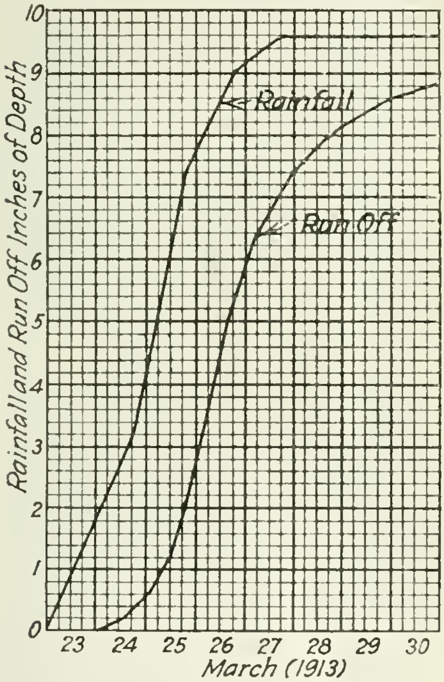


FIG 2. ACCUMULATED RAINFALL AND RUN-OFF ON THE MIAMI RIVER ABOVE DAYTON, OHIO.

Storm of March 23-27, 1913. Drainage of Miami River above Wolf Creek, 2,525 Sq. Miles.

Fig. 2 shows the accumulated rainfall on the Miami River watershed and the accumulated run-off of the river above Dayton.

The principal facts of interest are as follows:

Drainage Area of Miami River at Dayton above Wolf Creek, 2,525 sq. mi.

The country is generally rolling and is nearly all cleared for cultivation.

The average river channel capacity outside of cities and towns at the time of the flood was only about 9.5 percent of the flood discharge.

Dayton is located at the confluence of Mad, Stillwater and Miami Rivers and Wolf Creek.

The Miami River has a slope of 3 to 4 ft. per mile for a distance of 35 miles above Dayton, Mad River a slope of about 6 ft. per mile, Stillwater River a slope of about 4 ft. per mile and Wolf Creek a slope of 17.5 ft. per mile.

Rainfall on Miami Watershed (Mar. 23-27, 1913), in 116 hrs., more or less, 9.6-ins.

Run-off Miami River above Dayton (Mar. 24-30), in 168 hrs., more or less, 8.9-ins.

Ratio, 92.7 percent.

Rain began to fall about midnight, Mar. 22.

River began to rise about midnight. Mar. 23.

River began to rise rapidly about midnight, Mar. 24.

Period of concentration on river apparently about 48 hrs. at beginning of storm.

Maximum flood rate during the night of Mar. 25-26 and lasted for several hours.

Maximum 72 Hours—Rainfall midnight Mar. 22-midnight, Mar. 25, 7.9-ins.; run-off midnight, Mar. 24-midnight, Mar. 27, 7.2-ins.; ratio (run-off coefficient), 91 percent.

Maximum 48 Hours—Rainfall, 7 p. m., Mar. 23-7 p. m., Mar. 25, 6.1-ins.; run-off, midnight, Mar. 24-midnight, Mar. 26, 5.6-ins.; ratio (run-off coefficient), 91.8 percent.

Maximum 24 Hours—Rainfall, 7 p. m., Mar. 24-7 p. m., Mar. 25, 4.1-ins.; run-off, midnight, Mar. 25-midnight, Mar. 26, 3.1-ins.; ratio (run-off coefficient), 75.6 percent.

The conditions on the watershed at the time of the flood were substantially the same as described for the Scioto. There was no snow on the watershed, the ground was watersoaked and practically frozen, the rate of evaporation was low and conditions in general were especially well suited to produce a large run-off.

Run-off Coefficient

From the above figures, a run-off coefficient of 90 to 91 per cent. may be expected from a storm of the duration and intensity of that experienced on the Miami, with other conditions particularly favorable. The location of Dayton at the confluence of several large streams is thought to be one reason for the high rates of run-off. Also, the lack of storage on the watershed as compared with that on the Scioto undoubtedly was another cause.

Sudbury River Run-off

A freshet in the Sudbury River in Massachusetts on February 10-13, 1886, is described by Fitzgerald in Trans. Am. Soc. C. E. Vol. 25, 1891, p. 253 et seq.

Drainage area Sudbury River at gaging point, about 75 sq. mi.

Drainage area Cold Spring Brook at gaging point, about 6.4 sq. mi.

Cold Spring Brook drainage area is included in the Sudbury. The latter has about 38 per cent. of its surface covered with woods.

Rainfall in 3 days including 2 ins. of melted snow, 6.7-ins.

Run-off of Sudbury River in 8 days, 5.1-ins.

Run-off of Cold Spring Brook in 8 days, 5.4-ins.

Ratio run-off to rainfall, Sudbury River, 76.1 percent.

Ratio run-off to rainfall, Cold Spring Brook, 80.6 percent.

Note that these ratios relate to the total run-off of 8 days compared to the rainfall in 3 days, and are not properly called run-off coefficients.

There was considerable snow and ice on the ground at the beginning of the rain. Some of the rain as it fell was absorbed by the snow. About three-quarters of the snow went off with the rain and the remaining portion followed a few days later. The ground was frozen at the time.

Cameron Creek Run-off

A flood on Cameron Creek near Hurley, New Mexico, is described in Water Supply Paper No. 358, p. 662-3.

Drainage area above gaging station, 4.4 sq. mi.

Average rainfall on watershed, Aug. 10, to 14, 1913, 2.34-in.

Equivalent to 5,490 acre-ft (mostly on August 14).

The flood reached the gaging station at 3.20 p. m., August 14 with a discharge of 2,300 sec. ft. The stream continued to rise until 4.25 p. m. on the 14th, the maximum discharge being 5,490 sec. ft.

It then began to recede and at 3 a. m. on the 15th ceased to flow.

Duration of discharge, 12 hrs.; mean discharge, 1,370 sec. ft.; volume discharged, 1,360 acre-ft., equivalent to 25 per cent. of the rainfall on the drainage area.

"This low percentage run-off is attributed in large measure to the preceding period of drought, the general condition of the drainage area, and the high rate of evaporation."

This record is of interest as indicating the extent to which a dry porous soil can absorb rain and prevent a high rate of run-off.

Conclusions

Careful study of the foregoing evidence seems to indicate that in estimating rates of flood flow for which provision should be made in works for preventing flood damages, a run-off coefficient of 0.80 should be employed in cases where the earth is moderately impervious or the slopes fairly steep. This probably represents the proportion of the rainfall rate likely to be realized in floods of somewhat rare occurrence—say once in 25 to 100 years.

Under extreme conditions, the kind which would be accepted by the courts as "Acts of God," which may perhaps occur at intervals of from 100 to 1,000 years, it is probable that a higher rate of run-off will be attained, and for estimating flood flows which controlling works such as spillways must be able to withstand with safety, a run-off coefficient not less than 0.90 should probably be assumed, and this, of course, would be applied to the higher rainfall rate which would obtain under these extreme conditions.

CONTRACT FORMS

By George W. Tillson, Consulting Engineer, 313 S. Catherine Ave., La Grange, Ill.

(Editor's Note: In presenting the following paper before the 1921 meeting of the Illinois Engineering Society, Mr. Tillson made no attempt to discuss the forms of contracts recently adopted in some places where the prices for the work vary in accordance with the prices of labor and material. He feels that conditions will soon be back to normal so that these new forms will not be required; also that they will be used mainly for large contracts extending over a long period, and that in any event most of the ideas here presented will be adaptable to the modified forms.)

Practically all corporations, whether public or private, as well as many individuals, have their construction work performed according to a formal contract. It is important, therefore, that such an instrument should be drawn up with greatest care.

The document that is commonly called the contract should be made up of three separate and distinct parts, each independent of each other, but the three combining to form the contract itself. These three parts are known as Instructions to Bidders and Form of Proposal, Plans and Specifications, and Form of Agreement. Now, while these parts are independent of each other, they must be so worded as not to be in actual or apparent conflict. As the three make up one whole that must be treated as a whole; this point is exceedingly important.

Great care should also be used to see that the items to be covered are always placed in the proper part. This is not difficult if the questions are given proper attention.

The object of drawing up all documents before bids are asked is to give the bidders all the information possible about the work, both as to quantity and character, and to tell them what obligations the successful one must enter into and to inform the corporation just what it may expect as to character of work, time of completion and amount of payment.

Instructions to Bidders and Form of Proposal

In these days it is considered the best policy when advertising for proposals for any kind of work to furnish the fullest information possible regarding it. How difficult this will be depends, of course, upon the character of the work itself. Road work, for instance, does not require as much preliminary investigation as a sewer job, while such contracts as were awarded by the Board of Water Supply of the City of New York, during the last 15 years, required a vast amount. Any corporation asking for bids wants as much competition as possible. To make intelligent bids men must know all the conditions under which the work must be carried out. If the corporation itself makes all the necessary investigations, it can furnish the information to all prospective bidders, in this way often inducing people to bid who otherwise might not think it worth while to investigate for themselves. Then, too, in any event, a certain amount of work must be done in order to prepare plans and information for any kind of bidding and the extra cost of making everything complete will generally not be excessive. Of course, such information must be accurate, otherwise much controversy and often litigation will arise if in carrying out his contract the successful bidder should find conditions varying materially from those shown when he made his bid. This is one of the main arguments used against the corporation attempting to furnish all preliminary information about character of ground, for instance, and conditions under which the work must be performed.

Bids should be received by items, a positive and specific price made for each so that a slight variation in quantities will not matter. If an amount of rock is to be excavated and the approximate amount is not known, a contractor cannot figure as to its exact cost. He may take a chance on it being small and bid very high or very low with the idea that in either case it will not materially affect his bid. But should the quantity prove to be large he may receive an ex-excessive amount, or, on the other hand, be obliged to do the work at considerable loss.

In the case of a sewer contract, if an attempt be made to show the amount or locality of water to be encountered, great care should be exercised, as the water line may change appreciably between the time of making the survey and the carrying out of the work. If water is shown to exist anywhere on the line of the work, a note should be made in a conspicuous place stating that these conditions existed on a certain date, and it is not known that they are permanent. Attention should be called to other than physical conditions, if any exist.

If other than cash is to be paid for the work, it should be stated in just what form the payments will be made. If the work is to be guaranteed for a term of years, or any legal conditions are to be observed, it should be plainly set forth.

If any guarantee is required on any part of the work, it should be so stated. Also, if any deposit is required with the bid or bond for the carrying out of the work.

Proposals

Blank forms for proposals should always be prepared, so that all bids will be made on the same basis, and so, easily and accurately compared. Any variation from the prepared form should render the bid informal and cause it to be thrown out. A statement to this effect should be made in the instructions to bidders.

These forms should be made out carefully and in connection with the specifications and agreement so that there may be no conflict between either. The writer has in mind a contract for sewer construction where the proposal stated that the price bid included the cost of protecting any and all railroad tracks that the sewer passed under. In the agreement there was a clause that said the contractor should allow the railroad company every facility for protecting its track. The proposal plainly stated that the contractor was to protect the tracks while the agreement as plainly intimated that this work was to be done by the railroad.

The contractor saw the point and insisted that he should be reimbursed for his alleged extra work. The Board of Public Works at first laughed at the idea, but when asked what the clause in the agreement did mean if it did not mean the railroad company would do the work, and being unable to answer, finally allowed the contractor one-half of the cost of the work. As a matter of fact, the proposals should not contain conditions. These should all be in the agreement.

In the above case, if prices had been given simply for constructing certain sizes of sewers, and a clause in the agreement had stated that wherever the sewers passed under any railroad tracks, the cost of protecting the tracks should be borne by the contractor, there would have been no controversy.

Specifications

The object of the specifications is to tell the contractor the character of the materials he must furnish and how the work must be performed. This should be done clearly, definitely and concisely. Nothing should be described generally. Expressions like "equal to," "as good as" should not be used. The properties of the article should be described. The whole theory of competitive bids is equality; that each bidder should have the same information.

Before an advertisement for proposals for public work can be published in New York City, the proposed contract and advertisement must be approved by an assistant corporation counsel especially designated for that purpose. He takes the stand that the engineer should know what he wants and ask for it. And it would seem as if he were right. He objects to generalization or the naming of specific kinds of articles. Such as a certain brand of paint, or certain make of a lock, the idea being to say just what is wanted and then let the manufacturers work accordingly.

The person who draws up the specifications should have such a knowledge of materials or work required so as not to make too stringent requirements, and not to call for dimensions that are not generally manufactured unless it is absolutely necessary. It is a simple matter to specify what might be difficult and expensive to make up. If standard forms and shapes can be used, they should always be called for. A few years ago the cities of Boston, New York and Philadelphia used granite paving blocks of such dimensions that the blocks of one city could not be used in either of the others, though practically just as good. So each quarry had to know what city it was making blocks for and a shortage in one city could not be made up by a possible surplus in another.

Then, too, in making specifications for material that is to be used from year to year, such as paving brick, granite or wood paving blocks, asphalt, cement, or anything of this character, the manufacturers should be consulted with, so that unnecessary conditions may not be imposed. By doing this the co-operation of the manufacturers is secured, and this is always to be desired.

The old idea that an agreement between, or consultation with the engineers on the one side and the contractors and manufacturers on the other, means collusion and fraud, is exploded, as it is generally recognized that only by a full and complete co-operation can work be performed most cheaply and efficiently.

From what has been said it should be easy to determine what should be put in the specifications and what should not. But variations from these ideas are very common.

The writer some time ago was called upon to investigate a newly laid pavement. The question arose as to length of guarantee, if any. A careful study of the agreement failed to find any such provision whatever. But when looking over the entire document it was learned that the specifications called for a guarantee of five years. This certainly was an item for the agreement. Care should be taken so as not to insert in the specifications any requirements that are not to be enforced. Otherwise the cost of the work may be increased or a contractor knowing the customs and usages of a locality may be able unfairly to defeat a bidder coming from the outside.

Leave as little as possible to the judgment of the engineer, architect, or whoever may be in charge of the construction. The writer knows that many people will say "Oh! that does not amount to anything—no court will sustain that." But they are wrong. In the first place there is no desire to get into court, and in the second place there are many instances where the court has ruled that where the contract says that the decision of the engineer shall be final, or that certain things must be done when ordered by the engineer, the contract binds and its provisions must be fully carried out.

Plans

The plans of any work show the character and location of the structure, dimensions of details so that the bidder can tell just what he is expected to construct. Although bearing the same relation to the contract as the specifications, it differs from them in showing what is to be built rather than how.

The plans should be full and complete, all details being drawn to such a scale that they can be easily understood. As they form so important a part of the contract, on any work of much magnitude they should be signed by the contractor, so that in case of a dispute there can be no question what particular plans are referred to. This is important as in many instances the plans are so large that they cannot be bound with the contract.

Care must be taken to see that all notes made on the plans are strictly in accordance with the specifications, instructions to bidders and form of proposal. While this is a simple and unquestionable proposition, and it may seem that too much stress is laid upon it for that reason, much confusion and litigation have often arisen because there is so often a difference in the requirements of these different parts.

Agreement

The agreement is practically the summation of all papers. The contractor knows what he is expected to do, and the corporation knows what it is expected to pay for the same. The agreement fixes the conditions under which the work is to be performed, and when signed by both parties, binds them both to carrying it out.

It should provide that the instruction to bidders, form of proposals, plans, specifications and the agreement, all taken together, should form the contract the provisions of all of which the contractor is bound to carry out. It should state clearly who is to have responsible charge of the work and who is to decide disputes, should any arise. It should also state how and upon what individual formal notices to the contractor should be served. It should also provide for the cancellation of the contract in case the contractor failed to carry out its provisions, and in such event what penalty should be imposed. It should state just when partial payments are to be made, if any, and of what amount, also time and conditions of final payment.

If the work or any part of it is to be guaranteed for any particular time, this should be clearly stated.

It should specify the time of beginning the work, time allowed for its completion, and penalty, if any, if it is not finished within the required time.

In this paper no attempt is made to include all the provisions that should be inserted in an agreement, or other parts of the contract, but it is hoped to show their character so that whatever item it is desired to insert in a contract shall be placed in its proper place in order that the contract as a whole shall be entirely logical and one that can be enforced in the courts, if necessary.

In looking over the contracts of different municipalities, for instance, one is surprised at the different forms used and the variation in details. Much variation, of course, is caused by the difference in the laws governing the cities, but much of it is due to the lack of attention given to details.

In New York City, where public contracts have been given out for over a century, the present forms are very voluminous and are the results of experience. It is said that when, for instance, a contractor sues the city upon any particular clause of the contract and recovers damages, the legal department either changes that clause or adds another to meet the objections of the court. When one reflects that this has been going on for a hundred years, with very many thousands of contracts, it is not strange that the present forms are so lengthy.

While a contract should be clear and explicit so as to be fair to both parties, it should also be as concise as posible and provide for the rights of the corporation and the contractor.

Bond

The contractor is required to give a bond for the faithful performance of his contract. The amount varies with character and size of the contract. Its form is simple as it simply binds the contractor to do what he says he will do. It does not go into details, but refers to the contract, and this is one of the reasons why all the parts making up the contract should be clear and consistent with each other.

A bond is a highly technical document, and to enforce it the legal provisions of the contract must have been carried out.

It is not a part of the contract as it is not signed by both parties. It obligates a bondsman to pay to the corporation a certain sum if the contractor fails to live up to his undertaking.

Summary

In closing the writer wants to sum up briefly, even to the point of repetition, what he feels are the important things to be considered.

Make all conditions, physical or legal, clear and plain, so that prospective bidders will make their prices on the same basis, and on the same printed forms.

Let the plans and specifications show location and amount of work, character of materials, and just how the materials are to be used.

Let the agreement contain all the conditions by which both parties to it are to be held and bind up these different parts into one controlling and complete instrument to be known as the contract.

THE TREND OF ENGINEERING SPECIALIZATION

By Wm. E. Vogelback, of the Sanderson & Porter Engineering Staff, 72 W. Adams St., Chicago, Ill.

The study of industry is a study of organization. After many years of systematic grouping and arrangement of activities, we find business emerging in the last decade as one of the major professions, subdivided into a multitude of minor professions. Each of these minor professions, such as advertising, credit, management and salesmanship, has become a highly specialized science. Other major professions, particularly engineering, have followed this same trend of specialization. A century ago a man in any branch of the engineering profession was identified simply as an engineer. Fifty years ago he was a civil or mechanical or electrical engineer, while today these latter terms give but a vague idea of his qualifications or his occupation. Specialization finds its way into all industries and professions, subdividing single occupations into many, and confining the individual more and more to specific tasks. Men have learned to anticipate the trend of events, and, therefore, we find a profession, as engineering, for example, crowded with men of but limited training, and capable of but minor specific tasks.

There is an evil here to the detriment of the individual as well as to the profession. As it is, the world needs men of vision—men who are capable of big things—men who are scientists. Comparatively few men are scientists in the broader application of this term. Few men are possessed of the ability to analyze complete problems; to see the relation between the problem in its entirety and any or all of its component factors. The individual minds of the great majority work synthetically. They grasp only that particular phase of a problem which comes under the immediate observation; one factor at a time without regard for the relation of that factor to the sum total.

Specialization does not assist in turning out these scientists—these leaders of men—but on the contrary, materially assists in their suppression, and hence we must look elsewhere for the forces which tend to preserve this balance.

Educational Institutions and Professional Societies

These forces will be found in our educational institutions and our professional societies. Here, stringent requirements should be fulfilled and ethical standards should be maintained. But of these two, the greater responsibility rests upon our educational institutions. The measure of proficiency of a college is not what studies are embodied in its curriculum, but what the average student learns, which will be of advantage to him in the years which are to follow.

Analytical and Synthetical Thinkers

In the short space of the usual college course today it is not expected that colleges will turn out men fully equipped for their professional practice. The aim should rather be to inculcate a method of logical reasoning, to turn out *analytical* thinkers—scientists. But I feel sure that you will agree with me that too many men just out of college come better equipped with a collection of facts than with methods of analysis. In other words, we are turning out *synthetical* thinkers—men whose measure of comprehension of a subject is the quantity of facts they possess. I desire to emphasize this distinction between analytical and synthetical thinkers. Every individual belongs to one or the other of these classes. The class of synthetical thinkers comprises the rank and file, the detail workers, the narrow specialists. The class of analytical thinkers comprises the executives, the leaders, the planners, men of vision and foresight.

The degree of our analysis of any subject depends upon the interest we have in it. And our interest will depend upon our comprehension of the subject as a whole. If we reflect back upon those subjects in which we were most proficient in school, we will find that they were the

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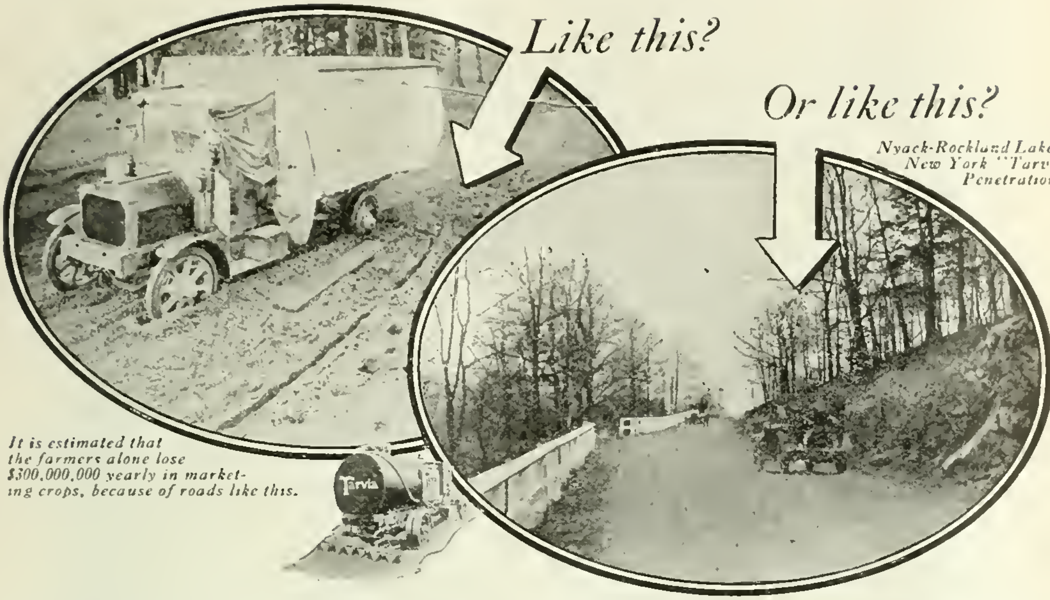

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ones in which we had the greatest interest. And probably we all recall our attitudes toward those subjects which we then seemingly knew we would never have occasion to put to practical use. Interest in a subject is more easily obtained by a preliminary survey of the subject to be studied.

Early Training of Successful Men

Take our large cities, centers of industry, with their vast day and night educational opportunities. Would it not appear that the great majority of our successful men should be those brought up under these educational advantages? And yet as we run through the pages of "Who's Who" we observe in page after page the names of men whose education was acquired in the village school house, or small town college, or by home study. I believe these incidents are relevant and important, and that they are a natural result of a well-defined cause. This cause is the greater ratio of practical learning to the degree of specialization. In the smaller towns, industry is centralized and extensive specialization is not expedient. Here the young man entering business sees the small shoe manufacturing industry or the rice industry in its entirety. He sees the relation between the different departments and the whole plant. With the whole mechanism under one roof, so to speak, his view is comprehensive. This is impossible in the industries in our larger cities. Here specialization has reduced the work of the individual to a mere routine. He fails to see the relation of his job to the industry. In time perhaps he will have held many jobs, but he will always be working under the disadvantage of lack of comprehension.

Evil Effects of Specialization

After a man has completed his college training the evil effects of specialization, as applied to him, must be stemmed by the professional organizations. Here, by his association with other men in the same general profession, he extends his interests into broader fields. Perhaps the most beneficial work that can be done by a professional society is that of maintaining appropriate standards of ethics and qualifications for membership. Here, too, is charged a large share of activity in securing appropriate license legislation. Limited preparation for the professions should be discouraged.

The big problem of today is how are we going to keep the synthetical class from growing greater in proportion to the analytical class. We see how specialization tends to confine more and more the individual to routine duties; to make of him a mere cog in the great wheel of industry. The remedy calls for a greater interest in our undertakings. The larger business institutions have come to regard this interest from the standpoint of the individual's partnership in the business. They have evolved the medium of employes' organizations and house organs for educational purposes. In this way they have been able to maintain a partial balance between specialization and training.

Controlling Trend of Specialization

In the profession of engineering the individuals must have recourse to their professional societies and we find such organizations as the American Association of Engineers fulfilling an urgent demand and materially assisting in preserving the balance. Nevertheless this profession is crowded with men who have spent but a few months in some school, preparing themselves for the position of estimators, computers, draftsmen, etc., and yet with this limited training assume the professional title of engineer. This accounts in a large degree for the growing disparity of remuneration between engineering and other professions or occupations.

There is but little activity in the world that does not require engineering. Next to law, engineering should find a leading place in national government, but not until our educational institutions, our professional societies and our individuals recognize and control this trend of specialization, instead of being controlled by it, will engineering find its place and proper standing, and attain its leadership in world affairs in general.

The foregoing address by Mr. Vogelback was delivered at the Conference on Employment and Vocational Education held at Chicago, November 12, 1920, sponsored by the American Association of Engineers.

Bitoslag—The new Bitoslag booklet, recently issued, illustrates and describes the use of this improved paving product, consisting of a mixture of mineral aggregate, preferably slag, a filler and asphalt. The advantages of the material are described and many typical installations are illustrated. There are also reproduced letters from satisfied users of this material. The booklet may be obtained from the Bitoslag Paving Co., 90 West St., New York City.

WATER WORKS SECTION

SAN FRANCISCO'S FAILURE TO ACQUIRE THE SPRING VALLEY WATER WORKS

By C. E. Grunsky, Consulting Engineer, 57 Post St., San Francisco, Calif.

The proposition to acquire the Spring Valley Water Works was recently submitted to the voters of San Francisco for the third time and was defeated. A two-thirds vote would have been required to carry this proposition. San Francisco will continue, therefore, for some time longer to be the only city of first magnitude in the United States which does not own the water works by which water is supplied to the inhabitants.

The Property in Question.

It had been agreed in this case to let the city engineer select and designate the items of the plant, including lands in watersheds and lands of value as water producing areas, which the city should acquire, and to let the state railroad commission fix the price at which the deal was to be consummated. The property included a distributing system, pipes, service reservoirs and pumping stations which had grown with the city. It included the three storage reservoirs on the peninsula south of San Francisco, the Pilarcitos with a capacity of 1,000,000,000 gals., the San Andres with a capacity of 5,000,000,000 gals., and the Crystal Springs with a capacity of 23,500,000,000 gals., the latter storage capable of increase by raising the dam to about 42,000,000,000 gals. The property also included the company's water developments on Alameda Creek, from which source about one-half of the Spring Valley Water Company's water is at present obtained. Some 61,000 acres of land mainly in the watersheds tributary to the storage reservoirs were included among the property which the city could have acquired.

The Water Supply Problem

It is well known that the agitation for public ownership on both sides of San Francisco Bay has made it difficult for the private interests which controlled the development of the nearby water sources to effect this development at a rate in keeping with the growth and potential requirements of the rapidly increasing population. It is also well known that the local sources of water must, within a comparatively short time be supplemented by the bringing of water from some suitable remote source. The people on both sides of the bay have, heretofore, been in much uncertainty as to the adequacy of the water supply from local sources. There is no adequate living stream within easy reach. Dependence has had to be placed on storage and the peculiarities of the California climate are such that storage means not alone the bridging of the annual period when the local streams are dry, due to the long rainless period of summer, but, also the holding over of water from one season of copious rains and ample runoff to meet the deficiency of possibly two years in succession of materially less than normal rain. Where dependence is placed on surface runoff alone from coast range areas near San Francisco, the conclusion was early reached that, to be fairly safe, the storage reservoir should have a capacity equal to a 900 days' supply. This may seem excessive to those who are only familiar with conditions on the Atlantic slope; but the wisdom of this provision has been repeatedly demonstrated in the case of San Francisco.

The city has now for over 30 years been obtaining a portion of its water from the east side of San Francisco Bay. Subsurface sources have there been made use of to a considerable extent. The surface storage on the Peninsula has thus been materially supplemented by underground storage on the other side of the bay. Furthermore, the project of increasing the water output of the east bay sources is well under way. The water of Calaveras Creek, a main tributary of Alameda Creek, will be held back in a reservoir, which is already in service at part capacity. The water works taken in their entirety are a going concern which have grown and have been expanded as the city has grown. They are supplying to the city an average daily amount of water somewhere between 35,000,000 gals. and 40,000,000 gals.

Recommendation Made in 1902

The writer, as city engineer of San Francisco in 1902, in reporting upon a water supply project for San Francisco with Tuolumne River as the source of supply made the following statement:

"This project is submitted in compliance with directions of the Board of Public Works, as authorized by the Board of Supervisors under charter requirement. It is not to be inferred, however, that the city engineer desires to recommend in submitting this report and a cost estimate, the original construction of an entirely independent water works system as here outlined * * * No other conclusion can be reached than that the interests of the city and of the Spring Valley Water Works are mutual—to have the established works in part, at least, retained in service and to have the new works supplement that part of the Spring Valley Water Works system which can be retained in use."

First Step Toward Acquistion in 1909

Despite this advice no serious steps were taken for the acquisition of the Spring Valley Water Works until 1909. The proposition then formulated to buy at a price of $35,000,000 all properties then owned by the water company without reservation, was defeated early in 1910 by a narrow margin. Four years later, under reservation by the water company, of various items, more especially a large tract of land within and closely adjoining San Francisco, the second proposition to sell, this time at $34,500,000 was again turned down by the electors.

Why People Voted Against Project

The question arises as to the underlying causes of the recent refusal on the part of the people to do what is so obviously desirable. Perhaps the reason is to be sought primarily in the impression that the Tuolumne River project is being built and will soon make high quality Sierra Nevada water available. There have been $45,000,000 voted for this project, and more than one half of this sum is being expended in the construction of the Hetch Hetchy dam and diversion works, conduits and tunnels and power plants, which will, however, leave the water still in Tuolumne River in the the foothills of the Sierra Nevada, east of the San Joaquin Valley and more than 100 miles by proposed conduit route from San Francisco.

There seems to be still a considerable proportion of the people of the city who do not understand that it would be an economic waste to duplicate the distributing system now in service and that even if such duplication were decided upon that the city would still be in need of of the near-by storage facilities now owned by the Spring Valley Water Company, and which can not be dispensed with as a part of a satisfactory system, as no equivalent substitutional storage sites exist on the peninsula. Then, again, the congressional action under which reservoir and other rights of way for the Tuolumne River project were granted to San Francisco is not understood by every one. In some quarters the fear has been expressed that if the city acquired the Spring Valley Water Works there would be more delay in bringing the Sierra Nevada water into the city than if these water works continued to be privately owned. The restrictions imposed by congressional action in this matter are onerous and may long delay the bringing to San Francisco of Sierra Nevada water. They are in effect that, before Sierra Nevada water is carried beyond the limits of the San Joaquin Valley, the near-by sources of water supply must first be fully developed. The exact words of the inhibition are:

"That said grantee (city of San Francisco) shall not divert beyond the limits of the San Joaquin Valley any more of the waters of the Tuolumne watershed than, together with the waters which it now has or may hereafter acquire, shall be necessary for its beneficial use for domestic and other municipal purposes."

The question may well arise in view of this language whether this restriction applies as is generally believed to be intended, if the near-by sources of supply are privately as well as if municipally owned.

Price Not Approved.

The price, too, at which the water works were to be purchased did not meet with universal approval and there always remained some uncertainty as to the dependable quantity of water that a purchase of the water works would place at the disposal of the city. It is only necessary, in this connection, to quote from the pamphlet entitled, "Facts, Figures, Arguments," prepared and distributed by the Campaign Committee of the administration for use in the recent campaign. We read in this pamphlet:

"The city is to acquire the right to pump not exceeding 15,000,000 gals. daily of water as against the lands retained at Pleasanton by the Spring Valley Water Company. This right is in excess of any amount of water which has heretofore been pumped from that source. The company agrees not to interfere with this right except that it may take such water as is necessary for irrigating the retained lands, but nothing further."

The Pleasanton ranch lands which the water company was to retain and for which it is inferred that water was thus reserved, have an area of 4,730 acres. It is readily conceivable that during the irrigation period of 6 or 7 months, from April to October, the aggregate amount of water applied to these lands, when brought under intense cultivation, will be equivalent to about 24 ins. over all. This would represent an average draft of 14,000,000 to 15,000,000 gals. per day for 6 or 7 months of each year upon the same Pleasanton sub-surface sources from which the city would be drawing water. The writer has failed to find anything in the pamphlet that would show that against this irrigation draft there is any protection assured to the city. This fact is cited merely to show that despite the thoroughly organized campaign conducted by the city administration for the proposition, it was not made clear what the city was to get and this, as a matter of course, threw more or less doubt upon the fairness of the price.

Finally, as in all such propositions, under which new responsibilities are placed upon the municipal government, there were no doubt some who were swayed by lack of confidence in the present administration. The intensiveness of the campaign conducted by the city officials could only heighten distrust where distrust already existed and it did not succeed in bringing out a large enough vote to offset the effectiveness of a determined, though very quiet, opposition.

Despite the result of the recent vote the question of San Francisco's acquiring the Spring Valley Water Works by purchase must again come up and will continue to come up until the city owns these properties. The writer still holds the view to which he gave official expression in 1902—as above quoted—that the interests of the city and of the Spring Valley Water Company in so far as the acquisition of the water works properties by the city is concerned are mutual. He believes, furthermore, that if all affairs relating to municipally owned water works were entrusted to a properly constituted Water Board—the lack of which has long been felt—that a recommendation by such a board would go far toward quieting opposition.

IMPOUNDED WATER AT BLOOMINGTON, IND.

By Donald H. Maxwell, Assistant Engineer, Alvord & Burdick, Hydraulic and Sanitary Engineers, Hartford Bldg., Chicago

Bloomington is located on the summit of the divide between the east and west forks of White River, in the driftless area of southern Indiana. A ground water supply is not available. The topography is rugged and good reservoir sites for an impounded supply are apparently plentiful on the contour map. Unfortunately the impounded supply that has actually been developed by the city has been unsatisfactory and inefficient. To appreciate one of the serious defects in the existing impounded supply, and the possibility of a satisfactory reservoir supply, it is necessary to consider the geological structure in this vicinity.

Geological Structure

The rock formations at Bloomington are stratified and dip gently to the west southwest, so that the successive outcrops form north and south strips from ¼ mile to 4 miles wide, their lines of contact made very irregular by surface erosion. The lowest formation exposed in the vicinity of Bloomington is the Knobstone, consisting of dense sandstones and shales several hundred feet in thickness, which appear in the bottoms and sides of the valleys to the north, east and southeast of the city. Above this lies the Harrodsburg limestone which outcrops on the uplands north, south and east of Bloomington, and in the lower portions of the city. Immediately above this formation occurs a stratum about 60 ft. thick of Bedford limestone, which underlies the surface in the higher portions of Bloomington, and outcrops along the sides of ravines to the north and south of the city. Next above the Bedford limestone lies the Mitchell limestone, which outcrops over an area about four miles in width, extending west from Bloomington. It is in this latter formation that the present city water supply has been developed. The rocks of this whole region are overlaid on the uplands by a thin, rather impervious soil cover and the alluvial deposits in the valleys are shallow.

The sandstones and shales of the Knobstone are unusually impervious and tough, but resist weathering very poorly, and are deeply eroded where exposed. The limestones are in general soluble and are honeycombed with solution channels. This is particularly true of the upper strata of the Mitchell formation.

The geological conditions are in general distinctly adverse to the development of an underground water supply for a city as large as Bloomington, which has a present population of 12,000. In fact good wells for domestic water supply are infrequent.

The influence of the rocks is evident in the varying topography around Bloomington. To the west in the central portion of the Mitchell limestone outcrop, the uplands are rolling, and pitted with sink holes. The water courses are shallow and often disappear into the cavernous limestone to isue later as springs at the contact plane with less soluble rocks below. Eastward toward the edge of the Mitchell limestone outcrop and beyond, the topography is rough and the streams deeply eroded in the lower limestones, and in the sandstone and shales of the Knobstone formation. The topography in this area offers numerous reservoir sites, but on account of the varying character of the rock formations, they are not all equally desirable from the standpoint of watertightness. This has been demonstrated by local experience.

Present Impounded Supply

The two older city reservoirs are located entirely in the cavernous Mitchell limestone formation. The dam of the newer Leonard Springs reservoir rests on Bedford limestone, while the upper part of the reservoir is in the Mitchell limestone.

The experience with these three city reservoirs has demonstrated that a watertight reservoir should not be expected in these limestone formations, particularly in the Mitchell limestone. At the old reservoirs leakage occurs in solution channels through which the water finds its way around the dams, and under the spillways in natural rock to such an extent that several years ago the entire city water supply was taken from a spring or leak below the lower dam at the main pumping station. When the reservoirs are not full, water not pumped to the city is pumped back into the reservoirs to help conserve the supply. At the newer Leonard Springs reservoir, there is a large marsh immediately in front of the dam, with indications of a considerable flow of water from the reservoir above. The leakage from these reservoirs is so great that even though all unused visible leakage is pumped back into the upper reservoirs, they become rapidly depleted in dry weather. Efforts to correct the leakage have been unsuccessful.

Advantages of Knobstone Area

Satisfactory reservoir sites are available in the creek valleys east and north of Bloomington at no greater distance than the existing city reservoirs built in the Mitchell limestone area. In these creeks the Knobstone formation provides an impervious basin which is ideal for retaining an impounded supply, and the narrow deeply trenched valleys afford numerous good dam sites.

In striking contrast to the city reservoirs in the limestone is the very succesful reservoir built in the Knobstone formation by the Indiana University for its own water supply. This reservoir was located on the recommendation of Prof. E. R. Cumings, geologist at the university.

The reservoir is formed by a concrete arched dam 40 ft. in height at the mouth of a small ravine entering Griffys Creek, and has a watershed of about 200 acres. This reservoir is absolutely tight and clearly shows that the city of Bloomington could obtain equally satisfactory reservoirs by utilizing the available reservoir sites in this formation instead of those in the limestones to the west.

The relation of the geology to the water supply of this region has been very fully described in a paper by Professor Cumings. The conclusions of Professor Cumings are reiterated by the report on the city water supply, made by Morris Knowles in 1914, which included a report on the local geology by Prof. W. O. Crosby, the geologist. Professor Crosby pointed out the defects on the Mitchell limestone for an impounded supply, and recommended that the city supply be developed in the impervious Knobstone formation.

The new Leonard Springs reservoir was built in the limestone formation subsequent to these recommendations. As above pointed out this reservoir has repeated the experience with the old reservoirs in the limestone, and Bloomington is again confronted with serious water shortage. The firm of Alvord & Burdick reported on the water supply in 1920, and recommended that the city abandon the reservoirs in the limestone area in favor of an adequate impounded supply in the Knobstone formation.

Deficiency in Present Supply.

Even if the impounding reservoirs of the Bloomington municipal supply were free from leakage, there is good reason to believe that the present development would be insufficient fully to supply the city during years of greatest drought. There are no records of the local watershed yield, but for the purpose of judging the adequacy of the existing development at Bloomington, comparison may be made with the long record of watershed yield at Lexington, Ky.

This latter record covers a period of 26 consecutive years. It is interesting to observe in this record the importance of a long record in determining the safe yield of a watershed, that is, the yield which may be depended upon in the year of greatest drought. If we consider the yield of the driest year in the 26 years' record at Lexington as 100%, the safe yield, as indicated by shorter records which did not include the driest years, would be as follows in percentage of the safe yield for the entire 26 year period:

	Per cent.
Driest year in 26 yrs.	100
Second driest year, once in 18 yrs.	120
Third driest year, once in 15 yrs.	125
Fourth driest year, once in 11 yrs.	160

It is apparent from these figures that the application of a short record of yield in developing an impounded supply may lead to a very serious overestimate of the safe yield.

At Bloomington the estimated safe yield of the city's impounded supply, based on the Lexington experience, is approximately one million gallons per day, as compared to a present average pùmpage rate of about 1.5 million gallons per day. It is evident from this that the existing impounded supply at Bloomington is insufficient to provide the city with water throughout the driest year that may be expected. The deficiency might be as much as 60%.

The frequent water shortages experienced at Bloomington are due in part to the fact above pointed out that the development is deficient in safe yield. This deficiency is made more serious by the excessive leakage from improperly located reservoirs.

This paper by Mr. Maxwell was presented at the recent joint meeting of the Iowa and Illinois sections of the American Water Works Associations.

WATER PURIFICATION AT WHITING, INDIANA

By Samuel A. Greeley, of Pearse, Greeley & Hansen, Consulting Engineers 39 West Adams St., Chicago, Ill.

The communities in the industrial district of northern Indiana, extending from South Chicago on the north to Gary on the southeast, depend upon Lake Michigan for their public water supplies. The population of this district numbers close to 200,000. The domestic or sanitary sewage which is cared for by the public sewers is being gradually diverted from the lake and with the completion of the Calumet-Sag Chanel and it conecting sewerage works, in 1921, it will be only at very rare intervals that domestic sewage from public sewers reaches the waters of Lake Michigan. At present only one small district, Robertsdale, sewers into the lake.

Industrial Sewage

There is, however, an immense volume of industrial sewage discharged into the lake, estimated roughly at well over 100 million gals. per 24 hours, and including with it some sanitary or domestic sewage from plant toilets. The industries are varied from cement mills to chemical works, but are predominantly oil and metal industries. Both of these industries produce considerable volumes of coal tar and petroleum wastes which impart tastes to the water supplies of most persistent character. Under the war impetus, there was a marked increase of industrial capacity with larger volumes of sewage reaching the lake.

Whiting Conditions

Our first active conection with the water supply of Whiting was in the fall of 1916, or about 5 years ago. We had, however, studied the entire district for sewage treatment as far back as 1912. At both times (1912 and 1916) there was a pronounced petroleum flavor to the Whiting water supply but, so far as we know, similar complaints were not made of the water supplies of Hammond, East Chicago and Gary. At the present time tarry tastes occur in the East Chicago supply and probably occasionally in those of Hammond and Gary. There appears, therefore, to be an increasing and changing industrial sewage pollution.

The Whiting Testing Station

Because of the persistent petroleum flavor at Whiting and the lack of sufficient data upon which to base the design of a plant to treat such water, the construction of a small testing station was advised. The station was built and operated to determine (1) the effect of aeration on the taste; (2) the action of chemicals and coagulation upon the taste, and (3) general data reflecting the effect of the oil in the water upon the usual ratings of rapid water filtration plants. The tests covered a period of about 3 months during the summer of 1917. The only means of determining the residual flavor of the filtered water was by actual taste and three independent series of observations were made by: (1) Pearse and Greely; (2) the Columbus Laboratories, and (3) the laboratory of the Standard Oil Company. The observers agreed upon a substantial removal of the petroleum flavor.

The Filter Plant

The design for the filtration plant at Whiting combines all of the requirements which the operation of the testing saation showed were essential.

The principal elements are, an aerator, a mixing basin, two coagulating basins, six filters, a filtered water basin, and the head house.

The capacity of the plant, based upon the filters, is 4,000,000 gals, per 24 hours. Provisions for enlargement are also made.

Water is supplied from the pumping station at the Standard Oil Company, about ½ mile distant, to the aerator, from which it flows by gravity through the plant to the filtered water storage basin. From there it is pumped by high service pumps into the mains.

The Aerator

The aerator is located on top of the coagulation basin roof. Structurally, it is a basin 30 ft. by 48 ft., in plan, surrounded by a concrete wall 3 ft. 6 ins. high, with vertically grooved columns on top for inserting stop planks between to confine the spray. The bottom of the aerating basin is stepped to a central collecting basin. Two 14-in. cast iron pipes, 8 ft. apart, lie on the floor of this basin and are tapped on 3-ft. centers for 22 No. 13A Spraco nozzles. The spray is directed, not vertically, but slightly inclined so that the two rows of sprays will collide. The spray in falling cascades down a few steps to the pool in the center, which is kept at a fixed depth to retard freezing.

The Mixing Basin

The water from the aerator enters the mixing basin, which is in and practically on a level with the second floor of the head house. It was placed there for two reasons in particular, first for purpose of observation and second, to reduce the length of chemical pipe lines.

The mixing basin is approximately 33 ft. by 12 ft., with an average depth of 5 ft. It has 4-in. brick baffle walls of around-the-end type spaced on about 2-ft. centers. The outlet from the mixing basin leads directly into a mixed water conduit which passes through the head house wall into the coagulating basins.

Coagulating Basins.

There are two coagulating basins, separated by a dividing wall, each 40 ft. by 81 ft., with an average depth of 16 ft. The capacity of the two basins is about 700,000 gals., providing a sedimentation period of 4.2 hours on a 4,000,000 gal. rate or 3 hours on a 6,000,000 gal. rate. The basins are covered with a concrete roof of the beam and slab type of construction. The roof is supported by 14-in. square columns spaced 10 ft. 4 in. both ways. Drainage of the basins is obtained by a 1 ft. slope in the floor with four 10-in. sluice gate outlets in sumps located at the low points. The inlet to each basin from the mixed water conduit is a 20-in. circular sluice gate, and two 30x36-in. sluice gates in the dividing wall provide a cross connection for operating the basins in series. An 8-in. brick baffle wall extends from one end down the center of each basin to within 10 ft. of the opposite end. The outlets to both basins are similar and consist of an overflow or skimming weir discharging through two 16-in. circular sluice gates to a settled water conduit lying directly over the influent or mixed water conduit. Both of these conduits are 24x28 in. in section and are supported along one wall of the basin. The settled water conduit re-enters the head house, passes through it to a right angle turn and down the center line of the filter pipe gallery.

The Filters

Six filters, 12 ft. by 19 ft. 6 in. each, have a filtering area of 234 sq. ft., and a rated capacity of 666,000 gal. or a total of 4,000,000 gals. per day. Each filter has three concrete wash water gutters which run across the width of the filter and discharge into an 18-in. main gutter which runs lengthwise. A 12-in. connection leads to the main drain in the pipe gallery. The influent to each filter is a 10-in. pipe.

The filtering medium consists of 30 ins. of sand 15 ins. of gravel, with underdrains of the Harrisburg type. The effluent passes out through an 8-in. rate controller and returns to the auxiliary filtered water storage basin underneath. The 12-in. wash water supply line is suspended directly beneath the concrete infiuent conduit in the pipe gallery with 12-in. laterals to each filter. The rate of wash is estimated at 15 gals. per sq. ft. per minute. A 4-in. connection for filtered water to waste is also provided. All of the valves are hydraulically operated from an operating table with the exception of the 4-in. waste valve, which has an extension stem leading to a nut in the operating floor above.

The pipe gallery is 11 ft. 6 ins. wide and the arrangement of the pipes is such that a clear space about 5 ft. wide and 7 ft. high down the center is provided. The main drain is of concrete and runs directly beneath the pipe gallery floor. The filters are divided in two sets, three on each side of the pipe gallery. Each set is supported upon an auxiliary filtered water basin 45x18 ft. by 11 ft. The outlet to both of these basins is into the filtered water storage basin.

Filtered Water Storage Basin

The filtered water storage basin is approximately 94x91 ft., and 14 ft. deep. With the two auxiliary basins beneath the filters, a total storage of approximately 890,000 gals. is provided. This is equivalent to 5.3 hours' storage at a 4,000,000 gal. rate. The floor of this basin is below ground water level and provision for uplift was necessary. The design adopted is an inverted flat slab with panels 10 ft. 8 ins. by 11 ft. 6 ins. The supports are 14-in. columns, which in turn support the roof. The roof is a beam and slab type with the slab support on four sides. A 2 ft. earth covering has been provided. The basin is baffled with 8-in. walls to prevent dead water areas. The outlet to this basin is into a conduit, low enough to drain the basin, which leads into the basement of the head house. Into this conduit the high lift and wash water pump suctions are connected.

The head house is a 4-story structure, including the basement. The basement contains heating plant, coal storage, elevator machinery, but principally the pipe connections to the pumps located on the first floor above.

Pumps

For high service duty two 3,000,000-gal. and two 5,000,000-gal. pumps are provided, so connected that each set may pump separately or in combination forming a two-stage pump. The wash water pump is a 5,000,000-gal. pump, designed for direct washing of the filter.

The second floor contains the offices, laboratory, chlorine room, shower bath and locker room on one side of a passageway and on the opposite side, the mixing basin and the lower portion of the chemical solution tanks with the orifice boxes. Two dry feed chemical machines are provided.

Alum will be stored on the third or top floor.

The second floor passage-way opens directly onto the operating floor of the filters, and the first or pump room floor connects down a few steps into the pipe gallery. A doorway at the opposite end of the pipe gallery is provided.

Architectural Features

The plant is located along the main line of the Pensylvania railroad, and on one of the principal thoroughfares of Whiting. It was decided, therefore, to make the plant artistic from an architectural standpoint as well as serviceable for operation.

The superstructure is of brick with a concrete shell. Stone window sills and copings, and a stone entranceway add to the attractiveness. The roof is flat with pyrobar roofing supported on concrete beams. The exterior walls of the basins are exposed on practically all sides and to relieve the monotony they are paneled and surmounted with a coping.

The filter sand has an effective size of not less than 0.35 nor more than 0.44 millimeters and a uniformity coefficient of not more than 1.65.

Costs

Some data showing the cost of the Whiting filter plant as compared with costs elsewhere are shown in Table 1. The total cost including all items such as land, engineering and extras for both filter plant and high lift pumps was approximately $200,000. The work was carried out during the period of peak material prices and while labor was still scarce, most of heavy work being completed prior to August, 1920.

Operation

The plant was put into operation during November, 1920, and is now in charge of A. C. Bromschwig, formerly of the St. Louis filter plant. He has under him for the operation of the filter plant and high lift pumping station 6 men—two for each 8-hour shift.

It can not be said, of course, that the plant has yet reached its best operating routine, as this will require experience

TABLE I—SOME COMPARATIVE UNIT BIDS ON WATER FILTER PLANTS

		Earth Excavation Per Cu. Yd.		Reinforcing Steel Per Pound		Concrete Per Cu. Yd.	
	Year	Low Bid	Average 3 Lowest	Low Bid	Average 3 Lowest	Low Bid	Average 3 Lowest
Evanston, Ill.	1913	$0.90		$1.79		$13.90	
East Chicago, Ind.	1918	1.00	$1.30	10.00	$10.00	13.38	$17.65
Whiting, Ind.	1918	.77	1.18	5.50	4.87	17.50	(1)

(1) Estimated from lump sum bid.

with a variety of seasonal conditions. Some operating data may be of interest, however. During January filter runs averaged 8 hours and have now been extended to about 12 hours. With the relatively clear raw water, it has been found helpful to add lime at the rate of 0.7 grains per gal. in addition to alum at the rate of 1.5 grains per gal. The best combination of chemicals and points of application is, however, still to be worked out. Considerable floc appears necessary to clear or scrub the water of the petroleum taste.

The record shows three observations of oily flavor out of 48 taste tests. All three occurred on days following several days of southerly wind movement. This is, of course, not conclusive, but there is evidence of an increasing improvement in the quality of the filtered water at Whiting.

No trouble with algae has been reported.

General Considerations

In the opinion of the writer, the water supplies of this district should be studied broadly as influenced by industrial sewages. Four factors stand out: (a) The location of sewer outlets; (b) the location of water intakes; (c) the treatment of the sewage, and (d) the treatment of the water.

The problem will eventually be solved by the economical adjustment of these factors. It appears clear at the start that the treatment of the industrial sewages of large volume is likely to be the most costly. The construction of water purification plants (because the water supplies are very small in volume as compared with the sewages) is considerably less costly and is called for in any event as the first line of defense against bacterial pollution, material turbidity and other objectional qualities of the raw water. The effect of the industrial sewage on the fishing industry of the Illinois River will also need consideration. Well organized seasonal study of the factors involved is the first step.

This paper, by Mr. Greeley, was presented at the recent joint meeting of the Iowa and Illinois sections of the American Water Works Association.

PERSONAL ITEMS

George B. Gascoigne, Consulting Sanitary Engineer, Cleveland, Ohio, has been retained to report and prepare preliminary drawings upon sewerage and sewage disposal improvements for Springfield, O. Estimated cost, $1,000,000. Mr. E. E. Parsons, is City Manager of Springfield.

Alexander Murdoch recently became City Engineer of Chicago after passing a competitive examination conducted by the Civil Service Commission in which he had a rating of 92.7. Five engineers took the examination; only one other passed and he with a rating of 20 points lower than Mr. Murdoch. A native of Baltimore, Mr. Murdoch lived in Philadelphia for many years. Before coming to Chicago he was chairman of the Claims Board of the Emergency Fleet Corporation in charge of adjusting uncompleted war-time contracts. Formerly, he was Vice President and Chief Engineer of the Fidelity and Deposit Co. of Maryland, where he had charge of completing construction work taken over by his company as bondsmen after contractors had abandoned the work. He was for some time in the service of the city of Reading, Pa., serving first as assistant city engineer and later as city engineer. He is a graduate of the University of Pennsylvania.

Mr. F. Carl Martini, for 9 years assistant engineer in the Water Works Construction Bureau of the city of Chicago was recently promoted to the position of Engineer of Contracts in the city service.

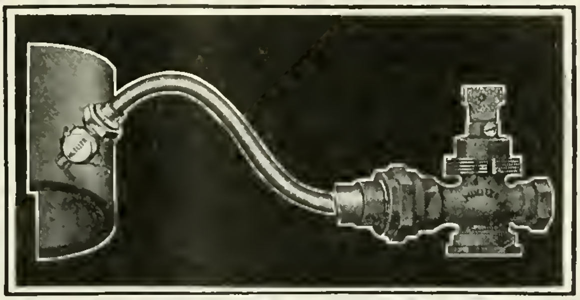
OPERATING A WATER WORKS PLANT UNDER STATE SUPERVISION

By C. M. Roos, Secretary, Cairo Water Co., Cairo, Ill.

After eight years of state regulation of public utilities in Illinois we are hearing much discussion of the questions of whether or not the law providing for such regulation should remain as it is, or be repealed entirely and go back to so-called "home rule," or be revised in some manner to correct certain alleged faults. Discussion of this utility regulation question by those who advocate "home rule," has brought forth expressions from various interests and classes throughout the entire state, which appear to be largely in the majority, favoring a continuation of state regulation as opposed to home rule.

Home Rule vs. State Regulation

Few questions in Illinois at present are attracting as much attention from commercial organizations, business men, bankers, professional men, municipal authorities and labor organizations as this one of regulation of public utilities. In all of the discussion little has been said



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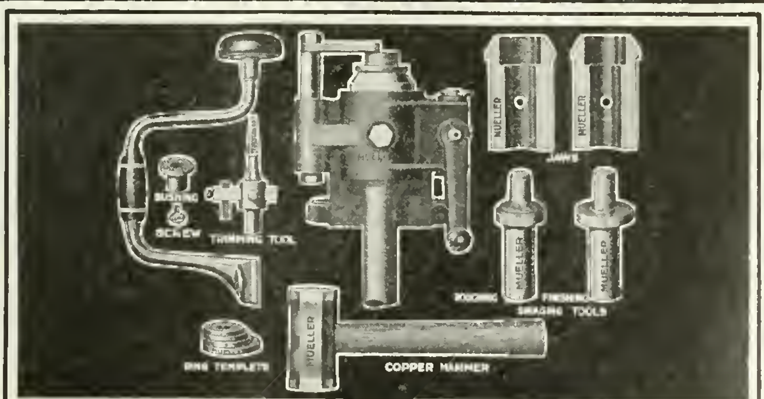

publically by the utilities themselves. It is obvious why there should be hesitancy on the part of the utilities in going on record in a discussion of this character, because past history proves that there is a tendency on the part of the public to look upon statements by public utilities with a certain suspicion, and not to accept them in the good faith which should exist if co-operation and best results for all interests concerned are to be obtained.

But have we not reached the time when common sense, good business for all concerned, and the best interests of the general public demand that the experience, opinions and advice of public utilities be heard in the discussion of this and other similar utility questions which vitally affect the public? Certainly no other interests are better qualified to participate in the discussion of public utility problems than the public utilities themselves. The woeful lack of intelligent understanding on the part of the general public of some of the vexing utility problems of today is largely because the utilities have hesitated frankly and openly to discuss these problems and to take the people into their confidence.

People Do Not Understand Utilities' Predicament

This entire situation is largely due to the attitude which the utilities have taken toward the general public. Utilities have not talked to the people as freely as they should. The utility business is the most vital business in any community, having a more direct bearing on the community welfare, progress and convenience than any other class of industry. There are few classes of business more dignified and contributing more to the comforts and welfare of man and which are today operated in better faith than the public utilities. Utilities have much to talk to the people about, many interesting and vital things about the business to explain, and the sooner the general public knows the real facts about the utility business, coming frankly and in good faith from the utilities themselves, the easier will it be, wisely and successfully, to solve some of the problems with which we struggle today.

If the public really knew conditions as they exist today in the public utility business there would be little difficulty in solving our utility problems, the utilities would be in a position to do financing to better advantage, confidence in utility securities would not be shaken and utilities would be in a position to make needed improvements and extensions, all of which would be directly to the advantage and interest of the consumers and would contribute directly to community development and the re-establishment of general business confidence.

Public utility educational campaigns are needed and the burden of conducting them rests upon the shoulders of the utilities. Is it not true in practically every community that the public criticises and openly attacks its public utilities more freely than any other class of industry within the community, and yet only a very small percentage of the citizens of a city will ever take the time and enough direct interest in their utilities even to visit the plants, see how the work is done or talk with the managers and learn first hand some of the things they should know about this most vital part of their community life and existence?

Utilities Had No War Time Profits

A recent personal experience in talking with a prominent business man who has the direct management of a large industry, illustrates how grossly misunderstood is the position in which the utilities have been thrust during recent years by men whose intelligence would not permit such an attitude if they knew the inside of the utility business. In commenting on a recent increase in rates for water after hearing the explanation that the last year's business resulted in an operating loss of about $12,000, the business man said: "Your company's investment in this city represents approximately $500,000, and my judgment is that it could not be duplicated for anything like such an amount. You show an operating loss of $12,000 for one year on a half million dollar investment. I know of a business in this city with an investment of $100,000, which showed an operating loss last year of more than $12,000. Why should you find fault with such a small loss with such a large investment as you have, as you should be better able to stand it than the $100,000 business?" Such comment to the utility man is really amusing, but it must be regarded seriously, as the man who said it was serious about it, and he represents an intelligent class in the community. This man does not stop to think that the $100,000 business to which he referred earned profits of several times its capitalization during the fat years of and following the war, and now has a reserve in actual cash sufficient to withstand the strain of many years of loss at the rate of $12,000 per year. In contrast with this condition the

utility business with five times the investment not only failed to show a return on the basis of its large investment, but in most cities showed a loss during most of the period of high commodity prices, and now is not only without a cash reserve, but has its credit impaired and an extremely low market for its securities.

What the Educational Program Should Include

The public utility educational program should include:

1. Interesting members of commercial organizations, city councils, women's clubs and civic and labor organizations in making careful inspections of the utility plants. These visits should be made in groups and instructors at the plants should explain details of operation, maintenance, expenses, etc.

2. When at all practical local citizens should invest financially in their local utilities. The people themselves can do much to make their utility investments the safest and most desirable to be found, and as a result they will not only profit financially directly from their investment, but indirectly in service rendered by the utilities and in the ability of the utilities to keep pace or set the pace for community development and expansion.

3. Local boards of education should be led to see the importance and necessity of having pupils of all grades in the public schools study their local utilities. In most cities the utilities could provide lectures periodically to the school children, and also to the school instructors who, in turn, could teach the subject in connection with their regular class studies.

4. Newspaper advertising in the form of heart-to-heart talks with the people. Enclosure slips in local mail telling the consumers about their utilities.

5. It should be known in the community that questions and complaints or criticism about service, etc., are solicited by the utilities instead of discouraged, so that consumers will not hesitate to go direct to the utilities about any matter in connection with their business in the community.

Education Along Three Lines

Education of the public should be along three distinct lines, viz.:

1. The people should take a real and direct interest (financial if possible) in local utilities, familiarizing themselves with the business to the extent possible.

2. To select capable well qualified men to represent them in their government, local and otherwise, regardless of political affiliation and to trust to the judgment of experts in deciding questions of a technical or professional character.

3. To be less hasty in openly criticising constituted authority unless or until the basis for criticism is well and intelligently established. Unless the attitude of our American people toward constituted authority changes it will soon be difficult to persuade highly qualified men to serve in public office. Lack of confidence in constituted authority destroys the very basis of sound government and the results are evident on every hand.

We are living in an age when the people demand control and rule as never before. The rights of the people must be defended and preserved, as this is a country of and for the people, and no one has any authority whatever, civil or otherwise, to deprive any citizen, who respects the laws established by the majority, of his rights as a citizen. But rule or control or regulation by the people does not mean that safety, economy and efficiency in all channels of civic and industrial activities can be secured by direct supervision or regulation by the masses, who can not be expected to be qualified to pass wisely on all phases of community life and industry. Thus the judgment of a doctor of medicine would scarcely be good in deciding a technical question in connection with the regulation of a water works. The same can be said of many other classes of citizens without in any sense reflecting upon their intelligence.

Rule by the people in proper common sense form means that they select or provide those whose business it shall be, impartially, to represent the people in the various positions or offices, and who shall be considered as properly constituted authority in their respective positions. It is presupposed that such constituted authority shall either be well qualified to pass intelligently on the questions in their line, or who will proceed to qualify for the work by familiarizing themselves thoroughly with it.

Unique Aspects of the Water Works Business

The water works business is unique in many respects as compared with private industries. It is by nature a monopoly in its community which it serves. It is to the interest of both the consumer and the operator that it be a monopoly. Duplication of investments in public water supplies in any city invariably results in the necessity of finally consolidating the systems, thus throwing upon the consumers

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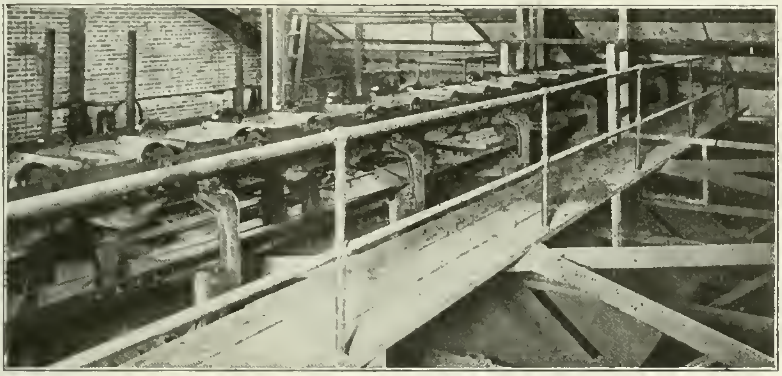

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A water works is unique in that the investment in it is or should always be of a permanent character. The very nature of the business requires this. Our limited franchises (a relic of Illinois home rule) prevent economical financing of permanent investments in water works and also prevent private utility corporations from installing in communities as high type equipment as otherwise could be provided. Attempts by local communities to fasten upon water works utilities iron clad contracts in the form of franchises, and at the same time demand immense investments in equipment, the protection of which depends directly upon the bargaining again at the expiration of the franchise with local authorities who though otherwise intelligent men have no technical knowledge of water works and cannot be expected to have, cannot but result in working havoc at no distant date. The truth of this will certainly soon dawn upon many cities much to their sorrow.

A water works plant is unique in that it is expected to operate continuously whether costs of supplies are high or low, regardless of labor troubles or transportation difficulties, whether the business is profitable or not, whether the company's credit is good or bad, and when repairs are difficult and expensive to make on account of inability to cease operations for a period. In addition to all of this the plant is supposed to be operated on the basis of a bare legal interest rate of return on its investment as its maximum return, with no guarantee against losses. No profit is supposed to be figured in water work business. An interest rate of return on an investment in an industry cannot be considered as profit. To insure holding the return to utilities at the rock bottom or below, the public stands by dictating the rates to be charged for service.

Contracts With Private Industry

Now in contrast with a water works plant, note that a private industry has the sky as its limit for profit and when business is bad it closes its doors and lays off its employees, thus cutting down expenses. It ceases operations at will to make repairs at ease and economically. Its machinery and equipment usually operate only about 8 or 9 hours per day and 6 days per week, which gives the mechanical department ample opportunity to do emergency work to good advantage. It markets its securities to much better advantage than a water company possibly can. It has an unlimited field for development. Finally, it is its own boss in the sense that it has no public regulation of its rates or prices for its product.

These statements as to conditions under which a water works utility must operate as compared with a private industry is true in a sense whether it is under state regulation or home rule. In both cases it is public regulation by the people. The question under discussion by so many in our state is which method of regulation is to the best interests of all concerned.

Public Utilities Must be Regulated

The public utility business by nature should be and must expect to be subject to public regulation. The only real fault or complaint along this line which utilities should file is that it is discriminatory and grossly unjust that the public should "regulate" utilities, which mean keeping profits down to rock bottom and far below in many instances and at the same time not "regulate" the control of the state's natural resources and necessary commodities upon which utilities must depend to operate their plants.

Public control of utilities and failure to control the business which furnishes utilities with necessary operating supplies has resulted during the last few years in the utilities' already deflated purse becoming leaner and leaner, with the contents of same filling the purse of private industry in enormous profits. The State Public Utilities Commission is not at fault in this. The fault lies in the provision by our government for regulation of one class of business while another class is earning large profits from money from the first class, all unmolested, because no authority has been provided to regulate certain private industries.

This discussion is not presented for the purpose of registering an objection on the part of a public utility against public control of its business. Its object in part is to state that both home rule and state regulation of utilities are controlled by the people, of which control so many are jealous. Its object further is to call attention to the fact that the general public does not realize that the public utilities have suffered enormously in depleted earnings and heavy losses during the last few years, when other industries were growing fat, and that the small increases in rates authorized from time to time recently by the State Public Utilities Commission were absolutely necessary in practically every case to barely keep the utilities alive.

What the People Have Forgotten

The people of our state do not appear to remember that from January 1, 1913, to January 1, 1917, the State Public Utilities Commission lowered rates for utility service throughout the state to the extent that over $5,000,000 was saved to the consumers during that period.

The general public apparently does not realize the tremendous significance of the fact that during the last few years the increase in the cost of money to the public utilities has been three times that to manufacturing industries, and that the only way capital can be secured for our utilities is in the open market in competition with these other more attractive securities.

Our people fail to realize the significance of the fact that in the United States today the investment in public utilities, exclusive of railroads, amounts to approximately $15,000,000,000, of which about $1,250,000,000 is in Illinois, and that this immense investment has not been made by a favored few, but by the people themselves who hold utility securities. In Chicago alone $565,000,000 is invested in utility companies, being more than twice as large as Chicago's investment in its own utilities. These figures represent book value. Reproduction of our utilities as of today would show a much larger investment than is indicated by these figures here submitted.

Capital Invested in Utilities Not Appreciated

The general public does not realize that it is benefited directly and otherwise more by the capital invested in its public utilities than in any other enterprise within its borders, yet the tendency on the part of the public generally is to abuse or fail to appreciate capital invested in its utilities more than in any other industry.

Those who are opposing state regulation do not know the great value and importance of having uniform systems of accounting, well-established standards for service, equipment, etc., for all the utilities in force throughout the state, all of which have been brought about by state regulation and which cannot be provided or maintained otherwise.

The general public is woefully ignorant, indifferent or forgetful of all of this, largely because the utilities have failed to talk frankly to the people as they should.

While the public utilities as a class have hesitated to go on record in expressing an opinion about state regulation, yet it is a fact that many utilities have chafed under the apparent delays in securing absolutely necessary relief through the State Utilities Commission, and when relief would finally come it would often be inadequate to provide for increases in operating costs subsequent to the time when applications for increased rates were filed.

Composing Conflicting Interests

We as utilities must realize the fact that the State Commission has been dealing with a public sentiment invariably strongly prejudiced against public utilities, which made it difficult for the people to understand the absolute necessity and justice of increased rates for service. The Commission, a representative of the people, has the people to consider as well as the utilities. Few of our communities realize as we utilities do that they owe the State Public Utilities Commission a real debt of gratitude for having tided the utility business of the state over the most dangerous and difficult period in history, when commodity prices soared from 100 to 300 per cent. above normal, and at the same time holding rates for utility service down to a very small fraction of this increase in general commodity costs.

Though the utilities have suffered greatly during this difficult period, it is a remarkable fact that our state regulatory body has handled the situation without a single case of a utility ceasing to function.

Rates for service seems to be the point around which practically all criticism of state regulation on the part of the general public centers. Illinois has no reason to complain about its utility rates for service, particularly about water rates. The average highest rate for water in Illinois is .304 cts., and the average best commercial rate is .13 cts. per thousand gallons, as of Jan. 1, 1921, which is considerably lower than the average rates in other states.

Confidence in utility investments must be restored. The interests of the public will best be served by having it so, regardless of the direct effect it may have on the utilities themselves.

Regardless of the attitude of the public utilities toward state regulation, anything less than state regulation of our utilities will mark the complete collapse of the market for utilities securities and thus destroy the very foundation and framework of our entire economic structure.

This paper by Mr. Roos was read before the recent joint meeting of the Illinois and Iowa Sections of the American Water Works Association.

Engineers' and Contractors' Directory

IT 3-31

Construction News and Equipment

EQUIPMENT EMPLOYED ON ROAD CONSTRUCTION IN MINNESOTA IN 1920

By O. L. Kipp, Construction Engineer, Minnesota Highway Department, 920 Guardian Life Bldg., St. Paul, Minn.

Plans were prepared sufficiently in advance during the early part of 1920 so that a large amount of work was placed under contract during the early part of the season. In fact, by the first of June it became apparent that it would not be possible to place under contract all of the work which had been contemplated by the counties, and for which plans were being rapidly completed. A questionnaire was therefore sent to all the highway engineers in the state, requesting information as to the status of the uncompleted contracts in each county and the amount of the various types of road building equipment actually in service, and the date on which any of it would be released for additional work. The information secured by this questionnaire confirmed the opinion of the department that the amount of work already placed under contract was more than sufficient to keep all of the available equipment busy for the remainder of the season, and it was therefore determined to issue an order to abandon further lettings of road work, except where it could be shown that equipment was available for the construction of the project or where the work was of an unusually urgent nature.

A tabulation of the data received on this questionnaire revealed the fact that the number of men and the quantity of equipment and stock actually engaged in highway construction in the state comprised the following totals:

6,092 men employed, 36 steam shovels, 26 locomotives, 281 dump cars, 98,523 lin. ft. of track, 145 elevating graders, 363 blade graders, 1,168 wheel scrapers, 1,011 slip scrapers, 526 fresnos, 1,460 dump wagons, 69 mixers, 30 finishing machines, 466 motor trucks, 91 trailer wagons, 156 tractors, 57 loading bins, 31 belt loaders, 14 derricks, 23 drag lines, 26 screens, 6,212 horses and mules, 18 pile drivers, 44 pumps 13,000 lin. ft. pipe, 2 asphaltic heating plants, and 2 steam rollers.

The total volume of work which the foregoing equipment were able to complete during the season of 1920, was as follows:

Grading—1,120.9 miles, comprising 9,409,849 cu. yds. of excavation, costing $5,737,016.36, the average cost per cu. yd. for the grading being 61 cents, which includes the cost of overhaul, loose and solid rock excavation.

Gravelling—831.69 miles, comprising 1,023,992 cu. yds. of gravelling costing $2,481,700.82. This is an average of 1,230 cu. yds. of gravel per mile, costing $2.42 per cu. yd.

Paving—12.39 miles of Asphaltic Concrete, comprising 107,546 sq. yds. of paving costing $325,699.08. Also 66.98 miles of Portland Cement Concrete, comprising 714,361 sq. yds. of paving costing $2,228,616.69.

Clearing and Grubbing—3,275.18 acres, costing $240,540.89.

Guard Rail—205,555 lin. ft. or 39.0 miles, costing $134,529.33, which is an average cost of $3,449.48 per mile.

Tile Drain—613.341 lin. ft., or 116 miles, costing $166,915.42, which is an average cost of $1,611.34 per mile.

Portable Culverts—153,923 lin. ft., costing $332,102.87.

Monolithic Culverts—335, containing 7,054.81 cu. yds. of concrete, costing $325,112.98.

Bridges—198, costing $1,716,797.91.

Total Cost of Construction—Completed on state roads in the year 1920, including miscellaneous items not enumerated above $14,405,091.06.

State Aid—$1,250,202.20 paid on 1920 construction.

Federal Aid—$2,711,620.00 paid on 1920 construction.

During the season of 1920 17 paving contracts were under construction, in which various methods and types of equipment were used. The high records for progress were made on three projects, namely: Project No. 114, Sherburne County. Project No. 107, Watonwan County, and Project No. 64, Rice County.

On the first of these projects a central mixing plant was used, which was equipped with a 6-bag mixer. The average pavement laid on this contract was

870 sq. yds. per day, with a maximum of 2,196 sq. yds. laid in an actual running time of slightly less than 10 hours. The plant was so equipped that the mixer discharged in 8 seconds, and the time for charging the mixer was not over 5 seconds. It is, therefore, apparent that this equipment was capable under perfect conditions of delivering an even greater yardage during a 10-hour day.

On the second of these a central proportioning plant was used, the material being hauled from this plant with 2 and 2½ ton trucks, equipped with pneumatic tires, and an ordinary dump body divided into two compartments. A 4-bag paving mixer was used on this work, and the average output per day was 681 sq. yds. The maximum output was 1658 sq. yds. The subgrade on this project was in a very satisfactory condition during the time of operation, except for a period of a week or ten days when frequent rains seriously affected the progress of the work and the general subgrade conditions.

On the third of these paving jobs a central proportioning plant was used with industrial haul from the plant to the mixer. Both steam and gasoline engines were used, but it is believed that the gasoline engines proved more satisfactory on account of their light weight and low center of gravity. The mixing equipment consisted of a mixer mounted on a steam shovel base, and a tower of structural steel built over it for hoisting the batch boxes. The base also carries the hoisting engine used for this purpose. The whole is pulled by a 35-horsepower steam tractor, which supplies steam to both the hoist engines and the upright engine, which turns the mixer. The average output of this plant was 736 sq. yds. per day, while the maximum output was 2,145 sq. yds., which were laid in 10 hours and 21 minutes mixing running time.

The specifications on all of this work required a 1-2-4 mix, and the average thickness was a 7 1-5 ins., the pavement being 6½ ins. at the side and 7½ ins. at the center, with a curved crown and flat base.

The engineering and supervision of the 1920 construction was under the immediate supervision of the highway engineers of the counties in which the work was situated. The method of handling the work varied, according to the requirements of the various projects. The number of engineers employed in supervising this work is estimated at 275 engineers and instrument men, besides rodmen, chainmen, and miscellaneous assistants. This estimate does not include the force employed by the central office of the highway department.

HOUSTON CONSTRUCTION CO. PAVES 109 FT. PER HOUR

Winter weather has no effect on road building programs in Texas. Early in January the Houston Construction Co., Houston, Texas, started work on a 15½ mile contract on State Highway No. 3, Orange and Beaumont Road.

Remarkable results are being attained on this work. When W. S. Warfield, Vice President and General Manager of the Company, bought his 21-E Smith Paver last Fall, he looked over the work done by Alan Jay Parrish, who established a 1920 record of 779 ft. in 10 hours, with an average of 450 ft. per day for the whole season. Mr. Warfield claimed at that time that he would break this record. And it looks as though he would—in fact, he has already laid almost as much in a seven hour day as Mr. Parrish did in ten hours.

The Texas job is utilizing Lee Body trucks instead of the industrial railway system for transporting the aggregates to the paving mixer. The material yards are located at Orange, Tex. right along the road that is being built. A Byers crane connected to a stiff leg derrick, with a clam shell bucket, handles all the materials, loading them into material bins direct from the cars on the railway sidings.

Fifteen trucks are used to keep the paving mixer supplied with the aggregates. The trucks are loaded from material bins which measure the correct quantities of sand, stone and cement automatically. A four bag batch, 1-2-3½ proportioned full minute mix is required by the state.

The trucks are run onto a turn-table just ahead of the paver, where they are turned and then backed up to the paver skip. They then dump their loads directly into the closed end skip.

The working schedule has all been well arranged so that there are only 43 men on the entire job, including those at the material yards, on the trucks and at the paving mixer and finishing machine.

It is a 16 ft. road, average thickness 6¼-in. On the first five days, 3,600 lin. ft. were laid, an average of 720 ft. per day. The biggest single day's run was 762 ft. in seven hours. Mr. Warfield ex-

The Paver of Low Mixing Cost

EVERY second of time saving means money saving—profit making on a paving job. The paver that is lowest in cubic yard mixing cost is the cheapest mixer. Any other is costly.

Extra Yardage Built in

Koehring mixers *are designed* to give the lowest mixing cost. Centralized control—the many automatic actions found only on Koehrings enable the operator to maintain that day after day speed of operation which means a big season's extra yardage.

Heavy Duty Construction

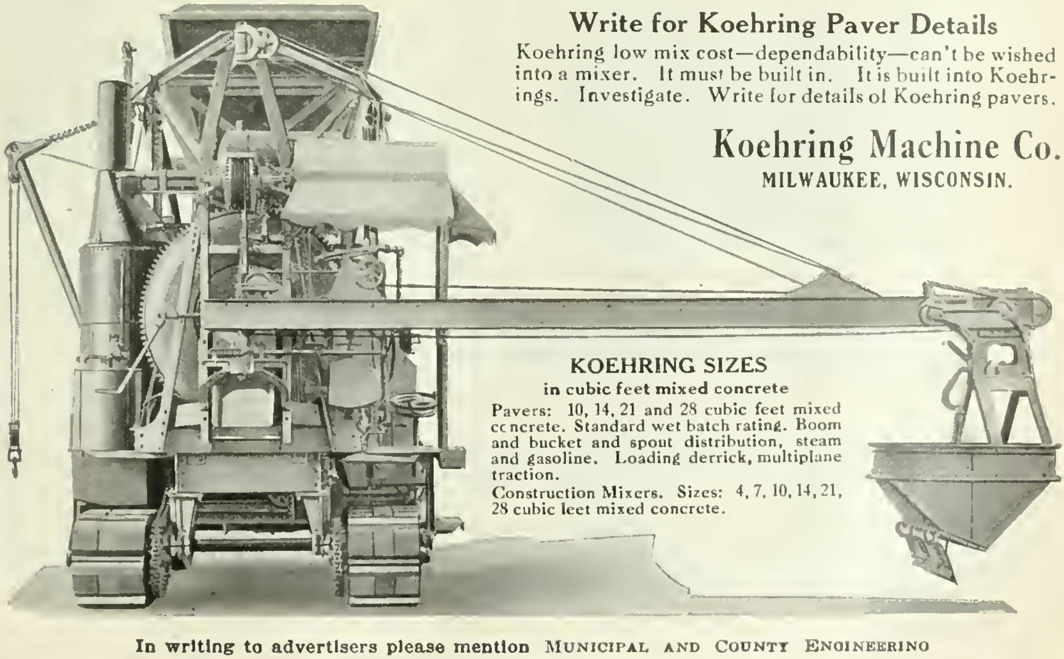
Heavy duty construction is but another term for dependability—and dependability pays a big extra profit in trouble-free continuous operation—which means lowest mixing cost.

Koehring mixed concrete is dominant strength concrete.

Write for Koehring Paver Details

Koehring low mix cost—dependability—can't be wished into a mixer. It must be built in. It is built into Koehrings. Investigate. Write for details of Koehring pavers.

Koehring Machine Co.
MILWAUKEE, WISCONSIN.



pects to put down at least 1,000 ft. in nine hours after the job gets going "full blast." He claims the mixer will handle it easily if the materials can be brought up fast enough.

Blaw-Knox road forms are being used and a Lakewood tamping and finishing machine. The paver is gasoline equipped. A swivel spout is used instead of boom and bucket for delivery of concrete to the road.

THE USE OF TRACTORS ON ROAD CONSTRUCTION AND MAINTENANCE WORK

By Louis A. Wilson, Highway Engineer, The Holt Mfg. Co., Peoria, Ill.

To handle every phase of road building, the tractor must be able to do all or more than men and teams could do; the tractor must do this work as efficiently and in a workmanlike manner at a lower cost. The ability of the "caterpillar" tractor, for example, to handle this work successfully can better be appreciated by this detailed account of performance records gathered from many operations over the entire United States.

Stump Pulling

Clearing the right-of-way is quite often the first step necessary before the grading operations can begin. In the past, stumps have been removed largely by the use of dynamite. The power and flexibility of the tractor has provided a new, and in many cases a more economical, method for removing these stumps.

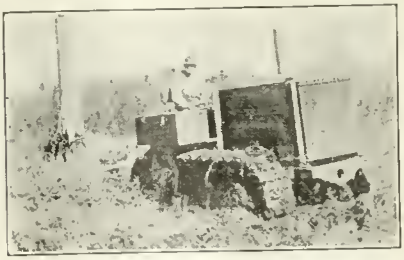


FIG. 1. TEN-TON "CATERPILLAR" PULLING OUT A 24-IN. STUMP.

Mr. Guy L. Shaw has used the 5-ton "caterpillar" during the past two years, and in stump pulling has established an average daily record of 200 stumps or trees. This operation was in the Illinois river bottom lands, completely covered by willow trees from 6 to 18 ins. in diameter. Figuring all the charges that entered into his daily operating costs, the price per stump or tree removed was approximately 15c.

The "American Highway Engineering Hand Book," by Arthur H. Blanchard, page 421, under the subheading of "Pulling Stumps," states the following: "The Holt 'caterpillar,' 60-h.p. (10-ton) will remove sound stumps up to 18 or 20 ins., and the 'caterpillar' feature gives it a very decided advantage in getting over uneven or swampy ground. * * * It has been known to pull 100 stumps per hour for 7½ hours, and on a speed test has also averaged 450 stumps per day. * * *"

It is well to remember in this connection that pulling stumps by this method eliminates the hazard contingent with the use of dynamite and nitroglycerine caps. The tractor requires but two or three men, one to drive the tractor and one or two men to make hitches on the stumps. It not only pulls the stumps out, but with the same power it drags them to the pile where they are burned, thus reducing the labor necessary in clearing up the land after the stumps have been blasted out, and pieces strewn all over the ground.

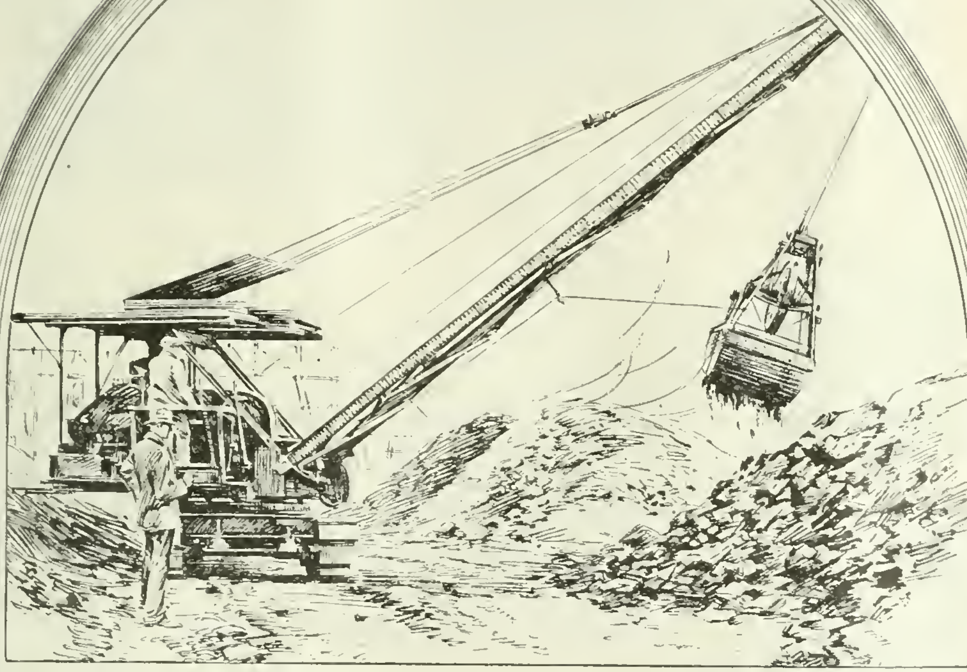
Tractors and Wheel Scrapers

After the roadway has been cleared of trees and stumps, various methods of grading may then progress. Many road builders prefer wheeler outfits. The tractor with a train of wheelers gives a new method of moving dirt. Both the 5 and 10-ton "caterpillar" are used with wheel scrapers.

The Maney wheelers, made by the Baker Manufacturing Company, Springfield, Ill., have a train hitch which permits the use of six or eight Maney wheelers behind a 10-ton "caterpillar." Two men operate the outfit, one man to drive the tractor and one man to load and dump the train of six wheelers. This work is being handled by Mr. A. G. Millard, contractor, Okmulgee, Okla. He moves dirt from 300 to 1,300 ft. During the past season 300 cu. yds. of dirt was the smallest amount moved in any one day. Daily yardage runs from 300 up to 600.

To obtain such daily performance records requires power, traction and the ability of the tractor to handle the train of scrapers in narrow quarters, over fresh fills, and all other conditions of rough going which present themselves in the ordinary routine of building a road. The "caterpillar," with six Maney wheelers, can be turned in a space not to exceed 22 ft. This application of the tractor represents power, speed, increased daily

P&H



"WHISKING THE LOAD AWAY"

Equipped with a clam shell bucket the P & H Excavator-Crane grabs its loads, whisks it through the air, drops it and is back for another bite. Coal, ashes, gravel, sand, earth, are thus handled.

With a magnet and one man to operate, a P & H can load, unload or move pig iron, scrap, building steel.

Exchange a digging bucket for a magnet, and the same man can excavate a cellar or a ditch, level a hill or road; and with a back-filling bucket fill up the ditch again.

With other attachments to the hook, pile driving can be done; beams or structural pieces for bridges or buildings can be set. For speed and ease of handling most anything, a P & H is adapted. There are so many uses for it that it pays dividends at all times.

New Bulletin 5X has many photographic illustrations of applications. A copy is yours for the asking.

P&H EXCAVATOR-CRANE

EXCAVATING MACHINERY DIVISION
PAWLING & HARNISCHFEGER CO.

In Milwaukee since 1884.

New York, 50 Church St.; Philadelphia, Stephen Girard Bldg.; Pittsburgh, Fidelity Bldg., Chicago, Monadnock Block; New Orleans, Whitney Central Bldg.; San Francisco Monadnock Bldg.; Los Angeles, Central Bldg.; Seattle, L. C. Smith Bldg.; Portland, Yeon Bldg.

Selling Agents in 16 other cities.

FIG. 2. THE A. G. WILLARD OUTFIT, A 10-TON "CATERPILLAR" WITH SIX "MANEY" WHEELERS MOVING 300 TO 500 CU. YDS. OF EARTH PER DAY.

yardage, and reduces the cost per cubic yard.

In the mountainous part of Kentucky, where road grading is quite often allotted to the steam shovel, two 5-ton "caterpillars," each with two "Maney" wheelers, are doing the work cheaper and faster than had heretofore been done by the steam shovel and a string of wagons. Mitchell, Townsend & Carter, Clay, Ky., with 4 "Maney" wheelers, 2 tractors and only 6 men, move an average of 550 cu. yds. of dirt per day, a distance of approximately 500 ft. They cut down heavy grades and make deep fills with this outfit. Not being tied down by custom or habit, these contractors have found in the tractor power, economy and speed in moving dirt with wheel scrapers.

Tractors and Elevating Graders

In some parts of the country the elevating grader is the predominating method of moving dirt. Reports read by the Research Committee at the annual meeting of the Northwestern Association of General Contractors, Minneapolis, Minn., March 11 and 12, 1921, established the fact that "caterpillar" tractors increased the daily output of an elevating grader about 30 per cent. The report further indicated that the contractor operating a grader with teams will sooner or later be forced to get rid of the stock and use tractors. The cost of feeding and wintering stock is an economic waste. Ordinarily a 10-ton "caterpillar" will replace 12 to 16, and, many times, 18 head of horses or mules on an elevating grader. The tractor speeds up the work, increases the yardage per day, and reduces the daily costs.

Some contractors have gone even farther in motorizing their elevating grader outfit and use 5-ton "caterpillars" to pull the dump wagons. The 5-ton will take 2 or 3 ordinary dump wagons, or 1 or 2 3½-yd. dump wagons. In either case, the 5-ton will replace 2 or 3 drivers and 6 to 8 mules, and will move faster and more continuously and work harder and will rest less than stock could be expected to do.

Comparative figures on the costs of operating elevating graders with teams and

FIG. 3. A 10-TON "CATERPILLAR" ON AN ELEVATING GRADER WITH TWO 5-TONNERS HANDLING THREE DUMP WAGONS EACH.

Here Is a Road Maintainer Every City and Town Needs This Year

At last—a motor-driven, self-contained road maintainer that is low in first cost and in operating cost, yet high grade mechanically in every respect.

More and Better Work

Under average conditions, the Utilitor Road Maintainer will do more and better work than a three-horse outfit. One mile of almost impassable, rutted dirt road can be dragged into boulevard condition in six hours at a cost of $5.00.

Very Low Operating Expense

After a road has been put into good condition, it can be maintained for from one dollar to one dollar and a half per mile—depending upon the width of the road.

No More Poor Roads or Streets

There is no reason from this time on why any city, town or county should have poor roads or streets. Experience proves that it is not how BIG a drag is used, but how OFTEN a road is dragged—that counts.

Investigate Its Many Advantages

This outfit is very simple. A sixteen-year-old boy can operate the machine and do a good job.

It can be turned in a ten-foot radius, making it possible to go over bad spots in the road many times without covering unnecessary ground.

Write for illustrated folder which shows photographic examples of work done by the Utilitor Road Maintainer. Please Address Sales Division R 12.

MIDWEST ENGINE COMPANY
INDIANAPOLIS, U. S. A.

Showing side and rear view of Utilitor Road Maintainer equipped with five-foot drag. Other sizes supplied on request

BEST WAY TO DEVELOP DEEP GRAVEL DEPOSITS

When Material Runs to Depth Exceeding 15 Ft., or is Under Water, Engineers Advise Installation of a

Sauerman Dragline Cableway

It is now generally agreed by engineers who have studied the economics of gravel production, that the most satisfactory equipment for developing the average pit is a **Sauerman Dragline Cableway Excavator.**

DIGGING

The ability of these dragline cableway excavators to work over spans of 200 to 700 feet or more and dig, elevate and convey from pit to hopper or pile in one operation enables them to handle gravel at a minimum cost per ton, no matter how small or how large the proposition may be.

CONVEYING

They are suited to digging either loose or hard packed material, operate with equal efficiency whether gravel is in a dry pit or partly under water, and have no equal for taking gravel from the bottom of a stream or pond.

DUMPING

Evidence of how Sauerman cableways are contributing to the success of hundreds of commercial sand and gravel producers is published in Pamphlet No. 14, a copy of which will be sent on request. If your gravel deposit is shallow, or lies on a hillside, ask also for Pamphlet No. 12, describing Sauerman Power Drag Scrapers.

SAUERMAN BROS.
1142 Monadnock Bldg. CHICAGO

operating elevating graders with tractors show quite a variance in daily savings in favor of the "caterpillars." The saving effected by the use of tractors varies from $30 to $75 per day, depending upon the efficiency of the operation and the nature of the country in which the outfit is being worked.

Fig. 4 illustrates the outfit of W. C. Mullen, contractor, Vicksburg, Miss. On this work, a race track, Mr. Mullen established a record for moving dirt with elevating graders. The following data, covering this operation, will show in detail the various items entering into the cost on this work, the equipment used, and the high daily yardage maintained throughout the year as a result of the tractor's consistent performance:

Size of "caterpillar," 10-ton.
Western elevating grader.
Length of run, 500 ft.
Width of cut, 50 ft.
Number of dump wagons, 14.
Capacity of dump wagons, 1½ yds.
Time to load, 20 secs.
Time to change wagons, 15 secs.
Total yds. loaded per day, 1,200 to 1,500.
Distance of haul, average, 700 ft.
Length of work day, 10 hrs.
Average day's work, 1,350 yds.
Number of teams, 14.
Number of mules per team, 4.
Number of drivers, 14.
Number of wagons, 14.
Capacity of wagons, 1½ yds.
Time of load and change, 35 secs.
Total yds. loaded per day, 1,200-1,500.
Distance of haul, average, 700 ft.
Length of work day, 10 hrs.

Daily Operating Costs

Team and Wagon Costs:

Team and wagon and harness investment—	
62 mules at $500 each	$31,000.00
14 wagons, 62 harness	5,750.00
Daily interest on investment at 8 per cent., 240 days	$12.25
Daily depreciation at 20 per cent., 240 days yr	30.62
Repairs	1.00
14 drivers' wages at $3	42.00
Feed for 62 mules at $456.25 per yr. each for each of 240 work days, each mule $1.90—62 head	117.80
Board of 14 drivers at $1	14.00
Cost for hauling 1,350 yds	$217.67

Machinery Costs:

"Caterpillar" and elevating grader investment	$8,500.00
Interest on investment per day at 8 per cent., 240 days	$2.83
Depreciation, based on 20 per cent. and 240 days per year	7.08
Repairs	3.00
Operator's wages	8.00
39 gals. gasoline at 30c gal	11.70
¾ gal. motor oil at 50½c gal	.38
1/10 gal. trans. oil at 70c gal	.07
4 gals. track oil at 18c gal	.72
4 lbs. grease at 15c per lb	.60
Board of 2 men at $1	2.00
Helper's wages (grader man)	4.00
Cost of loading 1,350 yds	$40.38

Cost for loading	$40.38
Cost for hauling	217.67
	$258.05

Cost per yd. for loading	.0299c
Cost per yd. for hauling	.1612c
	.1911c

Sixty-two mules were figured through the foregoing, as that is the number Mr. Mullen keeps on hand to insure 52 head ready for work. He says the "caterpillar" does the work of 32 mules.

Such records as these are continually gathered by the research division of the Holt Manufacturing Company. The figures in these reports are taken from the contractors' records, and are approved by the contractor himself before they are released. In this way the company is in constant touch with the field conditions under which the tractors are operating and with the results being obtained by the user. Men handling this research division are engineers who are familiar with the practical application of tractors to elevating graders and other dirt-moving equipment.

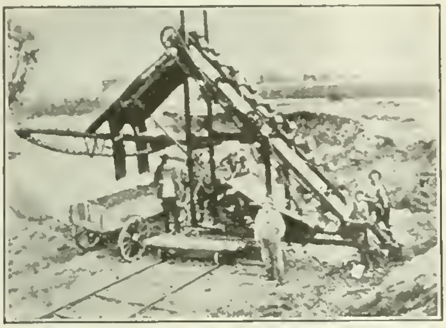
Tractors and Blade Graders

Probably the economy of using tractors for handling blade graders can best be appreciated by a condensed report from seven counties in Georgia. These counties have kept records for years, showing the costs of this work when handled by mules and the costs of similar work since they installed "caterpillar" tractors.

In the seven counties 11 "caterpillar" tractors did the same work in one year which formerly required 239 mules to do. The table and brief analysis of the seven Georgia counties here given show a condensed report of the economy and speed effected.

The Michigan Jr. Gravel Screener and Loader

Takes Gravel out of Pit or Pile, Sereens out Sand and Stones and Loads the Gravel into Wagons or Trueks.



Calhoun County (Mich.) owns *four* machines, and contractors own *three* others, making *seven* in one county.

The Michigan Jr. holds the low record of cost of handling screeded gravel from pit to wagon or truck. This is the all-important consideration, Mr. Contractor. This saving is your profit.

Machine runs up and down side of pit or pile on a track and takes off slice of about ***four*** ft. each time. After going along track once, track is moved over and loader returned along side of pit or pile.

The Screener and loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

Machine has elevating capacity of ***one yard per minute,*** and the only operating expense is salary of three men, under ordinary conditions. One operates machine and two break down embankment.

Sand and stone are conveyed 20 ft. away and do not have to be moved. Machine moves under own power. Easily moved from one pit to another. It is all steel, engine enclosed. ***Saves $30 to $50 a day*** in expenses and makes money in handling gravel.

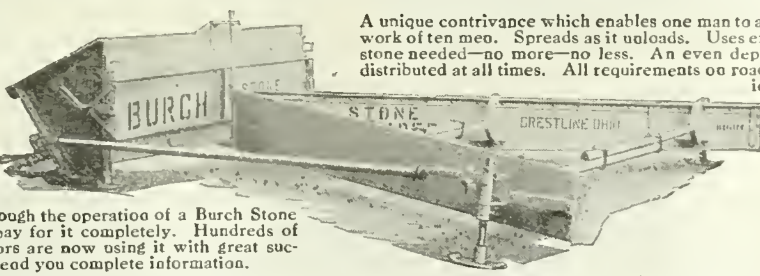
For further particulars write to

THE JORDAN & STEELE MFG. CO., Inc.

CHARLOTTE, MICHIGAN

ONE MAN CAN UNLOAD AND SPREAD STONE SIMULTANEOUSLY

THE BURCH STONE SPREADER



A unique contrivance which enables one man to accomplish the work of ten meo. Spreads as it uoloads. Uses exact amount of stone needed—no more—no less. An even depth of stone is distributed at all times. All requirements oo road provided for io adjustments.

You cao save enough in oaly a few days through the operatioo of a Burch Stone Spreader to pay for it completely. Hundreds of other contractors are now using it with great success. Let us seod you complete informatioo.

Dept. G-4 THE BURCH PLOW WORKS COMPANY, Crestline, Ohio

WM. E. DEE CLAY MFG. CO.

Proprietors of MECCA CLAY WORKS

Manufacturers of

STANDARD AND DOUBLE STRENGTH

Sewer Pipe, Drain Tile, Culvert Pipe, Well Tubing, Flue Lining, Wall Coping and Fire Brick.

WORKS { Mecca, Parke County, Ind., on C. & E. I. R. R.
Newport, Vermillinn County, Ind., on C. & E. I. R. R.

Chicago Office, 30 N. LaSalle Street.

ACTUAL COMPARATIVE PERFORMANCE AND COSTS ON ROAD GRADING AND MAINTENANCE WORK IN SEVEN GEORGIA COUNTIES WITH TRACTOR AND TEAM OUTFITS

Counties	Marietta	Macon	Baldwin	Sumter	Houston	Dooley	Lowndes	Total 7
No. of "Caterpillars"	1	1	2	3	1	1	2	11
No. mules previously used	25	34	32	72	16	12	48	239
Investment of tractor & graders	$8,250.00	$8,500.00	$12,450.00	$19,355.00	$5,400.00	$4,960.00	$14,000.00	$72,915.00
Investment of mules, harness & graders	13,350.00	17,020.00	17,200.00	34,190.00	8,280.00	7,440.00	27,140.00	124,920.00
Mi. graded per day	10			15			11	75*
Work days per year	200	240	200	225	200	300	260	162.5
Caterpillar operating cost per day	$39.24	$41.93	$67.04	$94.35	$25.72	$26.43	$79.55	$374.26
Mule equipment operating cost per day	64.02	111.49	113.46	225.13	61.92	37.44	121.49	732.95
Saving per day by caterpillar	24.78	69.56	46.42	130.78	36.20	11.01	41.94	360.69
Saving per yr. (7x10)	4,956.00	16,694.00	9,284.00	29,425.00	7,240.00	3,303.00	10,904.00	81,807.30

*Average.

Brief Analysis of Performance and Costs in the Seven Georgia Counties

Approximate daily mileage......75 miles
Cost per mile by "caterpillar".......$4.99
Cost per mile by mules............. 9.77
11 tractors replaced 239 mules.
Initial investment tractor outfits $72,915.00
Annual saving effected by tractors 81,807.30

"Caterpillar" outfits paid for themselves in 204 working days.

Additional miles which could be graded with annual saving =

$$\frac{\$81,807.30}{\$4.99} = 16,361 \text{ miles.}$$

Initial investment for mules and equipment $124,920.00
Initial investment for "caterpillar" and equipment....... 72,915.00

Saving on initial investment. $52,005.00

107 counties in State of Georgia own and operate "caterpillar" outfits.

Using Tractors in Hauling Road-Building Material

Where the road is to be concrete or

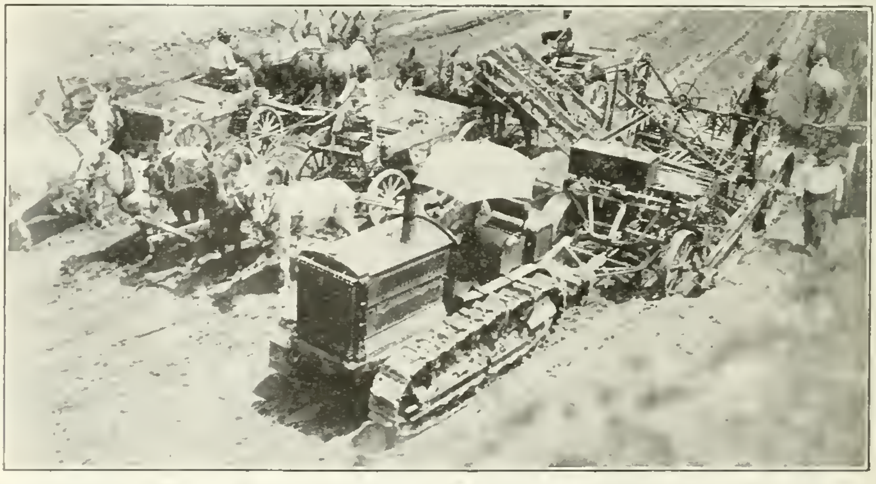


FIG. 4. W. C. MULLEN, OF VICKSBURG, MISS., OPERATING A 10-TON "CATERPILLAR" ON AN ELEVATING GRADER AND AVERAGING 1,350 CU. YDS. PER DAY. CUT RUNS AS DEEP AS 25 FT.

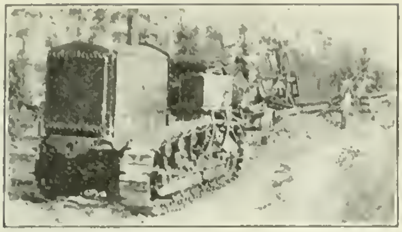


FIG. 5. TEN-TON CATERPILLAR WITH TWO HEAVY BLADE GRADERS.

gravel surface, the "caterpillar" tractor with a train of reversible trailers again plays an important part in transporting the heavy tonnage of road-building material. The method of handling a train of reversible trailers on a narrow roadway is interesting. The tractor pulls the train of loaded trailers up to the stone or gravel already dumped on the subgrade. When the tractor pulls up to the gravel on the subgrade it is uncoupled from the train, turns in its own length, and travels along the side of the trailers to the rear of the train. Here it couples on and backs the train to the gravel already dumped on the grade. The trailer train is then dumped, and the tractor, being on the tail end of the train, takes the train back to the stock pile or storage bin for more material. In this way, as illustrated in Fig. 6, it is unnecessary for the tractor to turn the train of trailers on the roadway. It is possible by this method to work on very narrow roads without inconvenience or lost time, at an extremely low cost per ton mile.

The following data, reprinted from "Engineering and Contracting," on hauling costs, shows the lengths of the different loaded hauls, the tons delivered per day, and the cost per ton mile. The cost data includes such items as interest on the investment, depreciation based on the thousand-day life, labor, gasoline, oil, etc. The record is based on a performance of 18 months, during which time approximately 11,000 tons of material were delivered:

"The Holm Page Co., of Rockford, Ill., began operations about the middle of 1919 on Project No. 7, a stretch of the Peoria road extending 3 miles north and 4 miles south of Henry, Ill. In November, 1919, when they were forced to suspend operations for the year, they had completed approximately 1¼ miles of finished pavement. It so happens on this job that the only available siding was located in the town of Henry. This necessitated a material haul of 4 miles, part of which haul was through a low, swampy section. A 10-ton 'caterpillar' tractor with Troy

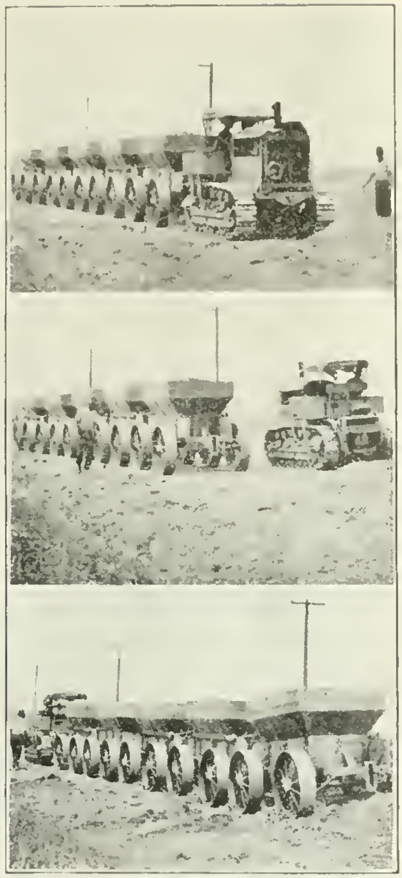


FIG. 6. USING TRACTOR AND TRAILER TRAIN FOR HAULING GRAVEL ON A ROAD CONSTRUCTION JOB.

Top:—Pulling up to Gravel Previously Dumped. Middle:—"Caterpillar" Uncouples and Goes to Rear of Trailer Train. Bottom:—Backing Train Preparatory to Dumping Trailers.

trailers was employed to deliver the material to the job.

"In 1920 a 5-ton 'caterpillar' tractor was added to the outfit, which practically eliminated teams on this job. The cuts and fills were very light and the surface was very hard; being an old gravel road, scarifying and grading was done with an Austin Rip Snorter and a 'caterpillar' tractor. With this combination it was possible to scarify approximately 1 mile per day for a 16-ft. road and to keep the grading completed well in advance of the mixer. This work being done under the Illinois Highway Commission's specifications, which allowed only ¼ in. variation in the sub-grade, and being held strictly to this allowance, it was found after some experimenting that to insure uninterrupted operation of the mixer, correct thickness throughout of the pavement and a firm sub-grade, that the most economical method was to hand-finish the sub-grade, considering the hard gravel surface that had to be finished within ¼ in.

"The sand and gravel were obtained from Chillicothe, Ill., which, being on the same railroad and but 15 miles away, ameliorated considerably the difficulty in obtaining coarse aggregate. The sand and gravel were unloaded with a Byer's auto crane with ¾ yd. bucket into an overhead bin. The 'caterpillar' and trailer train were then loaded by gravity from the bin. It was interesting to note the quantity and hauling cost of the material delivered from the bin to the sub-grade and the method of placing the material for the mixer. To obtain the greatest net load with the least tare weight 8-in. sideboards were put around each Troy trailer. In this manner 5 Troy trailers with sideboards would hold as much as 6 regular trailers, or a net load of 30 tons.

"The following table shows the different lengths of haul, tons delivered per 10 hours, the trip time and the cost per ton mile for the various lengths of haul:

Haul loaded miles.............	1	2	4
Tons delivered 10 hrs..........	390	180	120
Cost per tone mile.............	0.112 ct.	0.105 ct.	0.095 ct.
Trip time	50 min.	1 hr. 25 Min.	2 hrs. 30 min.

"There seems to be some question still in the minds of contractors as to which is the best method of placing material—on the sub-grade, in the ditch or on the shoulders. All methods were employed at the beginning of this job, but finally the gravel was dumped on the one side of the sub-grade and the sand and cement placed on the opposite shoulder.

"This method allows room on the sub-grade for the wheelers to work, avoids congestion and eliminates a great deal of work, which would result if the material had been placed in the ditches, or if the gravel had been placed on the shoulder. Waste is practically eliminated, the gravel and sand shovelers being able to keep the sub-grade and shoulders clean. The wide tires of the trailers smooth and roll the sub-grade.

"The construction methods, being simple and flexible, are facilitated by a complete understanding and co-operation between the contractor and the resident engineer. The work was not handicapped by the necessity of maintaining the road for traffic. This added materially to the uninterrupted progress of the work. Another factor which added materially to the success of this project is the organization which had been perfected by Mr. Frank Miner and Mr. Kirkendall. It is a result of serious thought and contrivance to overcome the ever-present labor question and delivery of material. Every man has a task to do and when he has finished he has a breathing spell. The whole scheme works to the end of having each man see that every other man does his share of the work, with the result that the concrete mixer is going full blast 10 hours a day.

"In the early part of 1920 a small industrial track about 200 ft. long was laid along the shoulder. Small cars with 3-batch boxes, propelled by man power, were used to bring the aggregate from sub-grade to the mixer, where it was dumped in the pan with a small self-propelling crane. With such an outfit it required 41 men on the concrete crew and the highest daily record was 250 ft. of finished roadway. Recently this system was changed, the industrial railway discarded and the aggregate wheeled to the pan. This required placing the gravel on the sub-grade and the sand on the opposite shoulder. This system required 30 men, including a superintendent, distributed as follows:

"2 men on the tamping machine, 2 men at the spout, 1 engineer, 1 fireman, 2 men carrying cement from the stock pile, 1 man dumping cement into the pan, 4 men wheeling gravel, 8 men shoveling (2 for each gravel wheeler), 2 men wheeling sand, 2 men shoveling (1 for each sand wheeler), 2 men bringing up forms and placing them in advance of the mixer, 2 men covering up the green concrete with each and sprinkling.

"Each man has a very definite task to perform, and with such an arrangement the daily average is 415 lin. ft. per day, or 738 sq. yds. of finished concrete. The aggregate is mixed in a 4-bag batch Foote mixer. It is mixed for 1 minute, the time being regulated by a batch meter on the mixer. The mix on this project is 1:2:3½. Two men set the necessary 660 lin. ft. of forms per day.

"The Lakewood finisher requires but two men for the complete operation and easily finishes the daily output of this organization.

"The concrete is 16 ft. wide, 7 ins. thick at the sides and 8 ins. thick at the center.

No expansion nor reinforcing whatever are used. At construction joints a ½-in. opening is left and later filled with tar to insure a smooth, sound cohesion between the old and new work.

"The labor situation in this vicinity, while it is not serious, is a very vital factor. At the present time labor at 50 cts. per hour, with board at $1 per day, is just sufficient to keep the job moving.

"The cost data contained herewith includes labor, fuel, oil, interest on investment, depreciation on equipment, repairs, maintenance, etc.

"The personnel handling the work on this job are: Frank Miner, General Manager for Holm Page Co.; Gene Kirkendall, Superintendent; E. B. Blough, Resident Engineer for Illinois Highway Commission."

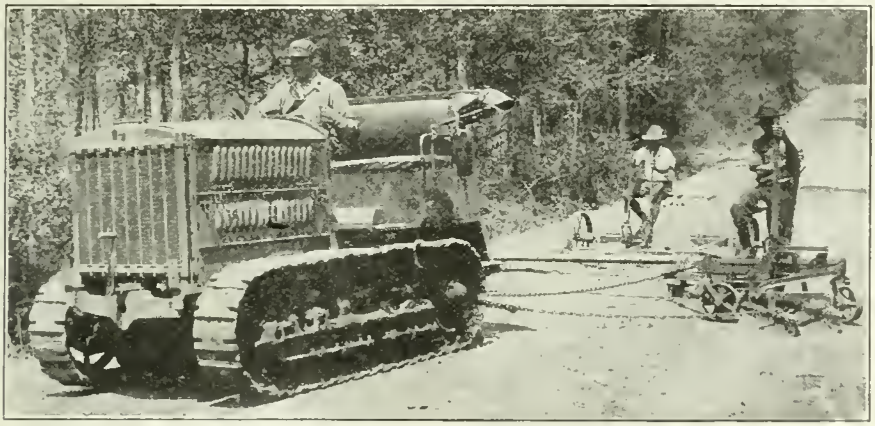


FIG. 7. "CATERPILLAR" TRACTOR PULLING ROAD MAINTAINER IN SUMPTER COUNTY, GEORGIA.

The figures in the above report have been checked and approved by the contractors who did the work.

Tractors on Maintenance Work

Having completely and successfully handled every operation of building an earth road with tractors, this money and effort spent is all in vain unless they are properly maintained. Here again the tractors meet the most important obligation to the community. Proper maintenance means action and speed over many miles of road in the shortest possible time. The roads must be dragged or leveled off when they are still wet—before the sun dries out the tops of the hills and leaves only dust to fill the ruts.

Fig. 7 illustrates the Sumter County operation. On this class of work the speed of 3 miles per hour with power to handle the work effectively has proven the economy of the "caterpillar" tractor for maintenance.

The cost of maintenance varies with the different types of road, but with speed and power for a maximum mileage of maintenance, the cost is reduced to a minimum. In this connection the report from Sumter County, Georgia, is of interest. In this county the 5-ton "caterpillar" is being used for road maintenance, and pulls what is called a three-way maintainer, which is a gang of drags that covers the whole road at one operation. With the power and speed of the 5-ton "caterpillar," Sumter County can single-drag 30 miles or double-drag 15 miles of road in a day. The report shows that during the 10 months they have operated this tractor, the cost for repairs has been approximataely $27. The daily operating cost, the cost of the same work when formerly handled by mules, and the daily savings effected are shown in the detailed report as follows:

DAILY COST OF OPERATION OF 5-TON CATERPILLAR TRACTOR DOING WORK OF 16 MULES IN ROAD MAINTENANCE WORK IN SUMTER COUNTY, GA.

Investment in tractor	$4,150.00
Investment in maintainer	370.00
Total investment	$4,520.00
Daiy interest on investment, 7 per annum and 225 days per year	$ 1.40
Daily depreciation on tractor and grader, based on 20% per annum and 225 days per year	4.02
Wages of engineer	4.00
Wages of maintainer man	2.50
Board of 2 men, $1 each	2.00
Repairs	2.00
27 gal. gasoline at 29c	7.83
¾ gal. motor oil at 66c	.50
¼ gal. trans. oil at 72c	.18
2 gal. track oil at 20c	.40
2 lbs. grease at 12½c	.25
Total daily cost	$25.08

16 mules and 8 drivers—outfit necessary to do the work of 5-ton "Caterpillar" on maintenance work. Daily cost of operation:

Investment 16 mules at $400 each	$6,400.00
Investment maintainer	370.00
Investment 8 sets double harness	560.00
Total investment	$7,330.00
Daily interest on investment based on 7% per annum and 225 days per year	$ 2.28
Daily depreciation on mules, $6,400, based on 15% per annum and 225 days per year	1.26
Daily depreciation on maintainer and harness, based on 20% per annum and 225 days per year	.82
Wages of 8 drivers, $2.50 each	20.00
Board of 8 men, $1 each	8.00
Feed for 16 mules at $1.78 each	28.48
Shoeing mules and repairs on harness	1.00
Total daily cost	$64.84
Daily cost of 16-mule outfit	$64.84
Daily cost of 5-ton "Caterpillar" outfit	25.08
Daily saving with 5-ton "Caterpillar"	$39.76

It is interesting to note the variety of operations on road construction which can be handled economically with a tractor which is designed and built to meet the requirements of road building, a variety of speeds to meet the different soil conditions, and with traction to assure the guaranteed drawbar horse power.

FIRE AT WINTHROP HARBOR PLANT WILL NOT HANDICAP AUSTIN MACHINERY CORPORATION

The fire in the Winthrop Harbor (Ill.) plant of the Austin Machinery Corporation on March 22, while extensive at this plant, will not, according to officials of the corporation, in any way interfere with production and prompt delivery of Austin trenching machines, backfillers, building mixers, pavers, draglines and shovels, as practically all lines of Austin machinery are also being built at the plants at Muskegon, Mich., as well as at the former plant of the Toledo Bridge and Crane Company at Toledo, O.

President B. A. Linderman immediately arranged for the plants at Toledo and Muskegon to increase their stock production orders to take care of the shortage which would otherwise occur through the loss of the Winthrop Harbor plant.

The fire at the Winthrop Harbor plant completely destroyed the "unfinished stock" warehouse and store rooms; both the trenching machinery assembly and paving mixer assembly buildings, and a number of machines on which assembly was practically completed; but the fire did not reach the "finished machines" warehouses and, fortunately, a number of machines had just been loaded on cars for shipment and were saved.

The plants at Muskegon and Toledo are fully equipped for turning out all standard and special machines in quantity, patterns of all kinds being protected in duplicate, and all of the popular sizes of Austin construction and public service machinery are under construction at more than one plant.

The Austin Machinery Corporation advise they have on hand in Muskegon and at Toledo, ample stocks of wagon loaders, the popular sizes of trenching machines, backfillers, mixers, pavers and ½-yd. and ¾-yd. draglines and shovels, and that a new lot of 1-yd. shovels and draglines are now coming through the Toledo plant.

NOVEL METHOD OF STOPPING OVERFLOW OF CESSPOOL

On the grounds of the suburban residence of Mr. Winterson near Annapolis, Maryland, was a cesspool 8x8x8-ft. that frequently filled to the top and overflowed, saturating contiguous ground on one side.

It was walled up with dry placed stone to within 2 ft. of the surface of the ground. It was located at the head of a slope. One hundred feet down the hill the surface of the ground was lower than the bottom of the cesspool.

It was decided to try stopping the overflow by making the soil more open or absorbent. This was accomplished by a method new to this locality.

A row of 2-in. bore holes, 12 in number and 10-ft. deep and 6 ft. apart, was put down leading away from the cesspool in the direction of the low ground.

Each hole was loaded with a pound of 40 per cent ammonia dynamite, thoroughly tamped; holes connected up in series and fired with electric blasting caps.

The theory was that the blasts would break up the hard soil, make it more absorbent and that the liquids in the cesspool would sink into the ground rapidly enough to avoid any overflow at the top.

The work was done in February, 1920. Two days afterwards, the level of the fluid mass in the pool had gone down 4 ft., and notwithstanding it has been in continuous use since, it had not risen above that level in October of the same year.

The total cost of the job was $24.50. Two men did the work in four hours.

PATENTED PAVEMENTS PERMISSIBLE UNDER DECISION OF ILLINOIS SUPREME COURT

Under decision handed down by the Supreme Court of Illinois in February, 1921, an act passed in 1919 by the Illinois State Legislature regarding patented pavements is declared constitutional. Prior to that year, the use of patented pavements by the several cities of the state had been prohibited under the Supreme Court's decision of the then existing law. The Legislature then passed an act permitting municipalities to contract for patented pavements, provided they are placed in competition with unpatented pavements.

Pursuant to this, the city of Rockford, Ill., received proposals for several types of pavement, including Warrenite Bitulithic, patented by Warren Brothers Company, Boston.

A taxpayer, R. J. Schultz, brought an action to restrain the contract on the grounds that the act of 1919 was unconstitutional and that the proceedings had not fully complied with the act. The Supreme Court, in unanimous opinion, written by Mr. Justice Carter, decides against the plaintiff taxpayer on all points and sustains decision rendered by the county court more than a year ago.

This case, now finally disposed of, has been in the courts for nearly two years, and is of interest not only to the state of Illinois, but to other states.

Contracts Awarded

ROADS AND STREETS.

Ala., Mobile—Hancock Bros. and E. B. Toulmin, award. contr. for paving 4.7 mi. Old Shell Rd. and graveling Hall's Mill Rd., at $141,530.32.

Ariz., Phoenix—State Hwy. Dept. let contr. for paving 8.8516 mi. Tucson-Nogales Hwy., Sec. A, 18 ft. wide, FAP 29, to J. L. Hoopes, Miami, at $305,-616.

Ariz., Phoenix—J. L. Hoopes, Miami, Ariz., award. contr. for contr. of Tucson-Nogales Hwy., Sec. "A," 18 ft. pavement, at $162,510; state to furnish material at cost of $96,821.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick Street, Los Angeles, award. contr. for constr. 7.65 mi. conc. hwy. in Road Imp. Dist. 14, at $298,000.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick St., Los Angeles, award. contr. for paving 7.562 mi. hwy. (China grade) in Rd. Impvt. Dist No. 10, Kern Co., at $345,000.

Cal., Bakersfield—Bakersfield Engrg. Co., award contr. for paving 21st St., (abt. 136,000 sq. ft.) with 5-in. Willite at 26½c ft.

Cal., Calexico—Geo. H. Oswald. Los Angeles, award. contr. for approx. 13 mi. conc. sidewalks, 5 ft. wide, with same mileage of conc. curb and cross walks at each street intersection, at $250,000.

Cal., Sacramento—Contracts for state highway work award. on projs. as follows: Fairchild-Gilmore-Wilton Co., Pacific Electric Bldg., Los Angeles, contr. for paving 14.6 mi., Kern Co., betw. Las Cruces and Zata Sta., at $201,185; Guy F. Atkinson, Portland, Ore., award. contr. for paving 12 mi. Fresno Co. betw. Oil King Sch. and Huron Rd., at $252,746; Bates & Borland, Oakland Bank of Savings Bldg., Oakland, contr. for paving 8.1 mi. Fresno Co. at $109,874; Henry J. Kaiser, Seattle, Wn., contr. for paving 15.6 mi. Shasta Co., at $292,286; also contr. for paving 13.6 mi. Tehama Co., at $182,043. Minimum specfs. for paving on all these projs. is 5-in. conc., reinforced.

Cal., Mill Valley—S. P. Brownlee, award. contr. by Council for road work in Tamalpais Park, at $50,000. Other new rd. impvts., costing $300,000, will be started in county within next 30 days.

Cal., Oakland—Bates & Borland, Oakland, award. contr. to constr. conc. hwy. from Alameda Co., Niles to Newark, at $184,745.

Cal., San Diego—Bent Bros., Central Bldg., Los Angeles, award. contr. for paving 10.12 mi. Bellena-San Julian Rd., 18 ft. wide conc., at $291,419.

Colo., Denver—State Hwy. Dept. Denver let contr. for grading and draining 6.847 mi. Muddy Crk. Rd. above Kremmling 28 ft. wide, F. A. P. 75, Grand Co., to Hinman Bros., Kremmling, at $22,235; 4.884 mi. rd. betw. Victor and Cripple Crk., 20 ft. wide, F. A. P. 52, Teller Co., to E. H. Honnena, Colo. Springs, at $23,817; 1,748 mi. rd. betw. Colo. Springs and Canon City, 28-ft. wide FAP 47, El Paso Co., to Pickering Bros., Salt Lake City, at $21,663; grading, draining and gravel surfacing 3.504 mi. betw. Wray and Schramm, 28 ft. wide, F. A. P. 40, Yuma Co., to E. Lindsey, Denver, at $22,350; paving and draining 2.727 mi. Morgan-Brush Rd., 18 ft. wide, FAP 38, Morgan Co., conc., to La Nier-White Co., Ft. Morgan, at $68,613; grading and surfacing .758 mi. rd., 28 ft. wide; also bldg. brdg. over Platte River betw. Lake George and Divide, to have two 40-ft. spans, FAP 112, Park Co., to J. R. Donaghy, Pueblo, at $21,046; paving and draining 1.334 mi. rd. from Boulder eastward, 18 ft. wide, FAP 87, Boulder Co., involving 14,092 sq. yds. conc., to A. Doble, Poplar and North 2nd Sts., Sterling, at $42,232.

Del., Smyrna—Stange & Allen, Washington, D. C., award. contr. for constr. of 3.41 mi. hwy. thru Smyrna for Delaware St. Hwy. Dept., at $222,479.

Fla., Perry—Hutton Engrg. & Constr. Co., Savannah, Ga., award. contr. to pave streets, etc.; 37,000 sq. yds. $200,000 available.

Fla., Lake Worth—W. B. Eckler, West Palm Beach, Fla., award. contr. to constr. conc. rein. block sidewalks. $125,000 available.

Ill., Chicago—County Board let following contrs. to constr. 5 stretches of roads in Cook County: ½-mi. stretch, known as Maywood Road, let to H. C. Goeltz & Co., at $19,000; Des Plaines River Rd. let to Ready & O'Callaghan Coal Co., at $176,601; W. 111th St., impvt., to Bronger & Black, at $319,175; Glen View Rd., to Ready & O'Callaghan Coal Co., at $112,482; Hans Blase, contr. for Touhy Rd. at $209,736.

Ind., Connersville—Keer & Murphy, Bloomington, award. contrs. for paving 3 mi. Laurel Rd. with 2-course conc. at $105,948; graveling 3 mi. Bentonville Rd. to Conner, Jenks & Bierley, at $43,845.

Ky., Glasgow—R. B. Tyler Co., Louisville, Ky., award. contr. for 11 mi. Kentucky rock asph. paving in Barren Co., at $469,000.

Ky., Hawesville—Hancock Constr. Co., award. contr. for 13½ mi. Ohio River Rd., at $120,000.

Ky., Williamstown—Connel & Brecht, award. contr. for 1 mi. rd. in Williamstown and 3 mi. bet. Williamstown and Dry Ridge, at $174,000.

Md., Snow Hill—Piel Constr. Co., award. contr. for 3.62 mi. conc. rd., Worchester Co., at $133,312.

Mich., Ionia—Schnieder & O'Harrow, Lowell Mich., award. contr. for graveling, drng., structs., and surfacing to width of 12 ft. with gravel, at $71,850.

Minn., Grand Rapids—A. Guthrie & Co., 336 Jackson Street, St. Paul, award. contr. for over 27 mi. of rd. from Grand Rapids to St. Louis Co. line east of Keewatin sub-grade, at $415,517.

Minn., St. Paul—Fielding & Shepley, 216 University Ave. St. Paul, award. contr. for paving White Bear Rd.—city limits to White Bear Lake—at $329,966.

Miss., Woodville—Bass Constr. Co., Hazlehurst. Miss., award. contr. for 10.5 mi. State Trunk Rd. betw. Woodville and Natchez, at $71,137.

Miss., Tupelo—Mills Elec. & Constr. Co., McComb, Miss., award. contr. for 16 mi. conc. rd. east and west thru Lee Co., at $310,000.

Neb., Omaha—Jas. J. Parks Co., Omaha, award. contr. for paving Dodge St., at abt. $80,000. 200,000 sq. yds. vitr. brk. blk.

N. J., Belvidere—Bd. Freeholders Warren Co., will pave 12 mi. Phillipsburg-Port Golden Rd., conc. by Day Labor, abt. $600,000.

N. C., Greensboro—Jameson Bros., Raeford, award. contr. by State Hwy. Dept. for bldg. 12 mi. topsoil rd., Stokes Co., at $61,453; 2 bridges and culverts on rd., to Rogers & Shumway, Petersburg, Va., at $37,204; 7 mi. topsoil rd. to Chandler & Ragland, Virgilina, Va., at $31,655; 2 brdgs. to Hagerdron Constr. Co., Commerce, Ga., at $24,462.

N. C., Hertford—F. J. McGuire, Norfolk, Va., award. contr. to constr. asphalt streets here, at $75,000.

N. C., Jefferson—Callahan Constr. Co., Knoxville, Tenn., award. contr. to grade and surface 80 mi. of roads with sand and gravel. $500,000 available.

N. C., Washington—P. G. Ligon, 2000 Brookfield Ave., Baltimore, Md., award. contr. for impvt. various sts., at $421,176.

N. M., Clovis—New Mexico Constr. Co., Albuquerque, N. M., award. contr. for Warrenite-Bithulithic paving here, at $220,000. This previously reported to have been award. to Clark & Henery Constr. Co., San Francisco.

N. M., Sante Fe—L. V. Stryker Constr. Co., Denver, Colo., award. following rd. and brdg. contracts: Proj. 1-C, Colfax Co., $64,762.04, exclusive of 10% for engrg. & contingencies; Proj. No. 50, Luna Co., $61,781 and Proj. No. 51, Socorro Co., at $56,933; Lee Moor Contr. Co., El Paso, Tex., award. contr. for Proj. 27, El Paso, at $153,250 and Dan La Roe, Palestine, Tex., contr. for Proj. No. 29, Eddy Co. All bid prices named are exclusive of 10% for engrg. and contingencies.

O., Columbus—G. Sheridan, Columbus, awarded contr. for grading bldg. brdgs. and culvts. and paving 2.2 mi. Ohio-Sandusky Rd., 50 ft. wide, Franklin Co., brick, at abt. $338,000.

O., Pt. Clinton—Bert Pettibone & J. Fred Graves, Lakeside, award. contr. for bldg. 7 mi. rd. betw. Oak Harbor and Pt. Clinton, at abt. $200,000.

O., Toledo—Contracts for impvt. of rd. to cost approx. $640,000 award. as follows: Hill Ave. to LaBoiteau & Huger; Douglas Rd. to Warren & McKechnie; Starr Ave. to Tom Garrigan; Clinton St., to Warner & McKechnie; Brint Rd. to Thomas Constr. Co. and South Ave. and Bryce Rd. to Russell & Jennison.

Okla., Ardmore—Maney Bros., 304 Empire Bldg. Okla. City award. contr. for graveling 16 miles of road, 18 ft. wide, at abt. $340,000.

Okla., Walters—Wichita Falls Constr. Co., Wichita, Tex., award. contr. for paving various streets, 26-60 ft. wide, 2-in. asph. conc. on 5-in. conc. base, at abt. $470,000.

Pa., Harrisburg—Frank J. Groman & Sons, Bethlehem, award. contr. by State Hwy. Dept. for imp. of sect. of rd. connecting Boylestown and Easton, at $359,351. Project calls for constr. of 34,871 ft. one-course rein. conc. roadway, 18 ft. wide.

Pa., Harrisburg—Conner & Ley, Philadelphia, award. contr. for constr. of 11,374 ft. conc. roadway on Route 281, Bensalem Twp., Bucks Co., at $143,854.

Pa., Harrisburg—Vincenzo Di Francesco, Llanerch, Pa., award. contr. by State Hwy. Dept., for project planned for Route 133, Upper Darby and Haverford Twps., Delaware Co., where 12,077 ft. one-course rein. conc. will be laid. His bid was $118,429.

Pa., Wilson—Kavanaugh-Denivo Constr. Co., Youngstown, O., award. contr. for grading, paving, curbing, sewering, etc. 4,600 ft. on State Street, at $127,480.

S. C., Moncks Corner—J. C. Fairy, Orangeburg, S. C., award. contr. for 16 mi. Charleston-Monocks Corner Rd., at $101,000.

Tex., Amarillo—Potter County let road contracts as follows: Willite Constr. Co., Houston, Tex., $280,000, pave 16 mi.; Standard Constr. Co., Dallas, $239,000, pave 12 mi.; McKnight & Haymer, Amarillo, gravel hauling.

Tex., Dallas—Contracts for constr. of Millers Ferry Paved Rd. from Dallas to Wilmer and Hutchins, and for constr. of Denton Rd., award. as follows: Hill, Wilson & Watson, grading & surfacing; Texas Rd. Co., for paving; Jackson & Goods for bridging. Total cost on each road approx. $440,000.

Tex., Denison—Edward C. Baum, Durant, Okla., award. contr. for constr. of 40,000 sq. yds. rein. pavement. $200,000 available.

Tex., El Paso—El Paso Bitiluthic Co., Piedras St. award. contr. for grading, draining and paving 15.45 mi. Alamogorda Rd., State Hwy. 33, at $527,170, including 10 per cent for engrg. and contingencies.

Tex., Kingsville—Road contr. let as follows: A. C. Buchanan & Son, Temple, Tex., draing. structs., at $17,201; W. T. Montgomery, San Antonio, Tex., $112,860, surface 18.6 mi. Hwy. No. 12.

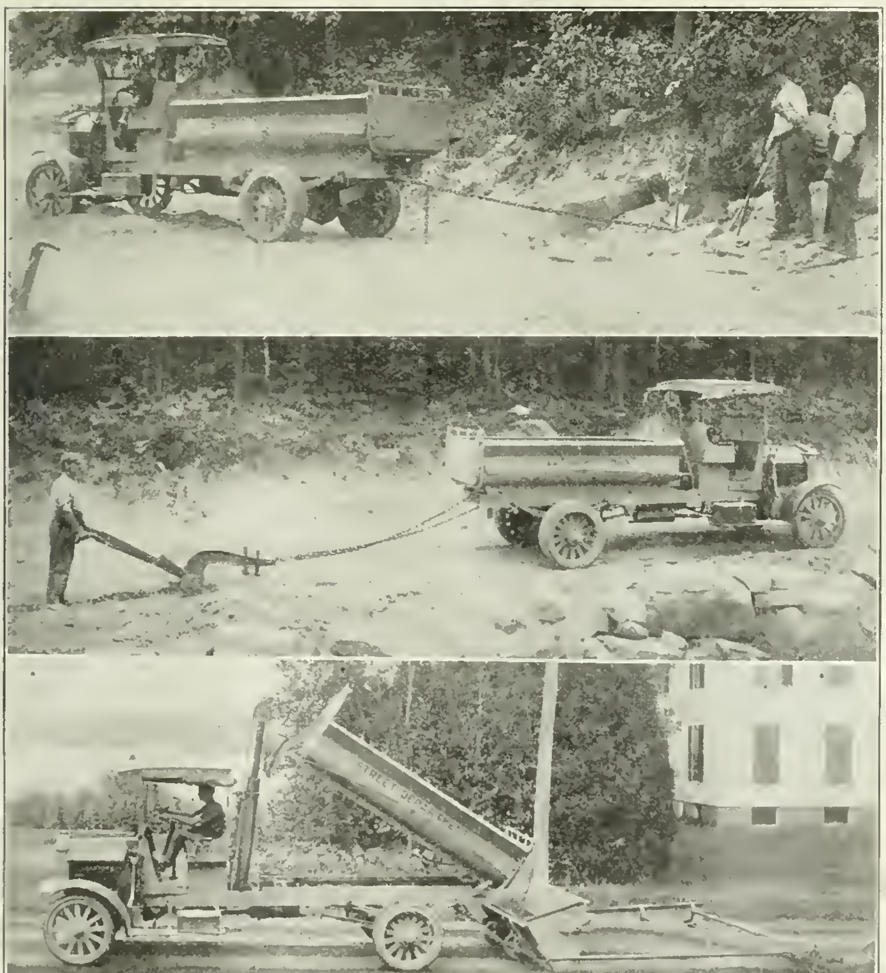
Tex., Wichita Falls—Prentice & Potts, awarded conc. pavement, $200,000 available.

Va., Staunton—Carpenter, Major Bros. & Co., Clinton Forge, Va., award. contr. to constr. 20 mi. waterbound macadam and penetration macadam rd. $250,000 available.

Wash., Seattle—S. A. Moceri, award. contr. for paving 1st Ave., North, et al, at $27,174; Puget Sd. Bridge & Dredging Co., award. contr. for filling and grading First Ave., So., at $88,422; Independent Asphalt Paving Co., award. contr. to furnishing 21,000 tons rock riprap for Alki Ave. seawall, at $2.45 per ton.

Wash., Tacoma—T. M. Morgan, Everett, award.

MOTOR TRUCKS



FEDERAL 3½-TON TRUCK OPERATED BY STREET DEPARTMENT, CITY OF LACONIA, N. H., REMOVING BOULDER, PULLING PLOW, PULLING BURCH STONE SPREADER, ETC.

Motor Truck Operation and Accounting LXIX

SHOULD ROAD CONTRACTORS BUY OR HIRE MOTOR TRUCKS?

Recently in conversation with some men in the motor truck industry it was suggested to the editor that it is much better for the road contractor to own the motor trucks he needs on his work than it is to sublet the hauling work to a hauling contractor equipped with trucks.

These men made a good argument in support of their belief, pointing out that inasmuch as the trucks really set the pace for the contractor's entire crew, and his other equipment, that he should have that complete control of them which can be secured only by ownership. They raised other points of like import and feeling that this is an interesting and important topic for discussion the editor has invited several active men in the motor truck industry to state their views on this subject.

At the outset it may be well to state that the editor does not wish to mobilize all the opinion favoring the ownership of trucks by contractors while denying a hearing to those who, in general, would advise the road contractor to sublet his hauling on road construction work. It is the opinion of the editor that there are some jobs on which the road contractor should own trucks and others on which he might do well to rent them. This seems a reasonable opinion but the reader will naturally ask: "Where will you draw the line? When should the road contractor own and when should he rent trucks?" In other words there are certain limiting conditions within which ownership is preferable and outside of which renting is preferable. It is our opinion that this discussion, in which we invite all interested men to join, will help the individual road contractor decide whether or not, in view of his resources and the extent and nature of the work on which he is engaged, he should buy or hire trucks. If this end is realized the discussion will serve the best interests of all parties and that, of course, is its purpose.

The Discussion

Wm. C. Greany of the Transportation Engineering Department of the Packard Motor Car Co., expresses very concisely the opinion above suggested by the editor. He writes: "In our opinion it would be inadvisable to make any blanket statement covering this subject. It has been our experience that the merits of each particular case must be fully considered in order to determine whether owned or rented equipment would be the most profitable in any specific situation."

A valued correspondent writes as follows in a letter preliminary to a more extended discussion by him of this subject: "It appears to us that there would be every advantage to a contractor owning his own equipment, as do the fleet owners in the United States, of which there are over 12,000 who are owners and users of five or more trucks. This arrangement would get the contractor in line for much better prices on trucks and parts, as it does the fleet owner at the present time for buying trucks direct from the largest motor truck manufacturers at a considerable discount from the list prices."

Mr. A. W. Stromberg of the Acme Motor Truck Co., Cadillac, Mich., writes as follows:

"It would seem that where road contractors sub-let the hauling on construction jobs they are losing out on the possible chance for greater income provided the road building contract covers a big enough project. If the owners of trucks make money on the hauling, the road contractor should make that much more if he owned the trucks, instead of subletting the jobs.

"The size of the road building contract, of course, largely determines the question of whether or not it is more profitable to buy the trucks or to sub-let the hauling. Even on a rather limited contract, it sometimes turns out to be more profitable for the road builder to own his own trucks. We have in mind a special case at Midland, Michigan, where a firm by the name of McKimmy and Yager with a 2-ton Acme dump job in 30 days work on the project practically paid for the

truck itself. On a larger contract it should work out that much better. The contractor by having his own trucks would be able to systematize loading and unloading methods, and work out efficiency plans to even greater advantage than the hauling contractor who usually must conform to the wishes of the road builder.

"It requires a thorough analysis in each case to determine which is the better proposition. Frequently it will pay a road contractor where loading and unloading conditions are most favorable to purchase his own trucks, and if he has no use for them after the job is completed he can dispose of them and still be further ahead of the game than if he had sub-let the hauling. A great many contractors who have been doing this are finding that it frequently pays them to carry the trucks over to the next road building season. During the slack season if they are equipped with combination stake and dump body they can be used in general hauling and a substantial revenue can be derived in this way.

"The tendency seems to be more and more for the road contractor to take on trucks of his own, and we believe that it is conditions such as mentioned above which are bringing him to handle road projects in this way. The conditions in each case are usually so different that a separate analysis must be made and a decision arrived at on this basis."

Mr. Frank B. Willis, Sales Manager of the Duplex Truck Co. of Lansing, Mich., has submitted the following discussion:

"In the first place, the motor truck has proven an absolute necessity for road building work. This is due to the fact that in most cases it is necessary to haul every yard of material which is used in making up the road construction and there is no other way of hauling than by motor truck. As a general thing the road contractor is not the type of business man who pays close attention to details. For this reason there is perhaps not one out of fifty who keep any accurate record of performance of trucks in road building work. They have been led to make their bids for road building jobs based more on their past experience of general costs than on their own knowledge of the actual costs of the particular job on which they are bidding.

"We have noticed cases where road builders have taken contracts for construction work at a price lower than the actual costs of hauling the gravel to the point of work. There was no reason for this other than a lack of attention to details and of knowing the cost of operation. Because of the keen competition in road building, contractors have found themselves losing money in their truck operations and unfortunately have persisted in the idea that they should hire their hauling done. If the truth were known, this is in reality the most unsatisfactory and unfair method for the reason that as a rule the hired truck contractor does not bear the same measure of responsibility as does the road contractor. He is dependent on transient employment in order to make a living and for that reason he does not care to assume the responsibility of fulfilling his contract to the letter. So far as details are concerned, he is no more interested in the operating costs than has been the contractor himself and as a rule when he finds that he is not making any money on the job, he breaks his contract and the road contractor finds himself in a pinch.

"For this reason, if no other, it should be more to the advantage of the road contractor to own his trucks. If he will pay the necessary attention to operating costs so that he might know where he stands there would be no reason why he could not make money on his truck operation. The sooner the road contractor realizes the necessity of paying close attention to the details of his operations the sooner these difficulties will be eliminated."

Mr. F. J. Alvin, General Manager of The United States Motor Truck Co., Cincinnati, Ohio, writes:

"There is one old true principle in business that is sound, and that is, that the successful man in any field is judged by his ability to do things right and proper, and being equipped to see that the work is done properly.

"Now the contractor, or sub-contractor, who owns his equipment is in position to know exactly what can be done, and what should be done, and he can undoubtedly be able to accomplish better results.

"Naturally, owning his own equipment, he is interested in seeing that it is kept in order and ready for work, and that the great efficiency of development is maintained and kept to the highest standard that this class of work should be kept.

"To my mind the successful contractor doing large construction work is placed at a decided advantage in being able to provide his own equipment, because he then can insist on things being done the way he wants them without any interference or having causes develop over which he has no control.

"There is one more important idea in connection with the contractor owning and operating his own motor trucks and that is, he can insist on the high character of the men employed in this work, and be able to maintain a competent force acting under the direction of an executive head.

"This company has had quite a lot of experience with successful road contractors, and some of them who own and operate a large number of our trucks have been able to accomplish a great deal more than those who relied on hiring different equipment.

"Of course a great deal of successful work is done by a large contractor subletting the work to sub-contractors who in turn own their own equipment, and the writer does not wish to put himself on record as being opposed to the hiring of hauling contractors to do the hauling on construction jobs, because at certain times this work is so enormous and of such a large character, that it is absolutely necessary that sub-contracting be done, but as a matter of good business it does seem to me that any contractor doing road building is in a much better position owning and operating a good portion of his motor truck equipment, because it enables him successfully to set out the method of operation along definite positive plans that means the greatest efficiency and at the least expense."

Mr. H. L. Dewey, Sales Engineer of the Republic Truck Sales Corporation, Alma, Mich., writes:

"From our knowledge of motor trucks in road building service, it is a fact that most motor trucks equipped with dump bodies and hoists or body equipment adapted to road construction work, have been owned by individuals or separate hauling companies who have contracts with road contractors for moving road building material, and that road contractors have hired their trucks in the past.

"We know of no reason why this condition exists except that it relieves the contractors of a certain amount of worry and trouble in operating trucks; but it has been to their disadvantage, as they cannot control the trucks doing their work, especially when they need them most. They are at the mercy of the truck operator. When they own their motor truck equipment they are able at all times to control the moving of road building material at any point along their road construction job.

"It would seem to the writer that this would be a very vital question with the road contractors themselves where they may possibly have two or three jobs under construction at one time and the trucks could be moved to the different jobs wherever they were most needed. And at the end of the road building season the contractor would have motor trucks ready to start work the next season without the possibility of a delay waiting to secure a sub-contractor to move his material.

"It also might be mentioned that road trucks are generally in great demand at certain seasons of the year and it is almost impossible to secure sub-contractors with motor trucks during the busy period, unless the road contractor foresees this condition and secures the promise of this service far enough in advance so he will not be handicapped in his work. Road contracts are let to contractors with the understanding that the work will be done on a certain date and it is necessary for the road contractor to give a bond guaranteeing that the work will be completed at that time.

"We believe this subject is a very important one and that if enough publicity is given it to road contractors in general this condition could be changed, which naturally would make it much easier for truck manufacturers to get to the proper officials or contractors and present their truck proposition, without unnecessary loss of time and trouble in closing sales. This seems to have been the greatest difficulty in trying to promote sales of trucks for road building purposes. Instead of interviewing the road commissioner and the road contractor and then the sub-contractor for hauling the material, it would only be necessary to call on the road contractor himself to present the proposition."

Mr. C. C. Frame, Transportation Engineer of the Service Motor Truck Co., Wabash, Ind., writes:

"We have always considered this question more or less individual with contractors. If a road contractor can hire his hauling done for less than he can afford to operate his own equipment and the hauling contractor with whom he deals serves his interests as well as he could himself it would, of course, be to the advantage of the road contractor to hire his hauling done.

"We personally are becoming more and more of the belief that motor truck operation is a business of its own the same as other large agencies of transportation.

"Knowing what we do of the results obtained from motor trucks by individual

KISSEL

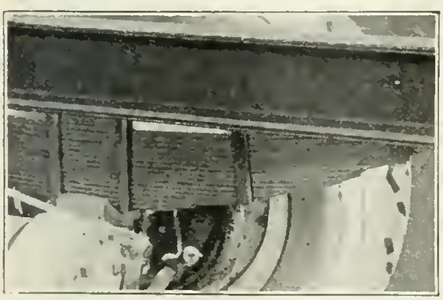
Designed—Geared—and Powered for Flexibility—Proper Speed—100 Per Cent Service

Kissel Road-building Trucks are specially designed and adapted to contractors' individual requirements—which, like in the case of C. F. Lytle, will prove a speedy, economical and dependable haulage service.

Whatever the size of your contract, the Kissel engineers will design a fleet of special units—working as a unit and hauling by a system that not only reduces the cost per load to a minimum, but renders a better haulage service.

Kissel Qualifications—Facilities—Experience and Organization emphasize Kissel's ability to specialize on Road-building Trucks and Equipment, from the regular Heavy Duty Road-builder and Dual Hopper Dump Body Truck to the Special Road-builder's Truck like Mr. Lytle's.

Double Frame and Extra Heavy Springs for Strength and Durability



Kissel Engineering Service is at your disposal. Send for specific details of road building service and names of prominent Kissel fleet contractors.

Brief Specifications of Kissel Special Road-builder's Truck

Short wheelbase—special double channel frame for strength—36x6-in. front and 42x9-in. rear Pneumatic Cord tires—special steel body with special center partition and gate to handle two batches—powerful motor—special sectional driver's cab—Horizontal two-cylinder Hoist—tire pump—***the whole job geared and powered for flexibility, power and proper speed.***

KISSEL MOTOR CAR CO., Hartford, Wis., U. S. A.

SPEED—ECONOMY—DEPENDABILITY

owners, we are convinced that the great majority of truck owners are not obtaining anywhere near the transportation results from their trucks that they are capable of.

"We are, therefore, of the opinion that it is highly possible for a motor transportation company to so manage its trucks that it can haul for individuals for less than the individuals can do the hauling themselves.

"We have a booklet 'Transportation Engineering and Truck Usefulness' which very generally covers this point.

"In practice, however, there are at the present time many advantages to be gained by the road contractor in owning his own truck equipment. In the first place he has complete control of their operation and can work them as many hours a day as required and also use them for a variety of purposes which would probably not be covered in the contract with the hauling contractor.

"For example, if he is having his hauling done by the yard mile, he could not expect his contractor to make emergency trips for a small quantity of material.

"A road builder owning his own truck equipment could also interchange different types of bodies and perhaps road oiling machinery on the same truck. He could also utilize the truck for pulling scrapers, etc., and where the road operations are large enough to utilize a man in charge of the trucks it would very likely work to the advantage of the road builder to own his own truck equipment.

"At the present time there seems to be a condition existing among road builders in regard to motor trucks, the same as with other road building equipment. That is, the road builder usually expects one season's contract to pay for all the machinery involved. This may apply to other machinery such as scrapers, etc., but is different with motor trucks since good motor trucks should also be looked upon as a business asset capable of returning an income every day and if not engaged in road work can be utilized for other purposes the year around.

"If more road builders would look at the motor truck from this angle they would undoubtedly recognize more reasons for owning their own truck equipment."

The following very interesting discussion was submitted by a gentleman who modestly requests that his name be withheld and we must, of course, be governed by his wishes although we should like to give him the credit to which he is entitled for his contribution to the discussion of this important subject:

"Road contractors, unlike poets, are made as well as born. They are a canny, close-figuring, shrewd class of men and usually have very excellent reasons for the practices which they follow in connection with their business.

"When road contractors, as a class, do thus and so, we have reason to believe that they know why they are doing it. They have learned by experience, as a rule, how to figure costs so that there will be some slight margin left after the bills are paid, which margin will enable them to justify their being in business. If it were the universal practice of contractors to hire their hauling done instead of doing it with their own vehicles, we should feel that there was no possible ground for an argument and any time devoted to prove that contractors should own their own trucks, would be just that much time absolutely wasted. There is, however, a considerable variation in practice. Some contractors do substantially all of their hauling by means of their own trucks. Others contract for practically all their hauling service. Between these two extremes there are other contractors who own trucks and do a certain portion of their hauling but who contract for the balance.

"To the man who sits beside the road and views the question from the outside, it would seem as though there should be but one logical position to take on the question of truck ownership by the road contractors. The reasons why it would seem feasible and desirable for road building concerns to own their own motor equipment may be briefly stated as follows:

"1. Trucks are always available for service when needed. The man who depends upon contracting his haulage may find difficulty in securing reliable hauling contractors when and where he desires their services.

"2. When the contractor owns his own trucks, they may be readily adapted to various services. If he needs trucks for hauling timbers he may remove the dump body from one of his regular service trucks and put on a body equipment which will be suited for that purpose.

"3. Again, he may divert his trucks to special services. If he has contracted with haulers for so much per yard, the man who holds the contract will wish to keep his trucks busy on that yard haulage and will resent having the trucks diverted to any other work, no matter how necessary it may appear to be. The contractor, on the other hand, who owns his trucks can put them at work where, when and on such kinds of work as need to be undertaken.

"4. Again, the contractor may be carrying more than one job at a time. His maximum haulage requirements on the different jobs may vary at different times. If he owns his own trucks he can readily divert them from one job to another as the need may require. If he is getting his hauling done by contract, he may find it difficult thus to shift trucks from one place to another, particularly if one truck job offers a better opportunity for profit to the contract hauler than does the other.

"5. Why should the contractor not make whatever profit there is to be made on the hauling, as well as on any other phases of the contract? Undoubtedly the men who do his hauling on the contract basis, figure so as to make a profit. That profit which he pays to the contract haulers must come out of his general profits on the job as a whole. Why should he not retain that profit by doing his own hauling?

"6. Trucks owned by the contractor are likely to be better serviced and to stay on the job more continuously than trucks owned by hauling contractors. The road contractor who owns his own trucks will need to have enough of them so that he can afford to keep them properly serviced under the direction of a capable mechanic. While the hauling contractor on the other hand, with but two or three trucks may be so engrossed in seeing the yardage mount up as to neglect his trucks to his own ultimate loss and to the delay of the construction operation.

"7. Again, the contractor who owns his own trucks will be more likely to use them on all occasions where truck haulage is most economical no matter how relatively small the amount of haulage may be. If he owns his own equipment, he will utilize that equipment where it can be utilized to best advantage. If, on the other hand, he must contract for his truck haulage, he may often find times when a certain amount of trucking would be profitable but because the amount is comparatively small, he will use some other form of equipment which he may have and with which he can do the work, although at greater expense, rather than to hunt up a hauling contractor to handle it.

"Of course the road contractor reduces his initial investment materially by hiring his hauling done instead of doing it himself. He would reduce his initial investment still more by hiring the mixing of his concrete done by another's equipment and hiring the placing of the concrete on the road done by other's equipment, but the man who hires all his work done in a road job is likely to find he is contributing his profits to the people who have actually furnished the equipment to do the work.

"A farmer might hire his ground plowed and harrowed and seeded and also hire the equipment for handling the harvest. Very few farmers, however, follow that practice, because they feel that if any profits are to be made in putting in or harvesting the grain, they prefer to make them themselves. Further, they know that they can do the work at seasonable times, whereas, if they had to depend upon hired equipment, they would also have to depend upon the convenience of the man who owned it. The contractor who owns his own motor trucks can bid with assurance. If he is so fortunate as to secure the contract, he can go ahead whenever he will and will not be obliged to wait for the convenience of the men who are to furnish the equipment for the work.

"8. Again, it would seem as though the ownership of equipment would raise the standard of reliability and responsibility of the contractors involved. If no initial investment is required, there is nothing to prevent any man with a little nerve from entering the contracting field. The results are likely to be that the entire contracting business will be brought into disrepute and road construction will be, to a constantly increasing extent, done under direct County and State authority by day's labor instead of by contract."

Mr. W. E. Blodgett, advertising manager of The Autocar Co., Ardmore, Pa., writes:

"There are many reasons why road contractors should operate only their own motor trucks:

"1. The efficiency with which all of their machinery is able to operate is dependent upon the constant flow of materials from railroad sidings or storage, to the mixer or tamping machine.

"2. The length of time in which their capital is tied up is dependent upon the early completion of the work.

"3. The return they are able to get from their overhead investment and permanent organization is dependent upon the earliest possible completion of each job.

"4. The time that they can possibly start a new job, with its additional profit, depends only upon the earliest possible completion of their present contracts.

"5. only by owning their own motor trucks can they control absolutely the transportation of material, which is the one main essential in making them a profit.

"6. By owning their own motor trucks they can control absolutely the size and type, avoiding damage to the sub-grades.

"7. By owning their own motor trucks they can insure themselves of having their transportation done at the lowest possible cost.

"8. Road contractors must of necessity make the maximum progress on days when the weather is suitable, as weather conditions frequently mean the difference between a profit and loss on the closely bid contract.

"They cannot afford to leave out of their control factors that can be controlled.

"9. By a moderate investment in well selected motor trucks and a system of moving materials with one handling from railroad sidings to the mixer, contractors can do away with the much larger investment in industrial railways, etc."

The editor will be much pleased to continue this discussion at the readers' pleasure. We expressly invite readers to submit their views on this important topic.

HIGHWAY TRANSPORT CLEARING HOUSES

(Editor's Note: The following matter is the full text of the report of the committee on Highway Transport Clearing Houses, presented at the 1921 convention of the National Highway Association on April 29, 1921, at Detroit. Tom Snyder of Indianapolis is chairman of the committee.)

As chairman of this committee I have made many inquiries as to just what should be the function of a Highway Transport Clearing House, or what should be the complete character of service rendered by a Highway Transport Freight Station.

My inquiries covered a wide field of motor transport activity, and the answers were as varied in definition as the number of inquiries made.

It is perhaps not unusual that as yet, there should be no clear, well-defined point of view on either of these questions, as experience, the great teacher, has had little opportunity of working out these important factors of motor transport application.

I am convinced, however, as a result of these inquiries and their answers and as a result of my own experience in motor transport, that a Motor Truck Terminal and Clearing House is assential to successful motor transport, as freight terminals and clearing houses are to steel rail or water transportation.

The theory that all shipments to be transported by motor truck can be picked up at the shippers platform by the transport truck, and that the highway transport truck can also deliver to store door, or be successfully applied as a cartage vehicle must be given up.

This statement may excite considerable opposition, because so much has been written and said about the motor truck rendering a service direct from shipper to consignee and that because of such service unnecessary handling of freight has been saved, which is all true, but which will be the special or rare case when motor transport is broadly applied as a definite link in the whole service of transportation.

I know of no important industrial center in America from which (within the next six years) less than 8 different Motor Transport routes will be operated, and from some centers this number may be increased to 20 or 30.

It would be a daily occurrence for some shippers to have consignments for each of these routes, and limited platform space, which has long been a menace to American industry, would prevent the transport truck from each of these routes picking up their route consignments at shipper's platform space.

Many shippers in Indianapolis, Cleveland, Cincinnati, Louisville, Chicago, Milwaukee and other centers who now have access to the better short haul motor transport service will not use it because of their limited platform space.

Many shippers have said to me that they would gladly use motor transport for all short haul consignments if their shipping department could load to their own freight delivering vehicles, to be dropped off at a motor transport terminal while making daily deliveries to all other terminals.

There are four definitely fixed reasons why Motor Transport Freight Stations and Clearing Houses are essential to successful motor transport operation.

1. Shipper's limited platform space, which is too often inadequate to serve his own demands.

2. Most large shippers maintain regular cartage equipment which makes regular daily trips to steam, electric, and water transport terminals, and could add consignments to motor transport terminals at less cost than transport trucks could pick up, providing, however, truck terminals would be properly located.

This applies to the endless number of small consignments, which makes up the major portion of all tonnage for all short haul shipments.

When full truck load or even a comparatively large consignment for highway transport is made, a clearing house record on cost of cartage should determine when it is most economical for the transport truck to pick up at shipper's platform.

3. Until highways will sustain tonnage and permit speed in motor transport, it is economically necessary that this mode of transportation confine itself to the service of transporting the higher class of commodities.

The motor truck renders an express service-plus, but only through a motor truck terminal and clearing house can highway transport schedules be established and maintained or sufficient tonnage in express, first and second class freight secured to make it a real factor in transportation.

4. Generally speaking, motor transport is as yet an indefinite thing, it lacks substantiality, responsibility, dependability; the general shipper can not accept it as a definite phase of transportation as he has accepted the steel rail.

A public Motor Transport Terminal and Clearing House is a gateway to and from all highways. It will supply that definite point of contact which highway transport now lacks; it will indicate substantiality, responsibility and dependability which the shipper wants; it will become a crystallizing point from which an analysis of possibility and application can be made; it will make every citizen in every industrial center of America the consignee of every producing farmer within 50 miles of that industrial center; it will put every rural merchant within 50 miles but 6 hours away from his base of supply.

The highway will never serve its ultimate purpose until every citizen, consumer or producer has dependable and beneficial transportation access to it, and this is not possible except through a highway transport terminal.

Character of Motor Transport Terminals

Large industrial centers with well populated surrounding territory will require an outbound and an inbound building or section.

These terminals could be established and sustained as private enterprises and be made profitable through a terminal cwt. or package fee to be added to the transportation charge, and through the operation of a cartage which would be in great demand on pick ups and deliveries to consignees and from shippers who do not operate their own cartage vehicles, and from thousands of individual citizens who through highway transport and motor terminal service will become the consignees of agricultural producers.

These terminals should be established and sustained through the cooperation of Wholesale Shippers' Associations, Farm Federations and Motor Transport Organizations.

The building should be long and narrow, providing the greatest possible amount of platform space on each side of building, insuring relief from building, platform or vehicle congestion.

The building should be divided into route sections, local cartage vehicles delivering to platform on one side of building within route sections according to consignments, these consignments handled through narrow building to outbound platform for shipment that day or left within building if scheduled for following day shipment.

The inbound building or section should be of the same character, permitting inbound transport truck to unload cargoes on one side of building and local cartage vehicles to clear from opposite side.

Because of the flexibility of motor transport, terminals will be very well cleared daily.

For outbound terminal, shipments consigned to routes over which less than daily service is rendered should not be received earlier than one day prior to scheduled departure of truck.

For inbound terminal, local cartage service could easily keep terminal clear.

Schedules should be established over all routes offering tonnage in exchange for service, the terminal clearing house keeping all shippers informed as to schedules, transport rates and service offered.

Many private truck owners can be found within or around industrial centers with whom contracts can be made to operate over routes on schedules, if the terminal clearing house will centralize the industrial demand for service. It is very evident, however, that a standardized fleet of trucks fully under the direction and control of a terminal clearing house system will render the most dependable and the most economical service.

Dry and Cold Storage Warehouses as Motor Transport Terminals

All dry storage warehousing firms who see the great changes in transportation and distribution which highway transport is rapidly bringing about are providing liberally for motor truck platforms.

Large manufacturers of common commodities are already consigning to warehouse for distribution from that point, to store door any where within motor transport service from the warehouse, and by various sales systems eliminating the jobber, the broker, and the wholesaler.

Increased motor truck platform space is already in great demand at cold storage warehouses, because farm bureaus and federations are instructing agriculturalists to transport by motor truck to cold storage, avoiding the commission broker and holding their season's crops for the unseasonable market periods, Farm Bureaus and Farm Federation Committees acting as sales agents.

In smaller towns and cities in which highway tonnage is not great enough to sustain a motor transport terminal, storage warehouses are rapidly taking on this function and because many of them operate a cartage business in connection with warehousing, find that it fits in splendidly and contributes to their regular line of activity.

Thus the terminal problem for motor transport throughout America is not as great as it has been considered, the greater problem being that of limited platform space at warehouses and at shippers' places of business.

The trailer is rapidly being found a means of relief from the problems of limited platform space, and is perhaps best illustrated in several routes operated out of Indianapolis.

Where shipping points along these routes receive as much as one or two tons, the consignments are loaded on a trailer and delivered to a local warehouse or cartage man who delivers to store door from trailer while the transport truck goes on its way, and on its return picks the trailer up, often well loaded for the return trip.

Trailers are also used as highway clearing houses in the transportation of milk, two trailers to truck being used on some routes.

These trailers are dropped off at important highway crossings loaded with empty cans, the transport truck going on to the end of the route and returning loaded picks up the trailers which have been loaded with full cans by smaller pick-up trucks and on a scheduled system which avoids delay for the transport truck.

Platforms are also being built at important highway cross-roads from which the transport truck picks up consignments or to which it unloads a great variety of commodities shipped to farmers in the neighborhood of the platform.

These platforms are small clearing houses and have done much toward increasing highway transportation in Indiana.

Interurban Electric Railways have entered into competition with the motor truck in the transportation of live stock to the Indianapolis Stock Yards, but before it was possible for them to secure any portion of this business it was necessary for them to build stock yards and loading platforms at many points along their routes.

The Electric Roads have been trying for several years to secure this business, and a transport rate of 75 percent less than motor transport rates were offered, but it finally took the terminal clearing house and definitely scheduled service to get a portion of the business.

The cost of operating railway terminals upon the basis of cwt. and the relation of this cost to the transportation receipts for hauls of various distances were apparently never analyzed until within the past few years.

It must have been depressing to many of the larger carriers when it was learned that the terminal cost per cwt. on the greater portion of their short haul tonnage was greater than the total transportation rate allowed.

The many almost insurmountable causes for this fact are due principally to yard, trackage and switching limitations which would not apply at all to motor transport terminals.

Surveys in many of America's industrial centers have disclosed that terminal building, yardage and trackage expansion sufficient to meet the normal transportation demands upon steel rail carriers is physically and financially impossible.

Because of the flexibility of the motor truck, with its trailers, semi-trailers, and demountable bodies, and because every highway, street or alley becomes an outlet for the movement of tonnage, the Highway Transport Terminal will never be subject to the limitations of steel rail terminals.

EDITORIALS

THE WATER WORKS SITUATION

In this issue we are devoting more than the usual amount of space to water works matters because of the annual convention of the American Water Works Association soon to be held, at which copies of this number will be distributed. Several very interesting articles on water works subjects, written for our exclusive use, are published in this number.

The time is appropriate for considering the situation in the water works field. The private companies were very hard hit, of course, by advancing costs, since they had only a moderate fixed income with which to meet the increased expenditures. Some relief has been granted them in rate increases. Municipal plants were, in many cases, on such a basis that water funds were used for general purposes, so by practicing some economies and using their funds for their own needs water departments have managed to get along fairly well.

Of course, there has not been a large volume of new water works construction and the reconstruction and extension of old works has not been great. As in every other line, therefore, water works improvements have not kept pace with the demand, but have been postponed from year to year, until now there is an accumulation of needed projects which will represent a cost running far into the millions of dollars. Much of this work should not be postponed any longer in the expectation of lower costs, for while costs must come down some time, it is doubtful economy to use overtaxed, insufficient and inefficient works too long just to save a small percentage on the cost of new improvements. A revival of construction is likely to be accompanied by rising costs again, as we are not likely to get back to the pre-war price level on construction for many years to come. For these reasons work should go forward now on needed water works improvements.

RESERVE WATER FILTER CAPACITY

Water filtration plants are frequently, if not usually, built too small. Water consumption usually increases rapidly after the installation of a filter plant, and new plants are frequently overloaded while serving the population for which they were designed, due to the increase in the per capita consumption of the more attractive and safer water produced by the plant. For this reason alone filter plants should be made of ample size.

But there is another reason for making these plants of generous proportions, and that is to provide reserve filter capacity. Additional filter capacity should be provided to take care not only of peak loads, but also so that one filter at any time can be put out of service for inspection and overhauling. Sufficient attention has not been paid, in the past, to this need for reserve filter capacity.

THE GREAT AMERICAN DETOUR

The detour is rapidly becoming a national institution. It is still possible to make it more a convenience than a highway horror, but if this is to be accomplished thought must be taken and some money spent.

During the era of highway construction, on which we have as yet scarcely more than entered, detours will be frequently encountered, by the tourist at least, and it would be well to formulate a rational detour policy now. Certain fundamentals should be kept in mind by the engineers whose business it is to lay out detours and prescribe their use.

First of all, it should be recognized that the purpose of the detour is to facilitate travel quite as much as it is to safeguard construction operations. Traffic should not be diverted from the main highway unless there is a mighty reason for doing so. This seems so obvious that it would not be stated here but for our observation of a case last year, in which the main outlet, in one direction, from a very large city, was closed for months while the road was, presumably, under repair. During this time an exceedingly heavy traffic was required to drive over ground so rough that it was a serious question whether those riding would not be injured, not to mention the damage to hundreds of expensive cars that bumped over that detour every day. After some months of this the main road was again opened to traffic and was found to be in practically the same condition as when first closed. Just how this came about is unknown to us, but evidently somebody bad blundered.

Detours should be kept as short as possible, for aside from their greater roughness they are naturally longer, as a rule, than the road which they temporarily supersede. The man who lays out a detour should try to make it as short and as smooth as possible; his job is only half done when he gets rid of traffic for the time being, for he must take care of it at the same time.

Where the detour passes over an uneven surface it is well to spend some money to make of it a fairly smooth roadway, if this can be done with the usual road grading and surfacing machinery, especially where the traffic is considerable and the detour is to remain in operation for a month or more. There are precedents for spending money to secure merely a temporary result, as in snow removal, for example.

Some detours are quite passable, others not too bad, while still others are misdemeanors, if not crimes. It is well to remember that the public is very resentful of being thumped with a detour.

INSTRUCTION OF ENGINEERING STUDENTS IN ADVERTISING

An interesting departure in engineering education has been observed at the Iowa State College, where a course in technical advertising is being conducted, with an enrollment of 25 men. These men are students in civil, mechanical, electrical and chemical engineering and in architecture. Certain features of the course are of general interest.

The first four weeks of the eleven-week course are devoted to a study of the fundamental principles of advertising—that is, the place of advertising in business, the methods of advertising and the psychological features of attention, interest, desire, conviction and action. At the end of four weeks each student establishes a hypothetical business, in which he markets some new, simple technical product. He is assigned a definite advertising appropriation, and on that basis devotes the remainder of the time to the development of the initial advertising campaign for his product. He selects the advertising mediums he will use, lays out his advertisements, works out a few direct mail pieces and some sales letters. During the course the class studies a considerable number of pieces of advertising copy which have been published in the technical press, with the idea of finding their strong points and their weaknesses.

In a two-hour course running through but eleven weeks it is not possible to go very deep into the subject of advertising, but enough information is given the men to enable them to go on with the study of advertising by themselves later on.

We have been particularly interested in the course of study briefly outlined, and should be glad to see other engineering schools add similar courses. It will mean much to many of the students to have the business world revealed to them in this way, and by broadening their outlook as well as their knowledge, will increase the possibility of their finding their proper places later on. Many engineers would like to get into manufacturing, but do not know how to go about it. Young engineers who enter manufacturing establishments through advertising and sales positions will learn how to get into manufacturing for themselves later on if they wish to do so. Men of the type who study engineering in colleges are needed in manufacturing, and in advertising and selling also. Some day engineering graduates will fill many responsible positions in the advertising departments of the engineering manufacturers.

FIREPROOF SCHOOLHOUSES

There is now a shortage of schoolhouses, just as there is a shortage of buildings for business and residential purposes. The great movement of the people to the cities during the past few years, when building operations have been so severely curtailed, has, of course, filled existing school buildings to overflowing. In many localities school is being held in portable and temporary structures, and in some places in churches.

There has been ample time for the proper planning of new school buildings, so when construction of this type of buildings is resumed the errors of the past should be avoided and we should build better than ever before. What remains of the idle period should be utilized in proper planning.

Surely the time has come for the fireproof schoolhouse. Every school building, containing four rooms or over, should be built of the highest type of fire-resisting construction.

With the need for new school buildings so clearly defined, there is no excuse for cheap or flimsy construction. There must be no more fire-traps built for helpless school children.

WIDTHS OF ROADWAYS AND SIDEWALKS IN MUNICIPALITIES

(Editor's Note: The following data and discussion are from the report of a committee of the National Highway Traffic Association, of which Mr. Hugh J. Fixmer, Paving Engineer, Board of Local Improvements, City Hall, Chicago, is chairman. This report ,written by Mr. Fixmer, was presented at the annual meeting held in Detroit April 29, 1921. The report gives emphasis to the fact that roadway widths should not be standardized. Each street presents a separate problem requiring engineering study. The cost of street improvement is too great to permit guesswork as to the width of the paved roadway. The width should be designed to fit the use of the street. It must accommodate the traffic (whether parked or in motion) and the use of the abutting property. The formulas, in this discussion, are introduced to indicate a basis for study of the problem and outline the main factors having a bearing on it.)

It is quite obvious that the width of the street is to be determined by the use to be made of it. The proper width of street is a summation of the width of roadway, width of sidewalks and extra or reserve width. The extra or reserve width is set apart for parkways, to add beauty and comfort, and to provide for future expansion of roadway and sidewalk width. In the typical city where the width of street is fixed and defined by buildings, the width of roadway and sidewalk must be carefully proportioned. Where these widths prove inadequate to accommodate the traffic the street must be widened by condemnation. Where this cannot be done, because of physical, legal or economic conditions, the traffic must be restricted and regulated by police power.

Width of Roadway

The width of pavement or roadway is determined by traffic needs, by tradition, by esthetic requirements or by limitations of site or cost. In the city the value of the pavement to the users is of paramount importance. The pavement must prove safe and comfortable to use, must be truly economic, must present an agreeable appearance, and must accommodate the abutting property and the character and amount of traffic using it.

The realization of the above qualities is intimately affected by the factor of width of roadway. Owing to the great increase and diversified use of motor vehicles, the fundamental basis of pavement design today is to fulfill the needs of the traffic; to serve the users of the street in an efficient manner. The following quotation is from a paper presented before the 1920 annual meeting of the American Society of Municipal Improvements by Mr. Robt. Hoffman, Chief Engineer, Department of Public Service, Cleveland, Ohio:

Two Ponts of View on Roadway Widths

"The determination of roadway widths may be considered from two different points of view. One is from the viewpoint of appearance, governed by rules of proportion, or by making provision for predetermined widths of sidewalk strips or for lawn and parking spaces. The other viewpoint is that of traffic accommodation.

"The first viewpoint applies principally to parkways, boulevards and certain classes of residence streets where beauty and proportion largely control the design rather than economy and utility. Making the roadway from 50 to 60 per cent. of the street width between property lines will, in many cases satisfactorily suit conditions. The design of the planting strips and lawns will, however, nearly always control the width and arrangement of the paved roadways. Even here the expected traffic should receive consideration, but its subordination to other conditions may be perfectly logical and free from criticism.

"Consideration of roadway widths from the second viewpoint, that of traffic accommodation, obviously applies to the greater number of cases, and should be the prevailing point of view when considering any basis of design or the standardization of widths."

Kinds of Traffic

There are five general classes of traffic using the city street. These are: Pedestrian, horse drawn, motor driven, street railway and stationary traffic. Stationary traffic consists of vehicles loading or unloading merchandise, and vehicles, mostly motor driven, appropriating the public space for parking. Since all classes of traffic have the common right to use the street, the street should be designed to afford each class the maximum of comfort and safety without abridging or destroying the rights of the other classes.

Effective Width

The effective width of roadway is that part available to moving traffic, and is affected by the presence of street railway tracks, by the provision for parking vehicles, by the custom or necessity of backing vehicles against the curb to load and unload material, by slippery surface, by excessive crown of surface, by accumulation of snow and refuse and by uneven or worn out pavement surface.

Requirements of Traffic

The width of roadway required for traffic is a function of the necessary clearance, of the width and permissable speed of the vehicles and the volume or amount of traffic. The relation between roadway width and width of vehicle, for each line of traffic (standing or moving), is given by the following formula:

$W = B + C + S/10$ .... (1)

S being the permissable maximum speed (in miles per hour) of the vehicle traffic.

W = required width of roadway for one line of traffic parallel to the street axis (in feet).

B = width of vehicle (over all) in feet.

C = lateral clearance factor, varying from ½ to 1 (Ft.).

Thus in order to fix the width of roadway to accommodate the character of traffic the widths, particularly the allowable maximum, of all vehicles, together with the permissable speed must be known. Where vehicles stop or park parallel with the street axis the required width from the formula is over all width plus one-half foot. Where vehicles are permitted to park at an angle or back against the curb to handle goods, the width must be increased from 6 to 12 ft. over the width needed when standing parallel with the curb. The space to be provided for parking or so called stationary traffic must be definitely settled.

To determine the effective width, or width to be kept open for moving traffic, we must know the number of moving lines of traffic to provide for.

The distance required to stop a motor driven vehicle equipped with proper brakes, road in good condition and driver alert, is determined by the following formula:

$D = S/10$ .... (2)

D = Distance in feet to stop vehicle.

S = Maximum allowable speed in miles per hour.

The headway required for fast moving vehicles varies with the maximum speed, the factor of safety assumed (to allow for poor brakes, possible slipperiness, time for driver to act), and the length of the vehicle is:

$H = DF + V$ .... (3)

H = Headway in feet.

F = Factor of safety (ordinarily equal to 2).

V = Length of vehicle in feet. V is important only at low speeds, and varies from 10 to 30 ft. depending on kind of vehicle.

The maximum number of vehicles* per hour per line of moving traffic is given in the following formula:

$$N = \frac{5280M}{H} \quad \text{.....................} \quad (4)$$

N = Maximum number of vehicles per hour per line of moving traffic.

M = Assumed average speed in miles per hour.

The number of lines of traffic to be provided for should be based on the future use of the street. A traffic census is of little value unless carefully interpreted, and then is only important as an aid to judgment.

The total width of roadway to accommodate the character of traffic using a given street is the summation of the number of traffic lines required for moving and stationary traffic.

A given width reaches its greatest capacity when speed is uniform or average speed approaches the maximum speed. This ideal condition is never reached and closely approached only on long stretches of open country road or certain boulevards.

On the city street the speed is restricted to a low average, due to frequent cross traffic, presence of car tracks, and mixed character of traffic. To accommodate an increase of traffic, the roadway must be widened or the maximum speed reduced and the average speed increased. A double track street railway requires a width of 20 ft. for safe and rapid operation. On streets other than those carrying car tracks the requirements of rapid vehicle traffic indicates a minimum width of 20 ft. for the rapid moving middle traffic.

Regulation of Width and Speed of Vehicle

The necessary width of roadway for vehicle traffic is a function of clearance, width and permissible speed of vehicle as shown in Formula 1. Table I shows necessary width for each line of traffic:

$(W = B + ½ + S/10.)$

*See article by author in Eng. & Contg., Apr. 2, 1919, p. 328.

TABLE I. RELATION OF ROADWAY WIDTH TO WIDTH AND SPEED OF VEHICLE.

Permissible speed of vehicles in miles per hour (Min.)	Overall Width of Vehicle (In feet) 6	6½	7	7½	8	8½
	Width of Roadway Per Line of Traffic					
Parked or standing parallel to curb (stationary)	6½	7	7½	8	8½	9
5 miles per hour	7	7½	8	8½	9	9½
10 miles per hour	7½	8	8½	9	9½	10
15 miles per hour	8	8½	9	9½	10	
20 miles per hour	8½	9	9½	10		
25 miles per hour	9	9½	10			
30 miles per hour	9½	10				
40 miles per hour	10					

Apart from consideration of pavement damage due to impact, tire equipment, etc., the speed must be regulated from the standpoint of public use, safety and economy. It appears that 10 ft. should be the proper width for each line of rapid traffic, and 8 to 9 ft. for side or slower moving traffic. Thus a truck measuring 8½ ft. over all would be limited to a maximum speed of 10 miles per hour, and shoul dnot travel along the middle strip reserved for rapid traffic.

It seems the general concensus of opinion that, until demonstrated uneconomic, the width, length and height of vehicles should be limited to 8 ft, 24 ft. and 12 ft., respectively.

Economic Value of Width

City pavements are expensive, and it is wise carefully to determine adequate width. Pavement cost varies from 50 cts. to $1 per foot in width per lineal foot, or $2,500 to $5,000 per mile per foot in width. It is for this reason that the maximum width should be a minimum to accommodate the needs of the traffic and abutting property. Streets should not be paved too wide where use does not demand it. The regulation of width of vehicles is certainly justified in view of the added cost to accommodate a small percentage of extra wide trucks. The loss occasioned by congestion, detours, restricted business and so forth, due to an inadequate roadway should be determined. This loss, when capitalized, indicates the sum that can be wisely spent to increase the roadway width or construct new trafficways adjoining, above or below the present street surface.

Sidewalks

The main purpose of the sidewalk is to accommodate the foot or pedestrian traffic. Other uses are incidental and can be ignored in determining the proper widths. The width of the sidewalk is often reduced by the presence of poles, hydrants, receptacles and building encroachments, usually stair entrances. The arbitrary, or "practical" rule for sidewalk widths on each side of the street, is given by the formula:

$$Sw = L \times 2 \quad \ldots\ldots (5)$$

Sw = Sidewalk width in feet on each side of street.

L = Number of lines of traffic provided by the roadway.

The traditional method of determining sidewalk width is to make Sw from 8 to 20 per cent. of the total street width. A line of pedestrian traffic is universally taken as 2 ft. in width. It is obvious, therefore, that the effective sidewalk width should be a multiple of two.

In large cities the matter of adequate sidewalk width is vitally important. A formula can be developed for sidewalk width similar to the one used for roadway width. The width for one line of moving pedestrian traffic is taken as 2 ft. This includes allowance for clearance at the average speed of ½ to 3 miles per hour. The distance apart (headway) is determined by speed, or rather degree of congestion, and comfort.

The following formula shows capacity of walk per 2 ft. of width at various rates of travel for various distances apart:

$$N' = \frac{5280\,M'}{H'} \quad \ldots\ldots (6)$$

In which N' = Max. number of pedestrians per hour per line of traffic. (2 ft. width).

In which M' = Average speed in miles per hour.

In which H' = Headway, or distance between bodies. (Allow 2 ft. for body).

In which Sw = Width of sidewalk in ft.

In which T = Total number of pedestrians passing per hour.

$$Sw = \frac{2T}{N'} \quad \ldots\ldots (7)$$

The minimum value of Sw should not be less than 4 ft. In practice 5 ft. is considered a minimum for comfort, in walking two abreast or passing.

In a congested street, due to frequent interruption by cross traffic, etc., with an average speed of 1 mile per hour and distance between pedestrian of 6 ft., we find $N' = 5280 \times 1 \div (6+2) = 660$ persons per hour per 2 ft. of width or 300 per hour per foot of width. This is approximately the maximum, since the clearance (for comfort) varies nearly directly with the speed.

City Planning

The importance of street and roadway widths is now quite well understood by students of city planning. The proper development of property as well as the enjoyment of community life, is dependent on the street layout. Let us trace the history of street widths in the average American city. The universal street and road width east of Ohio is 66 ft., an arbitrary unit based on the "surveyor's chain," this unit being adopted to facilitate computation of areas in terms of acres, rather than from any consideration of traffic needs. This traditional or "standardized" width is inadequate in many places and wasteful in others. Many streets are laid out with the width based on willful expediency or vague imagination, no thought apparently being given to the needs of traffic; accessibility, need of parkways, or future use of the street.

The general rule for adequate street

$W = Wr + Ws + Wp + Wg$

in which

width is given by the simple formula:

W = total width between buildings.

Wr = necessary width of roadway.

Ws = necessary width of sidewalk.

Wp = width of parkways.

Wg = Reserve width or width necessary to widen roadway and sidewalk when character of street and property changes. Very often Wg is taken equal to Wp, the parkways being absorbed later on in the roadway and sidewalk space. In some cases Wg is laid out between the sidewalk and so-called building line. This is good practice where legal, and later on, enforcible. (See Table II.)

Table II is submitted to show approximate sidewalk and street widths required for modern traffic for usual types of streets, in the average municipality. This table does not represent an attempt at standardization. It appears here to indicate the proper method of determining street width, which should, if possible, be secured when the street is originally platted.

It is still the general custom to determine roadway width on the basis of limitations of site and cost. While this method may be warranted in a few cases, it should be generally discouraged. Some cities have attempted a general standardization by assigning ratios to the roadway or sidewalk width. Usually the roadway width is established at 40, 50, 60 or even 70 percent of the total street width. There should be no general standardization of roadway or sidewalk widths. As stated before, the width should be an expression of the use of the street or the needs of the traffic and abutting property.

TABLE II. ROADWAY, SIDEWALK AND STREET WIDTHS.

Class of Street	No. Traffic Lines	Prob. Lgth. of Vehicle	Prob. Max. Wdth. Vehicle	Max. Speed Allowed	Prob. Aver. Speed	Max. No. Vehicles (per hr.) (No Parking°)	R'dway Width	Sdwlk. Wdth. (Each Side)	Pkwy. or Reserve (Each Side)	Minimum Total Street Wdth. (Bet. Bldgs.)
Residence street...	2	16	7	20	15	1600	‡20—24	(4)—6	9—12	‡50—60†
Residence street...	3	16	7	20	15	2400	30	6	12	66†
Boulevard	6	14	7	30	20	3270	56	10	22	120
Business street....	4	16	8	20	10	2200	40—48	12	28 to 24*	120*
Through route bus. st. (car line)...	6	20	8½	20	10	3180	60	16	0 to 14*	92 to 120*
Retail bus. st. (car line)	8	16	8	15	5	3520	80	20	0	120
Industrial street...	4—6	24	8½	10	3	1440—2160	44 to 68	10	0	64 to 88
Outlying drive or (road)	2	14	7	30	20	1200	20	4	16	60†

*Allow for future traffic increase.

†Where zoning laws are in effect and character of street is settled. Otherwise require reserve space by establishing 30-ft. "building lines."

‡Side frontage street for local traffic only. (No parking allowed.)

°Where parking is permitted reduce capacity to correspond with number of lines of moving traffic or increase roadway width to accommodate increase in number of traffic lines.

Each street should be studied not only alone but in connection with the general street plan, and widths adopted to fit its use. City planning, with its provision for zoning, will greatly assist in defining the character of the street and thus enable us to design street, sidwalk and roadway widths more efficiently in the future.

PRACTICAL LIMITATIONS IN "SURFACE TREATMENT" OF OLD BRICK OR BLOCK PAVEMENTS

By W. L. Hempelmann, Engineer, Middle-western Division, Asphalt Sales Department, the Texas Co., 10 S. La Salle St., Chicago, Ill.

At varying intervals the engineering journals record attempts to surface-treat old brick or block pavements. The thought generally is to produce a smooth surface, eliminate the noise, and last but not least, obtain a two or two and one-half dollar pavement for considerably less than fifty cents per square yard. The temptation to get something for nothing prevails in the paving game just as well as in other commercial lines.

Irrespective of one's experience in paving matters, a moment's reflection will convince the individual of the impossibility of building the equivalent of a sheet asphalt or asphaltic concrete wearing surface over an old brick or concrete pavement by simply applying a little road oil and covering it with sand or stone chips. On the other hand, under favorable conditions, the surface-treatment of certain types of roads has been very successful.

Surface Treatment Satisfactorily Practiced in the South

In the South, certain hard roads constructed with coquina rock, shell, limestone, etc., have been very satisfactorily surfaced by an application of an asphaltic oil covered with hard stone chips. The surface of such roads when dry is more or less porous and absorbent and such treatment makes a very smooth, economical road surface, free from dust, and easy to maintain.

In the larger cities it is generally looked upon as an economical procedure, where the physical conditions of the pavements permit, to resurface old brick or block pavements either with binder and top or with an asphaltic concrete wearing surface. One reason is that the traffic in such communities in the main is heavier, the service to be rendered correspondingly greater, and usually the product of an asphalt mixing plant is available.

The Smaller Cities Adopt Surface Treatment to "Save Money"

In the smaller cities the general tendency is to try to get away from the use of what is termed "expensive equipment." This tends to put the official in charge in a receptive mood to consider the surface-treatment of his rough pavements with a bituminous material. Generally the conversation relative to the procedure is about as follows:

"All you have to do is to clean the street, apply the bituminous material liberally, and cover with chips."

The simplicity appeals to the engineer in charge and in the majority of cases, with no experience to the contrary, he agrees to try it out. Within three or four months after such treatment such engineer desires to give his fellow engineers the benefit of his "discovery" and accordingly he writes an article. Frequently, before the ink is dry in the journal containing such write-up, there are some indications that the desired "sheet asphalt surface effect" will probably not be realized and usually after such treatment has gone through a winter and a spring there are considerable areas that have scaled off or others in which the material has been displaced by traffic. The representative who volunteered the construction information either hears about the results or accidentally happens into the city once after he has made the sale of the original material. His reception by said engineer can be better imagined than described. The "Never Again" Club has another new member.

Note Distinction Between Surface Treatment and Resurfacing

The fallacy of surface-treatment of old worn brick or block pavements comes in not being able to provide a uniform depth of wearing surface of uniform density throughout. When we undertake to resurface a brick pavement we are very careful to fill or cushion all depressions even prior to the application of the binder course under a sheet asphalt wearing surface. One of the reasons for this procedure is to insure a uniform density throughout the depth of the asphaltic covering, whether in the low spots it be 5 or 6 ins., or only 3 or 3½ ins., over the high brick.

One of the main points to be borne in mind in the consideration of resurfacing old worn brick or concrete pavements is that the minimum depth of asphaltic surface (i. e. the material over the high points in the old brick pavement) must be such as to be able to absorb the shock of traffic without shattering or disintegrating the upper surface of the old pavement. The malleable asphalt surface must be thick enough practically to absorb the impact of heavy loads at high speed. If this condition does not obtain, traffic may shatter the upper surface of the old brick or concrete, and though the asphaltic mixture adheres to the material with which it is in contact, such wearing surface will begin to peel or come off, taking with it a thin irregular layer of the concrete or brick surface.

When the wearing surface over an old rough brick or concrete pavement is to be an asphaltic concrete mixture we still cushion or fill the depressions and all low places in the old pavement before applying the asphaltic concrete wearing surface. Sometimes the advocates of the surface-treating process of brick pavements will suggest that the larger holes be filled in with stone prior to the general surface-treatment of the street, but in any case it is impossible to obtain a uniform depth of bituminous material and stone to serve as a wearing surface.

What Happens to Thin Covering

Under traffic, as outlined above, with an insuffiicent depth of uniformly dense asphaltic wearing surface, the high spots in the old brick pavement soon cut though the bituminous material and make possible the absorption of water at such points. Old brick pavements that have been subjected to the use of steel-tired traffic are absorptive and this fact permits moisture to get under the bituminous material. Subsequently, the warming up of the pavement due to the sun's rays brings such moisture to the surface of the brick, i. e., under the bituminous surfacing material. This condition tends to destroy the bond between the bituminous material and the brick and usually can be considered as a factor in helping to cause the surface-treatment to scale off. Usually the average consolidated depth of such surface-treatment (bituminous material and aggregate) is less than ½ in. How many experienced engineers familiar with standard sheet asphalt and asphaltic concrete construction would advocate one-half inch or less of sheet asphalt or asphaltic concrete as a covering for an old and irregular brick pavement? Still, the inexperienced official is willing to try out the surface-treatment with stone as the covering material, the various operations of which must produce a mixture on the old pavement which is anything but uniform.

The Essential Minimum Depth of Wearing Surface

To cover satisfactorily an old brick or block pavement the minimum depth of the bituminous wearing surface applied must be sufficient to withstand the shock of traffic and must be uniformly dense so as not to be displaced by traffic. Naturally this cannot be done by a wearing surface usually less than ½ in. thick on the average. Under very light traffic in small cities such treatments may go through a season without becoming an eyesore, but usually streets of that nature are not surface-treated simply because the demand of traffic does not warrant the expense. In any case, the attempted surface treatment of brick or block pavements, irrespective of how carefully the work may be done, generally leads to grief, and if attempted will subsequently bring up the same job either for reconstruction or resurfacing with sheet asphalt or asphaltic concrete in a relatively short time. The expense of the surface treatment is usually considered wasted or charged to "valuable experience."

SOME PROBLEMS IN CONCRETE CONSTRUCTION

By W. K. Hatt, Professor of Civil Engineering, Purdue University, Lafayette, Ind.

(Editor's Note: It was the purpose of Professor Hatt, in this paper before the Indiana Engineering Society, to review some of the present day problems in concrete construction. He discusses some of those features about which the views of engineers are either in conflict or the data are too few to allow agreement.)

In the year 1916 the results of deliberations of the Joint Committee (on Concrete and Reinforced Concrete of the several engineering societies were available in a so-called joint committee report. At the present time a new joint committee has been dealing not only with generalities, but drawing up specific recommendations, and even regulations, in such definite form that they may be used in the formation of specifications. This committee will probably report during the coming summer.

Materials of Concrete Construction.

Cement specifications have been pretty thoroughly standardized and recent advances have been in the direction of greater fineness. Aggregates are receiving close attention. The old time specifications, 1-2-4, 1-3-6, etc., are being revised in the light of scientific knowledge of the fundamental principles underlying the gradation of aggregates and the proportioning of concrete mixtures. During the past year there was a wide demand for aggregates which could not be met either because of transportation deficiencies or absence of available supplies. The use of local materials as they were found was forced upon the engineer. In Iowa, for instance, the mix was adjusted to the proportion of sand and pebbles in gravels as found in the pits.

The theory of proportioning concrete mixtures has been investigated very thoroughly by Professor Duff A. Abrams of the Structural Materials Laboratory of Lewis Institute, Chicago. Recent researches in connection with the work of the Hydro-Electric Commission of Ontario have also shed new light upon this question, which may be briefly reviewed:

I. *What Controls the Strength of Concrete?*

I suppose the best concrete will be most like a good natural stone, the particles near together and connected with the thinnest layer of a strong cement. How shall we bring this about? In the first place we must have clean, uncoated aggregates; and second, a strong cement; in the third place and very important, the cement paste of water and cement must be as strong as possible, not too dilute by the use of too much water.

II. *Water in Concrete.*

Water is needed for two services—first, to act chemically with the cement so that it will set; and second, it lubricates the aggregate and allows the contractor to put this more or less plastic mass in position. The secret of getting strong concrete with economical use of cement is to use as little water as possible for the particular job. I will to show later on that the character and grading of the aggregate may control the strength of the concrete through its effect upon the amount of water that must be used.

III. *Amount of Water Required.*

Of course different classes of jobs require different conditions of concrete with respect to its flowing properties. For instance, concrete which is to be put in narrow walls containing reinforcing steel must be quite fluid; a road concrete may be less fluid and concrete in a sidewalk, that is to be tamped, may be quite dry. Up to a certain limit the drier concrete will be the strongest, because the cement paste is less dilute. If all three jobs were to have the same strength we would have to use more cement or richer mix for the more fluid concretes.

IV. *Character of Aggregate.*

Now it may be asked if we can not avoid the excess water and the excess cement required to balance this excess water by some other means, say by changing the character and gradation of our aggregate. The answer brings us to consideration of the effect of grading of aggregates, which grading is generally specified by the engineer.

To introduce this topic let us take a well known case. Everybody knows that you can not produce a strong mortar or a good wearing top to a sidewalk by using a very fine sand, and that the strongest mortar is made with the coarse sand, having, that is to say, over 60 per cent of its volume in the coarser particles between the 1/8 and 1/4-in. sieve. Now the reason for this is that to obtain the same working qualities or consistency, the fine sand requires more water and if we use the same amount of cement we get a more dilute paste. We can not entirely make up for this by increasing the amount of cement because then the top of our sidewalk will not wear well. On the contrary with the coarse sand less water is required and there is a stronger cement paste.

The reason in turn that more water is required with the finer sand is that there is a greater sand surface to be wet and lubricated.

We are beginning to think that there is an element in the grading of sand and gravel connected with the surface areas, that must be covered, that controls the character of the concrete. Engineers design concrete sometimes by specifying that there shall be 3 lbs. of cement for every 100 sq. ft. of the surface of the aggregate. Now if the contractor supplies an aggregate that is too fine, that is one with greater surface, the engineer will increase the amount of cement and water to get the same strength and the same working consistency. All this, of course, is worked out by scientific experiments beforehand.

V. *The Grading of Aggregate.*

So that when we are thinking of sand and gravel we should think of the two together and a combination of the two, which will produce as small a surface area as is practicable. In other words, a fine sand below a 1/4-in., mix one part with two parts of pebbles, will not give as good a concrete as a coarse sand below a ¼-in. sieve, mixed one part to two parts pebbles.

This suggests the thought that the division between sand and gravel on the ¼-in. sieve is not the fundamental thing, and that we should think of our aggregate as a whole or combined sand and gravel.

Another thought may be introduced here, namely, that we need a certain amount of fine material in the concretes, otherwise they become harsh and unworkable and the concrete does not hold together on the job, but separates when it is being placed.

Production of Aggregates.

The aggregate industry has been divided into special interests, as crushed stone, sand and gravel, and slag. There is a tendency to combine these interests into one organization called the Mineral Aggregate Organization. Surely this would lead to the establishment of research which would settle some of these mooted questions.

The production of sand and gravel aggregates is of special interest to people in Indiana, where there is such an excellent quality of material. This industry industry has its own particular problems, some of which may be suggested.

1. Is it possible to produce a plant mixed aggregate, that is instead of shipping sand and pebbles separately, to ship the proper admixture of sand and pebbles to suit the sizes as found in the deposit? There would be certain advantages, as saving in the storage space, which is particularly valuable in large cities. Of course, the method of handling on the job must be such as to avoid a re-separation of the material.

2. The conservation of our sand and gravel material through intelligent use. Abrams has shown us that there may be quite a wide variation in the curve of sizings without substantial change in strength. We have found at Purdue University that as much as 15 per cent of the coarse sand may be allowed to pass over into the fine aggregate without changing the strength substantially. With a 15 per cent tolerance in the coarse aggregate below the ¼-in. sieve the production of cars per day would be increased up to 50 per cent in some cases and the waste of a large amount of valuable coarse sand would be prevented. Indeed some deposits may be divided into sand and gravel on the ⅛-in. screen and used 1-2-4.

3. The standardization of sizings and gradings of sands for various purposes, such as concrete sand, engine sand, plaster sand, sand for waterproof mixtures, for wearing surfaces, etc.

4. There is a tendency now to rule out gravel from, or require special protection in, fireproof structures on account of the supposed spalling qualities. This question demands further investigation.

5. The development of a proper test for hardness of gravels. At Purdue University a promising test has been developed, but it is too early to decide its usefulness.

Sieves should also be standardized. In our laboratory we use two sets of sieves, the so-called Tyler sieves, and the sieves specified by the United States Bureau of Roads. There is a third standard being urged by the United States Bureau of Standards. There, of course, should be only one scale of sieves to apply to specifications for grading of aggregates.

The question of the value of slag for an aggregate for concrete is still under discussion. It is agreed that this material may make an excellent aggregate, producing a hard, light and good wearing concrete, and that it is available where other suitable aggregates can not be found. The methods by which specifications can assure a chemically inert aggregate are not as yet determined.

In spite of the arguments of those who advocate the use of integral waterproofing mixtures, engineers and investigators are doubtful of their expediency. In fact the whole subject of waterproofing concrete is yet to be placed on a firm scientific basis. Methods formerly considered standard, as by the use of membranes, are being cast aside in the latest practice.

VI. Metal Reinforcement.

Standard specifications now permit both Billet steel and re-rolled rail steel. Some engineers are advocating strongly specifications for only one grade of reinforcing bars, namely, the intermediate grade rolled from open hearth Billet. Here it is again a question of the use of available supplies, and there is a danger of specifying an ideal product, which may not be available and which is unnecessarily high quality for the job in hand. The technical question of planing deformed bars to uniform sections for test is up for discussion.

We may say in general that the present movements are in the direction of changing ironclad and traditional specifications with more flexible provisions, whereby the producers and engineers are allowed to obtain the desired results by variation in the mix or aggregate. This must be so in the case of concrete where the available aggregates in the various parts of the United States should be used to the best advantage, saving transportation and other expense.

VII. *Consistency.*

Since it is realized that concrete should be mixed with as small amount of water as will yield the proper workability or mobility, it is important to devise some measure for this property. Professor Abrams devised the slump test in which a cylinder of fresh concrete was allowed to deform. The measure of consistency was the slump which ranged from ½ to 8 ins. for the various kinds of concrete. An improvement on this test was the substitution of a truncated cone for the cylinder. Still further improvement is the use of the Bureau of Standards' flow table. The truncated cone is placed on a circular table, which, through the medium of a crank shaft and cam, is lifted up and dropped ½-in. 15 times. The truncated cone gradually enlarges to a flatter mass. This later test is not so available for field use as it is for laboratory use, but it gives very nearly a straight relation between water-cement ratio and consistency. One improvement in control is to pre-wet aggregates in the stock pile.

VIII. *Mixing of Concrete.*

After all scientific research has fixed the proportion of mixture and the qualities of the materials, the concrete must be mixed and mainly in a batch mixer. The action of the mixer involves, first the hydration of the cement and the thorough mixing together of the greatest consistency in the concrete. Different mixers are designed to bring about different sequences of movements in the drum. Some have a sort of churning action in which the material moves outward and inward through the shape of the drum or by the action of deflecting blades. In other types material is lifted up by buckets and dropped, sometimes returning by the action of a chute to the inlet of the drum.

Specifications will define the minimum time of mixing from 2 minutes to 1 minute.

Recent improvements in mixers provide a device for measuring the amount of water in the batch and limiting this amount, and also providing a locking device, which prevents the operator from discharging the batch until the minimum time has elapsed.

The most thorough researches point to the fact that with improved mixers there is very little increase in the quality of the concrete after 1 minute of mixing. In large jobs concrete is mixed at central plants and transported several miles in trucks to the place of deposit. The method of handling such concrete and the consistency, etc., are yet to be determined.

The practice of chuting or spouting concrete from towers for long distances is common. Such concrete is likely to be too fluid and tests of such chuted concrete have shown strength of about 1,000 lbs. per sq. in., whereas the engineer expects 2,000 lbs. per sq. in. Certainly the angle of the spout should be such as to allow the concrete to flow without a separation of the ingredients, and this should limit the angle of the spout with the horizontal. This subject also needs investigation.

IX. *Methods of Depositing Concrete in Cold Weather.*

It is now a common practice to construct concrete buildings without regard to exterior temperatures, but the danger is in the use of too fluid a concrete, mixed with either an aggregate or water that is too hot, resulting in the shrinkage cracks and poor concrete. An accepted method is to heat the aggregate by allowing live steam to come out of a perforated pipe. Merely throwing the aggregate on the sheet metal under which a fire is maintained is defective practice. Sometimes a gasoline torch is turned into the concrete mixer.

Probably the latest improvement in mixing and placing concrete consists in holding the consistency and the amount of water to a minimum. Around New York, where contractors used to feel it necessary to put in sloppy concrete, they have been taught by engineers to put successfully concrete with ½-in. slump. Thorough mixing and depositing with adequate slicing and working results in a solid concrete of high strength.

The action of sea water on concrete is a subject of controversy and we must wait for the final word on this subject. Structures in sea water seem to be unaffected when the concrete is dense and the outside skin of the carbonated cement is kept intact. Where abrasion through ice and floating objects wear away this skin the sea water certainly does eat into the concrete. In many situations designers, therefore, protect the concrete between tidal levels by some protecting stone or other material.

X. *Expansion Joints.*

Just when expansion joints must be placed in long buildings is a subject of debate. The shape of the building enters into this question. A long narrow building would require expansion joints, where a square building of the same length will not. Structures exceeding 200 ft. in length and of a width less than about one-half of the length should, no doubt, have expansion joints not over 200 ft. apart to minimize the effects of temperature changes and shrinkage.

XI. *Fireproofing.*

There is probably no material which is not damaged to some extent by severe fires, and, realizing this, the regulations for fireproofing buildings are becoming more strict. The difference of requirement is made according to the character of the aggregate. Where the mortar and the coarse aggregate have different expansion coefficients some other protection, such as plaster on a metal mesh is specified.

XII. *Investigations.*

The most fruitful investigations have been those coming from the Structural Materials Laboratory of the Portland Cement Association, conducted in cooperation with the Lewis Institute, under direction of Professor Duff A. Abrams. The bulletins from this laboratory must be read by all those who wish to be informed of the latest knowledge on proportioning concrete and the effect of various elements upon its strength.

Investigations, which should be continued, include: The control of the spouting process so as to assure good concrete; the possibilities of central mixing plants; the use of hydrated lime and other powdered admixtures; continuation of the investigation of sizings of aggregates; development of field tests and convenient and cheap molds for specimens; the technical merits of various grades of reinforcing steel; the use of salt water in concrete of various grades; the strength of a concrete which may be reasonably expected in construction, a standard field method for determining consistency of concrete, investigations to prove the efficiency of concrete mixers.

The whole question of design of concrete road surfaces in respect to the varying values of the soil, the effects of loading, of impact, etc., is a field that has been worked upon but very little.

Some investigations should also be made of the design of a deformed bar, and specifications arranged to define those bars which are of sound design and of practical manufacture.

XIII. *Design.*

One of the mooted questions is the portion of bending moment which should be figured in columns. This is arrived at largely by theoretical considerations, and should result in the specification of the per cent of bending moment in the floors transmitting to the interior next to the columns. At present the specifications are vague.

The working stresses on reinforced concrete columns allowed by the New York building laws are much in excess of those permitted by the old Joint Committee report. This partly arises from the limitations in the old Joint Committee report of the amount of spiral steel that is counted upon as contributing to the strength of the columns. There is a tendency to increase to 2 per cent the amount of spiral reinforcement that is figured as contributing to the calculated strength of the column. A total of 6 per cent in the lateral and longitudinal reinforcement is sometimes used. The amount of stress to be figured in this lateral reinforcement and the quality are matters of discussion.

A subject of practical as well as theoretical interest is the implications on column design of the well known property of plasticity exhibited in concrete. That is to say concrete, under working loads, deforms slowly without increase of stress. This necessarily relieves the stress in concrete and increases the stress in the steel. The same condition will, of course, hold for slabs and beams. The logical treatment of this condition is wanting.

The increase in bond stresses, where steel is bent over or hooked at the ends is also to be considered.

Experiences of the United States Shipping Board and the tests in various laboratories lead many designers to recommend largely increased shearing stresses in properly reinforced concrete beams.

All of these matters, which are based upon laboratory experiments, have been, in the past, judged upon a very conservative basis. Specifications rest upon the state of the art and must provide for poor inspection and faulty manufacture.

Recent tests of concrete cylinders bored out in the shape of cores from constructions show a strength in concrete much larger than we had expected, up to 6,000 lbs. per sq. in. On the other hand other specimens on other jobs are low in strength. It is probable that laboratory tests are some where between poorly made concrete and the best field manufactured concrete.

Our regulations and building laws should certainly recognize the progress of the art, but in the interests of safety we should not go beyond the point where the necessary control is to be provided in construction. While concrete of 6,000 lbs. strength can be found in concrete roads, concrete of only 900 lbs. strength has been found in some spouted jobs. The engineer expects 2,000 lbs. The best construction companies would, no doubt, supply a better grade.

SPECIFIC DUTIES OF THE HIGHWAY ENGINEER AND CONTRACTOR

By W. A. Rogers, President Bates & Rogers Construction Co., Civil Engineers and Contractors, 37 W. Van Buren St., Chicago.

(Editor's Note: This very fair and thoughtful summary of the chief duties and responsibilities of the highway engineer and of the highway contractor is from a paper by Mr. Rogers before the American Road Builders' Association. It deserves close attention.)

The Engineer's Job.

Theoretically the engineer is the representative of the contractor as well as of the State, for the contract generally names the engineer the sole, unbiased arbitrator between the parties of the contract, with power to decide finally many matters arising under the contract. This places the responsibility on the engineer of deciding what is right and fair in matters at issue between the parties to the contract, and also the responsibility of interpreting the terms of the contract and specifications, which he or some other engineer has prepared.

Definite Specifications.

In preparation of the plans and specifications a long step towards harmonious and satisfactory relations will be made if the engineer has clearly in mind the structure to be built and describes it clearly and definitely in the specifications, leaving out all terms like "the work shall be done to the satisfaction of the engineer, etc." The contractor is entitled to have described in the specifications just what is wanted and can be followed. In a word, they should be reasonable. Incorporating in specifications, clauses which are practically impossible of fulfillment with the thought that better work will be secured by fixing up almost impossible standards is less apt to secure this result than if the specifications provide for what is reasonably possible of fulfillment.

It has been said that drastic specifications have sometimes been made for highway work with the laudable purpose of scaring away unsatisfactory and irresponsible contractors and putting into the hands of the engineer requirements which could be used to advantage in the case of irresponsible contractors, and on the other hand, could be eased up for those contractors who were doing satisfactory work. This is entirely wrong. It has just the opposite effect. When a specification is drawn, which in any respect is not workable, it casts a cloud on the entire document and the responsible contractor feels as though he were being placed in a position where an irresponsible inspector or engineer might cause him serious trouble and expense. It is, therefore, in the interest of the State and the duty of the engineer to prepare workable specifications, which can be carried out with the materials reasonably available and with the human labor which we have.

The highways of the country are not built under laboratory conditions and specifications and plans for highway work, which are prepared with the idea the subgrade can be sandpapered and the materials and water entering into the concrete can be measured as in a laboratory are not productive of the best work, but are productive of friction between the engineers and contractors and expense to both parties to the contract.

Should State Furnish Materials?

Contracts and specifications should be very definite and clear in the placing of responsibilities. In this connection I have a strong feeling that the furnishing of materials by the State is both wrong in principle and not productive of the best results, either as to harmony between the parties or as to decreased cost. It injects into the work a question of divided responsibility. It makes the State responsible for something which is part of the construction and on which the progress and economical operation of the work is vitally dependent. If the materials are not delivered in the order and at the rate which the work requires it adds to the cost, and the engineer who is not paying the bills can hardly appreciate this as does the contractor who is.

I know there is a feeling that the State can frequently buy materials more cheaply than the contractor, and that it is able to allocate a restricted supply better than the individual contractors buying at random can do. This may be so, but I have a feeling that the competent contractor can ordinarily buy as close or closer, and he can surely control the delivery more nearly as the work requires than the State. At least he thinks he can, and that goes a long way toward making for harmonious relationship.

If, however, the engineer does specify that the State shall furnish any of the materials, then the State should assume the full responsibility for delivery. If the State fails to deliver its materials as required by the work, thus adding to the cost of the work to the contractor, then in the interest of fairness and satisfactory relationship they should assume the responsibility for such failure. Placing on the contractor a risk over which he has no control is just adding another "gamble" to a game which is hazardous fications should be so drawn that they enough without it. Contracts and speciare as free as possible from risks of this kind, in the interests of both parties.

Proper Supervision.

Supervision of the work is another duty of the engineer. This is a great responsibility and should be delegated in the field only to men of good judgment and experience. Inexperienced, incompetent field supervision causes delay to both the State and contractor and increases expense at the time to the contractor and eventually to the State.

Bear in mind that the data on which a contractor of experience bases his price which he bids on any job is the cost of previous work of similar character interpreted in the light of the conditions of the work on which he is figuring. In his previous costs are reflected the cost of not only every onerous clause in the specifications, but also the results of unfair and incompetent engineering supervision. It is, therefore, necessary and desirable that engineers in charge of highway work should be thoroughly competent. Competent engineers are entitled to compensation proportionate to their skill and experience. It is mistaken economy to save on highway engineers, salaries. Well paid, experienced engineers are conducive to the best and most economical highway work.

There is no class of contract work which requires for its satisfactory handling, such continuous operation. In order to be profitable there must be a constant uniform flow of materials from the point of manufacture or origin through the railroads to the unloading plant and then from the unloading plant to the mixer. Anything which tends to vary this uniform flow, adds to the expense of the work. The engineer, who, without proper cause, stops the work, robs the contractor just as much as the highway man who holds a pistol to your head and causes you to deliver your money. But an experienced, competent engineer will not do this.

A Spirit of Accommodation.

The highway engineer should be a very broad man. He should have in mind that his job is to get as much highway built of the quality desired as can be built and at as low a cost as possible to the contractor. Materials, especially sand, gravel and broken stone, are products of nature. They are not built in a factory to a certain standard. They may be graded by human care, but there is bound to be a certain variation. It seems to me it is the duty of the engineer to conform as closely to the specifications as possible, but bearing in mind always the final result, that his job is to get roads built of a good quality, and that if, by slight variation in requirements of qualities of material, the same result can be obtained, he should be big enough and broad enough to meet the situation. He will realize that nature does not form the sand and gravel to fit an exact laboratory standard and that it may be necessary at times to conform to what may be reasonably obtained. This means that he will use his broad judgment and good sense in the acceptance and rejection of materials.

Similarly with inspection of the work, it is sometimes the tendency of the younger engineers to forget that it is the final result which counts and concentrate on the minor details. In other words, compliance with the specifications literally is made the important item, losing sight of the fact that what is desired is the completed highway of a satisfactory quality. Variations in the construction methods or materials which give the desired finished highway will be permitted by the seasoned engineer.

Fair and Quick Decisions.

It should be one of the duties of the engineer to make fair, quick and responsible decisions. Delayed decisions are often as unfortunate as wrong decisions. By responsible decisions I mean that the State, acting through the engineer, should be responsible for his acts as the contractor is for his. The contractor pays for his errors directly, in increased costs. If through error or othewise the State causes the contractor's work to cost more than it should, they should assume their fair responsibility financially.

Finally, decisions should be made without reference to whether they will please either the contractor or the public. In work for the public like highway work or government work it may sometimes be a temptation to consider whether a decision will meet with favor of the public or not and thus have a bearing on tenure of office. The position of the highway engineer should be made free from influence of this character. And let me repeat "The engineer should always bear in mind that he is in the dual position of representing both the State and the contractor."

The Contractor's Job.

As I now turn to the description of what the successful highway contractor must do I wonder that any contractor can ever qualify. The contractor for highway work undertakes to determine the best source of supply for materials which will meet the requirements of the specifications. He undertakes to see that the producers of these materials furnish them promptly and deliver them in the required amounts at stated times necessary for the work, to the railroad for transportation to the station nearest the work. He undertakes also to see that the railroad does deliver the material promptly to his unloading point. If either of these agencies fails to do its part it costs him money and time. After delivery to his unloading point, he then must unload, store, protect and then transport these materials to the site where they are to be incorporated in the finished road.

In addition he has contracted to employ a competent force, working under the direction of a competent superintendent, with the right sort of an organization. In the case of the contractor, errors in his judgment or of any of his organization, or lack of skill or ability are paid for in real money which shows up in increased cost.

He has also contracted to furnish an adequate and properly equipped plant for the proper handling of the work. Each job should be studied carefully and planted properly. Whether the delivery of materials shall be by truck or by industrial plant should be settled. The method adopted for unloading and storing materials is a very large and important item and the success or failure of the work is dependent, to a large degree, on the plant and equipment adopted. He must provide an adequate and satisfactory supply of water. Then he must co-ordinate all of the different elements, consisting of materials, water supply and an efficient crew to build the finished highway on a subgrade, finished to an exact surface. He must then see that it is properly protected and properly cured. As though this were not enough he must act as a policeman and see that the public, who are eager to use the new road, and can see no reason why they can not, are restrained from so doing. Sometimes when I think what the ordinary highway contractor undertakes to do, I wonder at his assumption of almost supernatural powers when he signs his contract and assumes the duty of furnishing the State a satisfactorily completed job, meeting all of the clauses in the specifications as near as is humanly possible.

Honesty Essential to Success.

Above all the contractor's organization should be made up of men who are willing to meet the engineers half way and who take a pride in the quality of their work, and who are anxious to give the State an honest job. Only in this way can the highway contractor be successful. If the engineers and contractors conform to the foregoing there will be co-operation between them. There will be a realization that they are partners in a great enterprise and that the best results can only be obtained by pulling together.

As a futherance of this spirit of co-operation the formation of organizations of highway contractors, both locally and nationally, should be encouraged. In this way may be obtained responsible bodies to whom similar organizations of highway officials and engineers may turn for assistance in obtaining the viewpoint of the man who builds the highways. The meeting of committees of the contractors' organizations with similar committees of the highway engineers will tend to free the contracts and specifications from clauses which are productive of ill feeling and increased cost, without adequate return in better quality.

Co-operation Between Engineers and Contractors.

This very thing is being done with advantage to both parties in other lines of construction work. Committees of the Associated General Contractors of America are meeting with committees of architects and engineers to "thrash" out questions of contracts and specifications and conditions of work, with the certain final result that mutually satisfactory contracts and specifications always result in a lower price to the owner and more satisfactory profit to the contractor.

In some states conferences have been held already between highway officials and engineers and contractors' committees, with the object of making the contracts more workable and with excellent results. I feel that this ought to be done in every state. I also feel, through such meetings between the national bodies, a standard form of highway contract should be formulated to be varied from according to local conditions. With such a standard form of contract, which is absolutely fair to both parties, we will get the most good roads built with the least money spent by the public.

SOLVING THE HIGHWAY BRIDGE PROBLEM IN NEW JERSEY

By Charles A. Mead, Bridge Engineer, New Jersey State Highway Commission, 790 Broad St., Newark, N. J.

(Editor's Note:—Because of highway transportation across New Jersey, particularly between the cities of Philadelphia and New York, the highway bridge problem in that State is such that structures of the best type must now be built. Mr. Mead here describes the present bridge engineering practice in New Jersey in a paper presented at the 1921 meeting of the New Jersey Association of County Engineers.)

It is the intention of this paper to dwell on some of the salient features in the design of bridges for New Jersey highways and the reasons for the construction adopted, in the hope that there may be produced structures of greater uniformity, adequate to meet all demands of traffic for years to come.

The State owns at present 704.2 miles of highways on which exist 568 bridges of over 5 ft. span. They comprise timber, masonry and metal structures of various kinds, lacking in uniformity of specification and condition, but all of which are called upon to support the traffic which the development of the internal combustion engine has thrust upon them.

80 Per Cent. of the Bridges Are Obsolete

It is not the intention of this paper to criticise the design of a generation ago, when a farm wagon or a load of hay was considered a heavy load. That bridges which were well designed for the loading of a by-gone day still give service shows in a measure what may be expected of those now building, for a well-designed bridge will carry a large percentage of occasional overload without distress. To-day, however, 80 per cent. of the existing bridges in this State are incapable of meeting the demands of modern traffic.

When the State assumed control of the highway system last year several very important bridges were on the verge of failure, two of the more recently constructed ones had actually collapsed, and others needed immediate attention in various ways to keep them in service until major repairs or rebuilding could be reached. This repair work has proceeded along with the preparation of plans for the new structures designed for modern loading.

The Loading Adopted

After a careful study of the various truck loadings actually in service and the tendencies of the times, both from a military and commercial point of view, a loading was adopted, commonly referred to as a 20-ton truck, which would produce bridges adequate for the demands of modern traffic and provide for such increases as are sure to come. The loading, therefore, is not so much a typical truck as a live loading which will produce serviceable bridges.

The geographical location of New Jersey between the two great commonwealths of New York and Pennsylvania makes it imperative that her structures shall be of the best.

Restrictive legislation, to be permanent, must be in accord with the demands of commerce. Growth far beyond the vision of traffic experts in every other mode of transportation has been experienced and highways will prove no exception to the rule.

The number of miles of road per bridge varies considerably, from one-half on Route 16 to 8 1/10 on Route 14. By far the greater number are located in the north. Roughly, 60 per cent. lie in the northern part, 29 per cent. in the central, and but 11 per cent. in the southern part of the State.

In the northern part of the State the deeper cut streams which have found their ultimate bed have more definitely fixed profiles, which give less latitude for span length and skew than in the southern part, where these conditions are reversed. Destructive floods are consequently more frequent in the northern parts.

Waterway Areas

It is to be regretted that no adequate

financial provision has been made in New Jersey for a comprehensive system of stream gaging, the data obtained from which through a period of years would be increasingly valuable and useful in many ways for economic development of the State.

Each bridge site receives study to determine the proper area of waterway. Existing openings are noted, shape and size of drainage areas determined, and estimates are made of rainfall and run-off. These data are checked by the Talbot formula and the desired area of waterway determined. This procedure is facilitated by the existence of a complete and accurate topographic map of the State which eliminates much survey work and greatly reduces the cost of preliminary investigation. Sub-soil conditions are studied at pier and abutment locations and foundations designed in accordance with the findings.

Conditions Governing Types

Deck bridges being the most economical in first cost and maintenance, are to be preferred wherever the conditions are favorable. Long spans and low headroom often compel the use of through or half-through bridges. Of these the most economical is the plate girder. Beyond the limits for plate girders the more elaborate lattice girder must be used, giving preference in all cases to riveted over pin connections because of the greater rigidity possible. For spans up to 20 ft. reinforced concrete slabs are to be preferred. Encased I-beams may be used up to 30 ft. Beyond that, built-up sections must be resorted to. Transportation limitations must be considered as a material factor in design.

Concrete being a durable structural material of low cost and diversified application, finds almost universal use in the modern bridge. Used in mass work for substructure and in combination with reinforcing steel for superstructure parts subject to transverse bending it forms an ideal material for permanent structures. Even though its properties are so universally known and appreciated it requires careful and honest workmanship and good design to produce enduring results. Walls may be either of gravity monolithic or reinforced slab types. The resultant line of pressure should be carefully determined so that toe pressures will not exceed the maximum allowable or movement perhaps fatal to the structure will result. They should be self sustaining under all conditions of loading and have adequate provision for expansion.

Foundations

Their footings should be set at a depth which will insure them against damage from frost or scour. In streams which have found their ultimate bed from 4 to 6 ft. below the stream bottom will be sufficient. In material incapable of supporting the required loads without unduly spreading the footings some other means must be used to carry the loads to a substratum which will provide adequate supporting power. For moderate depths with fairly compact intermediate strata so confined as to remain undisturbed, piles of wood or other material will be found most suitable. Wooden piles will usually be found most economical provided they can be cut off below low water line. For deeper foundations of major importance it will be necesary to use the more expensive but reliable open coffer-dam or pneumatic caison types. Happily the necessity for these more expensive substructures exists at few locations.

Drainage and Culverts

Proper attention should always be given to drainage. With weep holes provided in walls and the entrances to these holes properly guarded by rip-rap or French drains the back pressure from hydraulic heads will be reduced so that the theory of earth pressure will be realized.

Cast iron or reinforced concrete pipe of proper design and having proper headwalls will usually be found economical for openings of less than 40 sq. ft. For larger areas culverts should be used. They may be single or multiple monolithic arches or reinforced concrete slabs. If boxes of reinforced concrete are used the bottom slab should have the same care in the arrangement of reinforcing material as any other part of the structure for the load carried is equal to that on the top slab.

Waterproofing

Owing to the difficulty of making concrete entirely watertight and as water is almost a universal solvent, it is of the utmost importance that the entrance of water to any part of a structure be prevented. This is especially true of parts not accessible to inspection. Paint on metal work is effective on parts exposed to air which aids in the rapid removal of moisture. Structures should be so designed that all possible parts can be readily inspected. In the case of inaccessible parts, such as embedded steel, if reached by moisture, changes will occur and may progress with surprising rapidity especially if electrolytic action is present. Where there is no actual leaking, the presence of water will be indicated by surface staining, indications of leaching and spalling most strongly marked at joints or pour lines. The formation of rust scale on imperfectly embedded steel sets up great pressures, recorded as high as 4,700 lbs. per sq. in., which will destroy the bond and eventually menace the safety of the structure. Water should therefore be conducted away from the bridge as rapidly as possible by providing drainage grades in every part. Inaccessible parts should be protected by waterproofing which is cheap insurance. With waterproofing cost at 2% of the cost of the structure and money at 4% it is evident that if waterproofing prolongs the life of the bridge 6 months it pays to do it.

Floors

In regard to the construction of floors—because of under-clearances and reduction of dead load, it is generally desirable to produce the thinnest floor consistent with good design. This can be accomplished by carrying the live load directly on the floor slab after providing a small extra thickness of concrete cast integrally with the slab for wearing surface. Otherwise to protect the slab from wear, the entire surface may be covered with some bituminous compound applied in a plastic condition or with paving blocks of wood or other material. The latter making a slightly thicker floor than the former.

The width adopted is 30 ft. between curbs for all new bridges and sidewalks and to be provided where required.

The distribution of local concentrations on slabs is a subject which is being intensively studied from meager data resulting from destructive tests. The tendency is slightly to reduce the slab thickness from the old assumptions of distribution wherein the load was distributed at 45 degrees in each direction to the plane of reinforcement, resulting in a somewhat lighter and cheaper bridge. Further tests are however needed in order fully to cover this subject.

Where floor thickness is not a material factor, conditions more nearly approaching ideal may be realized in small spans by locating the slab low enough to permit the road construction to be carried continuously over the bridge. In any case the road paving on the bridge should extend continuously from curb to curb.

Slab floor bridges of short spans on solid supports will usually be found stiff enough to provide for lateral, longitudinal and centrifugal forces. The necessity for adequate bracing in all directions should never be lost sight of to the end that the resulting structure be rigid under all conditions. Unless a bridge can be used as unrestrictedly as the highway it connects, it is not an adequate bridge.

Bridge Railings

Bridge railings to afford necessary protection should be designed capable of withstanding the impact from unmanageable vehicles of the weights specified. A monolithic concrete railing well reinforced will be found adequate. Such a railing is not an extravagance as it can be produced at a cost about equal to a heavy galvanized pipe railing and is vastly superior to it in strength, endurance and appearance. It is the practice to mold the State's name, Route number and year of erection in these railings.

The only impression gained of a bridge by the traveling public is that attained by the appearance of the railings. These should leave in their minds the pleasant sensations of safety and harmony.

Aesthetics

There seems to be a widespread notion that arches are beautiful. Some are. Being predicated on immovable abutments they should never be used in flat marshy country where there is the slightest question of security concerning the founding material. Simple spans giving vertical reactions can be made attractive in appearance and when they are in harmony with their surroundings and express a structural necessity they are pleasing.

Good design requires an arrangement or grouping of parts so that the eye is led to consider the structure as a whole rather than an accumulation of unrelated pieces which lack interest because of their incongruity. It need not cost any more to produce structures which are pleasing to the eye than those which are displeasing. The matter of aesthetics is therefore of great importance.

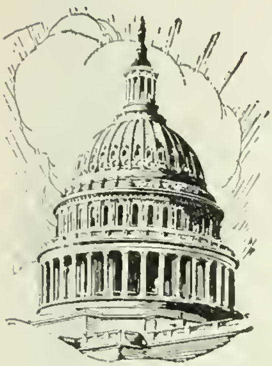
Viaducts being simply a succession of connected simple structures are subject to the same laws as simple spans. Especial attention should be given to their supports providing the rigid bracing and anchorage required.

Movable spans are often required over navigable streams. Their design should follow the principles herein outlined, the particular type being selected for its fitness in the location.

Limitations of Standardization

Questions are often asked concerning bridge standards and requests are frequently made for them. This work can easily be over systematized. It is possible to standardize certain structural parts of

President Harding *Urges* Road Maintenance. *He says—*



"I KNOW of nothing more shocking than the millions of public funds wasted in improved highways, wasted because there is no policy of maintenance. The neglect is not universal, but it is very near it. There is nothing the Congress can do more effectively to end this shocking waste than condition all Federal Aid on provisions for maintenance. Highways, no matter how generous the outlay for construction, cannot be maintained without patrol and constant repairs."

EXTRACT FROM FIRST MESSAGE
TO CONGRESS, WASHINGTON, D. C.
APRIL 12, 1921

Road patrol maintenance crew patching improved road with "Tarvia-KP"

Tarvia

For Road Construction Maintenance and Repair

New York, Detroit, Salt Lake City, Johnstown, Elizabeth, Chicago, New Orleans, Seattle, Lebanon, Buffalo, Philadelphia, Birmingham, Peoria, Youngstown, Baltimore, Boston, Kansas City, Atlanta, Toledo, Omaha

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bridge such as decks, abutments, walls, floors and railings and this has been done. It is not practical to standardize the assembly of those parts because it is very rare to find two physiographic locations where exactly the same structure will fit —hence the term "standard" as applied to complete bridges is a misnomer.

Wooden bridges or trestles may be proper in some locations notwithstanding their inflammability. With timber properly treated to resist decay and the destructive attack of the various marine borers, a properly designed structure with good maintenance will give upwards of 15 years' service. These must in any event be regarded as structures of expediency, having a temporary nature, to be replaced with more permanent ones as occasion demands. Timber structures with their necessarily weak joints must have especial attention given to bracing.

Questions of economics and expediency so largely enter into this subject that only the most general principles can be stated. All things considered, that bridge which is best for a given location is the one which will provide safe and adequate service at the lowest cost and be in harmony with its surroundings. Such bridges we are endeavoring to construct.

FEATURES OF ANNUAL ASPHALT CONVENTION

The second annual convention of The Asphalt Association was held at the Association headquarters in New York, April 13.

The annual address of the president, Joseph R. Draney, of the United States Asphalt Refining Co., New York, developed the need of many men for work during the highway construction period now opening. Mr. Draney reported that the asphalt industry, on the whole and despite present conditions, is in a sound condition with prospects for the production of enough oil to assure an adequate supply of asphalt for years to come.

Work for One Million Men

President Draney predicted that, unless reactionary pessimism grips the nation, 700,000 men wil be needed in the building of the 35,000 miles of new highways contemplated this year under the billion dollar road program outlined by the Federal government and the states and counties. Three hundred thousand more men, he said, will be needed in the quarries, gravel-pits, cement, brick and asphalt plants and factories devoted to the manufacture of road machinery. The road-building boom, he thought, will work great benefit to the railroads by bringing into service 100,000 idle freight cars to transport 100,000,000 tons of road materials.

"To set a great army of 1,000,000 men, now for the most part unemployed," said President Draney, "at building highways is to solve in part not only the acute unemployment problem facing the nation but also part of the rail troubles. Furthermore, money in plentiful quantities would be released for local circulation through wages to local labor and in payments to local producers of stone, gravel, sand and other materials, thus easing the pressure brought about by the reductions in the price and demand for agricultural products. Stimulation in the production of trucks, machinery and raw materials, and in engineering, and the employment of labor can positively be accomplished with an untrammeled road-building program. At the same time we would be reducing the dangers to travel by abolishing railroad grade crossings, more adequately bridging rivers and smaller streams, putting the outlying districts closer to medical and hospital aid and would bring the farmer and his market in closer touch."

Resolutions Adopted

1. Urging Congress to pass the Federal aid appropriation of $100,000,000, thus assuring a continuance of road-building under the supervision of skilled state and federal engineers.

2. Urging that highway management be divorced from politics and all materials and methods entering into highway construction be placed in open competition.

3. Declaring that every highway be required to show traffic justification for its construction, thus guarding against waste and extravagance.

4. Memorializing Congress to authorize the United States to join the Permanent International Association of Road Congresses made up of the highway departments of all nations.

5. Urging the Interstate Commerce Commission to authorize a reduction in freight rates for road materials, thus stimulating the road-building program.

6. Recommending that public officials carry forward road-building programs to the extent permitted by appropriations available, thus giving employment to many hundred thousand men now out of work and utilizing tens of thousands of idle open ton freight cars.

WATER WORKS SECTION

CAPACITY CHARACTERISTICS OF A DEEP WELL

By Lawrence W. Cox, Consulting Engineer, 1102 York St., Des Moines, Iowa

Due to their limited financial resources, a large portion of the towns in the State of Iowa, particularly the southern part of the State, find it difficult to secure sufficient water for public supplies. Hence it becomes essential to make the best use possible of such supplies as can be secured. Assuming that the supply of water is usable but scanty (which is the ordinary case), a careful determination of the capacity of the well with the corresponding depression of the water level in it, should be made. Then the supply may be well utilized by the installation of suitable pumping equipment.

Apparatus for Determining Depth to Water Surface in Drilled Well

During pumping tests the action of open dug wells can be easily watched, but with drilled wells the condition is very different. For the purpose of more carefully watching the action of drilled wells during pumping tests, the writer in 1915 developed an apparatus for the purpose of determining the depth to the surface of the water in the well at any time. This apparatus consists of a ½-in. galvanized iron pipe about 18-in. long, with a wood float inside. This pipe is suspended between the drop pipe of the pump and the well casing by means of two insulated wires, such as ordinary drop cords for use in wiring houses. Contact points are so arranged that when the pipe enters the water and the wood float lifts to its upper position, the two wires are brought into contact with each other. There are several ways by which this contact may be made, but the writer has found the method shown on the accompanying figure to be the easiest made and the most reliable. Another method would be to bring each wire to a separate light spring, across the top of the pipe. Then when the float lifts, it could push the springs together and thereby make contact. For current, from two to four ordinary dry cells are used. To assist in reading the depth to water, graduation marks are made upon the suspending wires. If these graduations are placed every 10 ft. the intermediate distances can be measured by a steel tape or by a foot rule.

The suspending wire is reeled on a spool, each wire being attached to a separate circular contact at the end of the spool. The spool is placed in a box which carries two corresponding contacts, so that as the wire is reeled either in or out, contact is continuously made with the batteries and lamp, which are placed in the box behind the reel of wire. An electric bell or buzzer can be substituted for the lamp, but the writer has found the lamp the more satisfactory.

The transmitter (½-in. pipe, with its float, etc.) as now made, and as shown on the accompanying figure, has a maximum outside diameter of 1⅛ ins., but this dimension can be cut down to ⅞ in. if necessary. The present apparatus has been used in a well with not more than 2½ ins. clear space between the pump pipe and the well casing and to depths of 260 ft.

Test of Well at Prairie City, Iowa

The application of the use of this apparatus to well tests and the results obtainable by careful well tests may be illustrated in the test of a well at Prairie City, Iowa. This well was tested in the fall of 1917. It had been in use for a good many years by the city. In fact, the city had worn out one set of pumping equipment with it, while pumping water at the rate of 16 G.P.M. As the city wanted to purchase new pumping equipment with greater capacity, if the well could supply sufficient water, a test was made.

The well was cased to a depth of 97 ft. with 12-in. pipe, and from this point to a depth of 343 ft., with 10-in. pipe. Below this point the hole was in limestone and not cased, extending to 500 ft. When not pumping the water level in the well stood at 110 ft. below ground surface or 13 ft. below the lap of the 12-in. and 10-in. casing. Hence no appreciable quantity of water could be expected to enter the well above the bottom of the 10-in. casing or 343 ft. from the surface.

For the purpose of testing, a double-acting cylinder was purchased and placed on the drop pipe which was already in the well. The old pump and engine were used in making the test runs.

Each test was made at a uniform rate of pumping and in each case the rate of pumping was carefully determined by frequent measurements of the water actually delivered.

The first test was at a rate of 32 G.P.M. and lasted 8 hours 30 minutes. Frequent measurements to the water level in the well indicated that at this time it was remaining substantially constant. Hence there was no object in continuing the test longer. Without the use of the apparatus described, we would have had no knowledge of the depth to water in the well, other than that it had not been pumped dry.

The second test was made at a rate of 44.6 G.P.M. After 25 minutes the water was lowered to the bottom of the pump pipe, when the rate of pumping dropped off to 37 G.P.M., no doubt closely indicating the capacity of the well with the water depressed to this point—that is, to 260 ft. from the surface.

The third test was made at a rate of 38.5 G.P.M. After a period of 1 hour 5 minutes, the pump broke down and the test was necessarily discontinued. Nevertheless the measurements taken indicated a curve having the same general form as that of test No. 1, and after a period of 2 hours and 30 minutes would no doubt have lowered the water to the bottom of the pump pipe.

The fourth test was made at a rate of 35 G.P.M. After a run of 50 minutes the pump again broke down, but the curve during this test was similar to and intermediate between those of tests 1 and 3.

Interpretation of Test Data

The accompanying figure shows the curves representing these various tests,

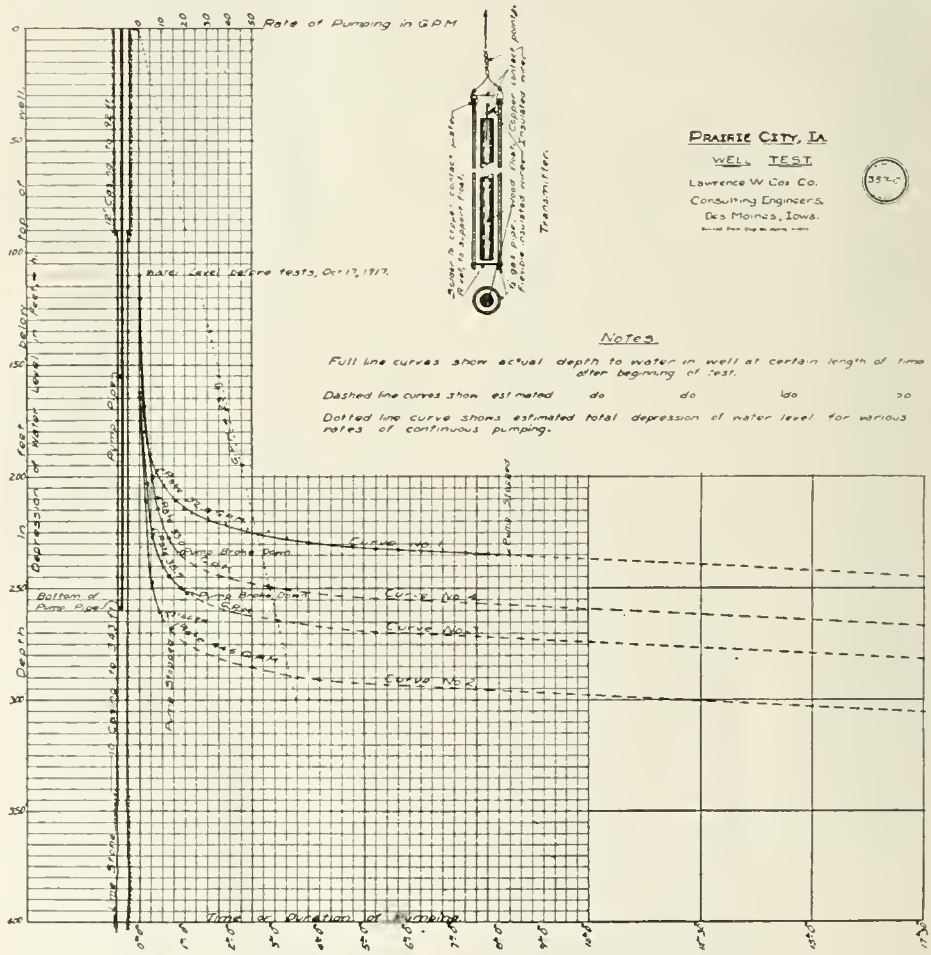


DIAGRAM SHOWING RESULTS OF WELL TEST AT PRAIRIE CITY, IOWA.

together with the plotted points indicating the readings taken. The first impression will probably be that the curves for tests Nos. 2, 3 and 4 have been extended far beyond the limits justified by such short time tests. Further examination, however, furnishes the following reasons for believing the curves to be substantially correct and within safe limits—that is, that the well will furnish as much or more water than indicated by them. It is probable that after a period of 8 to 9 hours, each of the curves should be horizontal instead of having the small slope shown.

1. The supply of water must enter the well below the bottom of the 10-in. casing, or below a depth of 343 ft. from the surface, or at least 233 ft. below the normal height to which the water stands in the well. Hence it is reasonable to assume that the nearer the water in the well is depressed to the bottom of the casing, the greater will be the rate of yield.

2. By actual measurements on the curve sheet, it is found that the vertical distance between any one of the curves 1, 2 and 3 and that of curve No. 1 (so far as readings were actually taken) is almost constant. Hence it seems logical to extend them at these uniform distances from curve No. 1.

3. The test represented by curve No. 4 drew the water to the bottom of the pump pipe, and, with the water held at this level, the well continued to supply 37 G.P.M. This must very nearly represent the capacity of the well with the water depressed to this point. Curve No. 4 represents a depression of the water level to this point after about 10 hours' pumping. But at this point the curve is very nearly horizontal. Hence this condition checks curve No. 4 within 2 G.P.M. or within 5 or 6 per cent.

4. It is evident that if any appreciable amount of water is drawn from the well, the water level will be depressed somewhat. Hence any curve representing the ultimate depression of the water for different rates of pumping must pass through the point of 0 rate and 0 depression of water level. Such a curve is represented on the accompanying figure by dotted lines. Next points were plotted representing the depression of water level as shown by curves 1, 2, 3 and 4, after 17½ hours' pumping. This period of time was selected because it was the greatest period of time shown on the curve sheet and because it surely represents the lowest practical point to which the water will be drawn, if the curves are reasonably correct. All of these points were found to lie substantially upon a straight line through the 0 point. The equation of this line is G.P.M.=0.23 h, where h represents the depression of the water level in feet, and G.P.M. represents the rate of pumping at a uniform rate, in gallons per minute. Actually the graph would have taken a slight curve, representing somewhat more capacity in the well, for large depressions of water level, than indicated by the straight line, but the difference would be small. Now, since this curve passes through the 0 point and through points for the curves 1 and 4, which have been well established, it furnishes good evidence that the curves representing tests 2 and 3 are also substantially correct, since their plotted points also lie on this straight-line curve. We can then determine for this well that the following rates of pumping can be relied upon within close limits:

20 G.P.M. for a draw-down of 85 ft.

30 G.P.M. for a draw-down of 130 ft.

40 G.P.M. for a draw-down of 170 ft.

50 G.P.M. for a draw-down of 215 ft.

The draw-down should, however, not be confused with the distance of the water from the surface of the ground. In this case this distance is 110 ft. greater than the draw-down.

The pumping equipment actually installed was designed for a capacity of 32 G.P.M. actual delivery, with an allowable draw-down of the water in the well of 150 ft., or to a depth of 260 ft. below the surface of the ground. This equipment has been in service since the fall of 1917 and has proven safe and satisfactory. As the demand of the town for water increases they can lower their pump pipe and install a larger cylinder, thus increasing their supply up to 50 G.P.M., but the cost of pumping against the additional head will of course be greater.

Money for Well Tests Well Spent

Numerous cases have been brought to the writer's attention where pumping equipment, not properly adapted to the wells, has been purchased and installed at great expense. Towns can not learn too soon that money spent in testing their wells is economically spent, except where the adequacy of the supply is otherwise well known, and engineers should insist upon their towns and cities having such tests made. The apparatus described for these tests can easily be made locally.

NEW REINFORCED CONCRETE COVERED RESERVOIR FOR ARKANSAS CITY, KANSAS

By R. E. McDonnell, of Burns & McDonnell, Consulting Engineers, Interstate Bldg., Kansas City, Mo.

(Editor's Note: This new reservoir at Arkansas City is the largest covered clear-water reservoir in Kansas; most Kansas reservoirs are not covered. The construction feature of raising the forms and thereby using a minimum amount of lumber is of special interest. The top of the reservoir is used for tennis courts, equipped and managed by the municipality.)

A 2,000,000-gal. concrete reservoir recently completed at Arkansas City, Kans., embodies some interesting features of design and methods of construction.

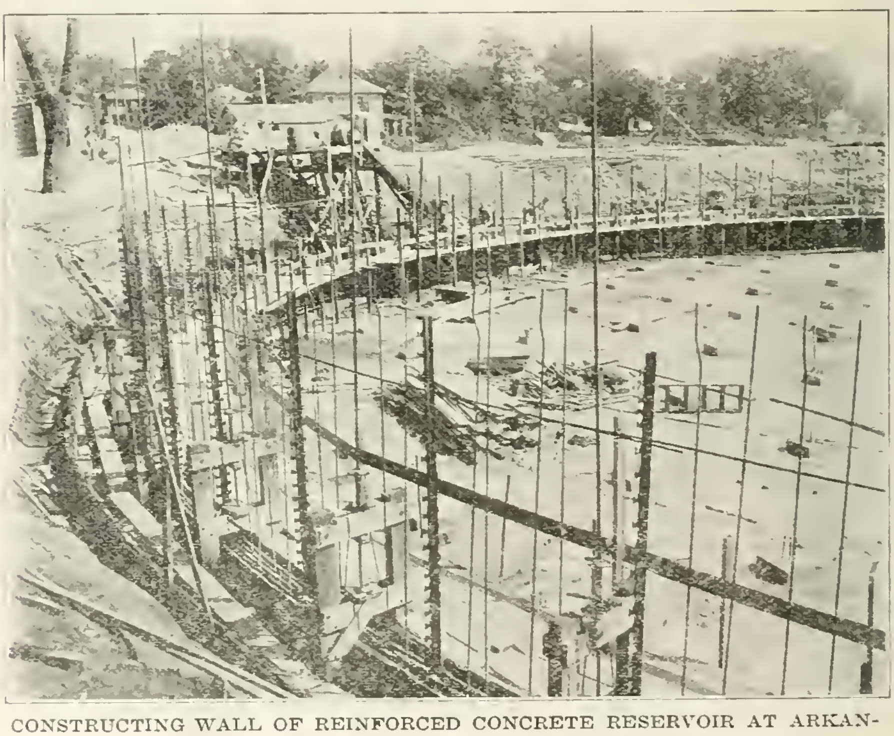
The water supply is obtained from wells equipped with motor-driven deep-well-type vertical centrifugal pumps located approximately 1¼ miles from the high-service pumping station, and is pumped through a 20-in. wood stave pipe line to the reservoir, located near the main pumping station. The reservoir provides a reserve storage for interruptions of power service, emergency demands, and allows the well pumps to operate at uniform steady rates.

Preparing the Site

The site available for the reservoir location was a low tract of ground that had been of a swampy nature and had been partially filled in with old refuse, brick, tin cans, street sweepings and rubbish. Test borings were made and the results indicated approximately an average of 8 ft. of old fill and original loam and 2 ft. of water-bearing sand overlying a solid limestone stratum, requirng 6 ft. of tight sheeting to hold lower banks. The ground water level was approximately 4 ft. above the rock surface. The rock surface was fairly smooth and level, having a grade or dip of less than 8/10 of 1 per cent. Several faults or cracks, from ¼ to 1 in. wide, averaging about 20 ft. apart, running at right angles to each other, were cleaned and grouted full with a 1:2 cement mortar, and after chipping off some of the uneven places, the entire rock surface was washed with a cement grouting and used as a floor.

Design Details

The reservoir is a circular reinforced concrete ring tension type, 156 ft. inside diameter and designed for a depth of 14 ft. of water. It is covered with a 5-in.



CONSTRUCTING WALL OF REINFORCED CONCRETE RESERVOIR AT ARKANSAS CITY, KANS., USING THE SLIP FORM METHOD.

reinforced concrete roof slab, carried by 10x15-in. beams spaced 12-ft. centers each way, and supported by 10x10-in. concrete columns. The roof was divided by expansion joints into slabs 24 ft. square, and rests freely upon the beams. The slab was designed for 90 lbs. live load in excess of the dead load. The entire roof was given a slope of 8 ins. from the center to the outside walls.

A trench was excavated in the rock to provide a sub-footing under the walls and to secure a good bond to prevent leakage. In order to provide for the indeterminate cantilever stresses, the sub-footing was finished off smooth and an asphalt expansion joint was provided between the sub-footing and the wall footing proper.

Use of Slip Forms

The wall was made 14 ins. thick, without taper toward the top, in order to facilitate the use of slip forms. The horizontal steel was placed in two rows and held in place by vertical standards, 6-ft. centers, built up of 3-in. channels, to which short strap steel lugs, with notches for holding the bars, were riveted at the required intervals. The channel standards facilitated the placing of the steel and insured the proper spacing and against the displacing during the pouring of the concrete. The standards were accurately centered and held in place by braces until the footing was poured, and then the standards were sufficiently rigid to be self-supporting.

A system of slip forms 4 ft. in height and in sections 12 ft. long were made up of 1-in. shiplap and assembled and centered in place. The forms were filled within 6 ins. of the top, and at this point they were raised by means of the ordinary slip form jack operating on a 1-in. jack rod. The jack rods were spaced approximately 8 ft. centers and two men made the circuit twice an hour, raising the form about 1 in. each time. The 1-in. jack rods were cut off at the top of the wall when the pouring of concrete was completed.

Concreting

The wall concrete was run continuously, requiring a total time of 80 hours for completion. Three 8-hour shifts, each consisting of 10 laborers and foreman mixing and placing concrete, 3 men placing and wiring steel, 2 men operating form jacks and 2 carpenters shifting runways and miscellaneous work. Two mixers were placed on opposite sides, but owing to shortage of labor only one mixer was in operation at one time, the crew changing from one mixer to the other every hour. Concrete was conveyed from mixers to wall in wheelbarrows on board runs.

This method of construction eliminated all construction joints and gave a smooth. finished surface which, under water test, showed practically no leakage, and only slight leakage was found through the small fissures in the rock bottom. Column footings were placed and tops carefully graded from center to walls to conform to roof slope, so that all column

CONSTRUCTING ROOF FOR REINFORCED CONCRETE RESERVOIR AT ARKANSAS CITY, KANS.

forms were of the same length, simplifying the construction and placing of forms. A part of the roof was poured during freezing temperatures, the work being protected by using a canvas tent covering, heated with steam coils, heating sand and water for mixing and covering completed work with paper and straw before removing the tent to the next section.

Tennis Courts on Reservoir

The location of the reservoir being on public park property, the top slab was given a float and trowel finish, the manhole openings and ventilators so placed that two tennis courts were laid out on top of the reservoir. Pipe couplings or sockets were installed in the roof slab for installing net posts, and also round the wall for fencing the entire area.

The principal quantities in the construction were 7,162 cu. yds. earth excavation; 1,038 cu. yds. concretet; 71.7 tons reinforcing steel and 4.2 tons channels and miscellaneous.

The total cost of the completed reservoir was $52,887.21. The reservoir was designed by Burns & McDonnell Engineering Co., of Kansas City, Mo.; constructed by Ray & Son, Contractors, of Baxter Springs, Kans., and the work was inspected and supervised by Charles W. Lusk, City Engineer of Arkansas City, Kans.

FEATURES OF ADDITIONAL WATER WORKS FOR ST. LOUIS, MO.

By Edward E. Wall, Water Commissioner, 312 City Hall, St. Louis, Mo.

Eight years ago the writer made a study of the water supply of St. Louis, Mo., the conditions affecting it and the extent to which the existing works could be enlarged, which led to the conclusion that by 1926 an additional supply would have to be provided.

During these eight years the capacity of the existing water works has been increased 50 per cent., the principal additions and extensions recommended at that time have been carried out, and a total of more than $5,000,000 spent for improvements.

When this investigation was made (1912-13), the average daily consumption was 82,000,000 gals. In 1920 it was 104,600,000 gals. During these eight years the highest daily average for one month was 126,000,000 gals., for one week 141,000,000 gals., and for one day 156,000,000. It takes no expert to see that the ultimate daily capacity of the present works (160,000,000 gals.) will in all probability be passed before 1926.

Following the 1912 report, investigation was made of several propositions for building new water works to supplement the present works when their ultimate capacity became insufficient for the demands of the city. A study of these schemes very promptly reduced the number worthy of consideration to two, namely: a practical duplication of the present works at the Chain of Rocks, with an additional high-service pumping station there, delivering water to the western and southwestern portions of the city through three large mains, and an entirely new 200,000,000-gal. plant located on the Missouri River about 9 miles above St. Charles, with a storage reservoir at Stratmanns, on the Olive street road, about 4 miles west of the western city limits, from which the water would be supplied by gravity to the city.

Proposed New Missouri River Plant

When the details of these two propositions were gone into, the Missouri River plant was seen to be preferable for many reasons. An extension of the city limits, which is almost certain to occur before many years, will make it necessary to supply water to a large territory already improved and lying west of the present city limits. This territory would be directly in the line of supply from the Missouri River plant, but would be still farther from the Chain of Rocks than any portion of the city now supplied from the existing works.

The Chain of Rocks is far from being an ideal site for a large water works. The intakes have to be built too far from shore and are at times inaccessible, the channel of the Mississippi is too unstable and too shallow at low water, the difficulty of keeping ice away from the gates, the cost of protecting the intakes and the sudden and freakish variations in the character of the water, all greatly increase the ordinary troubles incident to the operation and maintenance of a modern water plant.

All of these objections are greatly minimized or entirely removed at the site selected for the plant on the Missouri River. There the intake will be connected with the shore by a bridge about 200-ft. long, and will be located in a bend of the river, where it will be comparatively easy to ward off the ice in winter, where there is a depth of 30 ft. at mean low water, and where the water changes its character less often and more slowly and more in accordance with the rise and fall of the river.

Capacities and Costs.

The initial cost of each of these propositions was estimated in 1914 at about the same amount, namely, about $20,000,000. In neither case was it proposed to spend the full amount for the first installation, but only the amount necessary to construct that portion of the works to supply an average quantity of 60,000,000 gals. per day. About ten years later the work of gradually increasing the plant would be commenced and continued until the full daily working capacity of 120,000,000 gals. was reached.

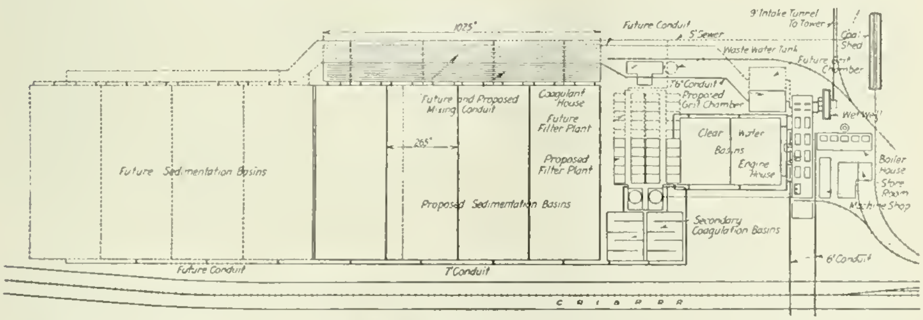
The present works would be continued in operation at their maximum daily working capacity of 120,000,000 gals., the Missouri River plant beginning to supplement this supply in 1926 with an average daily output of 30,000,000 gals. About 1942 this plant should be delivering thrice that amount to the city, and by 1960 its full daily working capacity of 120,000,000 gals. will be reached, at which time it is estimated that the population supplied will be almost 1,500,000, using an average daily quantity of 240,000,000 gals. of water.

Features of Missouri River Plant

The Missouri River plant, as designed, will be located at the foot of the bluffs on high bottom land about 1,800 ft. from the south bank of the river. The water will be drawn from the river, at the intake tower, through a tunnel to the wet well and screen chamber, to which the low-service pump suctions will connect. It will be lifted to a grit chamber, where the velocity will be reduced and the heavier sand dropped. Then it will pass through a conduit, being measured by Venturi meters, to the lime-mixing conduits, receiving the charge of lime en route. It will be in the mixing conduits not less than one hour, will then receive the charge of coagulant and pass into the sedimentation basins, remaining there not less than 16 hours. Drawn from the sedimentation basins it will be treated again, if necessary, in the coagulating basins, and then pass onto the filters. From the clear-water basins it goes to the suction of the high service pumps and thence through the supply pipe lines to the storage reservoir on Stratmann Hill, from which it will be drawn into the city through the service pipe lines to meet the consumption demands.

Intake and Wet Well.

The intake tower will be of concrete, faced with masonry, similar in a general way to the towers at the Chain of Rocks, resting on the bed rock at an elevation of about 40; will be in the channel at the deepest point about 200 ft. from the bank and will be connected to the shore by a steel bridge. The accessibility thus secured will much reduce operating charges. Gates will be provided at varying depths so that the heavy sand charges near the river bottom may be avoided except at extreme low-water periods.



GENERAL PLAN OF PROPOSED MISSOURI RIVER PLANT OF THE ST. LOUIS, MO., WATER WORKS.

The connection between the tower and the wet well near the bluffs will be by shafts and a tunnel 8 ft. in diameter, 2,075 ft. long, driven through bed rock and lined with concrete.

The wet well, screen chamber and engine house foundations will rest on the bed rock, about Elevation 15, and will be of concrete. The screen chamber and wet well will be similar to that at the Chain of Rocks, ice machines being provided to remove slush ice when necessary. The engine house will house the low service pumps, the high service pumps, the generators, wash water pumps for the filters and auxiliaries. It will be 449.5 ft. long by 74 ft. wide (interior measurements) and will contain a crane running the full length of the building.

Pumps

The low service pumps will be four in number when the installation is completed, two 50,000,000-gal. per day turbine-driven centrifugals being installed when the plant is put in operation, and 100,000,000-gal. per day turbine-driven centrifugals being added as needed, in 1936 and 1947. The average head will be 36 ft.

The high service pumps, as provided for now, are eight 25-million gallons per day triple expansion pumps working against an average head of 280 feet. Three will be installed when the plant is put in operation and others added as follows:

One in 1937, two in 1943, one in 1948, one in 1954.

The generators, for furnishing light and power for auxiliaries and the filters, will be in the south end of the building, two being installed at first and a third as required later.

The wash water pumps for the filters will be installed in the engine house. The concentration of all machinery under one roof will make for reduced operation cost and greater plant efficiency.

An office will be provided for the chief engineer and the clerk on the west of the building.

The boiler house lying east of and centering on the engine house will house five batteries of two 500 horsepower boilers each, provided with stokers, coal bunkers, conveying machinery, etc. Two batteries will be installed when the plant is started and additional ones in 1936, 1943 and 1946, as required. The building will be 205 feet long by 63 feet wide. The stack will be 225 feet high by 9 feet in diameter.

Additional buildings provided in connection with the pumping plant are a machine shop and blacksmith shop; locker and bath rooms are provided in the same building; a storeroom and yard and a storage coal shed.

All buildings, with the possible exception of the storeroom, will be built full size at the beginning.

Purification Plant

The purification plant will consist of the grit chamber, coagulant house, lime-mixing conduits, sedimentation basins, coagulating basins, head house, filters and clear water reservoirs, with connecting conduits. In the beginning the coagulant house, coagulating basins and head house will be built full size for the complete plant. All other parts will be built half size only and brought up to full capacity in 1941, when the demand exceeds an annual average of 60 million gallons per day. All will be of reinforced concrete with the exception that the building will be of the same materials as the pumping plant buildings. All descriptions are for parts to be built at first.

The grit chamber, designed to still the water to a velocity not exceeding 0.13 ft. per second, so that the heavier sand may be deposited, will be in three compartments, each hopper bottomed and connected to sewers so that the deposit may be flushed back into the river. It is 106 ft. long by 75 ft. wide by 18.5 ft. deep (average). The high water elevation will be 51.5. The water coming from the grit chamber will pass through a Venturi meter and conduit to the lime-mixing conduit, receiving the charge of milk of lime as it passes the coagulant house.

The coagulant house will contain the apparatus for mixing the dosings of lime, sulphate of iron, sulphate of alumina, etc., and the bins in which the chemicals used in the treatment of the water are stored 30 days' storage for each is contemplated.

The lime-mixing conduit, of concrete, covered, 9,225 ft. long by 64.8 ft. wide by 6.5 ft. deep, will contain nine channels, each 1,025 ft. long by 6.5 ft. wide by 6.5 ft. deep, with a total capacity of 3,000,000 gals. The water will be in agitation in this conduit not less than one hour, during which time the softening reactions should be completed. The coagulant will be added just before the water leaves this conduit.

Sedimentation Basins

The sedimentation basins are designed to allow a minimum of 16 hours' settling. They are made shallow, 12 ft. working depth, to reduce soil pressures and to prevent any such leakage and blow-out troubles as have been experienced at the Chain of Rocks. The original ground level varies from Elevation 36 to Elevation 40, while the working water surface will be Elevation 48.

The basins will be open with walls of reinforced concrete and bottoms of two layers of concrete blocks, breaking joints with a waterproofing layer between them. The water will enter at the river side through a number of openings and will be drawn off on the opposite side. The total capacity of the basins will be 60,000,000 gals., each of the four having an area of 167,110 sq. ft. and a capacity of 15,000,000 gals. Connections will be provided to a main sewer draining the whole plant.

A conduit will connect the basins to

the coagulating basins, where another charge of coagulant may be added when necessary. These will be two in number, each 131x170x12 ft. deep.

Filters

The filters are of the same general type as used at the Chain of Rocks, arranged about two main operating galleries, with wider pipe galleries and a clear water reservoir underneath. The filters will be 20 in number, each with a nominal capacity of 4,000,000 gals. per day.

The head house, at the entrance to the filters, will contain the wash-water tanks, the chemical and bacteriological laboratories, offices, locker and store rooms.

During a part of one month each year the river will be above the sewer outlets of the filters. A waste water tank, 48 ft. in diameter and 12 ft. deep, is provided near the coagulant house, connected to waste pumps in the house to provide for washing at such times.

The clear water reservoir connected to the suction of the high service pumps will have a capacity of 4,000,000 gals. and will be 184 ft. wide by 246 ft. long by 12 ft. deep. It will be covered.

Provision has been made for conduits, gates and connections, so that any part of the plant, except the sedimentation basins, may be by-passed.

The Stratmann Hill Reservoir

Between the river plant and the reservoir on Stratmann Hill, two supply mains are provided, each 6 ft. in diameter and each designed to carry 80,000,000 gals. daily, only one of which will be laid with the initial installation, the second being needed about 1942. The ground most suitable for a reservoir lies between the Bonhomme and Link roads and south of the Olive street road. Surveys have been made and contours drawn. The reservoir will have a capacity of 200,000,000 gals., and will be divided into two basins, each 1,042 ft. long by 437 ft. wide by 30 ft. working depth. The sides will be earth filled, 20 ft. wide at the top, with slopes of 1 vertical to 1½ horizontal on inside. The sides and bottom will be of concrete blocks 6 ins. thick, with a waterproofing layer of asphalt and felt and a protective layer of concrete. The top will be of concrete of flat slab construction, with a 2-ft. earth cover. The division wall will be of concrete.

The working water level will be at Elevation 310 and the reservoir bottom will be at Elevation 280. The ground at Stratmann Hill is good yellow clay and shale, so bearing stresses can be high. Gate chambers are provided for inlets and outlets and by-passes, so that both reservoirs may be withdrawn from service.

Service Mains

The service mains from Stratmann Hill reservoir to the city must be large enough to carry the maximum hourly consumption (at the rate of 270,000,000 gals. daily) and deliver the water at the city limits at Elevation 273 when the water in the reservoir is at Elevation 300. The points of entry into the city best to distribute the supply cannot be definitely determined at this time, but it is desirable that at least half be used in the district south of Forest Park. Four lines have been provided for in the estimates, one to be laid when the plant is put in service and to run on private right-of-way (100 ft. wide) to Maplewood, at Hope avenue, and crossing Manchester avenue to enter the city on Old Manchester road. This estimate ends the service main at Ellendale avenue, extensions from that point being handled by the distribution section. A second main, in 1933, will parallel the first. The third and fourth mains will be laid down Olive street in 1941 and 1950, respectively, as far as the city limits, where they will tie into the distribution system. These limits are, of course, tentative only, as it is impossible to predict the districts in which the consumption will be heaviest.

Each main will be of the same size and construction as the supply mains, and will be able to deliver 67,500,000 gals. per day at the city limits at Elevation 273.

The land for Stratmann Hill reservoir has already been purchased by the city, and negotiations for the necessary acreage on the Missouri River are now being conducted.

A bond issue of perhaps $16,000,000 will be proposed this year, to cover the cost of intake tower and tunnel, and that part of the buildings, basins, conduits, mains, etc., necessary for the first protion of the plant. A second bond issue of $10,000,000 or $12,000,000 will have to be made about 1940, to complete the plant to its ultimate daily working capacity of 120,000,000 gals.

PERKINS COAL HANDLING MACHINERY IN TWO ILLINOIS STATE POWER PLANTS

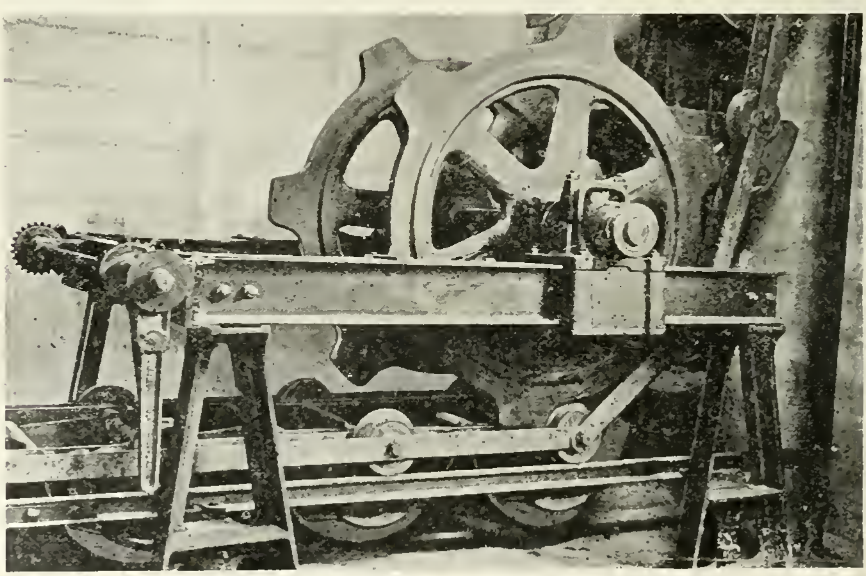
By W. F. Leggett, 2017 Sherman Ave., Evanston, Ill.

The list of things that come in pairs is a large one, but it is rare that two power plant coal handling installations are erected simultaneously, and are exactly alike in design, so that the location of each plant is the only means of telling them apart. Such, however, is the case with equipments recently installed in the power plants of the State Hospital at Alton, Ill., and the State Colony of Epileptics at Dixon, Ill. Plans and specifications for the two jobs were made at the same time by the consulting engineer for the Illinois State Board of Administration, and the parts were manufactured at the same time. The illustrations are from photographs taken at both plants and the description applies equally well to either installation.

Either run of mine or stoker size coal is received in hopper bottom cars, which are dumped into the track hopper, from which the coal is passed in a steady flow by a reciprocating feeder. If run of mine coal is being unloaded, the feeder passes it to a crusher, where two 24x24-in. semi-steel rolls reduce it to 1¼-in. stoker size before it passes into the Perkins pivoted bucket carrier, which is installed below the reciprocating feeder. If stoker coal is being handled, it by-passes the crusher rolls and is carried to the upper corner of the pivoted bucket carrier, where it takes a horizontal path and is discharged into the proper bunker, from where it is fed through spouts to the stokers.

The pivoted bucket carrier is composed of 24x15-in. malleable iron buckets hung on 1-in. rods between two strands of steel bar chain having 5/16x2½-in. side bars. It follows a rectangular path 118 ft. long on the horizontal runs, and 50 and 58 ft. high on the two vertical runs, the latter being higher than the former because of the dip under the crusher and feeder. The upper horizontal run is shown in one of the illustrations.

The engineering specifications call for a capacity of 20 tons per hour, but the Perkins carrier will easily handle twice this volume of coal, and is demonstrating its flexible utility as a conveying system by handling ashes as well as coal. When an ash run is to be made the doors of the ash pits are opened and the ashes are discharged into the lower run of the conveyor. The ash bunker is placed directly over the receiving track at the beginning of the upper horizontal run, and by setting the dumping mechanism at this point, the ashes can be collected until a carload has accumulated. The bottom of the ash bin is equipped with a rack and pinion gate, which is operated by a hand chain, and under the gate is a steel spout mounted on rollers which operate on a steel track, so that when ashes are being loaded it will project close to the car, but when



TAKE-UPS AT LOWER CORNER BELOW DRIVE.

TRACK HOPPER AND CASING FOR VERTICAL RUN.

idle it can be pushed out of the way. This spout is controlled by chains, and is entirely independent of the gate.

This installation is typical small plant equipment, and can be amplified to meet any requirements.

THE ECONOMY OF FEED WATER HEATING AND PURIFYING IN THE WATER WORKS PUMPING STATION

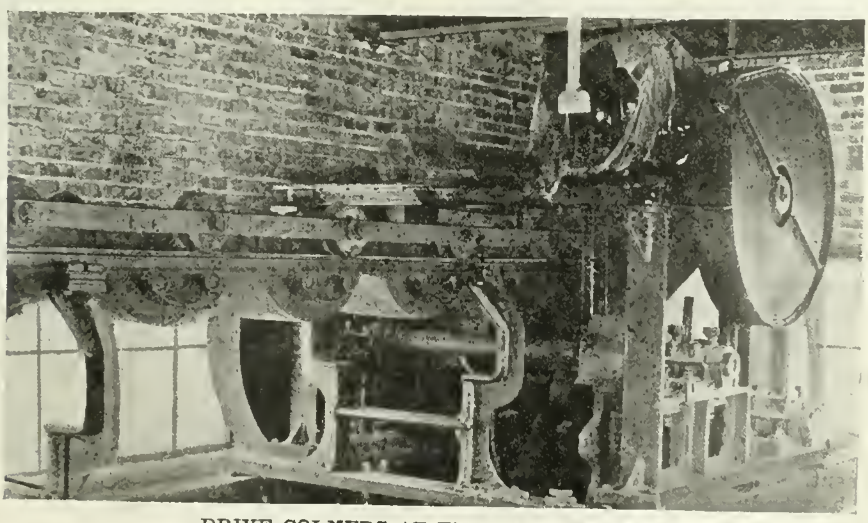
By Milton F. Stein, Civil Engineer, 6753 Lafayette Ave., Chicago, Ill.

Utilization of Heat from Exhaust Steam

In some smaller pumping stations, where non-condensing engines are used, the steam exhausts to the atmosphere. In larger plants, where the main units are condensing, the auxiliaries still furnish considerable exhaust steam. The utilization of this exhaust steam for feed-water heating is a very decided step toward economy. In the majority of cases feed-water heaters are provided, but there are enough exceptions to this rule, and enough instances of feed-water heaters improperly installed, poorly operated or entirely neglected to justify a few remarks on this subject.

In the very small steam-operated pumping station, using non-condensing engines, the preheating of feed water is of course a logical step toward economy. Ample steam being available in this case, it is possible to heat the feed water to over 200 degs. F., which results in a fuel saving of over 12 per cent.

Where condensing engines are used, there is still considerable steam from the auxiliaries which may be used for feed-



DRIVE CORNERS AT END OF UPPER RUN.

water heating. Indeed, it is more economical to use the exhaust steam from auxiliaries for this purpose than it is to operate them condensing, unless economizers are used to heat the feed water, which is impracticable in any but the largest pumping stations, and even there is of debatable value. The amount of steam available from auxiliaries is indicated in the following data for a station pumping about 3,000,000 gals. per day against 150 lbs. dynamic head. This plant supplies mechanical filters and repumps the filtered water to a service reservoir. It is modern in every respect.

Pump Unit	Lbs. of Steam Per Hour
High service pump	2,950
Vacuum pump for same	159
Low service pump	344
Vacuum pump for same	76
Boiler feed pump	127
Jacket returns	283
Total	3,939
Auxiliaries	545

Percentage auxiliaries of total, 13.8.

With this amount of steam it is possible to heat the feed water from 60 degs. F. to 210 degs. F., resulting in a fuel saving of 12.5 per cent. Furthermore, since a portion of the work of the boilers is transferred to the heater, the capacity of the former is in effect increased, in the present instance by one-seventh.

Types of Feed-Water Heaters

The two types of heaters are the open and the closed. The open heater is essentially a tight box into which the exhaust steam discharges. The water to be heated enters a distributing trough at the top, and from this flows evenly over a series of trays arranged horizontally, with a slight pitch, one above the other like shelves. The principal absorption of heat occurs in the drop from tray to tray, but also, to some extent, in flowing over the trays. As the feed water contains various salts in solution which precipitate out when the water is heated, the trays become incrusted, and provision is made for their periodic removal for convenient removal of this incrustation.

The efficiency in the main depends upon keeping these trays clean, so as to maintain the uniform flow of water in thin sheets, and prevent short circuiting of the water, which would reduce the time element as well as the intimacy of contact between water and steam. It is also important that the trays be accurately leveled or adjusted so as to give a thin, uniform sheet of flow. These are points for the operating engineer to observe, if he would obtain the greatest return from the exhaust steam. As an indicator of results, a reliable thermometer should be placed in the feed-water line leading from the heater to the boiler feed pump, and with sufficient steam and properly proportioned heater, this should read at least 200 degs. F. The engineer can answer the question as to sufficiency of exhaust steam by comparison of his plant with the example given.

As the exhaust steam is condensed and mixed with the incoming water, there is a direct saving of the residual heat in this, as well as of the resulting, practically distilled, water. However, a certain amount of oil from cylinder lubrication is returned with the steam. To remove this, an oil separator is placed in the exhaust steam line as it enters the heater, which is more or less successful. The presence of oil in the feed water is one of the arguments against the open heater. When used in connection with a water softener, this objection vanishes, as the oil is removed in the softening process.

In the closed heater the exhaust steam and the feed water are kept separate. It consists of a series of tubes or of coils, through which the feed water flows, inclosed in a shell of steel or cast iron. The exhaust steam fills this shell, and its heat is transmitted through the tubes to the feed water. In order to retard the steam within the shell until it is condensed, a back-pressure valve is usually placed on the steam outlet from the heater to the exhaust stack.

The advantage of this construction lies in the separation of the oil-containing exhaust steam from the feed water. Other advantages claimed, such as the reduction of load on the feed pump, by use of water from the city mains, are not justified, as the steam thus saved would be usefully employed in heating the feed water. For the same reason the back pressure caused by this type of heater results in no actual loss in plant efficiency. The feed water can be heated to within 10 to 15 degs. of boiling point (or temperature of the exhaust steam). As incrustation rapidly forms within the tubes, and a layer of grease accumulates on the steam side of same, it is necessary frequently to open the heater and clean the tubes if a high efficiency is to be maintained. Ordinarily this attention is required several times annually, and its need is indicated by the lowering of feed-water temperature.

Feed-Water Purifiers

It is surprising that while most other power plants, even of small size, use feed-water purifiers or softeners, these are very rarely seen in water works pumping stations, even of large size. Perhaps the water works engineer feels that he must demonstrate to the public his faith in the purity and steaming quality of the water he sells. Nevertheless, in a majority of cases the water could to advantage be softened for boiler use. Most well waters and many surface waters contain salts of calcium and magnesium in sufficient amount to build up a scale in the tubes and drums of the boilers, when they are precipitated by heating and by concentration in the boiler. This scale interferes greatly with the transmission of heat through the tubes to the water, and the heat which should go toward making steam goes up the stack instead, resulting in a marked waste of fuel. The scale can be removed by turbining, but even if this is faithfully done, it is impossible to avoid a heat loss of 5 or 6 per cent. as compared with a boiler that is always scale-free. In addition, there are the labor involved in turbining and scale removal, and the loss of service of the boiler for several days every three or two months or monthly, according to the scale quality of the water used, and the depreciation of the boiler due to overheating of the scale-covered surfaces and resulting from the process of scale removal. Under average conditions I do not think that the heat loss through boiler scale is less than 10 or 12 per cent. This loss, the labor and time of turbining, and the deterioration of boiler plant can be avoided by softening the feed water. Furthermore, the blowing off of boilers can be reduced to a minimum, and lubrication troubles in the steam end of pumps due to carrying over suspended matter with the steam are eliminated.

Water Softeners Using Lime and Soda Ash

The most usual types of water softeners make use of lime (either quick or hydrated) and soda ash as chemical reagents. These reagents are mixed with water to an appropriate strength in solution tanks provided with stirring mechanism, and the resulting solutions are fed into the water to be softened by automatic devices which proportion them to the amount of water used. After thorough mixing with the applied chemical solutions the water is allowed to settle in a large tank for several hours, then flows through a sand filter and is pumped into the boiler. The settling tank is so proportioned as to act as a storage reservoir, and takes care of the fluctuations in demand due to variable load on the boiler plant. The filter is of the closed type, operating under pressure, and requires no attention except a washing by back-flushing every day or two. The precipitate which accumulates in the settling tank is drawn off at intervals of one or more days through a blow-off valve at the bottom of the tank. By means of three simple chemical tests made daily upon the softened water it is possible to adjust the strength of the lime and soda solutions so as to obtain a boiler feed water of minimum hardness.

These softening reactions, like most chemical reactions, proceed much more rapidly in hot water than in cold. Therefore, it is advantageous first to pass the water through an open feed-water heater of the type above described, and water-softening apparatus for boiler plants is often designed with such a heater as an integral part, usually set on top of the settling tank. By this combination the troublesome question of oil returned with the steam is solved, as such oil is saponified and coagulated by the lime and soda in the settling tank and carried to the bottom with the precipitate. By using this so-called "hot process" of water softening the reactions are accelerated and the resulting precipitate is heavier and settles more rapidly to such an extent that the settling tank need be only one-fourth as large as for a "cold process" plant of the same capacity, which results in a saving in first cost sufficient to cover the additional item of the open feed-water heater. It is almost needless to add that if the feed water contains silt, mud or other matter which would cause foaming in the boiler, this will be carried down by the precipitate in the settling tank, so that the resulting feed water will be perfectly clear.

Zeolite Water Softeners

Within recent years another type of water softener has been placed on the market. This consists of a mechanical filter of the usual type, which contains, in place of sand, a mineral called zeolite, or sodium aluminum silicate. This mineral is found in natural beds, but is also prepared artificially, both the natural and synthetic products being on the market under various trade names. When water containing scale-producing calcium and magnesium salts is passed through a bed of zeolite, an exchange takes place, whereby the zeolite takes up the calcium and magnesium and gives off an equivalent amount of sodium, which remains dissolved in the water. It is thus changed in character from a hard water containing calcium and magnesium, to a soft water containing sodium, while the zeolite is changed from a sodium zeolite to a calcium-magnesium zeolite.

It should be noted that whereas the lime-soda process removes the objectionable salts from the water and reduces the total dissolved solids to a very low amount, the zeolite process exchanges objectionable salts for others, the total dissolved solids remaining unchanged in amount. As sodium salts are known to aggravate foaming, it follows that if a very hard water is softened by the zeolite process, it will indeed be softened, but in its changed condition may cause trouble through priming and foaming. It is also known that waters high in sodium salts have an embrittling action on steel, which may cause a rapid deterioration of boilers. For these reasons the use of zeolite softeners as applied to boiler feed water is rather limited, although it ranks very high in other fields of water purification.

It is evident from the foregoing that the character of the zeolite is changed by use, and to change it back to its original effective condition a salt solution is passed through it, after it has been in use for one or more days. This regeneration requires several hours, the brine solution resulting being wasted into the sewer. After regeneration, the zeolite bed must be thoroughly washed by a reversed flow of water, and is then ready for use again. The cost of salt offsets the cost of chemicals in the lime-soda process, so that an advantage of the zeolite process lies in the smaller size of installation, and in the ease of control, no dosing apparatus being required, and only a single, simple chemical test being necessary to determine when regeneration becomes necessary.

CONDITIONS GOVERNING INSTALLATION OF MUNICIPALLY OWNED POWER AND LIGHTING PLANTS

By C. M. Garland, Consulting Engineer, 1140 *First National Bank Bldg., Chicago, Ill.*

There are few communities today that are not served with power and light in some manner by public utility corporations. The principal object, therefore, eliminating politics and possibly the poor service of the local utility, for the installation of municipally owned power plants for lighting and power purposes is to save money for the community. In order to reach a decision, therefore, on a municipally owned plant, it is of the first importance that all the conditions be properly analyzed and proper conclusions drawn therefrom.

Governing Conditions

There are undoubtedly many communities in which a municipally owned plant, properly designed and properly operated, can be made to save the community considerable in the cost of light and power. There are just as many communities in which a municipally owned plant will cost the community considerably more than power purchased from the public utility corporation. As to whether the municipally owned plant will be an asset or a liability to the community depends:

1. Upon the size of the load.
2. Upon local conditions.
3. Upon the cost of power from the public utility.
4. Upon the efficiency of the plant built.
5. Upon the efficiency of operation.

The Size of Load

The size of the load affects the cost directly. It goes without saying that for small and medium sized plants, the overhead charge, plus the labor charge, plus the repair charge, are charges that are almost constant and almost independent of the load within comparatively wide limits. A proper load will therefore be one of the principal considerations in the decision as to whether or not a municipally owned plant should be installed.

Influence of Collateral Conditions

Assuming that there is sufficient load available to warrant the installation of a power plant, the next consideration is the question of local conditions. Ordinarily for a municipally owned installation to be an asset to a community, the load must be large enough to warrant the installation of condensing equipment. This means the supply of an abundance of water for condensing purposes. Where an abundance of water is not available for condensing purposes spray ponds or cooling towers must be considered which raise the cost of the installation.

Again, the status of the water supply for the town may be a valuable consideration in the decision regarding the installation of a power plant. Where the water works can be combined with the power

plant a very large saving in overhead can be effected. There may be also a considerable saving effected in the first cost of the plant through the reduction of the spare equipment required. It may also be possible to combine the pumping load of the water works with the power and lighting loads, to bring about a higher load factor on the combined plant. This is a consideration of the first importance.

Under local conditions also enters the cost of fuel for the particular locality. In some localities, a long distance from mines, the price of coal may make the installation entirely prohibitive. Again, the plant may be located near a mine and obtain fuel cheaper than the public utility corporation.

Cost of Power from Private Company

The cost of power from the local public service company is the next point to be considered, and in considering this item

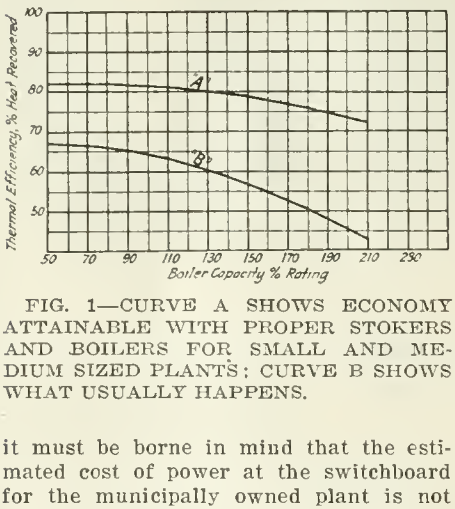


FIG. 1—CURVE A SHOWS ECONOMY ATTAINABLE WITH PROPER STOKERS AND BOILERS FOR SMALL AND MEDIUM SIZED PLANTS; CURVE B SHOWS WHAT USUALLY HAPPENS.

it must be borne in mind that the estimated cost of power at the switchboard for the municipally owned plant is not the price that can be charged by the plant to the consumers. This is a point that is often overlooked in local arguments by the layman in installations of this nature. The public utility rates to householders may, for example, average 10 cts. per kwh. The fact that a local plant may generate current for 3 cts. per kwh. at the switchboard does not mean that the municipally owned plant will be able to deliver current to its consumers at anywhere near this amount.

Reported costs of power from any plant must be very closely scrutinized, otherwise misleading conclusions may be arrived at; this is particularly true of municipally owned plants where interest on bonds, overhead charges, and, at times, operating expenses may be paid out of the city tax returns. Where such items are omitted from the cost, the plant shows a fictitiously low cost for power.

When the cost items are entered up properly on small installations it will be found that there are few installations in which the cost of power can be brought under 10 cts. per kwh., delivered to the consumer.

Plant Efficiency

Having decided that a municipally owned plant can be made a profitable investment for the community, the next step is to obtain an efficient plant. There is a decided tendency on the part of the layman, which is natural, and on the part of practical operating engineers to minimize the importance of a properly designed plant. This is due to the lack of knowledge of the many causes affecting the ultimate economy of a power installation. It is of the first importance that the plant be designed right to start with. If it is not so designed, the errors made in the design of the plant last just as long as the plant and exact a heavy toll from the consumers. As a matter of fact, the economy of the plant depends upon the selection of every piece of equipment entering into it. An economical plant cannot be designed by an engineer who is not familiar with the economy of each piece of apparatus entering into the plant, and there are few engineers that possess this knowledge, as the large number of uneconomical plants will testify.

The economy in the boiler room will depend upon the kind of fuel available. The economy in the use of this fuel will depend upon the selection of stokers, the selection of the boilers, the adaptability of the stokers to the boilers and the adaptability of the stokers and the boilers to the character of the load. The cost of the boiler plant will also depend upon these selections. It is entirely possible to build a boiler plant from the best equipment available, pay the highest price and yet obtain a plant poor in the use of fuel. It is not the cost of the equipment nor the quality of the equipment that decides the economy of a plant.

Take the curves of Fig. 1, for example; these illustrate the difference in economical results that may be produced by the installation of different boiler and stoker equipment, all of which are standard, well-known equipment. The curve marked "A" shows what can be accomplished in the way of economy by the installation of the proper stokers and boilers for small and medium sized plants. The curve marked "B" shows what is more likely to

happen. The probabilities are that in the building of a new power installation the owner will obtain the economical performance as illustrated by curve "B" rather than by curve "A." The probabilities are at least ten to one against his obtaining the combination of equipment that will produce the curve "A," although this equipment will cost only 10 per cent. more than the equipment which produces the curve "B," and the difference in first cost will be paid off by the saving in coal in the first nine months of operation. If the coal bill for curve "A" is $50,000 per annum, the coal bill for curve "B" will be approximately $62,500 per annum, or a difference of $12,500 per annum in the operating costs.

What is true of the boiler room is true in a measure, although to a much less extent, of the turbine room. The selection of auxiliaries is another important item for consideration.

Efficient Operation

Assuming that a properly designed plant has been secured, the next thing is to obtain efficiency in operation. As a rule, small plants cannot afford to pay for a high degree of efficiency in the operation. For this reason, as a rule, small plants cannot supply power and compete with public utility rates. While a properly designed plant makes it possible to obtain the best oconomy in operation, this economy cannot be obtained and cannot be maintained unless the plant is operated by men having full knowledge of the requirements for economical operation. If the public utility plant is operated on the patronage system, the probabilities are that it will be poorly operated and will be a liability instead of an asset to the community. For this reason, whenever possible, the management of a municipally owned plant should be vested in a commission or board of directors of non-partisan origin, as nearly as this is practicable, and these should be guided by an engineer outside the community specializing in power plant design and operation.

OPERATING DATA ON WURL SCREEN AND IMHOFF TANKS IN PLAINFIELD (N. J.) JOINT SEWAGE WORKS

By John R. Downes, Superintendent Plainfield Joint Sewage Works, Bound Brook, N. J.

(Editor's Note: The operation of the Plainfield, North Plainfield and Dunellen, N. J., Joint Sewage Disposal Plant for four years, has made available some data on quantities of solids removed, both by the Wurl screen and the Imhoff tanks. These data are here given in brief form, as presented by Mr. Downes before the New Jersey Sewage Works Association. He writes that a strong sentiment prevailed at the meeting in favor of the one story settling tank, with a separate digestion chamber, communicating therewith by control valves, as against two-story tanks, with uncontrollable slot connections between the two compartments.)

The works was designed to handle the sewage from 40,000 persons. The sludge separating portion of the plant originally consisted of six Imhoff tanks, each with a total flow length of 64 ft. and a total width of 25 ft. Each tank has four longitudinal settling compartments, with effective widths of 5 ft. each. Two gas vents, each 22-ins. wide in the clear, extend the entire length of the tank. The walls extend perpendicularly to 5 ft. 6 ins. below the flow line. The slopes, about 1 on 1, extend to the slot, 11 ft. below the flow line.

Screen Installed Two Years After the Tank.

The tanks were put into operation at the end of November, 1916, and operating experiences during the ensuing year indicated the necessity of removing the coarser solids, paper, fiber, hair and fecal matter from the sewage before it was admitted to the settling compartments; such solids not being amenable to treatment in the tanks. For the purpose of removing these coarse solids a Wurl screen was added to the slude separating equipment and was put into operation in September, 1918.

The Wurl screen is essentially a brass disk, 10 ft. in diameter, revolving on a shaft inclined 15 degrees. The disk is perforated with some 12,000 slots each 1-16 by 2 ins., and is submerged to about half its depth in the flowing sewage. The solids which are caught on the surface of the screen are swept into a trough by the revolving brushes, which continually scour the unsubmerged portion of the disk. A one-horsepower electric motor, which can be adjusted to run at speeds from 600 to 1800 R. P. M., operates the screen mechanism.

Table 1 gives information concerning the suspended solids in P. P. M., as determined by the Gooch Crucible method; the number of cubic yards of digested sludge removed from the tanks, (measured by shutting off the tank during drawing of sludge and measuring the depres-

TABLE I—OPERATING DATA ON SCREENS AND TANKS IN PLAINFIELD, N. PLAINFIELD AND DUNELLEN, N. J. JOINT SEWAGE DISPOSAL PLANT.

Date.	Suspended Solids. P. P. M. Screen Effluent.	Imhoff Effluent.	Slude from Tanks. Cu. Yds.	Beds. Cu. Yds.	Screenings. Total Cu.Ft.	Daily. Cu.Ft.	Flow Total M.G.	Flow Daily M. G. D.	House Connections 4,500 start 5,400 (6 months
1917	*148	37	1609	586	.....	..	939	2.6	5853
1918	*140	49	3520	1009	.....	..	1253	3.4	6398
1919	*142	38	4069	877	18250	50	1391	3.6	6804
1920									
Dec.	176	71	....	12	1220	47	110	3.6	6905
Jan.	135	70	....	....	1362	45	109	3.5	6909
Feb.	123	69	....	28	1273	44	100	3.5	6912
Mar.	116	67	415	....	1393	46	133	4.3	6921
Apr.	157	66	230	97	1383	46	113	3.8	6943
June	181	57	631	202	1302	43	93	3.3	6993
July	175	57	475	92	1426	46	107	3.5	7003
Aug.	152	48	523	129	1420	46	93	3.4	7036
Sept.	174	65	575	251	1282	41	96	3.2	7076
Oct.	193	66	364	109	1567	52	97	3.1	7078
Nov.	208	82	346	69	1359	45	95	3.1	7111
1920									
May	148	80	248	61	1364	44	105	3.4	6969
Average	161	66							
Totals			3807	1140	16351		12430		

*Raw in 1917, 1918, 1919. Higher results in 1920 due to mixing and comminuting effect of screen on the solids. Samples during 1919 were taken before sewage passed the screen.

sion of the water level); the number of cubic yards of air dried sludge removed from the drying beds, (cart measurement); the sewage flow in million gallons, and the number of house connections at the end of each month.

Two of the municipalities contributing to the plant were installing sewers for the first time and the third took in large new sections of sewers, so that the increase in number of connections during the first year was very rapid. In order to make the complete sludge data of the four years available for estimation of per capita and per connection quantities, the number of connections at the end of each month have been added together and multiplied by thirty to get the number of connection-days contributing the observed quantity of sludge; five times this figure is considered the number of person-days. This figure checks up well with the known population.

Screenings were measured in a wagon, most of the free water having drained away before measurement was made. The dry solids equal 11%.

Comparing the volume of solids removed by the screen with the total volume of settleable solids, indicated by cone glass sodings, indicates a removal of 15 per cent. of the latter. Comparison of weight of screenings with weight of suspended solids indicates a removal of 7 per cent. of the total suspended solids on a dry basis and the screen removes 10 per cent. of the solids removed by the combination of screen and tanks. Screenings indicated in above table amount to .0015 cu. ft. per person-day. Digested sludge indicated in above table amounts to .0085 cu. ft. per person-day.

Sludge

At the end of the 4th year of operation a sludge survey of the digestion compartments indicated that there remained at that time 750 cu. yds. of sludge. In three of the tanks the sludge was at the bottom of the hoppers and in the other three it was almost entirely floating at the surface of the gas vents. (This in spite of constant effort to beat it down.)

In addition to the above solids there has been removed from the gas vents a quantity of partly digested sludge estimated at 1,000 cu. yds. This was removed by pumping and by wheelbarrows and ranged in constency from a watery 96 per cent. sludge to a viscous 88 per cent. mass, containing much hair and fiber.

The sludge digesting portion of the plant consists of ten sludge hoppers to each tank. These are in two rows of five each, directly beneath the gas vents. The depth between the slot communicating with the settling compartment and the top of the hoppers is 6 ft., providing a total settled sludge capacity of 57,000 cu. ft.

With any operating program, which we have been able to develop, there accumulates, in time, a mass of floating sludge

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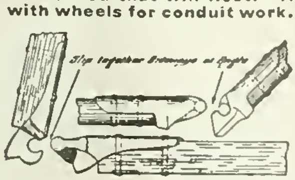

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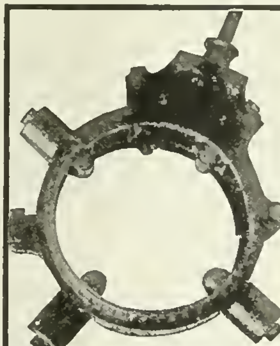

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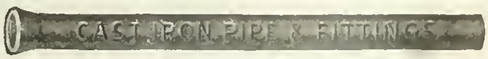

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of so slight a specific gravity that it will never settle. I do not refer to the thick viscous sludge appearing at the top of the gas vents and which may be wheeled off in wheelbarrows, but to a sludge of 95 per cent. water content and thoroughly digested. This sludge floating throughout the entire depth of the digesting compartments and gas vents is naturally carried back, via the slots, to the settling compartment by various currents. The result is a black film on the surface of the settling compartment and a very poor looking effluent, with an avidity for oxygen, which is a serious drain on the sprinkling filter.

It now appears that it will be necessary to pump out the upper portions of the digesting compartments at least once a year, in order to dispose of this digested but unsettleable sludge.

Sludge Drying.

With regard to sludge drying, we find that with 35,000 connected population we have approximately 4,000 cu. yds. of sludge to be removed from the tanks each year.

Our experience shows that it is not economical to put over 9 ins. of wet sludge on a bed, since this quantity will dry in a week or ten days of good weather, while any greater quantity will require a time measured in weeks.

It is surprising to find that, in spite of the fact that a coat of sludge 9 ins. thick will become spadable in a week or ten days of good drying weather, under actual climatic conditions we have averaged only a scant 6 dryings per year. The figures for three years being 5.8, 6.0 and 5.8 dryings per bed per year.

Therefore to dry 4,000 cu. yds. or 108,000 cu. ft. of sludge per year requires $108{,}000 \div 75 = 144{,}000$ sq. ft. of drying surface per year. And $144{,}000 \div 6 = 24{,}000$ sq. ft. drying area required to take care of 35,000 people under local weather conditions. This amounts to 0.686 sq. ft. per person.

Operating Costs.

Operating costs outside of supervision and organization charges are shown in some detail for 1920. It would hardly be worth while to go into operating costs for the other three years on account of the sliding scale value of the dollar, but the proportional distribution will be very nearly the same as for 1920.

It is interesting to note that outside of interest charges the comparative costs as between screening and removing the objectionable solids from the tanks by hand are just about equal. That is to say, the time now spent by a watchman on the screen and the cost of power about equal the cost of labor in removing the coarse solids. The plant, however, is much more "workable" and the nature of the labor much less objectionable when the solids are removed before reaching the tanks.

Outside of the "Imhoff" tanks and the Wurl screen, which, in view of the above statement, must be considered as a charge against the tanks, one man could do all that is necessary about the plant. To this other work we will suppose the highest paid laborer to be assigned and charge all ordinary labor to care of screens and tanks to sludge removal.

Cost of Operation, 1920

	Total	Chargeable to screens, tanks and Sludge removal
Labor	6437.66	4637.66
Heat, light, power, etc.	1131.39	240.00
Supplies, tools	1017.59	1017.59
Machine repair tractor, spreaders, etc.	247.05	247.05
Screen motor repair	186.28	186.28
Gasoline, oil, etc.	370.80	370.80
	9390.77	6699.38

Expressed in man hours, the labor required to operate the plant is:

For general attention to plant 2,450 man hours per year.

For night watch on screen, 5,630.

Care of tanks, 5,820.

Drawing and hauling sludge, 1,242.

Or general plant, 8 hours week days.

Watch on screen at night, 16 hours week days and Sundays.

Care of tanks, 17 hours week days.

Drawing and hauling sludge, 4 hours week days.

Screen Maintenance.

The screen has run practically continuously for two years. The first set of screen cleaning brushes lasted exactly two years before requiring replacement. The speed control apparatus on the motor is the only thing that has given any trouble; $151.01 has been expended to date on this item. Two broken brush flanges, cost for replacement and a duplicate of each for stock, $38. The current consumption is from 9 to 12 k. w. h. per day.

The maximum (working) loss of head on the screen is 13 ins., and the capacity of the screen, with 13 ins. loss of head and full screen speed (about 1 r. p. m.), is at the rate of 4,750,000 gals. per day.

Engineers' and Contractors' Directory

Construction News and Equipment

THE CARE OF CONCRETE MIXERS

By L. P. Lessard, Sales Department, The T. L. Smith Co., Milwaukee, Wis.

If contractors would give their concrete mixers the little attention that they require, they would last much longer. In most cases the operators are fully responsible for the upkeep of the machines and are never called to task because the mixer is in run-down condition. If the contractors themselves or a responsible foreman would see to it that their mixers were properly greased, oiled, cleaned, etc., there is no doubt that the mixer's life and efficiency would be materially increased.

Many building contractors do look after their mixers and their machines reflect this care in their operation. However, workmen usually leave their mixer just as they finish with it. Only recently the writer saw two workmen one morning pounding the loading skip with sledgehammers, trying to clean it out, because they had neglected to wash it out the previous evening. Imagine the mixer going through this pounding process every morning and possibly more frequently. No wonder the mixer lasts only a short time and needs to be replaced.

The following suggestions for taking care of building mixers are intended as an aid to those contractors who do not, but should, give their mixers careful attention. If followed carefully, good results will be noticeable in the looks and operation of the mixer.

Setting Up

When you buy a new mixer, see that it is assembled correctly before starting. Turn down the grease cups, oil the wearing surfaces where necessary, see that the bolts and nuts are tight, and be sure everything is all right, then go ahead. Manufacturers always send instructions for setting up, which should be your guide when assembling.

Oiling

Oil your machine liberally. Give the drum rollers plenty of grease; they have the heaviest duty. Don't forget your engine, either; it needs oil. Follow the engine oiling instructions carefully. Oil the drive chains to make them drive smoothly and endure. Oil all gears, especially bevel gears. Use a good quality of machine oil that will not thicken when cold. Also, use a good grade cup grease where grease is required.

Feeding

It has been found that as far as mixing is concerned, it does not matter in what order materials are fed into the drum. The feeding is done to meet the convenience of the operator. If desired, the old method of hand mixing can be adopted, as follows: Sand and cement, then add water and follow with crushed rock or gravel. A good way to get cement in without "dusting" is to put it into a barrow of sand, or, still better, to add some water to the batch before putting in the cement.

Where a sharp stone is used in the batch, it is well to put in a portion or all the sand first, as the sand will act as a cushion and protect the shell of the drum.

Do not fill the drum too full. A big batch mixes more slowly than a small one. There is a happy medium between best time per batch and best quality, which experiment will determine. Cement mortar or "sloppy" concrete is best mixed in batches of reduced size.

Washing

Wash out the drum before the mixer is stopped. It is necessary to keep the inside of the drum clean, as only a clean drum will do good work. Fill the drum with water and revolve until it is clean, then discharge the water. If water alone does not clean the drum, add a little crushed stone or a few small pieces of scrap iron.

If the drum is once neglected and cement allowed to harden inside, it is very difficult to clean.

Blocking

It is sometimes desirable to block mixers. Do this whenever possible. It not only prevents destructive vibration, but saves power and repair bills.

Care of Boiler

If you have a steam-driven mixer, follow these instructions carefully. Do not fire hard when the boiler is cold. The type of vertical boiler best adapted to concrete mixers has one weak point, viz., the top ends of the flues are not surrounded by water. In raising steam, the fire should not be crowded until some pressure is shown on the gauge, or the top of the tubes, will be overheated and the boiler will surely leak.

A boiler is really a sensitive apparatus and requires as much or more attention than the engine.

Repairs

Keep your mixer repaired. Don't allow parts to be worn so they affect the operation of the mixer. The minute you notice a worn part order a new one. It will pay you every time. Particularly watch your drum rollers. Replace them as soon as they are worn or become wabbly. Never allow your drum to run untrue. Watch every part and replace it with new one as required.

Ordering Repairs

Always keep the repair lists which the manufacturer furnishes. Order your parts by numbers or according to the factory instructions. You would be surprised how much time it will save, and the sooner you get the replacement part on your mixer the better for the mixer.

These simple rules, if followed carefully, will apply to any make of mixer. As a rule, manufacturers furnish instruction books which go into detail on each item, but if contractors will follow the above rules and use their own judgment about oiling, loading and taking care of their mixer, they will find that their mixer will give them better service and last much longer.

PERFORMANCE OF TRACTOR AND WHEEL SCRAPER OUTFITS ON DIXON-HENDERSON ROAD, WEBSTER COUNTY, KY.

By W. B. Hill, Jr., The Holt Manufacturing Co., Inc., Peoria, Ill.

In grading the Dixon-Henderson Road in Webster County, Kentucky, Mr. Mitchell, of Townsend, Mitchell & Carter, Contractors, is using two trains of tractor-drawn wheel scrapers consisting of two 5-ton Holt "Caterpillar" tractors, and four Maney four-wheel scrapers. This method of moving dirt is about a year old, and everywhere it has been tried out has effected for the contractor a consideramle saving over grading with teams.

The Dixon-Henderson Road is a Federal Aid Project forming part of the Dixie Bee line running from Chicago to Florida. The section under construction (Project 39, Sect. C) is about 5 miles long, and winds around the Kentucky hills with few level stretches, and with grades of from 2 to 6 per cent.

The contract calls for moving about 35,000 yds. of dirt, putting in some 20 concrete culverts, and clearing and grubbing about 2½ acres of ground. Free haul is 500 ft. with an overhaul of about 13,000 ft. on 5,000 yds. Character of soil is lime stone clay, free from rock.

Work was started in September, 1920, with teams alone. Operations were stopped for the year on December 17th. During the last month and a half, "Caterpillar" tractors and scrapers were used, replacing all except 4 teams. In 1921 work was begun on April 4th, with the same equipment (tractors, scrapers and 4 teams).

Method of Operation

The method of operation is to use the "Caterpillar" tractors on hauls of 150 ft. and up, and teams and slip scrapers on all of the shorter hauls. This forms an ideal combination, and gives the contractor an equipment so flexible and efficient that he can handle any given condition with maximum economy.

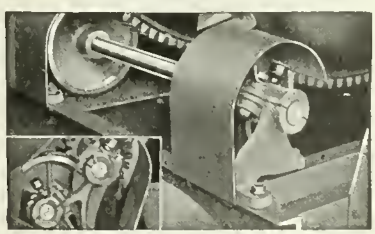
The efficiency of teams is well known on hauls of around 100 ft., on hauls across the road, knocking down short, steep banks, filling up deep holes and washouts, etc. But where teams begin to cost real money is on the longer hauls.

It is this condition that the "Caterpillar" drawn wheel scrapers handle best. The following are typical examples of the amount of dirt these outfits have moved: Working up and down a 6 per the corners when the flow was sluggish. cent. grade that was to be cut to 5 per cent., on an overhaul of about 1,300 ft., Mr. Mitchell found that one "Caterpillar" outfits gave him 400 yds. per 10-hour day.

The power units consist of two 5-ton "Caterpillar" tractors hauling 2 scrapers apiece. Six men are employed as operators; 2 on the tractors, and 1 on each of the 4 scrapers. On hauls of around 20 yds. one power outfit loads 180 yds. from the fill; second outfit 220 yds. from fill. This prevents delays. On longer hauls this is unnecessary. The road is about 24 ft. wide, which gives ample room for passing at any point. The "Caterpillars" turn the scrapers easily within this radius, and when necessary can turn within 18 or 20 ft. In going over or turning on soft fills, up grade, or through mud, the "Caterpillars" have ample power to pull the scrapers. In fact, Mr .Mitchell handles all of his trac-

Look under the drum!

IF it is a Koehring mixer, you will see that the heavy drum is supported by drum rollers, constructed on freight car truck principle. The drum rollers do not turn on a fixed axle, which under the down thrust of heavy drums soon must wear flat on the top side and set up pounding vibrations throughout the mixer. No—the rollers which support the Koehring drums are fixed to shafts which turn in big bearings easily accessible on the main frame! There's a simple, accessible, easily lubricated, long-life construction, right there at a point of greatest strain and wear. But it is only one of the better construction features which make Koehring the *Heavy* Duty Mixer.



The above shows the heavy brackets, mounted on the main frame on which are mounted the extra big bearings in which turn the drum roller shafts. Notice that the bearings are at an angle which brings the load on the full face of bearing. These bearings are extraordinarily long, and easily accessible for lubrication or re-babbitting.

CAPACITIES

Pavers: 10, 14, 21, 28 cu. ft. mixed concrete, steam or gasoline, multiplane traction, loading derrick, power discharge chute.

Construction Mixer: 10, 14, 21, 28 cu. ft. mixed concrete, steam and gasoline, power charging skip, batch hopper.

Dandie Light Mixer: 4 and 7 cu. ft. mixed concrete, low charging platform, power charging skip, light duty hoist.

Write for Bulletin P-10.

KOEHRING COMPANY, MILWAUKEE WISCONSIN

tor operations on direct gear, rarely if ever using low gear of the tractor, which gives approximately twice as much power. One scraper man is generally used to handle a train of 2 or 3 Maneys behind a 5-ton "Caterpillar," but Mr. Mitchell has found it better economy to use 1 man on each scraper for the following reasons:

They take better care of the scrapers and geep them in better order; they take a great interest in their particular scraper; they like job because seat is very comfortable and work is not hard; they can get a bigger load per trip; they can make a smoother, more even cut; they are a great help in the morning, speeding up work of greasing tractor and scraper wheels; they provide an extra man for an emergency; they cost little. With dirt paid at the prevailing rate, and the extra operator getting $3, a few more yards of dirt pays his daily salary.

Start Work Quickly After a Rain

After a rain operations can be resumed very quickly on account of the track laying construction of the "Caterpillars," which gives them a firm footing over soft ground. A thin cut is made to take off the top layer of mud. The sub-soil then encountered is dry, and there are no further difficulties. Plowing is unnecessary except in one or two cases; notably when making deep cuts of from 7 to 10 ft, it is sometimes necessary to plow through the very hard clay found at this depth.

Before starting on any particular section, the stakes are taken out and set on one side of the road. Particular attention is paid to getting down to grade on the crown; the sides being later finished with an 8 ft. blade grader pulled by one of the "Caterpillars.'

Mr. Mitchell has found that his four teams are particularly useful in smoothing out the road ahead of his wheel scrapers. For example, on coming to a gully, some 30 ft. wide with nearly perpendicular banks about 8 ft. high that crossed the right-of-way, he worked his teams with slip scrapers all day, filling in the bottom and plowing the banks down somewhat. When he had made roughly a 25 per cent. grade out of the banks, he moved his teams up farther ahead and put his "Caterpillars" and Maneys to work on the fill. As the two outfits dump 4 full yds. on every trip, the remainder of the fill was made in a short time. Such obstacles as trees, hedges, stumps and heavy roots are either dragged out by the "Caterpillars" or chopped out by hand. The contractor is doing his own concrete work, and is using a small one bag mixer. The equipment used is as follows:

Equipment

Two 5-ton "Caterpillar" tractors; 4 Maney four-wheel scrapers; 4 No. 2 slip scrapers; 1 plow; 1 Blade grader (8 ft.); 1 Dodge touring car; 1 International truck; 1 concrete mixer (1 bag); 75 ft. of chain, ⅝ in.; and small tools.

Personnel

One contractor; 2 tractor operators; 4 scraper operators; 4 mule team drivers (hired with teams); 1 dumpman; 1 roustabout; 1 man for clearing right-of-way; 1 loader (for teams); 1 truck driver; 1 concrete mixer foreman; and 5 laborers on mixer.

Herewith is given a table of capacities showing amount of dirt the 5-ton "Caterpillar" has moved daily, hauling 2 and 3 Maney scrapers respectively.

DETAIL TIME TABLE FOR 5-TON "CATERPILLAR" PULLING TWO 4-WHEELED SCRAPERS.

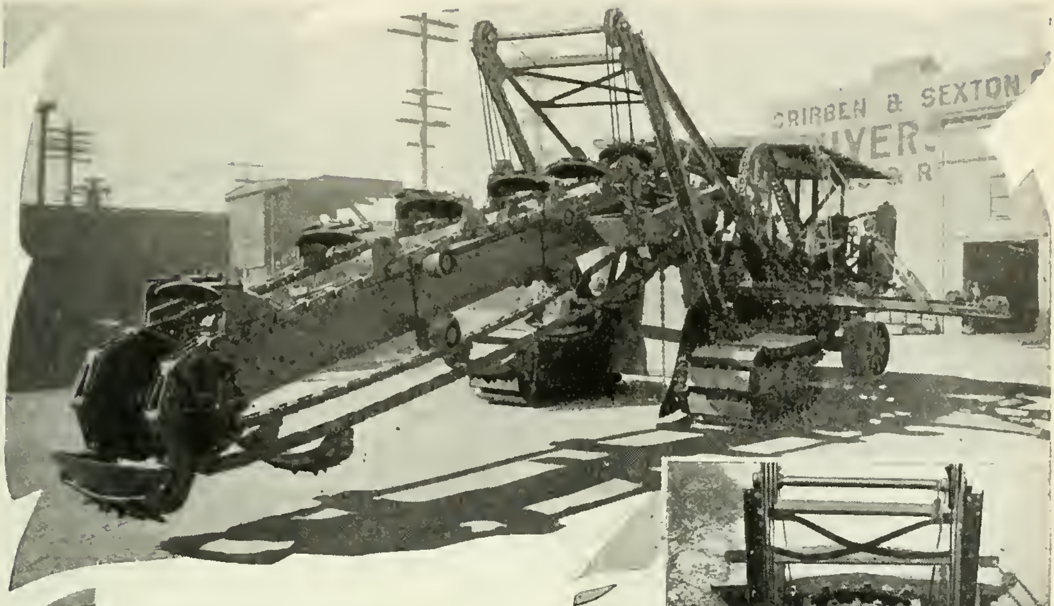
Length of haul in feet	300	600	900	1320	1800	2640
Round-trip time, hrs. and min	3:55	5:35	7:25	9:50	12:25	17:25
Cubic yards per trip	2	2	2	2	2	2
Cubic yards per 10-hr. day	262	214	160	122	96	68

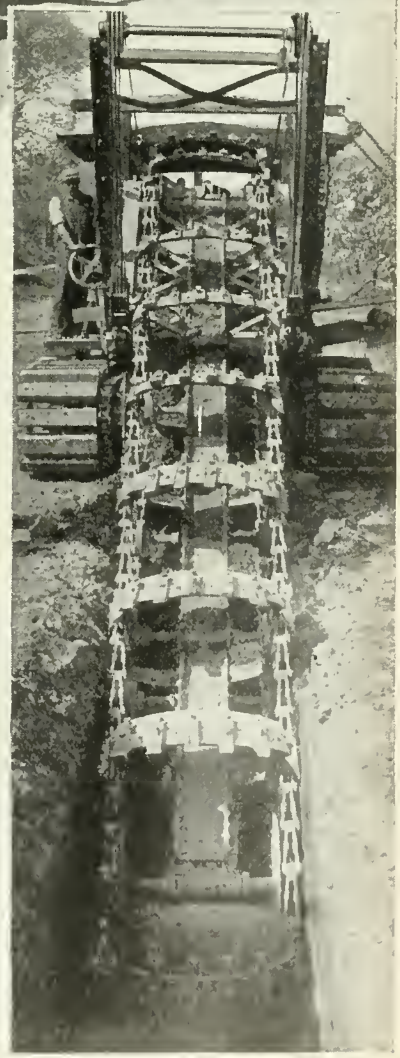
DETAIL TIME TABLE FOR 5-TON "CATERPILLAR" PULLING THREE 4-WHEELED SCRAPERS.

Length of haul in feet	300	600	900	1320	1800	2640
Round-trip time, hrs. and min	4:45	6:10	8:10	10:35	13:20	18:10
Cubic yards per trip	3	3	3	3	3	3
Cubic yards per 10-hr. day	360	270	210	150	120	90

Note.—The above calculations are based on round trip times that include over 15 per cent. for lost time, or more than 1½ hours per day. The table is not intended to show an absolute or guaranteed daily yardage. It was made from operations run under average conditions on level ground, and shows results that may be expected if the outfit is eifficiently handled.

Page 28 shows dynomometer record of 5-ton "Caterpillar" pulling 3 Maney four-wheel scrapers, which was taken February 15, 1921, through rolling field. Soil,





Coming Events Cast Their Shadows

Mother Earth fairly trembles at sight of the buckets with their sharpened steel teeth ready to bite a deep trench at the will of the one operator who controls this earth-eating monster.

Big, though it is, every part is carefully and thoroughly made. Every steel plate and girder is rolled before riveting—one reason for its resistance to side strains. In action or idle it is a machine that the engineer is glad to inspect.

And close inspection reveals the reasons for the greater digging capacity and the ıow maintenance costs. It also shows why the initial cost is more, and why it it the lowest in cost for a given period of years.

Bulletin IX describes wheel type excavators as well as the latest ladder type illustrated above. Write for a copy today.

EXCAVATING MACHINERY DIVISION

PAWLING & HARNISCHFEGER CO.

In Milwaukee, Wisconsin, since 1884

New York, 50 Church Street	Los Angeles, Central Bldg.
Philadelphia, Stephen Girard Bldg.	Seattle, L. C. Smith Bldg.
Pittsburgh, Fidelity Bldg.	Portland, Yeon Bldg.
Chicago, Monadnock Block	St. Louis, Blackman-Hill-McKee Mach. Co.
New Orleans, Whitney Central Bldg.	Birmingham, C. B. Davis Eng. Co.
San Francisco, Monadnock Bldg.	Salt Lake City and Denver, Landes & Co.

and Agents in 16 Cities.

POUNDS PULL ON DRAWBAR.

		Maximum	Average
Loading first scraper		6,200	4,960 at 1½ miles per hr.
Loading second scraper		5,800	4,520 at 1½ miles per hr.
Loading third scraper		6,000	4,800 at 1½ miles per hr.
Hauling loaded scrapers—			
	Maximum		2,800 at 3 miles per hr.
	Minimum		1,600 at 3 miles per hr.
	Average		2,140 at 3 miles per hr.
Dumping—			
	Maximum		3,100 at 3 miles per hr.
	Minimum		1,800 at 3 miles per hr.
	Average		2,540 at 3 miles per hr.
Turning empty—			
	Maximum		1,360 at 3 miles per hr.
	Minimum		960 at 3 miles per hr.
	Average		1,160 at 3 miles per hr.
Returning—			
	Maximum		1,500 at 5.71 miles per hr.
	Minimum		500 at 5.71 miles per hr.
	Average		928 at 5.71 miles per hr.

(*) Note.—The pounds pull on drawbar required to load first scraper is higher than that required to load second and third, because scraper operator took an extra deep bite with his pan and took up a load greater than 1 cu. yd.

medium damp clay, showing all phases of operation within guaranteed drawbar horse power of the tractor.

From costs on four months time already put in on the contract, Mr. Mitchell figures that his "Caterpillar" tractor outfit shows him a saving of from 20 to 25 per cent. over the cost of doing the same work with teams. His outfit is so flexible that it can be efficiently applied to any conditions likely to be encountered without loss of time and in the most economical way.

PROFITABLE ADAPTATIONS OF AN EXCAVATOR AND LOADER IN PITS AND QUARRIES

In the sand pits of the Belt Line Brick Co., Minneapolis, an interesting "two-man-machine" has been doing the work of 20 to 30 laborers daily.

In Minnesota Sand Pits

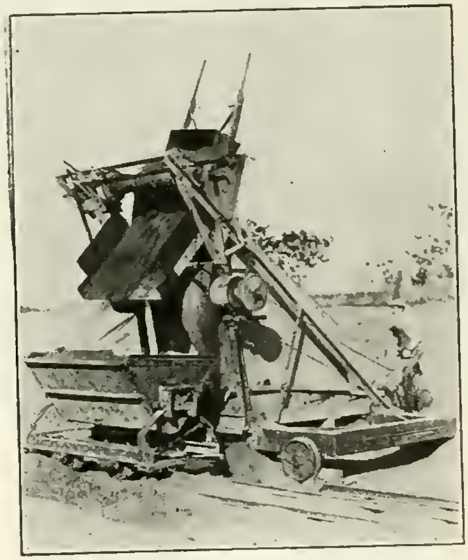
At the edge of the sand pit, as shown in the illustrations, two sets of tracks were laid. One was a narrow-gauge, over which industrial cars were hauled. The other track had a gauge of about 18 ft. and carried a wide, four-wheeled truck, on which had been mounted a Smith excavator and loader. The two sets of tracks were parallel, arranged so the machine could load directly into the cars of the industrial train.

Each car holds about two loads from the machine, which digs the sand and loads it into the cars, with only two men on the job. When necessary to move the digging point in the pit, the truck on which the excavator was mounted was merely rolled along its track to the desired position.

The machine is a portable dragline excavator and loader, ordinarily mounted on its own trucks and designed so it can be

SMITH EXCAVATOR AND LOADER WORKING AT GRAVEL PIT FOR ST. LOUIS COUNTY, MINN.

hauled by a team or motor truck from one location to another. It operates a digging slip or scraper similar to the ordinary horse-drawn scraper. This scraper digs in a radius up to 100 or 150 ft. from the machine. One man guides the scraper while it digs. When full, the scraper is hauled up to the machine unattended. The loaded scraper then rides into the pivoted arms of the excavator, which elevate it over the machine and the load is dumped into the waiting cars. One man operates the machine; one man guides the scraper.



SMITH EXCAVATOR AND LOADER LOADING SAND INTO INDUSTRIAL CARS.

Two hundred and fifty yards of sand per day was an easy average day's work for two men on the Belt Line Brick Company's pit.

The above adaptation of the Smith excavator and loader was unusual only in that the machine was mounted so as to run on rails, as explained above. Ordinarily the machine, on its own trucks and wheels, would be placed at any convenient spot, on solid ground, near the pit or excavation or material pile on which the work was to be done.

The fact that the machine itself works on solid ground and never has to get into the hole, is an important feature. Steam shovels and other excavating devices have to work in the hole. They have to load their wagons, trucks or cars in the hole. But the Smith excavator loads its wagons, trucks or cars on solid ground or up on their regular tracks, in the case of cars, and for that reason full loads can be taken each trip. At the same time there is no necessity for using snatch teams where the Smith excavator is working, as is necessary with steam shovel work, to help haul even the lighter loads out of the hole.

As Used by a Chicago Sand and Gravel Producer

A sand and gravel producer in Chicago, the H. Bairstow Co., found that an average of 50 per cent. more was hauled on each load when using this excavator as compared with loads that had to be hauled out of the hole when using a steam shovel. Quoting Mr. Bairstow: "We now load 3 cu. yds. to a load from the excavator. Formerly we could not average 2 cu. yds. while making a 9-ft. sand excavation. The excavator handles from 300 to 350 cu. yds. (wagon measurement) per day. The saving in horses would more than equal the cost of operating this machine." And he reports also that 2 men with this machine eliminated 15 laborers, 1 foreman and 3 snatch teams.

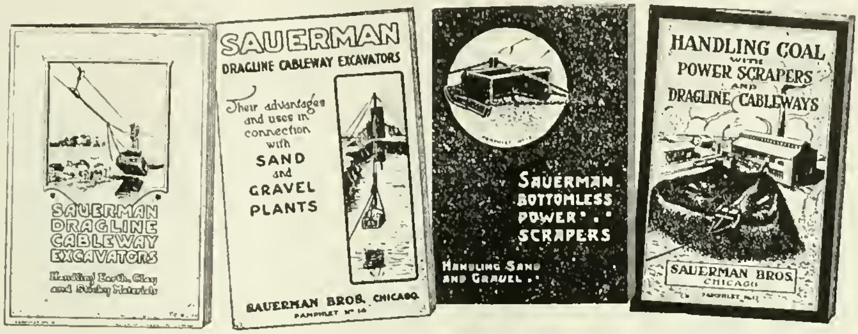
Another interesting feature of this machine and the fact that it remains out of the hole, on solid ground, is that when a job is finished, the machine is easily hauled away without any preliminary preparations or waste of time. There is no planking, blocking out or hoisting to be done. A team is hooked on, or a motor truck, and the excavator is moved to the next job as easily as if it were an ordinary wagon.

As Used by an Arkansas Gravel Producer

In Arkansas, the Benton Gravel Company, of Benton, used one of these Smitth excavators in their gravel pit. Their pit was a tough one for any machine work. They were getting out road ballast, which was formed in the pit almost as hard as concrete. This problem was easily solved by attaching a strong plow to the dragline cable in place of the digging slip, or scraper, and thus using the machine's power to break up this hard material. After breaking the surface with the plow, the scraper was again attached to the cable and the digging and loading was easy. The machine, in this case, was placed at the freight cars, so that the gravel was hauled in the scraper out of the pit and loaded directly into gondolas at a big saving of time and labor. Two men averaged 35 yds. an hour on this difficult work, according to H. J. Archer, manager of the Benton Gravel Company.

This machine can be adapted to many phases of digging and loading problems where heavy machinery is impracticable

Which of these Booklets do *You* Want?



Pamphlet No. 15 gives details and illustrations of the various types of dragline cableway excavator installations that interest engineers, dirt-moving contractors and clay plant owners.

Pamphlet No. 14 is a handy compilation of data on the dragline cableway excavator method of excavating and conveying sand and gravel, illustrated with many views of typical installations.

Pamphlet No. 12 describes the latest developments in the use of mechanical drag scrapers for handling gravel from hillside, and explains the adaptability of power scrapers for small pits.

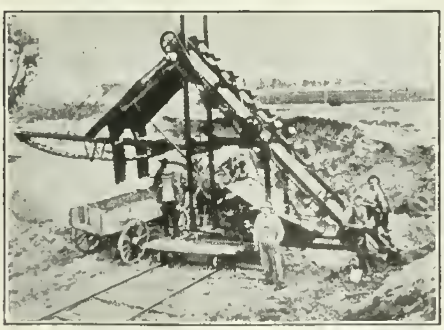
Pamphlet No. 11 illustrates practical solutions of various coal storage problems by use of scrapers and dragline cableways, some of this data being now published for the first time.

We invite your request for any or all of the above booklets.

SAUERMAN BROS., 1142 Monadnock Bldg., **CHICAGO.**

The Michigan Jr. Gravel Screener and Loader

Takes Gravel out of Pit or Pile, Screens out Sand and Stones and Loads the Gravel into Wagons or Trucks.



Calhoun County (Mich.) owns *four* machines, and contractors own *three* others, making *seven* in one county.

The Michigan Jr. holds the low record of cost of handling screened gravel from pit to wagon or truck. This is the all-important consideration, Mr. Contractor. This saving is your profit.

Machine runs up and down side of pit or pile on a track and takes off slice of about ***four*** ft. each time. After going along track once, track is moved over and loader returned along side of pit or pile.

The Screener and loader is self-contained, furnishing own power, and has attachment on screen that prevents clogging with clay, clods, etc.

Machine has elevating capacity of ***one yard per minute,*** and the only operating expense is salary of three men, under ordinary conditions. One operates machine and two break down embankment.

Sand and stone are conveyed 20 ft. away and do not have to be moved. Machine moves under own power. Easily moved from one pit to another. It is all steel, engine enclosed. ***Saves $30 to $50 a day*** in expenses and makes money in handling gravel.

For further particulars write to

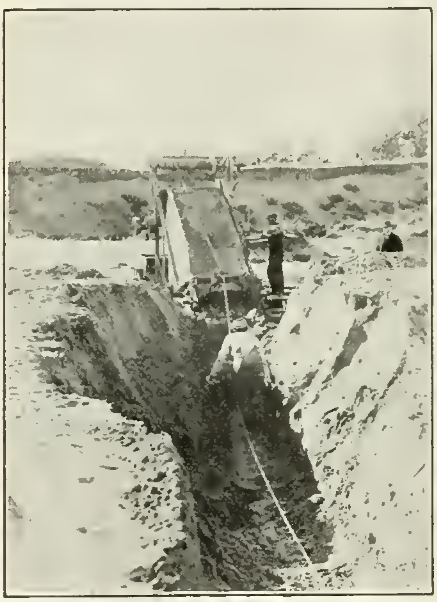
THE JORDAN & STEELE MFG. CO., Inc.

CHARLOTTE, MICHIGAN

and hand labor is too slow and costly. Excavating cellars or basements for buildings, loading coal, stone or other materials at yards, for heavy plowing, digging and loading sand and gravel, grading or excavating alleys, streets and roads, cut-and-fill work, stripping the overburden at quarries, etc.

As Used by County Road Officials

County commissioners are using the Smith excavator, for instance, in gravel pits and on road work. Green County, Wisconsin, has used one in a gravel pit, loading gravel directly into their crusher. St. Louis County, Minnesota, has used one with marked success in gravel and



SMITH EXCAVATOR AND LOADER DIGGING IN SAND PIT.

crushed stone digging and loading and on cut-and-fill road work. Sheboygan County and Green Lake County, Wisconsin, have both used these machines successfully on road work and in pits.

It is a speedy, economical and efficient machine—easily operated and capable of standing lots of hard service.

Operating Details of the Machine

These operating details may prove of added interest: The scraper, or digging slip, is controlled by the two cable drums —the hoisting drum and the retrieve drum. The hoisting drum has two speeds, permitting a digging speed for the scraper of 106 ft. per minute. When the scraper is filled, it can be hauled to the machine at the rate of 206 ft. per minute. In that same speed it is elevated to the point where the load is dumped. Then the pivot arms descend with the scraper and the retrieve drum carries the scraper back to the man in the hole at the speed of 228 ft. per minute.

The machine is furnished complete with digging scraper, cables, sheaves and blocks, bridle chain and stakes, wagon pole and all the necessary accessories. An 18-h.p. two-cylinder motor is used in this machine, with water-cooling tank. The frame of the machine consists of heavy channel steel, hot-riveted and strongly gusseted. Top and sides of upper frame consist of sheet metal bolted to frame and forming a house over main machinery and power unit. All parts are easily accessible and protected against dirt and rain. Complete shipping weight of the machine with all fittings is 11,000 lbs.

The Smith excavator and loader is made by the T. L. Smith Company, Milwaukee, manufacturers of concrete mixers, pavers and construction equipment for over 20 years. The excavator has been on the market for about 8 years, and during that time it has gone through a series of changes, dictated by actual operating conditions, until it is now on a high plane of efficiency. The machine costs considerably less than a steam shovel, and, as one user said, "it fills the gap between the expensive steam shovel and the still more costly gang of hand shovelers."

RELAYING GRANITE BLOCK PAVEMENT ON ASPHALT MACADAM BASE AT PROVIDENCE, R. I.

When the Department of Public Works of Providence, R. I., had to relay a considerable yardage of old granite block pavement last year, the engineers decided to use an asphalt macadam base under the relaid blocks. It is interesting to note the procedure in this construction.

The old granite block pavement was laid originally partly on a 6-in. cement-concrete foundation and partly on a rolled broken stone base. Much of the pavement had settled in places after undergoing considerable traffic, and it was found necessary last year to relay the block.

The first step was to take up and clean the old blocks thoroughly, no recutting being necessary. The sub-base was of gravel, varying in thickness up to 8½ ins. This sub-base was rolled thoroughly, and on top of it was placed 2-in. trap rock, which was rolled to an average depth of

3 ins. Smaller sized trap rock was spread and rolled to fill the larger voids.

This stone was then given a penetration treatment of No. 96 Texaco Asphalt, using about 1½ to 1¾ gals. per square yard. Stone chips were then spread and the base was rolled. Following this a sand cushion 1 in. or more in depth was spread on the asphalt macadam base, and on this cushion the granite blocks were relaid.

After the blocks were laid, and a small amount of stone chips had been swept into the interstices, the joints were filled with Texaco Asphalt. Sufficient asphalt was spread so as slightly to flood the surface of the blocks for about one-third their area.

After the Texaco asphalt filler had been applied, the surface was covered with clean stone chips and rolled, after which the street was open to traffic.

The engineers in charge are thoroughly pleased with the results, and the street offers an excellent thoroughfare for heavy traffic with a minimum of noise.

"LE CLAIR" SCRAPER ADDED TO SAUERMAN BROS.' LINE

The "Le Clair" power drag scraper is now being manufactured and sold by Sauerman Bros., 1142 Monadnock Block, Chicago, under an agreement with Mr. S. D. Le Clair, of San Francisco, Calif., owner of the patent rights.

VIEW OF "LE CLAIR" POWER DRAG SCRAPER IN OPERATION.

The "Le Clair" scraper, as will be noted from the accompanying illustration, is simple in construction and combines light weight with large capacity. In conjunction with the three types of Sauerman bottomless power scrapers, which are known as the "Crescent," "Excavator" and "Type C," the "Le Clair" gives Sauerman Bros. a complete line of scrapers for excavating and moving all classes of materials. Thus, Sauerman engineers, in planning power scraper installations for gravel pits, coal storage yards and so forth, now are in a position to employ any one of four differently designed scrapers, and can specify whichever is best suited to the conditions and requirements of the proposition then under consideration.

PERSONAL ITEMS

Mr. Edmund T. Perkins, M. A. S. C. E., First National Bank Building, Chicago, Illinois, sailed on March 15th for Barranquilla, Colombia, South America. Mr. Perkins goes to South America to report upon construction work in which American capital is interested.

Gunni Jeppesen, formerly Chief Engineer of the Strauss Bascule Bridge Company, has joined the Chicago Bascule Bridge Company as Associate Engineer. Mr. Jeppesen, who is a graduate of the State Polytechnical Institute at Copenhagen, Denmark, was connected with the Strauss Company for twelve years, from its inception until 1917, and since then has been engaged in industrial plant work as Structural Engineer of the Leonard Engineering Company.

Captain O. F. Healey, recently promoted to the office of Assistant City Engineer of Chicago, has been in the service of the city for five years with two years' service in the army. He was Captain of Engineers in charge of construction in the northwest quarter of France on the staff of the Director General of Transportation. Formerly he was Engineer of Contracts for the city. Under his regime there was installed a standardized and business-like system of contracts. Among the important engineering positions he has held was that of Assistant Chief Engineer of the Gravity Water Supply for Tacoma, Wash. He is a native of Aurora, Ill., and a graduate of the University of Chicago.

Holbrook, Warren and Andrew is the name of the corporation which has purchased the business of Miller, Holbrook, Warren and Company, Decatur, Ill. Under the latter name, the firm has built up a substantial professional business in the structural and municipal fields. Mr. Frank D. Holbrook was engaged for a period of about 15 years on Ohio River improvements for the U. S. Government. Mr. Willis D. P. Warren has been engaged in various classes of engineering work in Illinois for the past 17 years, devoting the greater portion of this time to municipal projects. Captain Clarence R. Andrew was formerly with the Government on Ohio River improvements and served in France in the Engineer Corps.

Contracts Awarded

ROADS AND STREETS.

Ala., Gadsden—Southern Paving & Constr. Co., Chattanooga, Tenn., awarded contract for street paving here at $171,708. A number of residence streets will be paved with asphaltic conc. One or two short streets in wholesale business dist. will be paved with vitr. brick.

Ariz., Tucson—L. Hoopes, Miami, awarded contract by St. Hwy. Comm. to construct 12½ miles paved road between Paso Robles and the Estrella River, San Luis Obispo Co., at $270,767.

Cal., Oakland—Bates & Borland, Oakland, awarded contract by St. Hwy. Comm. to construct 12½ miles paved road betw. Paso Robles and the Estrella River, San Luis Obispo Co., at $270,767.

Cal., Sacramento—Lynn S. Atkinson, C. C. Chapman Bldg., Los Angeles, awarded contract for paving with conc. 15.4 mi. State hwy., Kern Co., at $258,251.

Colo., Boulder—Strang & McGuire Co., Utah Savings & Tr. Bldg., Salt L. City, awarded contract for 53,000 sq. yds. paving in business dist.; asph. on conc. base; $202,589.

Colo., Rocky Ford—Strang & McGuire Co., Utah Savings & Tr. Bldg., Salt L. City, awarded contract for paving 23 blocks Main St., Warrenite-Bitulithic, at $161,854.

Colo., Denver—State Hwy. Dept. let contracts to Monaghan & Cunningham, 1711 Market St., Denver, for grading, draining and sand-clay surfacing 5,912 miles Brush-Akron Rd., F. A. P. 39, Morgan Co., at $24,929; 4,497 mi. Salida-Canon City Rd.; F. A. P. 113, Chaffee Co., at $51,891, 3,087 mi. Del Norte-Saguache Rd., gravel F. A. O. 100, Rio Grande Co., at $23,298, 3.1341 mi. Dolores-Cortez Rd., gravel, F. A. P. 126, Montezuma Co., at $29,580; J. V. Stryker, 1507 Blake St., Denver, contr. for grading, draining, etc., 5.36 mi. Peyton-Ramah Rd., F. A. P. 55, El Paso Co., at $45,247; Mison, Clark & Teyssier, 204 W. 15th St., Pueblo, for grading, draining and surfacing 4.091 mi. rd—Bayfield to Archuleta Co. line, gravel, F. A. P. 101, La Platta Co., $41,378; E. O'Neil, Meeker, grading & surfacing 1.8 mi. Rifle-Meeker Rd., F. A. P. 128, Rio Blanco Co., at $14,321; W. B. Cheek, 213 Plum St., Ft. Collins, paving 1.333 mi. Ft. Collins-Loveland Rd., conc., F. A. P. 85, Larimer Co., $33,235; F. C. Dreher, 525 Coper Bldg., Denver, paving 1.117 mi. Longmont-Denver Rd., conc. F. A. P. 88, Boulder Co., at $29,643; Denver-Brighton Rd., conc., F. A. P. 89, Adams Co., $86,795; G. A. Dalgren, So. Cimarron St., La Junta, paving 1.377 mi. La Junta Cwink Rd., conc., F. A. P. 96, Otero Co., at $44,054; J. H. Rice, Buffalo, Wyo., paving 1.273 mi. Denver-Arvada Rd., conc., F. A. P. 120, Jefferson Co., at $30,805; Levy Constr. Co., Symes Bldg., Denver, bldg. two-span conc. brdg. on La Jara-Alamosa Rd., F. A. P. 124, Conejos Co., $11,924; L. Robbins, Box 41, Boulder, bldg. 2 conc. brdgs. over Brush Gollow Crk., and Chandler Crk. on Florence Canon-City Rd., and Florence-Penrose Rd., Fremont Co., at $3,632 and $7,091, respectively.

Iowa, Des Moines—C. O. Mitchell, S. 15th St., Des Moines, awarded contract for grading Runnels Hwy., at 38½c, 117,600 cu. yds. earth.

Ky., Glasgow—R. B. Tyler & Co., 144 S. 4th St., Louisville, awarded contract for bldg. 11 miles rd.

from Glasgow north to Hart County Line, 16 ft. wide., Ky. rock asph. on old Telford base, at abt. $470,000.

Md., Baltimore—State Rds. Comm., 601 Guardian Bldg., Baltimore, let contracts for paving (1) 2½ mi. rd. from Denton to Prestons, Caroline Co.; (2) 1½ mi. lateral joining Salisbury and Ocean City Rds., Wicomico Co.; (3) 3 mi. link in Easton-Claiborne Rd., Talbot Co., (4) 3.62 mi. DuPont Blvd., Worcester Co., (5) 2¼ mi. rd. from Bethel Ch. to Black Horse, all concrete, to A. B. Sandridge & Co., Georgetown, Del., (1), $78,496; D. A. Hannaman Constr. Co., Salisbury; (2) $78,496, Piel Constr. Co., Edmondson Ave., Baltimore; (3), $96,954; (4), $133,-312, W. H. Hohn, Port Deposit, (5), $75,651.

Minn., St. Paul—Fielding & Shepley, Princeton St. and Mt. Curve Blvd., awarded contract for paving 5 miles St. rd. No. 4—city limits to Lake Ave., White Bear, except dist. betw. Kohler Rd. & Goose Lake Crossing, 20 ft. wide, F. A. P. 177, Warrenite Bitulithic, at $329,866.

Mo., Kansas City—Norton Bros., Kansas City, awarded contract for grading, regrading and constructing retaining walls on Twenty-third St., traffic Way link, at $345,070.

Magnolia, Miss.—Nealy Constr. Co., Jackson, Miss., awarded contract for 6.4 miles vitr. brick road betw. Magnolia and McComb City, at $238,863.

Mo., New Madrid—W. D. Lonergan, awarded contract for 19.81 miles, F. A. P. 40, width 24 ft., at $237,351. 186,658 sq. yds., one 6-ft. gravel surfaced pavement; also 4 bridges.

N. Y., Albany—State Hwy. Dept. let contracts for improving 4.69 mi. Belmont-Phillips Crk., Part. 1, Rd. 1559, Allegany Co., to H. W. Patterson, Hornell, at $147,878; 2.28 mi. Rhinebeck-Rhinecliff Rd., $1530 Dutchess Co., to Kennedy Constr. Co., Albany, at $78,301; 2.71 mi. Attica-Batavia Part 1, Rd. 8022, Genesee Co., to Oatka Engrg. & Constr. Inc., Warsaw, $91,189; 8.37 mi. Carthage-Antwerp, Part 3, Rd. 8023, Jefferson Co., to Smith Bros. Constr. Co., Lyons Falls, $259,522; 5.99 mi. New Woodstock-Cazanovia Rd. 8024, Madison Co., to G. W. Chambers, Rochester, $184,340; 2.99 mi. Sheridan Blvd.-Burnside Ave.—Rockaway Turnpike, Rd. 1396, Nassau Co., to Clemento Constr. Co., Inc., New York City, at $17,993; 2.85 mi. Defreesville-West Sand Lake Rd. 5658, Rensselaer Co. to Malloy Constr. Co., Schenectady, at $113,448; 3.46 mi. Pattersonville-Scotch Ch. Rd., 1482, Schenectady Co., to W. L. Lawton, Glens Falls, at $124,651; 725 mi. Candor-Danby Rd. 8026, Tioga Co., to N. E. Young, Union, at $234,042; 5.68 mi. Salamanca-Elliottville, Part 2, Rd. 1509, Cattaraugus Co., and 5.41 mi. Rd. 1039. Rep. Con. 1286, Onondaga Co., to Greenfield Constr. Co., 89 Main St., Hornell, at $218,858 and $55,553, respectively; 3.94 mi. Fayetteville-Chittenango, Part 1, Rd. 8025, Onondago Co., and 9.37 mi. Williamtown-Redfield Rd. 8029, Oswego Co., to J. Johnson Constr. Co., 765 Abbott Rd., Buffalo, $138,861 and $263,600, respectively; 0.59 mi. Suffern Village; Lafayette Ave. Part 1, Rd. 1535, Rockland Co., and Suffern Village; Lafayette Ave. Part 2, Rd. 5649, Rockland Co. to Fleming, O'Brien & McEntegart, Inc., 401 W. 59th St., New York City, at $23,907 and $32,674, respectively.

N. C., Hickory—Atlantic Bitulithic Co., Richmond, awarded contract to lay 40,000 sq. yds. street paving and sidewalk, at $2.91 per sq. yd., or total of $161,000.

Ohio, Columbus—Mannix Bros., Findlay, awarded contract for grading, bldg. bridges and culverts and paving 3.202 miles Sec. B, Greenville-Covington Rd., brick, at $177,112.

Okla., Muskogee—Healy Constr. Co., Muskogee, awarded contract for 23 miles gravel road, Muskogee Co., at $262,171.

Okla., Tulsa—Contracts totaling $834,375.46 let for paving ten streets as follows: Tibbetts & Pleasant, Louis Ave., at $78,396; Columbia Ave., $27,410; 7th St., $181,303; 6th St., $80,215; 5th St., $97,708—total $465,033; Comstock & Smedley, 8th St., $125, 760; 9th St., $132,346; Evanston St., $21,-422; College Ave., $30,047; 5th Pl., $59,765; total, $369.341. Paving is to be 7-in. conc. without special surfacing.

Ore., Portland—Independent Asphalt. Paving Co., Seaboard Bldg., awarded contract by St. Hwy. Dept. of Oregon to pave approx. 10 miles hwy, at $321,056.

Ore., Salem—State Hwy. Comn. let contract for paving 10.55 mi. Hood River, Mosior Sec., Columbia River Sec., 16 ft. wide, Hood River and Wasco Cos., to A. O. Kern, Portland, at $350,915; 6.72 mi. Forest Grove, Gaston Sec., Tualatin Valley hwy., 16 ft. wide, Washington Co., also grading 5.12 miles Barclay Springs, Tammis Mill Sec. and the Dallos-California Hwy., Klamath Co., to Warren Constr. Co., Journal Bldg., Portland, at $224,754 and $69,122, respectively; 8.57 miles Salem So. Section, Pacific Hwy., Marion Co., to J. E. Bonnell, 760 Commerce St., Tacoma, at $280,139.

Pa., Harrisburg—St. Hwy. Commr. Lewis B. Sadler, awarded contrs. for road impvts. in 8 counties as follows: John Herman, Latrobe, Pa., to build 6895 ft. one-course rein. conc. rdway., Route 68, New Alexandria and Salem twp., Westmoreland Co., at $89,577; Chester General Contracting Co., East Liverpool, Ohio, for constr. of 26,953 ft. conc., Route 204, Darlington Boro. and Darlington Twp., Beaver Co., at $547,676; Heyman and Goodman, Jersey City, N. J., to build 36,706 ft. conc. rdway., Route 151, Doylestown Boro. and Warrington and Doylestown Twps., Bucks Co., at $417,713; Torquato Brothers' Co., Windber, Pa., to build 16,819 ft. conc. rdway, Route 222, Scalp Level Boro. & Richland Twp., Cambria Co., at $205,361; Souder Constr. Co., Lancaster, Pa., for constr. of 11,459 ft. rdway, Routes 41, 42, 44, 123 and 298, Gettysburg Boro. and Cumberland Twp., Adams Co., at $174,090; Chas. H. Fry Constr. Co., Erie, Pa., for constr. of 9,924 ft. conc. rdway. on Route 86, E. Springfield Boro., Erie Co., at $108,715; T. L. Evans & Sons, Danville, Pa., for constr. of 19,487 ft. rdway. on Route 3, Cooper & Montour Twps., Montour and Columbia Cos., at $228,036. On first 3 projects mentioned and on fifth project, borough pays cost of extra width of paving.

S. C., Newberry—Southern Paving & Constr. Co., east 11th St., Chattanooga, Tenn., awarded contract for paving various streets, at abt. $180,000.

Tenn., Jackson—E. D. Harvey & Co., Memphis, Tenn., awarded contract by St. Hwy. Dept. for 56¾ miles State Hwy., Madison Co., at $198,780.

Tenn., Memphis—Oliver Constr. Co., Little Rock, awarded contract for conc. surfacing rd. from Memphis to Marion, 8½ miles, at $255,200.

Tenn., Sparta—A. F. Beardon, Birmingham, awarded contract for 13½ miles St. Hwy. No. 1, White Co., at $354,240.

Tex., Fort Worth—Texas Bitulithic Co., Dallas, award. contr. for 140,000 sq. yds. street paving at $494,200.

Tex., Marlin—Cook & Arrington, Crockett, Tex., and Harris & Powell, Tyler, Tex., awarded contract for 46 miles of roads at $308,000. 43,633 cu. yds. gravel surfacing.

Tex., Marshall—Harrison Co. let contract to Smith Bros., Crockett, and Healy Constr. Co., Dallas, for 24.9 miles hwy. No. 8, 12 ft. wide, gravel base, at $263,436.

Tex., Rusk—Smith Bros., Crockett, Tex., awarded contract for impvt. of 40 miles of roads, Cherokee Co., at $200,000.

Va., Martinsville—G. T. Franklin, Bassetts, Va., awarded contr. for 10 miles sand clay rd., $250,000 available.

Va., Wytheville—Wise County let $350,000 contracts for road construction as follows: G. W. Scott—road from Appalachia to Linden; Wise Constr. Co.—road from Big Stone Gap to East Stone Gap, etc.; Collier & Bruce—road from St. Paul to Russell Co. line; Berks Constr. Co.—road from Norton to Wise. All waterbound macadam, with exception of Norton-Wise road, which will be bitum. macadam.

Wash., Olympia—Following contracts let for state highway work: Olympia Hwy., Thurston County line to Kamilche, Mason County, to Wood Bros. & Tomei, Pt. Angeles, at $114,522; National Pk. Hwy., Muck Crk. to Ohop, Pierce Co., to J. W. Hover & Co., Everett, at $153,097; Pacific Hwy. at brdg. over Nisqually River, Pierce and Thurston Cos., Nisqually embankment, to Anderson & Lilljeback, Tacoma, at $28,939; Pacific Hwy., Blanchard to Allen, Skagit Co., to Skagit Constr. Co., Mt. Vernon, at $192,383; Pacific Hwy., Pioneer to La Center, Clark Co., to T. M. Morgan, Everett, at $196,471.

W. Va., Martinsburg—P. Flanigan & Sons, Baltimore, awarded contr. for street paving at $184,040.

Wis., Green Bay—Following contracts let for road work: Green Bay-West De Pere, Green Bay-Manitowoc, Green Bay-Shawano roads, to Rudolph Hansen Co., Green Bay, at $279,896; Bay Shore-Benderville Rd. to Ed. Shuster, Denmark, at $19,-680; Humboldt Rd., to Brogan & Burns, Green Bay,

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

PUMPING WATER SUPPLY OF CLINTONVILLE, WIS., DURING EMERGENCY WITH F W D FIRE TRUCK.

Motor Truck Operation and Accounting LXX

SHOULD ROAD CONTRACTORS BUY OR HIRE MOTOR TRUCKS?

Several expressions of opinion of men in the motor truck industry on whether it is better for road contractors to buy motor trucks or sublet their hauling work to motor hauling contractors, were published in the May issue. Some additional opinions are here expressed. H. C. Horine, of the International Motor Co., of New York City, writes:

"It is obvious, as in any other kind of work where the hauling to be done amounts to considerable volume, such that the trucks can be kept working a satisfactory number of days per week and weeks per year, that there can be no economy in contracting with others to operate trucks at a rate to cover the cost of operation plus a profit for the truckmen. If the road contractor can operate his own trucks as economically as the truckman owning his trucks he is simply saving the profit which he would otherwise have to pay the truckman.

"The advantages of the road contractor owning his own equipment, in addition to this fundamental one of cost of haulage, are many.

"For example: It is possible for the road contractor to employ a perfectly standardized fleet, standardized not only as to make of truck but as to capacity and special body and hoist equipment. This standardization tends to keep all of the trucks moving at approximately the same speed so that work may be laid out and scheduled accurately so that there is no congestion of trucks or delay at the various operations due to the trucks having different speeds. The trucks may all have the same size and speed and consequently loading and unloading of the material will be uniform. If, for instance, the trucks are being loaded by a steam shovel a standardized fleet will each take the same number of buckets of material; if they are dumping gravel, sand, rock, asphalt, etc., each load will be of the same quantity and so may be more easily spotted along the job. All trucks will be the same wheel gage and so may follow the same ruts on new ground. All may be of large capacity, which not only makes for a lower cost per unit of load handled, such as per yard or per ton, but means less total loading, maneuvering and unloading time; fewer vehicles to keep track of; and less interference with the work of the road construction gangs.

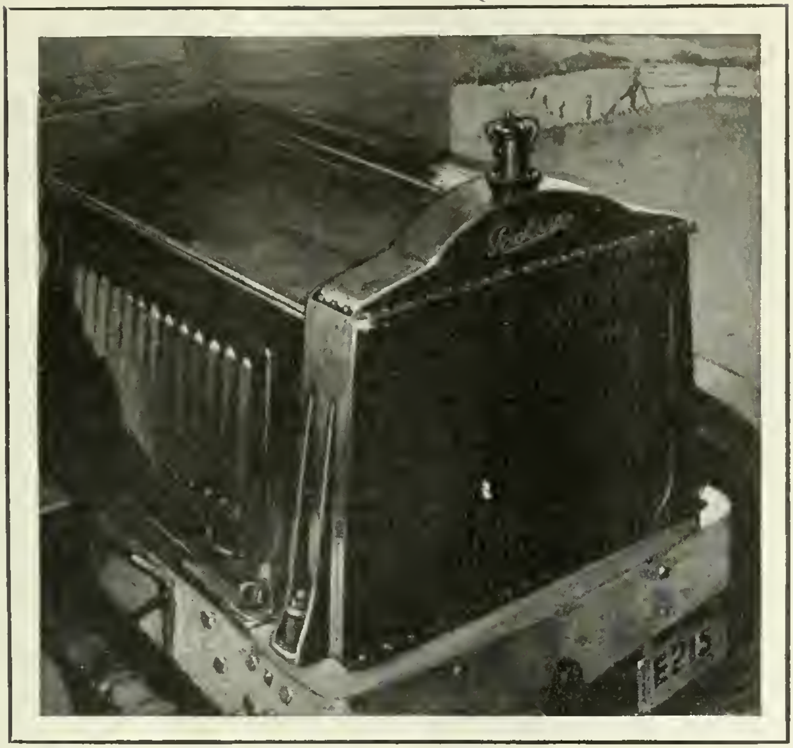
"It is sometimes of advantage for a contractor to own his own trucks when the volume of work to be done is not uniform, inasmuch as in the event of an extra amount of hauling being required overtime or extra shifts may be handled without difficulty and without exorbitant extra charges, or if it is necessary to withdraw one or more trucks temporarily or cut down the amount of work done by each, it is not necessary to pay for work not accomplished nor is there any difficulty about resuming the full schedule of work when it is again required. With hired trucks it is not possible to lay up a truck at will and have it instantly available upon demand.

"It is oftentimes impossible to secure trucks of uniform tonnage or speed when they are hired from truckmen and the rate per day to be paid therefore sometimes is not entirely equitable in each case. There is also some danger, where hauling is done on a tonnage basis, of operators overloading their trucks, which in the case of a new roadbed often does considerable damage and which would be eliminated were the proper distribution of weight to tire width adhered to. In the case where a number of trucks, say from eight upwards, are to be used on a job it is often not possible to hire the entire number required from one truckman and accordingly the cost of maintaining small fleets, particularly mixed fleets, is higher than when the entire fleet is of one type and maintained in one shop."

Mr. George E. Schumacher, secretary of the Available Truck Company, Chicago, writes:

"The average contract for road building we understand is let on a time basis. Regardless of whether this is a fact or not, it is only reasonable to expect that the contractor would make an effort to complete his work in as short a time as possible. We believe that better efficiency could be had by owning his own

PACKARD



Two Years of Work Without an Overhaul

Through more than two years a Packard Truck has carried capacity loads on new and old roads for the county commissioners at Newberry, Michigan. It does not yet require an overhaul.

The Packard Truck is durable. It is able and powerful. In hardest hauls, in exacting service and in unresting, dogged toil, the Packard goes on year after year, earning money for its owner.

Before ever a Packard is sold, Packard transportation engineers analyze the work to be done and then recommend that Packard best suited to meet all conditions. Packards are so rated to their jobs that they can do better hauling at lower cost.

Owners of Packard Trucks have the advantage, too, of local service facilities established nationwide to help maintain all Packard Trucks at the highest possible level of earning ability.

PACKARD MOTOR CAR COMPANY · DETROIT

Ask the man who owns one

trucks which would give him absolute control of his equipment at all times.

"One of the largest problems facing road contractors is to keep the trucks in operation. Very often the construction is being done several miles from either a town or garage. An individual owner is paid on a tonnage basis and he makes a special effort to haul as many loads per day as possible. Very often when he is running low of oil or if his truck should need other attention, he sees nothing but the "dollar" for delivering his load. Very often this neglect results in serious trouble which places his truck out of commission for several hours or possibly days, in which event the contractor would be compelled to hire additional trucks.

Consider the possibility of a contractor operating ten of his own trucks on a road building job. One man would be sufficient to oversee the care of these trucks and compel the chauffeurs to oil and grease and care for their trucks at regular times. Sufficient supplies representing a very small investment would be kept on the job at all times to take care of this service.

"Our experience with dump trucks on road building work has convinced us that this is one of the hardest kinds of services and the most severe test that motor truck equipment can be put to.

"Some owners who are operating from one to three trucks for contractors inform us that the average life of the motor truck on such work is two years as a maximum. This is considering only high grade trucks. We believe that if these trucks were properly cared for and not driven at excessive speeds that at least two years could be added to their life.

"We have not referred to the profits which are derived by contract hauling. Unquestionably these people are making money. We believe that the contractor would add to his profits by owning and controlling his own equipment. We have been given to understand that some of the largest contractors in Chicago own their own trucks, but do not acknowledge this fact. No doubt they have found it a profitable investment or they would not continue to operate their own equipment."

TRANSPORTATION EQUALITY

By M. L. Pulcher, Vice-President and General Manager Federal Motor Truck Co., Detroit, Mich.

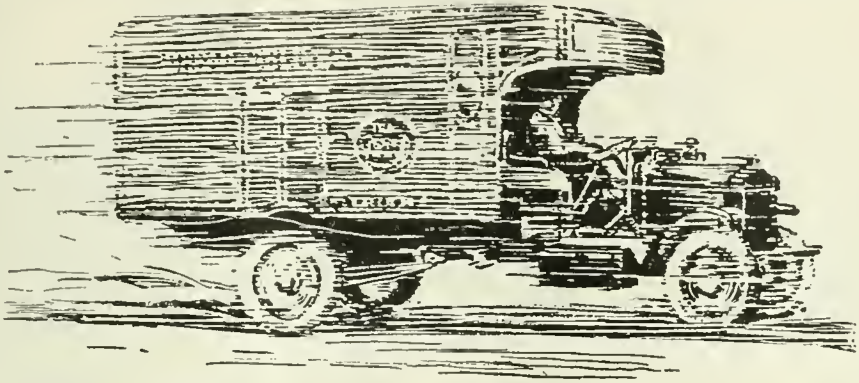
Many states are proposing legislation to limit the load that can be carried by a motor truck to such a degree that thousands of firms and men now owning heavy duty equipment will be forced out of business, and the capital invested in their trucks will be almost a total loss. Also, state and national taxation of motor trucks and passenger cars is being carried to an unreasonable point.

It seems that the old fable of killing the goose that laid the golden eggs has been forgotten, for motor trucks are one of the greatest aids to commerce that we have today. Motor trucks hauled 1,200,000 tons of freight in this country in 1920. This stupendous tonnage was almost one-half that carried by the railroads in the same twelve months, which amounted to 2,504,000,000 tons.

These figures do not represent a competitive tonnage, however, for most of the goods hauled by the trucks were also hauled by the railroads, and vice-versa. If the fast motor haulage had not fed the railroads, then the latter could not have transported this great volume. On the other hand, if the railroads had not borne the burden of the long haul, then the trucks could not have had the shipments to deliver at the other end.

But there are other ways in which the motor truck helps business and government besides quantity of goods hauled. The profits made in manufacturing them are taxed by the government. An additional excise tax is collected on the sale of each motor truck. The eventual owner also pays a state license tax usually based on horse power and weight. And in addition to all this, some states are now collecting a fixed sum for heavy duty trucks. In others, as before stated, they are ruling heavy duty trucks off the road —or taxing them off—which amounts to the same thing in the end.

There are five main means of transportation today—steam, electric, inland waterways, motor vehicle, and horses. Each one is particularly suited to certain kinds of transportation, and should be allowed to do that haulage for which it is fitted with the least hindrance. They all serve the public, which, in the end, is the government. There should be no discrimination against any one of these as opposed to the other. Each should grow and develop in proportion to its usefulness to the country. Certainly, motor truck owners, because they are making a fair living, should not bear a disproportionate part of the expense of government, nor should trucks be legislated off the roads or taxed where other



The Pacemaker

It is a big advantage to owners to buy a modern up-to-date truck which embodies every recent improvement that truck engineering has developed. No change of design is introduced by Pierce-Arrow until proven in use.

Until war demands interfered, every improvement developed was introduced in current production. Experimentation went right on. Now these improvements are embodied in present Pierce-Arrows. They are the most efficient trucks made.

Pierce Arrow

CHASSIS PRICES

2-ton	$3750
3½-ton	4950
5-ton	5700

All Prices F.O.B. Buffalo

THE PIERCE-ARROW MOTOR CAR COMPANY, BUFFALO, N. Y.

forms of highway transportation are not.

If someone answers, "The automobile and truck spoil our good roads," just ponder over this fact—it is the automotive vehicle that has brought us the better highways, and has contributed largely to their maintenance. Two-thirds of the 9,000,000 automobile and 1,000,000 trucks are owned by people whose incomes are $4,000 or less per year. Ninety per cent of these car owners use their passenger cars more or less for business.

As far as traffic laws are concerned, motor truck manufacturers and motor truck operators are agreed that there should be laws governing the gross weight, width and length of vehicle and load, and that the first of these, the weight, should be on the tire-inch basis, but they feel that all states should have a uniform law. Much motor trucking today is interstate, and as they are regulated today operators never know whether they are breaking the laws until they are held for some infraction. Indeed, in many states the laws are so unreasonable that all truck owners are automatically infringing on the regulations.

The Federal Highway Council Uniform Road Law is eminently fair, we believe, to all roads and to all truck owners. This law limits gross weight to 28,000 lbs. and 800 lbs. per tire-inch, and speeds on pneumatic tires up to this limit of weight to 25 miles per hour. Lesser speeds are provided for different weights on solid tires. Fifteen states have already adopted this law, which is endorsed by many highway officials and associations. Legislation that limits weight and speed of motor trucks should be the same the country over, the same as that governing rates on common carriers. These laws, properly enforced, would then govern truck operation properly, prevent undue injuries to the road, and be fair to all concerned.

That our present national government realizes these things, and will eventually bring about an equality of burden on the various forms of transportation is our firm belief, based somewhat on President Harding's own statement that, "The motor vehicle has become an indispensable instrument in our political, social and industrial life, and highways are not only feeders to the railroads and afford relief from their local burdens, but they are actually lines of motor traffic in interstate commerce."

This view is shared by many men high in government and state offices, and will, no doubt, be an influence to discourage discriminatory legislation such as is being now proposed in many states, as well as to influence a sane and less discriminating taxation program.

It is certain that the automobile and truck are vehicles of usefulness. They are common conveyances, necessary to the business man, professional man and the farmer. Such an additional tax on them as was recently proposed by Secretary of the Treasury Mellon would be as senseless as one levied on the farmer's horse and wagon or upon every boat plying our rivers and lakes.

MOVING BY MOTOR TRUCK FROM CHICAGO TO INDIANAPOLIS—"A PERSONAL NARRATIVE"

Several full issues of this motor truck section in recent years have been devoted to the Intercity and Interstate Haulage of Freight in Motor Trucks Over the Highways, and in nearly every issue of this section some facts and figures have been published on this subject. We have consistently advocated the use of trucks for short-haul freighting, so when the editor had occasion, recently, to move his housefurnishings from Chicago to Indianapolis he was pleased to take his own prescription and shipped the goods by truck. In order to record some facts and impressions with reference to this personal experience in motor transportation, for the use of others, the editor is, for the first time, breaking his self-imposed rule never to mention himself or any of his affairs in the columns of this magazine, which is made by and for its readers. Perhaps this one lapse in the observance of the editorial proprieties will be pardoned by readers because of the specific information given. Previous articles have been written from the viewpoint of the motor industry while this is from the viewpoint of the man who paid the bill.

While sentiment favored the truck, the choice was made strictly on a business basis. The complete cost of moving the furniture in seven rooms from an apartment on the third floor in Chicago to one on the first floor in Indianapolis was $195. This figure covered the round-trip of the truck, which ran empty one way. It also included war tax and insurance for $2,000 against fire, theft, collision, upset or flood. The distance between the cities is an even 200 miles, by the route traversed.

KISSEL

Fleet of 10 Special Kissel Road-builders' Trucks—capacity 3 batches of one yard each.

Kissel Road-Builders' Service

Includes—

Sand and gravel bins with measuring boxes under which trucks drive for loading in less than 15 seconds.

1—Properly designed truck to carry 3 batches of 1 yard each to the mixer.

2—Kissel designed measuring boxes dump correct amounts of sand and gravel into the truck almost instantly.

3—Turn-table that turns loaded truck ahead of mixer in a few seconds.

4—Proper supervision.

The above service made possible delivering a load of 3 batches to the mixer every 5 to 6 minutes, using 10 Special Kissel Road-Builder Trucks on a 6 mile haul or 12 miles round trip.

For further data and photographs address,

Kissel Motor Car Co., Hartford, Wis., U. S. A.

Special Turn-table requiring one man to turn truck completely around in a few seconds.

Kissel-designed skip end.

Kissel Truck dumping second batch into skip of mixer.

KISSEL

About 40 miles of this distance is over paved city streets or concrete highways and the balance is over waterbound macadam and gravel highways which are in good condition. The truck left Chicago at 4:30 one afternoon and reached its destination in Indianapolis at 5 o'clock the next afternoon. Thus but 24½ hours were required for the trip and the movingmen took 3 hours off during the night to catch a bit of sleep.

The truck was of 5 tons rated capacity with van body and long tailgate.

It was not necessary to crate the furniture in moving by truck, and it naturally follows from this that uncrating was also unnecessary. Books were boxed for convenience in handling and dishes and glassware, of course, were packed, but with these two exceptions crating, boxing and packing were dispensed with entirely, even in the case of "pictures on the wall." The movers simply carried the furniture out of one apartment, loaded it onto the truck, swathed it in retired bed quilts, and later unloaded it and carried it directly into the other apartment and their work was done. Not a dish was broken and the few minor scratches sustained by the furniture were no more than is commonly experienced in any move, however short.

The balance of the story pertains to what might have been had we moved by rail. In that case there would have been a charge of at least $25 for cartage in each city. Crating for rail shipment, and to withstand the onslaught of the railway freight handlers, would have cost at least $125 from estimates submitted. Freight would have been $80. Thus the cost of rail shipment would have been at least $255 or $60 more than by truck. Nothing is included in this figure for uncrating, which probably would have been done by the nominal head of the house without pay. It probably would have taken a full week to ship by rail, promises to the contrary notwithstanding, judging by recent experience in shipping office furniture between the same cities.

The avoidance of grief in using the truck was considerable, for it was necessary merely to engage the intercity mover, whereas in moving by rail it would have been necessary to hire two movers, one in each city, and to negotiate with the railroad operatives for the use of one of their numerous but elusive freight cars. All the worry incident to awaiting the receipt of the car for use and its later arrival at its destination was eliminated by the simple device of engaging the truck, which came when it was called and went where it was told without delay.

But one point remains to be mentioned and that is one which will be appreciated by anyone who has had occasion to move. The crating for rail shipment would have required the services of at least three expert craters for three full days and the muss and racket they would have made is more easily imagined than experienced. Thus this crowning offense against domestic tranquility was avoided by the wonderful ease, directness and flexibility of motor transportation. We are much obliged to the motor truck and to the hard, smooth highway.

MOTOR TRUCK NEWS NOTES

Using Truck to Pump City Water Supply

One of the most novel uses of a truck yet reported is that of pumping a city's water supply.

The title-page illustration shows an FWD fire truck at Clintonville, Wisconsin, pumping water for that city's supply into a tower, shown in the distance, which is 164 ft. above the pumping station and approximately one mile away from it.

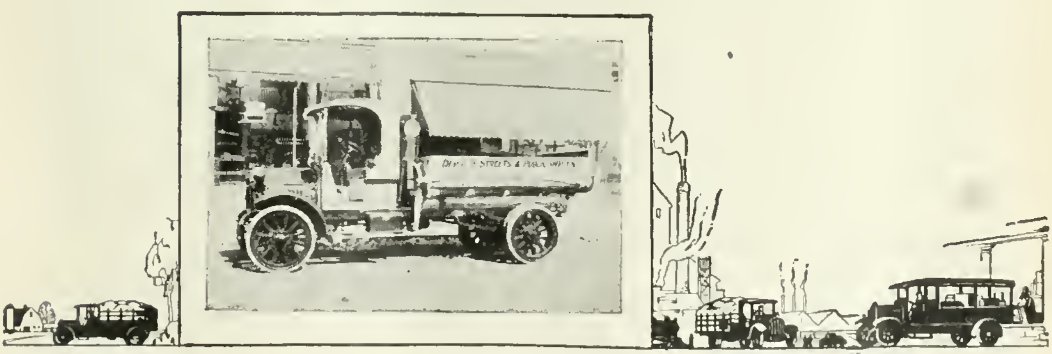
During a recent electrical storm the motors used at the pumping station in that city were burned out and, in the emergency, the fire truck was called upon and filled the bill in a very efficient manner. The truck, equipped with a 500 gal. pumper, was located near the city's well and the intake nozzle lowered into the water. The water was pumped through two lines of hose which were connected to the pipe lines inside of the pumping station.

Is Your Motor Truck Ready for Summer?

The sweltering days of summer will soon be with us and service stations will again be filled with heat-afflicted motor trucks. Will your truck be in the steaming-radiator line? Or is it prepared to give uninterrupted service during the summer months?

Overheating and other common hot weather troubles are usually due to lack of forethought and to mistakes that can be easily avoided. The main points which require attention are briefly outlined below by A. F. Masury, chief engineer of the International Motor Company, manufacturers of Mack trucks.

1. Do you understand the truck's cool-



ing system thoroughly? If not, now is the time to go over it carefully and find out all there is to know about it. See that the flow of water is not impeded by any sort of obstruction and that the overflow pipe is not bent below the level of the base of the radiator filler. Be sure that the overflow pipe is not clogged or flattened.

2. Is the radiator clean? The front of the radiator should be free from dirt, license plates and signs. Also, the back of the radiator should be unobstructed so that nothing will impede the circulation of the air.

3. Are the hose connections watertight and is the hose in good condition? Be sure that the rubber has not been affected during the winter by an antifreeze solution. Only the best quality rubber hose should be used, as the inside tubing of cheap hose is easily worn away and the rubber particles carried along with the water clog up the radiator.

4. Does the fan turn freely and is the belt tension right? The fan should be clean and its bearings should be well greased. A good test is to turn the fan by hand with the engine shut off. If it is possible to slip the belt easily, but not possible to spin the fan, the tension is right.

5. Is the carburetor choke in proper repair so that it opens all the way? Better open the seasonal shutter on the hot-air tube. Is the float level correct? If too high, slight flooding will cause an over-rich mixture.

6. Does the ignition system furnish a spark of sufficient strength? A weak spark due to excessive lubrication of the magneto, dirty breaker or distributor, or weak magnets, will have an effect similar to late spark timing and overheating will result.

7. Are the valve tappets properly adjusted? They should have from 0.008 to 0.010 in. clearance, which may be gauged by about the thickness of an ordinary post-card.

8. Are the cylinders free from carbon? If not, remove it.

9. Is the oil in the crankcase clean? Gasoline, dirt, or other foreign substances will impair the quality of the oil in the crankcase resulting in overheated parts due to insufficient lubrication. The oil reservoir should be drained every 1,500 miles, the walls thoroughly cleaned, and a fresh supply of oil should then be put into the crankcase.

10. Are you using the right grade of oil? Because of the increased temperatures it is often advisable in summer to use a heavier grade of oil than in winter.

11. Are the exhaust pipe and muffler clean? Practically 40 per cent of the heat of combustion escapes through the exhaust. It follows, therefore, that if any part of the exhaust system is obstructed, a part of this heat must be carried off by the cooling water, which will naturally raise its temperature.

12. Are the brakes free? A dragging break will cause overheating in hot weather that might not occur in cool weather.

Legislation Does Injustice to Truck Users

"Legislation limiting the weight of motor trucks should avoid working injustice upon truck owners and creating confusion when trucks cross state lines," says Mr. L. B. West, President of The West Construction Company, Chattanooga, Tenn. "Recently my own company invested $50,000 in 5-ton trucks and had no sooner put them in operation than state legislation was passed limiting the total weight of the truck and load to 7½ tons. It is a known fact that injury to the road is caused by the weight bearing upon each inch of tire in contact with the road surface.

"The only just and practicable basis of restriction is to provide a maximum weight per inch width of tire. The maximum weight adopted in a number of states is 800 lbs. per inch width of tire. If a standard basis were adopted by all of the states the truck manufacturer and truck user could proceed intelligently and without fear of having their product and equipment rendered almost useless by confusing and conflicting state laws. Traffic crosses and re-crosses state lines and it is an unjust absurdity for the owner of trucks operating legally in one state to find, as soon as he has crossed the state line, that he is subject to heavy fines and even imprisonment for using the same trucks in the same manner on identically the same kind of roads as characterized the other state.

"Not only do such conditions work injustice to the truck manufacturer and the truck owner but they are harmful to the taxpayer, for contractors cannot go in and compete in states where a large portion of their equipment may be barred from use and where the contractors who actually bid upon work are restricted to equipment that may not be operated as economically as the heavier units. Truck weight regulation is desirable, but it should be based upon a fairly well standardized conception of the justifiable limit in weight per inch width of tire."

EDITORIALS

THE GREAT AMERICAN DETOUR

Any discussion of present-day practice in laying out, marking and maintaining highway detours becomes an elaboration of the obvious, for it is the partial or complete failure to do what very obviously should be done with respect to detours that makes this a subject worthy of discussion.

Last month we called attention to a few of the fundamentals of this situation. Detours should never be inflicted on the traveling public except where absolutely necessary, and where they are imperative they should be made as short as possible and made and maintained as smooth as practicable. Where the detour is over an earth road this road should be properly maintained with the machinery commonly used on earth road maintenance. If a little-used earth road becomes a much-used detour, then money should be spent to put and keep it in good condition during its period of great usefulness, even if the money so spent is to secure merely a temporary benefit.

A variant of the "weakest link" truism is that a highway is no better than its detours. Recently we had occasion to drive 125 miles between two cities connected by a widely-known highway. Reports had it that this was an excellent hard-surfaced highway in this locality and that the speed with which it could be traversed was limited only by law, or by the best speed of a car, or by the driver's fancy. So the road was described; as found, it contained just five detours, three of which were long, rough and devious. That these detours fix the hauling limits for this highway is obvious, and it is also true that the speed and satisfaction with which this highway may be used with a passenger car are also limited by them. All of them were necessary because of construction operations and are mentioned merely by way of illustrating the statement that "a highway is no better than its detours."

It seems almost incredible that detours are not kept as short as possible, yet several times this season the local talent has assured us, at the end of an especially long and rough detour, that had we gone thus and so, contrary to the official markings, we would have had a shorter and smoother ride. In some cases this evidence was convincing in spite of its unofficial and hearsay character.

The marking of detours is often so carelessly done as to suggest to the bewildered stranger that the markings may be sufficient for those who reside in the locality, but they certainly are not sufficiently plain to serve the stranger's needs. Detours from highways known to carry tourist traffic should be very plainly and adequately marked from end to end. Detours so indifferently marked that they cannot be followed surely in broad daylight by a sober man of mature years and average intelligence, ought never be encountered, yet we have seen some of this description this year.

It is not an uncommon experience to be stopped by an approaching motorist on a detour and to be anxiously questioned by him as to the distance to the end of it. This has suggested that the total length of the detour should be posted on the end detour signs, and intermediate mileage markings would also be appreciated by many. It should be remembered that the anxiety of those who "watch and wait for the morning" is not greater than that of those befuddled and bouncing motorists who watch and wait for the end of a detour.

If there is one inexcusable and indefensible thing in modern detour practice it is this failure to mark them adequately, for any rodman, or common laborer or contractor's water boy, for that matter, should be able to mark a detour in a few hours and do the work so plainly that it would surely and safely guide the stranger. The expense of this would be as trifling as the time required. Fancy or expensive signs are not necessary. A pot of paint and a few smooth boards, if intelligently and carefully used, should serve.

Highway signs of any description should be on tall posts near the side of the roadway and not on short posts in a cluttered fence corner. These posts should be tall enough to attract attention by their height and close enough to the roadside to catch the tail of the eye. Signs on short posts in the fence corner are likely to be overlooked by the very persons to whom they are essential and for whom they are intended.

Highway sign posts of any sort, detour or otherwise, should be of square cross-section, or, if round, imbedded in concrete. The round, unanchored post is easily rotated through 90 degrees, and thus made highly misleading. One of the oldest pranks known to unregenerate youth is to "switch the arms on a guide post," the modern equivalent of which is to turn a round post and its sign through 90 degrees. This quarter turn is a bad turn for the stranger, causing him at least annoyance and delay and frequently serious trouble.

The entire detour situation, in some localities, is so discreditable as to be embarrassing to any one engaged in highway work or standing sponsor for it. Many of the irritations so caused are as unnecessary as they are inexcusable.

RECOMMENDED WATER WORKS PRACTICE

The Council on Standardization of the American Water Works Association is now in working order and ready to function. Provision has been made for the assignment of 15 hardy perennial topics to as many special committees. Year after year these topics have held the attention of water works men in convention assembled and many opinions have been expressed on each. There has been a wealth of information produced of great value to the studious and informed individual, but so abundant as to be quite overcoming to the well-meaning but uninitiated political maverick who has strayed into the water works field. What this man needs is not the accumulated literature of 41 years, but a simple, predigested code of recommended practice and procedure. The committees will undertake, in large measure, as we understand it, to supply this much-needed manual, chapter by chapter. It will be of the utmost value to a public which periodically turns its water works over to tyros and will free the worthy tyros from many blunders and foolish notions.

Out of the accumulated wealth of the past, in the form of data, discussion, opinion and description, will be crystallized, item by item, a dependable guide at once helpful and convenient to the experienced, a ready refuge to the inexperienced official in his hours of travail and perturbation, and, literally, a life-saver to that busy, well-meaning but uninformed group of people, expert in various other lines, but innocent of water works knowledge, referred to collectively as the "general public."

We bespeak for these committees the co-operation of all experienced water works men. Membership on one of these committees is an honor and a summons to perform a high duty.

FOR FAIR AND UNIFORM TRUCK LEGISLATION

Many motor truck owners are now confronted with a serious situation arising from ill-considered, makeshift and unfair truck legislation. In some places unreasonable restrictions have been imposed as to weight and dimensions of trucks and their loads, and forms of taxation are being devised that will actually force some trucks, and some truck owners, out of business. There are now four different taxes on trucks. Can the addition of other truck taxes have any other result than to make truck transportation financially impossible?

No one questions that trucks should be taxed, but they should be taxed in just proportion to the taxes levied on other means of transportation. Trucks should be taxed as a public utility and not as a public nuisance, the abatement of which is sought by taxing the cause out of existence.

Almost as important as fair legislation affecting trucks is the matter of uniformity in truck legislation. One of the oldest governmental evils we have as a nation is the lack of uniformity in state laws. There may be some excuse for the lack of uniformity of old laws, but what possible excuse can there be for a lack of uniformity in state laws enacted at this time, with all the evils of the old go-it-alone legislative system well understood? It is, of course, perfectly ridiculous for a truck owner to be a law-abiding citizen on one side of a state line and a law-breaker with the same truck and load on the other side of the line. Every truck is a potential interstate carrier, and the regulations under which it may operate lawfully should be identical throughout the country.

INDEX TO VOL. LX

The index to Vol. LX of Municipal and County Engineering, covering the period January to June, inclusive, 1921, is now ready for distribution, and subscribers who want a copy of it may obtain one free of charge by writing to the publisher.

UNIQUE METHOD OF ELIMINATION OF ODORS FROM INDUSTRIAL WASTES

By Harlan H. Edwards, City Engineer, Danville, Ill.

The dumping of household and industrial wastes into storm sewers has been a source of trouble for plumbing and sewer inspectors in many cities. In some cases this has created but little nuisance, while in other cases the mixture of the various types of wastes has caused the formation of very objectionable odors. Such a problem as this was presented to the engineering department of one of our small cities not long ago, and the method of elimination followed was unique.

The sewer in question was of the large circular brick type, 3 ft. in diameter, which received the rainwater and surface wash from a number of streets, through inlets which were not trapped to prevent the passage of air from the sewer into the street. Emptying into this sewer also was the sewage from a few residences that had become connected to the sewer at various times without the knowledge of the city authorities; the manufacturing wastes from a brewery and an ice factory, and the sour milk and floor washes from a creamery. The ice factory's hot water waste, combined with the creamery's sour milk and the brewery's bad brews, cooked up an odor that escaped from the inlets with an asphyxiating stench.

Not only was this objectionable along the street, but it was also very objectionable at the point of outlet of this sewer. The sewer discharged into a small creek which ran through the town, and which was dry during the summer. The discharge of the creamery and brewery waste into stagnant pools so concentrated the fearful stench that residences within a radius of several blocks were rendered almost untenable. Very little trouble and no complaint occurred as long as a flow of water existed in the creek, because the mixture coming from the sewer would be cooled and diluted sufficiently to keep down the odors. The problem, therefore, was to care for the flow of the sewer during dry weather, because during the period when water was flowing in the creek the sewer lost most of its objectionable features.

Preventing Escape of Gases

In order to overcome these conditions, the matter had to be attacked from two different angles. The first step was to prevent the gases from escaping into the street through the inlets; the second was to devise some means of disposal of the dry weather flow of this sewer. Both of these problems were solved effectually, while the cost did not prove excessive.

The method pursued to eliminate the egress of gases and vapors from the inlets was simple. It consisted in the installation of standard 10-in. vitrified tile traps, which were placed between the inlet and the sewer in the street and about 2 or 3 ft. below the surface of the ground. By the use of these traps, no gases could escape from the sewer on account of the water standing in the traps and sealing them at all times. It was feared at the time that the water in the traps might become frozen in cold weather, but after they had been subjected to the temperatures of one severe winter, no difficulty was found. It was feared also that the trapping of the inlets in this fashion would only serve to drive the stench to a point of escape through the many but unknown connections to the storm sewer, but so far no trouble has arisen.

Leaping Weir Utilized

This feature of the problem having been eliminated, the other and sometimes

FIG. 1—PUTRID VAPORS FROM SEWER MADE NEARBY STORES ALMOST UNINHABITABLE. FIG. 2—WATER STANDS AT LEVEL OF DOTTED LINE IN THESE TRAPS, THUS PREVENTING ESCAPE OF VAPORS OR GASES.

more troublesome of the two was attacked. After some investigation it was found that one of the main sanitary sewers flowed under the mouth of the troublesome storm sewer, there being a drop of some 6 or 8 ft. from the storm sewer to the sanitary sewer. A hole was

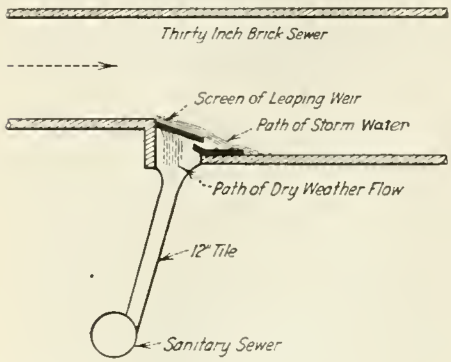


FIG. 3—SKETCH SHOWING OPERATION OF LEAPING WEIR IN SEWER.

punched through the bottom of the storm sewer and tile placed to form a connection that would let the sewage drop down into the sanitary sewer. While this would take care of the dry weather flow, it would also permit a great volume of storm water to enter the sanitary sewer during rainy periods. This was very undesirable. A leaping weir was therefore designed, so that all flows less than 30 gals. per minute would drop into the sanitary sewer, while all flows in excess of this would leap over this opening and pass on down to the creek. The bottom of the storm sewer was so cut away that this could be installed and some special castings were obtained to complete the design, which was proportioned in accordance with a formula derived as a result of a series of experiments made by Prof. H. E. Babbitt, in the Hydraulic Laboratory at the University of Illinois.

This installation has worked very well except for the fact that the grid or screen which was placed over the opening has caused a little trouble. At first this screen was placed at so steep a downward angle that it kept itself clean, but a sufficient amount of the dry weather flow trickled along the bars and escaped into the creek, renewing the nuisance during the hottest weather. The screen was then put in a flatter position, but while this eliminated the trouble from the sewage escaping into the creek, it introduced another problem in the clogging of the screen with leaves, paper and other debris brought down in the sewer. Experiments are now under way which will probably correct this troublesome feature. The leaping weir was first put into operation on a hot, dry day in August. Within 30 hours the bed of the creek was dry around the mouth of the sewer and the stench had disappeared.

TRAFFIC CONGESTION ON CITY STREETS FORCING MORE CAREFUL PLANNING OF STREET AND BOULEVARD SYSTEMS

By Charles H. Cheney, City Planner, Consultant to the Portland (Ore.) City Planning Commission, City Hall, Portland, Ore.

So suddenly has the age of the motor vehicle come upon us and so critical has the resultant traffic congestion become all over the world, that constructive steps to solve traffic problems are of interest to all cities. While temporary regulations, one-way traffic and other makeshift measures are being tried out, no permanent solutions have been found to compare with the linking up of a few

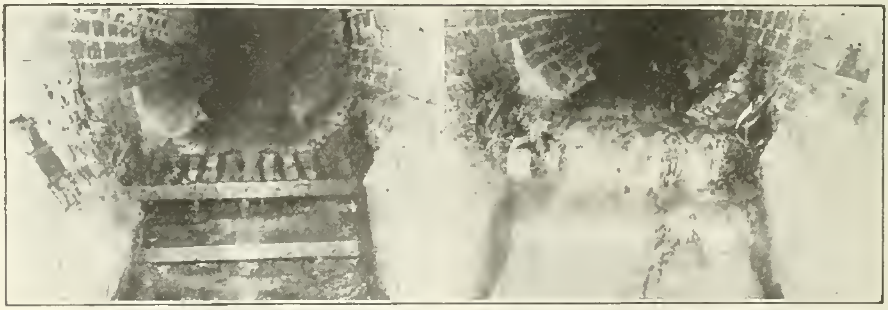


FIG. 4—VIEW OF LEAPING WEIR. DRY WEATHER FLOW DROPS THROUGH THIS GRATING WHILE LARGE AMOUNTS OF RAIN WATER PASS OVER IT AND FLOW DOWN THE SEWER. FIG. 5—THE GRATING CLOGS SOMETIMES WITH LEAVES, STICKS, RAGS, PAPER, ETC., WASHED INTO THE SEWER.

wide, direct, conveniently located thoroughfares connecting all parts of the city.

Traffic congestion is forcing more thorough and careful study of street conditions, both as to what we have now and what we must anticipate in the near future. St. Louis in 1917 completed a major traffic street plan, in following which millions of dollars are now being spent for widenings and openings, because they will pay. Detroit, Chicago and many smaller cities have their problem well in hand.

The Major Traffic Street and Boulevard System Plan recently adopted by the City Planning Commission of Portland, Ore., after two years of study, is expected to do much for that city.* The problems met are typical of most of the cities of the country, and therefore of general interest.

Reasons for a Major Traffic Street Plan

It is more and more evident that in the future through travel should be limited to a few conveniently located traffic streets, on which ordinary drivers, once in the stream of travel, can know that they are safe, and move steadily ahead, and on which reckless ones can be more easily and economically regulated.

Commercial vehicles and hauling should be limited to a few definitely established major traffic streets until they have reached the nearest point to their destination. Only thus can we furnish enough heavy traffic pavements to satisfy traffic needs, or pay the bills for their making and upkeep.

Approval of the City Planning Commission is required by State law in Portland, as in many other cities of the country, on all maps of new land sub-divisions, both within the city limits or for six miles outside. In passing on the 26 such maps submitted to it during the past 18 months, the Portland commission found that it must have a general plan of major traffic streets, or through leads for its guidance. The Major Street Plan just adopted is comprehensive and will serve to convince owners of new tracts as to the necessity of a few and continuous through streets laid out in advance.

The wear and tear is so great, the danger to children and pedestrians so serious, and the cost of permanent wide

*NOTE—Figures quoted here are from the comprehensive "Major Traffic Street Plan, Boulevard and Park System for Portland, Oregon" report, recently issued by the Portland City Planning Commission.

large, that cities can afford to have only about every sixth or eighth street established and paved as a traffic street.
traffic pavements and their upkeep so

The greatest number of street accidents today are caused by reckless turning in or crossing at side streets. Once a comprehensive system of Major Traffic Streets is settled on all cars can be required to come to a dead stop before turning from a minor, or side street, into an established traffic street. Chicago already has such a system partially in effect. The Police Traffic Bureau and City Planning Commission recommend it for Portland.

Streets Should Be Arranged to Suit Their Use

During the past 15 years the coming of the fast motor vehicle, with trailers, carrying heavy loads, amounting sometimes to as much as 10 or 12 tons on two wheels, has made necessary more permanent and heavy hard surface pavement, and more direct through routes. These form the Major Traffic Streets.

The balance, or minor residence streets, comprise 85 per cent or more of our total system in most cities. For these minor streets Portland has adopted a minimum roadway between curbs of 20 ft., thereby making a saving of $112 a lot in paving cost, and it is expected that these narrow roadways will be safer, quieter, less attractive to speeders, and yet take care of all the traffic which originates or ordinarily has business on them. The Portland commission found that millions of dollars of needless and over-wide paving has been put down on such streets in the past, and estimates that several hundred thousand dollars, at least, will be saved taxpayers in the next five years, on new paving, by settling now which streets will not be needed for through traffic and wide pavements.

With a complete system of traffic streets decided upon, minor streets can be closed in industrial zones without question, wherever so desired for business reasons. Fewer cross streets in residence districts would reduce the cost of land, by eliminating the land lost in such streets, and their paving cost. Portland has 200 ft. square blocks in a large part of the city, and the closing of alternate minor cross streets is recommended. Home ownership was found to be discouraged and possibly seriously deterred by the unnecessary burden of overwide street paving on minor streets in the past.

In paying for paving on traffic streets through valued residence districts it was recommended that the abutting residence owners be not required to pay more than they would have to if located on a minor street, a benefit district on either side and the city or county out of its general fund making up the difference.

What a Careful Traffic Census Shows

Graphic illustration of the congestion points, irregularities and traffic difficulties of Portland were shown by diagrams of flow of vehicular traffic, street car traffic and downtown pedestrian traffic, made from traffic counts for typical days kept by the City Engineer's office. From these charts and other data collected, the following facts stands out:

1. Motor vehicles have come into use in much larger numbers than the horse-drawn vehicles they supplanted, requiring wider and heavier pavements.

2. Where there were but 2,493 motor vehicles registered in Oregon in 1910, there are 103,650 in 1920 (one-third in Portland). Twice as many may be expected in five years.

3. Street accidents in Portland have increased from 2,244 in 1917, to 8,379 reported in 1920, and over 1,000 for the month of January, 1921. Twenty-five persons killed and 1,121 injured was the 1920 toll for this city of 260,000 population. Other cities of the country are in proportion. One hundred dollars average damage in each accident might be a conservative estimate of property loss.

4. Vehicular traffic across the five bridges increased nearly four times in seven years, from 11,902 daily total in 1913, to 46,282 in 1920. This explains the traffic congestion downtown, which has grown in proportion.

5. Pedestrian traffic on the bridges meanwhile decreased from 28,389 in 1913 to 20,514 in 1920.

6. The diagram of vehicular traffic showed a few streets leading to the bridges, which do the greatest work, and therefore need to be widest and have the heaviest pavements. Greatest congestion appears at the bridge approaches, which are most in need of relief by enlargement and separation of grade crossings.

7. Certain bridges do not carry their fair proportion of the traffic seeking the center of the city and new diagonal street approaches should be arranged for them so that they may do their share.

Traffic Delays are Costly

"The problem of transportation within cities is one of rapidly increasing importance, yet one which has attracted very little attention," says J. P. Newell, Consulting Engineer and former President of the Clity Planning Commission, in an introduction to the Portland report. "Much thought has been given to the transportation of goods, but I refer to the movements of the people themselves. Probably 125,000 people move a distance of a mile or more and back again in Portland each day. Save one minute each way for each person and you have 250,000 minutes, worth at least $2,000, or 6 per cent on $10,000,000. Does any one ever make such a trip without at least one minute's unnecessary delay?

"We are apt to overlook the fact that the probability of a delay is almost as bad as the certainty, in wasting time if one must get to work or keep an important engagement; he must allow for probable delays just as though they were sure to happen. A city is a great workshop, and ease and freedom of movement of its people, are as important, even from a financial standpoint, as to the workmen in the factory. Delays increase, according to the square or the cube or the nth power of the population."

Certain fundamental considerations, to be taken into account in the preparation of a Major Traffic Street Plan, include ultimate railroad terminal and belt line service, re-location of rapid transit lines finally to do away with grade crossings, elevation of bridge approaches over the railroads, and water-front hauling streets, the establishment of probable future bridge locations, water-front improvements, etc. The report on unification of railroad lines presented to the National Conference on City Planning of 1920, at Cincinnati, was used as a basis for studying these items in the plan, Mr. Newell and Mr. Cheney having been members of the committee presenting that report.

The Portland report includes a program for rebuilding two large existing bridges across the Willamette and for adding four new ones at the intervals when it is estimated they will be needed, between 1922 and 1940.

Three Kinds of Streets Found Necessary

For economy, safety and convenience it is necessary to divide all streets into three general classes, according to their use.

1. *Major Traffic Streets and Thoroughfares* should be located to give direct access by shortest route, carry unlimited traffic and be unobstructed as far as possible by street car lines or railroad grade crossings. They should be not less than 80 ft. in total width, both within the city

and leading out into the country for an average of six miles. In Portland some eight principal thoroughfares of 100 ft. in width are recommended, and waterfront hauling streets of 120 ft.

2. *Boulevards and Parkways* should be indirect in route so as purposely to avoid being later appropriated as traffic routes, and should exclude commercial vehicles and truck hauling. Direct routes should only be adopted when closely paralled by a Major Traffic Street.

It is a well understood practice, in cities having developed boulevard systems, that all boulevards should be not less than 150 ft. wide and preferably 200 ft. wide. This width is necessary to secure ample permanent parking strips for double or triple lines of trees on each side of the main roadway. Such parking and planting are what make a boulevard desirable, refreshing and useful, as distinct from ordinary or traffic streets.

"It is an abuse of language to call a street of ordinary width a boulevard. A street 100 ft. wide would be a street or avenue of handsome width, but a mean boulevard. As residence streets commonly have two rows of trees, a boulevard should have at least four rows, and should be wide enough to accommodate them properly. A width of 150 ft. would generally be a minimum for a boulevard.

"In the case of boulevards and parkways, the houses should be set back 25 ft. or more from the sidewalk, and suitable legal methods for securing this should always be adopted at the time of laying out a boulevard or parkway."*

The Boulevard System Plan should be carefully checked on the ground and provide a complete system for ultimately encircling the city with several loops linking up with existing boulevards, to show off to advantage the finest public buildings, parks and scenery the city has to offer, on routes that will be the most economical to acquire and build.

Business should be prohibited by Zone Ordinance on all real boulevards of the permanent boulevard system.

3. *Minor Residence Streets*, which comprise about 85 per cent of the total in the city, should be protected from the intrusion of needless traffic, to preserve the safety, quiet and comfort of people living on them. Forty and 50 ft. streets should be accepted, where building set back lines are permanently established by the city in the future. They should be paved with 20 ft. roadways or less, except where there are street car lines.

Like most cities Portland is already compactly built up downtown, and for a considerable distance out from the main center. Changes in streets, in these portions of the city at least, would be expensive and can only be undertaken where relief from present or future congestion make them imperative. In the Major Traffic Street and Boulevard System Plans adopted, every widening, extension or new street proposed has been carefully weighed by the City Planning Commission, as to its practical purpose and value, and only such proposals included as seem justified in cost for relief of traffic congestion.

This plan does not contemplate all these improvements at once, nor for some time to come. In fact, most of the widenings shown as ultimately necessary may be put off for one, and in some cases two, decades, if the recommendations made as urgent are put into effect reasonably soon, and always in accordance with such a pre-determined plan. Establishment of 10 ft. building set-back lines, on each side of many of the Major Traffic Streets now only 60 ft. wide, will suffice for a number of years.

Benefits Expected from Adoption of a Major Traffic Street Plan

J. C. Ainsworth, prominent banker and president of the Portland City Planning Commission, says of this report, "The Major Traffic Street, Boulevard and Park System Plan will go far to solve many of the city's most serious problems.

"This plan, if adhered to, will save thousands of dollars of needless overwide street paving, by designating the 85 per cent of our streets which will not be needed as through traffic streets.

"It will help the small home owner by establishing definitely the minor residence streets, where the burden of paving can be cut in half.

"It will save more money by stabilizing the downtown centers of traffic, thereby preventing unwarranted shifting of the retail center, with consequent depreciation and loss, while allowing for reasonable expansion of the business district in all directions.

"It will save time for every one, by relieving traffic congestion in all parts of the city.

"It will increase safety on our streets and should reduce street accidents by half, by establishing traffic streets at which a dead stop of all cars turning in

*Olmsted Bros., in report on Spokane Boulevard and Park System.

from side streets can be required, as in some eastern cities.

"It provides a system of boulevards, passing all the principal points of interest in the city and making the most of Portland's scenic attractions. The linked-up systems of highways, city and mountain drives provided, will attract tourists from all parts of the United States.

"The carefully selected locations for playgrounds and parks will save thousands of dollars to the city and the school board by eliminating duplications in playground and field house facilities.

"A comprehensive and practical plan of development is provided for us all to work to, so that investors may know where traffic is going and build accordingly."

SUCCESSFUL AMERICANIZATION WORK IN AN INDUSTRIAL CITY

By Bernice C. Skidelsky, of Community Service, 1 Madison Ave., New York, N. Y.

There is a spirit of good fellowship in Whiting, Indiana, that bids defiance to rivalry in any other community. The town will "meet all comers" in this respect, and fight them at least to a draw. It hasn't always been that way—but then that's the story.

The first settlers of Whiting made their way there about the middle of the past century. They were hard-working, earnest folk, of that solid and reliable stock known as "pioneers"; and sharing common dangers and common hardships in the process of wresting the unknown soil from a state of wilderness, they shared also a mutual friendship and esteem that made the little settlement like one large family.

About forty years later, the Standard Oil Company came to Whiting. It erected a plant there, and brought to its doors great numbers of foreigners, excellent people and worthy laborers, but unaccustomed to the ways of their neighbors, suspicious of them, and possessed of marked tendencies to segregate into small groups within boundaries of nationalities. Each little group had its own church, round which centered activities which were replicas of the activities they had known in the mother countries.

As a result, Whiting, which had been as sturdily American a community as one could find from coast to coast, suddenly found its unity gone and in its place a hodge-podge of unrelated cosmopolitanism that was vastly different from the old happy state of things.

Within 20 years, Whiting reached a census of 9,000, with 65 per cent of its population foreign born. Most of the industrial interests centered about the Standard Oil plant, but socially, the people of the town had not yet got together.

So matters stood in 1919, when a group of citizens of the community got together and discovered, as is so often the case, that the deficiency was not in the matter of good will, but in a lack of the knowledge of how to go about effecting the desirable change. The result was that they called into consultation a representative of Community Service, who was experienced in community service work among non-amalgamated groups.

The worker found the streets alive with children, playing as best they could in face of a lack of play facilities. He learned, also, that there was a very fine recreational park over at the Lake Front; but unhappily this was of little use, except on special occasions, because a number of railroad tracks lay between it and the heart of the town, so that the mothers had forbidden their children to go there unaccompanied.

But the most important thing he found was that the people were perfectly ready to co-operate. The Standard Oil Company presented a site for a community house, conveniently located in the center of the town and in the midst of the foreign groups. Since many young men of Whiting, Indiana, had given their lives on foreign battlefields, it was decided to make the house a memorial; and a vote of the town officials set aside $400,000 for the house and its fittings.

It then became a matter of execution. An architect was employed, and plans for the house got under way. Meanwhile, since the company had provided a small portable house to serve as temporary headquarters, recreational activities were planned and carried out. The first step was to organize an athletic association of 4,500 employes in the Standard Oil Company itself. This formed a nucleus, from which branched out other organizations including all men and women and children of the town. Community dances came soon, and were highly successful. Community singing was introduced, and as always it proved to be one of the most efficient methods of getting people together. An exhibition was planned wherein the foreigners could all come together in the common bond of handicraft, each with specimens of his own native work. A citizenship class was formed; and efforts were made to reach the women in their homes, since it was a little difficult to get some of them out into more public interests.

The Board of Public Works co-operated by erecting toboggan slides in various sections of the city, and flooding a portion of the city park for skating. The Community House provided games and books. A "story hour" on Friday afternoons brought youngsters in scores. Indeed, it is asserted that Whiting's kiddies now "count their weeks by Fridays."

The children wanted to get in on the dancing, too. But it wasn't considered advisable to admit them to dances held for grown-ups, so special classes in aesthetic dancing were organized; and these vie with the story hour in popularity.

The organizer suggested a formation of a "Community Service Club" to carry on the work so auspiciously begun, which was forthwith accomplished. Christmas of 1919, the first of the club's existence, witnessed a demonstration that Whiting had again become one, for it was celebrated by a pageant that gave opportunity for everyone's participation. The special contribution of the Polish group for instance, was some very fine choral music.

So Whiting has become a unit again; it is no longer "Little Italy" and "Little Poland" and "Little Lithuania," and so forth, side by side in narrow town confines, but an American city, all the richer and stronger because it has known how to blend for its own best growth its diversified elements into a single whole.

U. S. BUREAU OF PUBLIC ROADS FAVORS FREE COMPETITION BETWEEN MATERIALS OF CONSTRUCTION

The following statement on the policy and procedure of the United States Bureau of Public Roads was issued recently by T. H. McDonald, Chief of the Bureau:

The mileage of Federal aid roads which have been built or are now under construction, is nearly sufficient to encircle the globe. This is the record of work accomplished since July, 1916, when the Federal government first stepped in to aid in the enormous task of building highways that are now called upon to carry more than 9,000,000 motor vehicles, plus a very substantial horse-drawn traffic in the forty-eight states.

The Federal aid law is well named. The Department of Agriculture has given the broadest possible construction to the law for the purpose of providing the greatest mileage of highways suited to the traffic to be carried over them, at the minimum expense. An analysis of the projects under contract shows that all types of roads, from the graded earth road to the finest paved surfaces, have been built.

On March 1 of this year, 22,030 miles of highway, extending into every state, had been completed or were in process of construction, at a total estimated cost of $361,946,868. The percentage of this total estimated cost which will be incurred for each type, and the mileage of each type, based upon the records of plans approved, are as follows:

	Per cent of total estimated cost	mileage
Type 1, including earth, sand clay and gravel....	32.2	15,300
Type 2, including water bound and bituminous macadam	9.0	1,530
Type 3, including brick, bituminous concrete, Portland cement concrete...	48.8	4,890
Miscellaneous	4.0	310
Bridges	6.0	......
	100.0	22,030

The States initiate the road projects, but before Federal aid is granted, an engineer of the Federal Bureau of Public Roads makes an inspection of the roads to be improved, studies the local conditions, consults with the State Highway Department, and no projects are approved which are not considered suited to the conditions to be met. Many popular fallacies exist as to road improvement, and there have been many misconceptions as to the types of roads on which Federal aid funds may be used. Properly built earth roads are the fundamental requirement in all highway improvement. Regardless of the material or type of surfacing which is to be placed, the preparation of the road bed requires the highest engineering skill and experience. The department considers that the use of adequate sums for the securing of proper location, thorough drainage, permanent bridges and culverts, and the elimination of railroad crossings is demanded if enduring improvements are to be the result.

Federal aid is allotted to the improvement of earth roads, but only with the stipulation that a suitable surfacing will be placed as soon as funds become available. This allows the road bed to be prepared and become thoroughly consolidated before the surfacing is placed, which is highly desirable from a construction viewpoint. To follow such a course, however, is out of the question when a road is heavily traveled and some form of surfacing must be provided. To care for traffic under these conditions, frequently a sand-clay or gravel surfacing is provided, which will serve for several years and yet allow the road to be maintained under reasonably heavy traffic. Granting that the preparation of the road bed has been properly done, many kinds of road surfaces will give excellent service. The element of time is important. There are so many miles of roads to be constructed, and their cost will be so enormous that the most careful and detailed study of each road project must be made to provide, at the lowest possible cost, roads which will give satisfactory service and which can be maintained without undue depreciation under the traffic which is to use them. Many times the question has been asked the Bureau: What type of road is best? The answer is always the same: There is no one best kind or type of road surface.

A recent statement issued by the officials of the Bureau expresses this thought in the following language:

"It is the policy of this Bureau to consider the conditions on each individual Federal aid project, as there are elements such as subgrade, drainage and present and prospective traffic, which vitally affect the determination of the standards of construction to be used."

That is, there must be a careful analysis, both of the engineering and economic conditions for each particular case to determine the kinds of materials that can be used successfully, and after these facts are determined then the various types of construction which can be used economically should be brought into competition to secure the best possible results. There have been occasional attempts to write into State laws or the governing conditions of bond issues a requirement as to the type or kind of roads to be constructed. To follow such a course would be most unfortunate. The cost must always be considered in determining the type of road surfaces which are selected, and the allowable cost must be determined by the traffic which is to be borne. Local conditions vary to such an extent that very careful consideration must be given each project before determing the character or type of roads to be built. This principle was recently expressed to a Chamber of Commerce, asking for information, in the following language:

"Types of highways should not be specified by law. This is a matter to be decided by the State Highway Department in which should be lodged full authority, both to construct and to maintain. Competition between different types of material should be maintained and selection made to fit traffic requirements in each case. The Bureau does not recommend any one type to exclusion of others."

OBSERVATIONS ON THE HUMAN SIDE OF ENGINEERING

By W. W. Horner, Chief Engineer of Division of Sewers and Paving, City Hall, St. Louis, Mo.

(Editor's Note: These observations on the human side of engineering are from an address by Mr. Horner before the Engineering Freshmen at Washington University as abstracted in a recent number of the Journal of The Engineer's Club of St. Louis.)

It is quite customary, whenever we feel dissatisfied with the progress of the engineering profession, to get a group of engineers together and debate the question, "What is the matter with the engineering profession?" Of course, it is a healthy sign when we realize that there is something the matter with the engineering profession, and we always manage to crystallize our ideas somewhat by these discussions. What I may have to say might have resulted from such a discussion. I have not prepared a finished lecture, or even a completely connected talk. It is merely a series of unrelated impressions.

The engineer is primarily a salaried man, as compared to the lawyer or doctor, who are generally in independent practice on a fee basis. The engineer, therefore, is generally a subordinate, and a subordinate, in the lower grades, to the members of his own profession, and, in the higher grades, to non-technical officials, either public or industrial. This condition undoubtedly brings about a state of mind which accepts subordination to some extent, and hesitates to take primary responsibility. This again reacts to prevent the profession as a whole from achieving a ranking position in the life of the present day.

I think that the engineer is somewhat handicapped in his relation to his fellow men, through his appreciation of the great natural forces with which he comes in contact. He is thoroughly impressed with the wonder of the universe, and the great physical laws, and is inclined to feel, subconsciously perhaps, that the human being in general is of small account in the great scheme of things. This must result, to some extent, in minimizing the value of the individual human being, and certainly goes a long way to prevent the development of personal self esteem which is one of the great assets of the average public man.

The surroundings of the engineer have changed in the last generation. In the last century the engineer was looked upon as a rather romantic character. He was a pioneer. Even recently, in an address to the American Society of Mechanical Engineers, Samuel Gompers said, "Engineers are the scouts of civilization. We send them ahead into the lone places, the wilderness, the jungles, and the great waste expanses, to build the necessary highways for civilized man." This conception of the engineer was general when civil engineering embraced the greater part of the profession. It undoubtedly had a great appeal to the adventurous disposition and rough character, and resulted in bringing into engineering a class of men who were natural pioneers. The survivors of this class today are our great old men of the profession.

The development of electricity, and the great industrial phase of American life, has called for a different type of engineer. There is little of the pioneer among men of the electrical and mechanical branches. The civil engineer already has been called into many phases of the congested modern life, and has lost a great deal of the pioneer spirit. We still have the miner, the irrigation, the water power man, and a few other smaller groups, to continue the romantic aspect of the profession, but we are now primarily concerned with industrial development and operation, and, although we do not appreciate it, with the details of modern life and human affairs, contact and reaction, as our psychological brothers would call it. This changed condition is not peculiar to the engineering profession, but is very similar to the situation which has abolished the romantic war correspondent of Richard Harding Davis fiction, and replaced him with the reporter or historian of the headquarters office. It is reflected also in the changed status of the soldier himself, who is no longer engaged with the heroic charges, and intricate minor strategy of other days, but must plan and execute human slaughter on a large scale. They are all merely signs of the times, but it is of vital importance that the engineering profession, and especially the new man going into the profession, appreciate this changed condition, and be prepared to assume the different responsibilities.

The engineering profession still maintains the respect of the people at large. It is considered conservative, solid and safe. Unfortunately this conception is reacting against the personnel of the profession. It is bringing to the engineering schools a great many men of small souls, who are seeking a safe living. It is quite too common to produce graduates who feel that their four years in college have earned them a right to a superior position, regardless of further activity. These men are our intellectual snobs. They are appalled at the ignorance that they find around them, and are continually making the mistake of underestimating men who have not had their advantages. I cannot help feeling that the profession is unduly burdened by men of this type, men who are natural subordinates, and yet jealous of their own subordination. In the present-day struggle it is not sufficient to be safe and sound in our ideas and activities, but it is necessary to take a leading part, and a progressive part in the industrial and business world, or to be relegated to the category of recorders and computers. There are, unfortunately, too few engineers who are either able or willing to undertake this struggle for the initiative.

Engineering is a science. In college we learn the basic branches. We learn something about the application of the facts, and we acquire a great deal of general information as to what has been done in engineering operations. In a way we acquire the simpler tools of the profession, and learn a very little about handling them.

The engineering graduate can deliberately choose from a considerable variety of work within the limits of the profession. He will be fortunate if he is able to analyze his own temperament and to choose correctly. There are fields of activity in the beginning which vary all the way from research, through design and application, to the direction of construction and operation to general management which may not be technical in any respect.

There is a great field for the engineer who is primarily a scientist, a research man. Engineers are criticised today for being individualists. It is said that they like to work separately, and to work directly with nature. This is the thing that the research man can do. He is the one engineer who can live the solitary life and still be successful. The man going into engineering, however, who feels that his temperament would incline him to take up this branch, must appreciate that just as his work will be independent and isolated, and, in a measure, free, so it will be unknown, and not to a wide extent appreciated, except in the case of great discoveries. As a result it will naturally not be highly paid. For the man who has a scientific temperament, however, who feels that he has gone into the engineering profession as a service, and who is either able or willing to accept a moderate recompense, research work will open a very great and wonderful field of activity.

I know of no other branch, however, where relatively complete freedom of activity is possible. To the mind of the man of high ambition and broad perspective the work of detail design and computation, the accumulation of data and details of analysis, are but the acquiring of greater facility in the use of the tools of his profession. To pass through these phases of engineering activity produces a wider knowledge and a greater confidence in his own ability.

Many men are satisfied with this phase of engineering. They mistake the tools of the profession for the end to be achieved, and, feeling a very just pride in their part of our technical life, become complacent. They are the great mass of our middle class or subordinate engineers. This class is essential to the progress of engineering work, and it is vital that we should bring into the profession a reasonable number of men who can do the detail work well, and be satisfied in the doing. In the end, they, too, must agree to a moderate recompense. This work, also, is in the shadow, and the public must be educated to appreciate its value.

It should be the great duty of the leaders of the engineering profession today to see that these two classes of engineers do not so dominate the profession as a whole that the popular conception of engineering will be limited to them. I think that the engineering schools have two great possibilities which lie at the root of the profession. First, to encourage the development of the executive ability of all those who have it in them, and, second, to help create a conception of engineering which will draw to the profession men of the highest type of mind. It is unquestionably true that the general standing of the profession, and the advantages to the individuals in it, will depend almost entirely on popular appreciation, or the popular conception of it as a whole. Just as I have tried to indicate that we have failed somewhat in recent years to attract the best minds to the profession, so has the profession suffered in the popular mind by comparison.

Where the young man thinks at all of his own native ability, the man of nimble wit and argumentative mind goes into the law. Too often the engineering profession will attract those who feel themselves lacking in both qualities. Fortunately for the profession, however, those who go in after a clear analysis of their own ability are few. We are lucky in getting a lot of good men who think they should be engineers because they have a faculty for mathematics, or enjoy tinkering with the front door bell. It is out of this class, the fellows who just happen in without knowing exactly why, that we should hope to make our best finds. If we can only pick the individuals from this group who have the native ability for mixing, who have an instinct for salesmanship, and then teach them engineering, we will get more and more great engineers. For, in the end, beyond the advantage of his fine mental training, the engineer's opportunities for ultimate advancement and service are not greatly different from those in the mercantile, commercial, or strictly industrial fields. The man with the same ambition, the same mentality as an engineering graduate, has a better chance to be president of a railroad or of a steel company than he would have had if he had not studied engineering, and when he arrives at that end he has every chance of being a much better president.

At the risk of boring I cannot avoid repeating the one thing we hear most often directed towards the young engineer, that is, that the man who intends to attain high position cannot afford to neglect the cultural side. As he must be able to sell himself and his engineering all the way up the ladder, so he must be able to take his place among the most broadly educated men at the top. The engineer should know something of art and a great deal of literature. He should have a fundamental knowledge of law and economics. He should, above all things, be able to write good English, and, if he is physically able, learn to speak it, and speak it in public without effort. He should develop an interest in people, and train himself intuitively to analyze character. He must appreciate that every single act is a part of some broader policy, and to understand when determination is truly effective and when it degenerates into mere stubbornness. He should learn to cultivate the practice of diplomacy, and should study the psychology of organization and management. All of this is on the human side, and all is necessary, because he can never be a big engineer unless he is, in a sense, a big man. It has seemed unnecessary to say much about the knowledge of pure engineering. The necessity for this should be taken for granted. As an eminent engineer recently said on the technique of engineering reports: "The first essential in report writing is for the author to know what he is writing about, and know it thoroughly and definitely."

There is no doubt that we are still in the beginning of the great engineering era. The engineering profession has now a higher standing and a broader appreciation than it has ever had, but it has not developed in accordance with its opportunities, possibly because of the inherent defects in its personnel, which I have attempted to outline, and partly because the big affairs of the country have been in the hands of interests thoroughly intrenched, and to some of which it has seemed better to keep the engineer as a servant rather than to take him as a partner. To complete the necessary change in the status of the profession, the engineers generally will have to realize their public position and act accordingly. If we would only understand how thoroughly every lawyer is in politics, and how completely the medical profession is interested in public affairs, we would realize better how necessary it is to impress upon the popular mind an appreciation of the value of engineering. It is not uncommon to hear a young lawyer say, "I haven't decided whether I shall practice or go into politics." It is more common to hear the engineer remark, "I am not sure whether I shall ask for a job at the waterworks or go with the railroad." One possesses vision, the other is still without purpose.

CONFERENCE ON ENGINEERING SOCIETY CO-OPERATION

An informal and unofficial conference of representatives of the American Association of Engineers and the American Engineering Council was held at the Hotel Statler, in St. Louis, on June 3 prior to the meeting of the Executive Board of the Council on that day. Mr. E. S. Carman issued the invitations to the conference, which included, besides himself, H. O. Garman, L. W. Wallace and C. E. Drayer. The conference was for the purpose of finding a way to develop closer relations between these two national organizations.

The following conclusions were reached unanimously:

1. This conference is unanimous in the opinion that there should be unity in the profession.

2. It is agreed that duplication of effort by the two organizations is undesirable on account of economic waste.

3. The discussion of the morning developed the desirability for the creation of conference committees to consider closer cooperation between Federated American Engineering Societies and the American Association of Engineers.

At the morning session of the Executive Board of the American Engineering Council Mr. Carman proposed the appointment of a committee consisting of the presiding officer, the secretary and one other member of the Executive Board to consider closer cooperation between the Federated American Engineering Societies and the American Association of Engineers. After considerable discussion, motion was made to read that a committee consisting of the presiding officer, the secretary and one other member be appointed to confer with representatives of A. A. E. and report back any recommendations it may see fit. The presiding officer, Calvert W. Townley, appointed Dean Kimball, of Cornell University, as the other member of the committee. During the discussion of the motion it was apparent that some of the board favored any reasonable basis of cooperation, but the majority stood squarely on the position that closer relations could be brought about only by the American Association of Engineers joining the Federated American Engineering Societies on the same basis as the other national societies, which were constituent members.

USE OF ASPHALT MACADAM PAVEMENTS IN REAL ESTATE DEVELOPMENTS

With housing conditions throughout the country only slightly improved, especially in the larger cities, and with the continued desire on the part of most city dwellers to have their homes in suburban or residential sections, instead of in the heart of a city, the subject of developing new residential areas has come to be of great importance among city engineers and city planners.

To be successful, new home areas must be beautiful and attractive, as well as within a convenient distance of the average person's place of work or business. In making these new real estate sections beautiful, realtors and city engineers have found that the problem of paved streets is one of the first to be solved; and after considerable study and planning, they have decided that the type of pavement in a newly developed home area must have these features:

1. A pavement easily and quickly constructed.
2. Economical and low in first cost.
3. Beautiful in appearance and suitable for the traffic it is to undergo.

Asphalt Macadam a Suitable Type

A pavement which has all these features and has proved it is ideal for the purpose is asphalt macadam. Extensive use of it during the last decade has resulted in its adoption by many towns and municipalities, as well as by real estate concerns, to pave newly developed residential districts. Among the cities that have used it are Asheville and Charlotte, N. C., Baltimore, Md., Chicago and many others.

Although the daily traffic over a street in a suburban or residential district includes numerous vehicles, yet the type of traffic is not the heaviest. It usually in-

PRIVATE ESTATE OF GEORGE A. McKINLOCK AT LAKE FOREST, ILL., SHOWING A TEXACO ASPHALT MACADAM DRIVE.

Construction News and Equipment

OWNERSHIP AND OPERATION OF TRENCH EXCAVATORS AND OTHER MECHANICAL EQUIPMENT BY THE WATER DEPARTMENT OF BALTIMORE

By V. Bernard Siems, Associate Civil Engineer Water Department, Oliver and Wolfe Sts., Baltimore, Md.

(Editor's Note: The following matter is the major portion of a paper presented by Mr. Siems at the 1921 annual convention of the American Water Works Association. The original paper was accompanied by numerous tables and diagrams which are too extensive for reproduction here, except in substance, but which, presumably, will be reproduced in full in the Journal of the Association at an early date.)

Machinery for excavating earth and other material has been recognized for years as more economical and efficient than manual methods where conditions will permit the use of such mechanical equipment.

In order to complete the construction of water supply and sewerage systems in the cantonments during the world war as quickly as possible, the United States Army used machinery entirely, and the results obtained have, no doubt, had a great effect on the increased use of trench excavators, cranes and backfillers by contractors and municipalities. The writer used trenching machines, cranes and backfillers entirely for the construction of the water distribution system for Camp Meade and Camp Franklin in 1918. The distribution system of Camp Franklin and the enlargement of the Camp Meade system were completed in 2½ months. Machinery of all characters was used to construct the intake and pumping stations and enlarge the filtration plant and balancing reservoirs at Camp Meade.

In 1913 the engineers of the Baltimore City Water Department saw the necessity for obtaining a trenching machine, air compressor and pneumatic hammer to execute more expeditiously the work in connection with the installation of water mains. The Highway Department in 1913 graded 33rd Street from Greenmount Avenue to Hillen Road, an approximate distance of 1.1 miles, preparatory to constructing a boulevard. The Water Department started the work of installing a 16-inch Middle Service water main by hand labor, and as the cost of doing the work was exceeding the estimated amount appropriated, the Department engineers rented a trenching machine from the Consolidated Gas Company; with the use of this machine the work was rapidly pushed to completion and the cost was less than the amount actually appropriated. This rented machine excavated 2,000 linear feet of trench, and the final cost showed that the excavating had been done at 16 cts. a cubic yard. Based on this excellent showing, the Water Department was permitted to purchase a "Parson's" trench excavator, Model "K." Another important reason for permitting the purchase of a trenching machine was that the greater part of future water mains installations would be in the northeastern and northwestern sections of the city where few, if any, subsurface structures would be encountered, and conditions would be ideal for operating trenching machines. The normal corps of 15 laborers was too small to permit constant operation of the trenching machine in the work of laying water mains and backfilling, and it was necessary to increase the number of men. In order to still increase the amount of work and bring the water mains construction corps to the normal size of 15 laborers air compressors and pneumatic hammers were procured. This latter equipment was also necessary to secure uniform caulking of all pipe joints and, thereby, decrease the possibility of leaks occurring after the laying of improved paving; it also reduced the time, and consequently the cost of labor, in caulking.

The first air compressor purchased was of "Foster & Hosler" make and had a capacity of approximately 80 cu. ft. Considerable difficulty was experienced in training the caulkers to use the pneumatic hammers intelligently in order to prevent breaking the bells of cast iron pipe. Tests conducted over a long period showed that pneumatic hammers should operate under a long stroke and at a moderate working pressure of 40 lbs. per sq. in. The Engineering and Construction Division of the Water Department now has the following equipment:

Equipment	*Original Cost*
4 Air Compressors (ranging from 80 to 210 cu. ft. capac.)	$ 8,189.00
2 Backfillers	3,488.00
1 Austin 5-ton Crane	8,095.00
1 Ransom Concrete Mixer	802.00
1 Air Piling Hammer	275.00
10 Ditch Pumps	3,447.00
3 Trenching Machines	23,794.00
Total	$48,090.00

Most of the machinery was purchased by the Water Department between the years 1918 and 1920. Since the year 1914 the Water Department has used trenching machines under almost all conditions in the installation of water mains in public highways.

The "Parson's" Model "K" trenching machine was put to a severe test at one time in excavating for the installation of a 4-inch water main in a private alley between 10 and 12 ft. in width. Difficulty was experienced in getting a trenching machine of this size in the alley, and damage was done to the wooden fences on each side of the alley. Even considering the difficulties and the expense entailed because of the damage done, the cost of installing the 4-in. main was much less than it would have been if done by manual labor. It may be interesting to note that a comparison of the cost of doing work in private alleys of various widths and public highways, whether done by manual labor or by trenching machine aided by hand labor, shows that the cost of the installation in private alleys is twice that of the cost in public highways. The Water Department, therefore, does not even consider the installation of water mains in private alleys. Judging from our records of cost, such installations should be discouraged by all municipalities.

Trenching machines have also been used to remove the cover of all sized water mains where it has been found necessary to enlarge or replace them by other mains, particularly so in cases where it is necessary to lower the water mains because of a change in the grade of the public highway. In the residential and business districts where it would be economical to excavate trenches with trenching machine for installation of water mains, accurate locations were obtained of water supply, gas supply and other services in advance of the work. The locations of these services were marked on the curb line, and the trenching machine operator very seldom disturbed any of them. as he raised the boom of the machine as it approached these marks. It was, of course, necessary to do the extra excavating around the service pipes by hand labor. In other instances the Department has found it economical to disconnect these services temporarily, in order to provide clearance for the operation of the trenching machine. Even with these additional costs there was considerable economy in the use of the trenching machine, especially on the installation of large water mains. From our cost data records, it is estimated that damages to subsurface structures by the use of trenching machines approximate 1% of the total cost of the installation of the water mains.

In 1918, due to the increasing number of extensions of water mains, the scarcity of labor and the high rate of pay necessary because of the salaries paid labor by industrial plants in and around Baltimore, it was decided to purchase additional trenching machines, a 5-ton "Austin" crane and backfillers. The cost of installing water mains was materially lessened by the use of this machinery in years 1919 and 1920. The 5-ton crane saved us considerable money, as we handled practically all cast iron water pipe and fittings of 20 in. and over with it.

Two types of backfillers are used—one the boom drag and the other the scraper drag. The boom drag is used on the backfilling of trenches for large mains and the scraper drag on smaller mains in territories where the Highways Department will permit backfilling of ditches by puddling the material. We have, however, also used it in public highways where ramming was necessary. Tests made with mechanical tampers have not shown satisfactory results thus far. It is hoped that they will be developed to the extent of the other machinery now used by the Water Department. We have a much larger equipment of machinery than that enumerated in machines of a smaller character which we purchased from time to time and which are not enumerated here. I believe that the Water Department of the City of Baltimore ranks first among the American municipalities in the use of machinery for doing the work in connection with the in-

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KOEHRING pavers are charged, discharged, and the concrete placed on the subgrade with fewest moves of the operator. *Automatic* actions reduce his work to greatest simplicity—saving him seconds on every batch all day long—producing more batches per day—*a considerable extra yardage*—which means a big extra profit in a season's work.

Watch the automatic actions on the Koehring charging skip—on the power discharge chute—on the boom and bucket operation. You will see why operators save seconds in getting the outgoing batch at the right spot on the subgrade and the new batch into the drum—why the operator is performing at high speed at the end of a day, as at the beginning. Seconds saved is yardage made!

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CAPACITIES

Pavers: 10, 14, 21, 28 cu. ft. mixed concrete, steam or gasoline, multiplane traction, loading derrick, power discharge chute.

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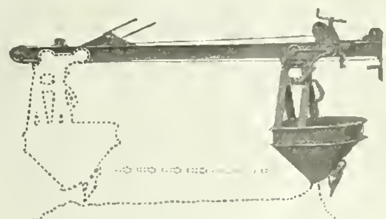
Write for Bulletin P-10.



The Koehring bucket shoots along the boom at power-driven speed. One move of the operator starts it—another move stops, and automatically opens the bucket gates at any point. One more move starts bucket back to charging position, evenly spreading concrete on the sub-grade, and automatically closing and stopping at filling position. Is it any wonder that water is in with the new batch on time, that the loading skip is back on the ground and receiving materials for the next batch—and not a second lost anywhere?

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stallation and maintenance of a water distribution system.

Organization for Operating and Repairing Mechanical Equipment

The automobile repairman, grade No. 1, in charge of mechanical equipment reports directly to the Assistant Civil Engineer in charge of the Construction Subdivision or his assistant the same as the water pipe construction foremen do; the five automobile repairmen, grades No. 2 and No. 3, are subordinate, being assisted by handymen, and to each group equipment which they operate and maintain is assigned.

The City Service Commission of Baltimore requires that an automobile repairman must have an elementary education, several years' experience in assembling or repairing and operating gas engines and other mechanical equipment; for handymen it requires an elementary education, one year's experience as general handyman in a machine shop and ability to follow instructions from an automobile repairman. The handymen are also used for burning out lead in cast iron pipe bells on mains of the larger size. From experience it has been found that the best men available for positions of automobile repairmen are those advanced from the position of handyman.

Experience in the use of mechanical equipment has proved to us that it is more economical and efficient to have a storage of duplicate mechanical parts available for any emergency than to order the repair parts when needed. The automobile repairmen, grade No. 1, in charge of mechanical equipment is held responsible for stock parts of mechanical equipment, and also for repairs to machinery. After the completion of the work the machinery is inspected thoroughly before being transported to another location, and, therefore, it is always in good working condition to commence the next work.

During winter months trenching machines, cranes, backfillers, air compressors, etc., are removed to the storage yards and completely overhauled. This is done only when there is no work on which this machinery can be used. The smaller gasoline pumps, melting furnaces, ground thawers, etc., are usually overhauled in the field.

Comparison of Costs—Hand Labor Vs. Hand Labor Aided by Machinery

A comparison was made of labor cost per foot of installation of water mains by manual labor and manual labor aided by trenching machine. It was observed that the percentage of economy obtained using a trenching machine with hand labor varies from 22.2 to 57.5 per centum. This percentage of saving is largely due to the intelligent placing of the laborers, as for example:—with an average corps of 14 men working with a trenching machine in the installation of a 6-in. water main two laborers work on the surface to remove the material falling from the traveling buckets, three laborers are used to prepare the trench for pipe laying, two caulkers and two laborers pour the lead and caulk the joints, four laborers backfill the trench and ram the material, and one laborer attends to the lead melting furnace and keeps the water main installation corps supplied with tools. Such an organization will permit constant operation of a trenching machine throughout the working day.

A comparison was made of excavation cost per foot of installation of water main by manual labor and trenching machine aided by manual labor. The percentage of saving with the use of the trenching machine varies from 50 to 56.8 per centum. A trenching machine will excavate from 15 cu. yds. an hour in 50% rock and sandstone to 25 cu. yds. an hour in loam, gravel and disintegrated rock.

A comparison was made of average number of feet of water main installed by a man a day by hand labor and by hand labor aided by trenching machine. The term "installed" includes the excavation for installation and backfill of the water main. The saving of time in the installation of water mains by the use of the trenching machine varies from 33.3 to 80 per centum. For example, it will take a water pipe corps of 15 men installing water mains without the use of a trenching machine 10 days to excavate for, lay and backfill 300 ft. of 20-in. main. Whereas a pipe laying corps using a trenching machine to excavate the trench will complete the excavating, laying and backfilling of the 20-in. main in four days and two hours.

A study was made of the average number of men the trenching machine replaces, of the trenching machine as a labor saving device. It was found that the number of men replaced by the use of the trenching machine varies from 20 to 70 men. For an example, take a 6-in. main: The number of linear feet of trench excavated in one hour by the trenching machine is 60, but it would require 20 men to excavate the 60 ft. of trench in one hour. The same principle

applies to the other size mains. Thus the number of men replaced by the machine on different sizes of pipe are as follows: for 6 in., 20 men; for 10 in., 20 men; for 12 in., 21 men; for 16 in., 25 men; for 20 in., 35 men; for 30 in., 60 men; and for 36 in., 70 men.

A comparison was made of labor costs per foot of water mains between joints caulked by hand and those caulked with the use of pneumatic tools. The term "laying" refers only to the placing of the pipe in the trench and to the caulking of the joints. In comparing the cost of caulking by hand and caulking with air hammers, it was noticed that there was a loss varying from 38 to 53 per cent. in favor of hand caulking, but this loss is overcome by the saving in time, varying from 41.7 to 65.7 per cent. by caulking with air hammers, thus resulting in a saving of 36.4 to 46.7 per cent. on the completed work.

A comparison was made of backfill costs per foot of installation of water mains by hand labor and by backfiller. It was found that the percentage of saving varies from 33.2 to 52.5 per cent.

In order to determine the effective depth to which lead could be compressed in the caulking of cast iron water pipe joints, research work was initiated at the Municipal Laboratory in 1914. The results of these tests showed that lead, like other engineering materials, has a distinct characteristic curve. From this curve can be found the greatest possible compression, which never exceeds 2½ ins. from the face of the bell, before the compressive molecular resistance of the lead itself equals or is greater than the tensile strength of the cast iron in the sides of the pipe bells. When such latter is the case, there immediately follows a bursting of the pipe bell; therefore, it was recommended that air compressors and pneumatic hammers operating under a long stroke and a moderate working pressure of 40 lbs. per sq. in. be used on all the Department's caulking work.

A comparison of cost of the laying of water mains by hand labor and hand labor aided by crane on pipe 30 ins. and larger shows that it cost $0.54 a foot to lay 30-in. pipe with hand labor aided by crane, and $0.95 a foot to lay by hand labor alone, or a saving of 47.4% by using the crane. On 36-in. pipe it cost $0.70 a foot to lay with hand labor aided by crane, and $1.42 to lay with hand labor alone, or a saving of 50.7%.

The large amount of work completed by the Water Department has been due to the fact that Mr. Wm. A. Megraw, Water Engineer, has encouraged the purchase of machinery for use in the construction of water mains, which procedure was inaugurated by Mr. Walter E. Lee, former incumbent.

Due acknowledgment is given herewith to the work of Mr. G. A. Warren, Assistant Civil Engineer in charge of the construction subdivision of the Engineering and Construction Division, and to his assistant, Mr. Maurice Goldstein, Junior Civil Engineer, for the cost data furnished.

Cutting 60-in. Cast Iron Main with Oxy-Acetylene Torch

The proposed changes in the distribution system at North Avenue and Oak Street required the removal of a 60"x30" three-way and inserting of a 60"x48" three-way and connections. As the operations of the Water Department were retarding the paving of the street, a method quicker than cutting the 60-in. cast iron pipe by hand labor was desired. An oxy-acetylene torch and operator were obtained through the local sales engineer of the Davis-Bournonville Company, and the cutting of the cast iron pipe was started immediately. The progress of the cut varied from 0.63 ins. a minute to 1.3 ins. a minute, the average being 0.7 ins. a minute; the thickness of the cast iron pipe was 1.7 ins. Upon investigating the cut edges, small cracks were discovered around the entire circumference at intervals of 1.5 ft. extending from ½-in. to 1½-ins. from the face of the cut. This necessitated the removal of the pipe and the insertion of a new piece of 60-in. main. The new main was cut on the surface by hand labor, thus affording a direct comparison of the cutting of cast iron pipe by hand labor and with the oxy-acetylene torch. The following results were obtained: The cost of cutting the 60-in. pipe (2 cuts) by hand labor was $232.52, including labor, overhead, depreciation and the cost of sharpening the tools; whereas the cost of cutting the cast iron pipe (2 cuts) with the oxy-acetylene torch was $104.23, including labor, fuel consumed, depreciation and overhead.

As the result of research work now being conducted by the engineers of the Davis-Bournonville Company, I am convinced that a practical way will be found for cutting cast iron pipe economically and quickly with the oxy-acetylene torch.

cludes pleasure automobiles or light commercial delivery machines. Therefore, a more permanent type of pavement, like sheet asphalt, is not required and the extra cost would not be justified. Consequently asphalt macadam has been most satisfactorily used, because it is durable and lasting under the type of traffic specified, and in addition provides a beautiful, noiseless, waterproof pavement, perfectly adapted to the aesthetic surroundings of a residential or suburban district.

Roadways on Private Estates

This type of pavement has also been used extensively in and surrounding large estates and country homes, because of the facility with which it is laid and the excellent manner in which it harmonizes with the usual charming surroundings of such places. Several of the most popular real estate developments near Charlotte, N. C., were paved in 1916, with Texaco Asphalt Macadam by the penetration method, and the streets in this locality have given excellent satisfaction. There are many blocks of the same type of roadway in the fashionable Grove Park section of Asheville, N. C., and the attention of public officials and real estate concerns throughout the country is being directed to these pavements as an example of how asphalt macadam may be used in developing new residential areas.

How to Build an Asphalt Macadam Road

There are two main parts to an asphalt macadam pavement: (1) The foundation; (2) the wearing surface.

The foundation may be either of the following: Macadam or gravel. Irrespective of type, the foundation should be solid, compact and of sufficient depth, and the subgrade under the foundation should be well drained and solid.

Two main materials make up the wearing surface of an asphalt macadam pavement: (1) Broken stone; (2) asphaltic cement.

The steps in constructing the wearing surface are as follows:

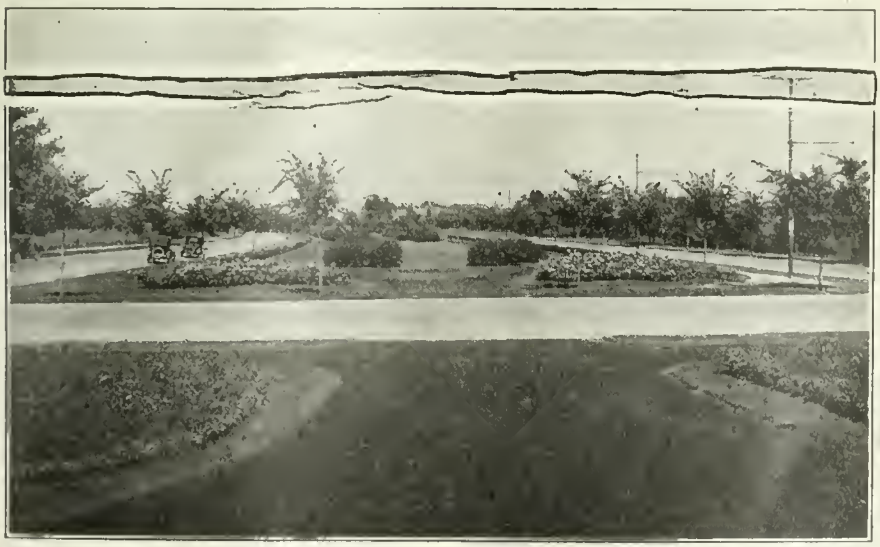
1. Spread clean, coarse, broken stone over the foundation. This stone should be from 1 to 2½ ins. in size, and should be spread so as to give a minimum thickness of 2½ ins. when compacted.

2. Carefully roll the stone which has been spread, so as to get an even contour and obtain the greatest possible mechanical bond.

3. Apply asphaltic cement by either the hand pouring or pressure distributor method, using from 1¾ to 2¼ gals. per square yard. The asphaltic cement should be applied uniformly and is heated to between 275 and 350 deg. Fahr., so that it will penetrate thoroughly the entire depth of the wearing surface.

4. Spread clean ¾-in. stone over the entire surface immediately after the application of the asphalt. These stone chips should be dry and free from dust.

5. Roll the entire surface until it is solid.



WARD PARKWAY, KANSAS CITY, MO., SHOWING HOW A TEXACO ASPHALT MACADAM PAVEMENT WAS USED TO PROVIDE AN ATTRACTIVE THOROUGHFARE IN A RESIDENTIAL DISTRICT

6. Remove all loose and surplus mineral matter.

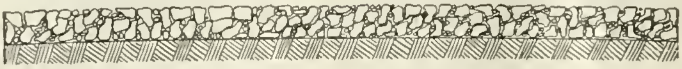
7. Make the second application of asphaltic cement in the same manner as the first application. The same grade of asphalt is used but the quantity is less, using from ¼ to ½ gal. per square yard in the second coat.

8. Spread ¾-in. stone chips and then roll thoroughly.

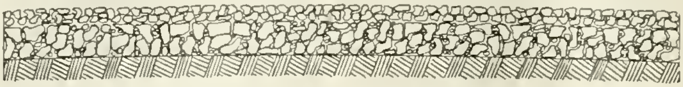
The Penetration Method

The above described manner of constructing asphalt macadam roads is called the penetration method. This method gets its name from the fact that the asphaltic cement penetrates and coats the layers of broken stone after they have been placed in the road. The asphalt serves as an adhesive and binding medium in forming the surface.

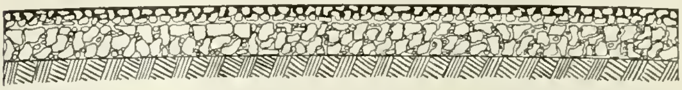
There are two methods of building asphalt macadam pavements by the penetration method. They are the hand pouring method and the pressure distributor method. Both accomplish the same purpose, only in one the asphaltic cement is applied by hand from pouring cans and in the other the asphaltic cement is applied under pressure by an automobile distributor.



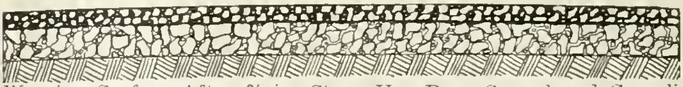
Foundation Which May Be of Gravel or Broken Stone.



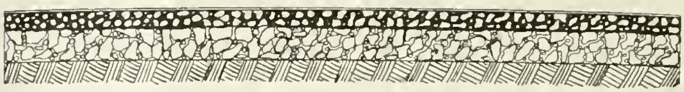
Large Stone for Wearing Surface Spread and Rolled Over Foundation. The Size of This Stone is From 1 to 2½ ins., and is Consolidated to a Minimum Depth of 2½ ins.



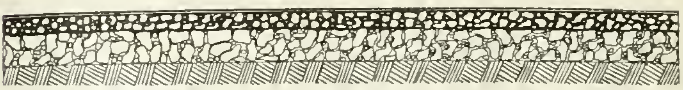
Large Stone for Wearing Surface After Application of Asphaltic Cement. Amount of Asphaltic Cement is from 1¾ to 2¼ Gals. per Sq. Yd.



Wearing Surface After ¾-in. Stone Has Been Spread and Consolidated by Rolling.



After Application of Seal Coat of Asphaltic Cement. Amount of Asphaltic Cement Applied is from ¼ to ½ Gal. per Sq. Yd.



After Covering Material Has Been Spread Over Seal Coat and Then Rolled.

STEPS IN THE CONSTRUCTION OF A TEXACO ASPHALT PAVEMENT.

TYPES OF PAVED RAILROAD CROSSINGS ON WAYNE COUNTY, MICH., HIGHWAYS

By Edward N. Hines, Chairman Board of County Road Commissioners, Wayne County, 312 County Bldg., Detroit, Mich.

Through co-operation with various railroad companies we are gradually improving all the grade crossings with Wayne County roads, said Mr. Hines in addressing the American Road Builders' Association. Wooden crossing planks are so expensive and of such poor quality that the railroads themselves are glad to cooperate in using some material which will last longer.

Grade crossings have been built by us in the past using the following methods:

First Type

Under light traffic railroads, street car tracks and sidings, we have been digging out under the ties to a depth of 1 ft. below the bottom tie and filling in with a 1-ft. slab of concrete. Then new ties are placed and new deep rails spiked on. The job is completed by pouring concrete between the ties and over the ties to the top of rail joining with our concrete pavement on either side and striking off level with the top of rail. Flange-way is provided either by allowing the car wheels to form their own flange-way or by placing a rail on its side against the inside of the main rail.

Second Type

One railroad has been progressive enough to allow us to experiment with one of its main double-track lines in putting in a pre-molded concrete slab crossing. These slabs are approximately 2 ft. by 6 ft. long, with a depth the same as the depth of rail. We build them at Wayne in our tile yard and haul them out to the crossing and lay them in place of the common plank. If this type of crossing proves to be a success for highway traffic it will be very desirable, because it is possible for the section crew of the railroad to remove the slab, ballast up the tracks and replace it.

Third Type

The third type of crossing which we have used has been the same as the first, except that the surface has been filled in with special granite blocks along the inner side of the rail, which provides a flange-way.

We have also started on a program of grade separation on important trunk-line roads, and three projects are under consideration at the present time.

TRADE NOTES

Actuated by a desire to assist flood-stricken Pueblo, the Pawling & Harnischfeger Co. has shipped, by special through train, a No. 206 Corduroy Traction Type Excavator-Crane, to the Mayor of Pueblo. This, they believe, will be of service in clearing up the debris, handling materials and for many other purposes.

The plant of the Heltzel Steel Form & Iron Company, Warren, Ohio, was partly destroyed by fire Thursday, June 2. The company, in addition to being manufacturers of steel forms for concrete road, sidewalk, curb and gutter and other concrete construction, are fabricators of general plate construction. The steel fabricating department suffered mostly from the damage—shipments of steel forms having been made a short time after the fire. This department has continued operation almost uninterruptedly since the fire. Because of the present road building campaign throughout the country the steel form department of this company was very busy at the time of the fire, and they are indeed fortunate that this department was not damaged to a great extent. Immediate steps have been taken to get the steel plate fabricating department back into operation, and it is expected within a few days wheels will be turning in this department.

NEW MINNESOTA LAW ON FORCE ACCOUNT WORK

To the Editor:

I have just read with interest your editorial, "For Force Account Work to Learn Costs," in your April number, and I heartily agree with it, except that I believe you should have gone farther and stated that public officials, in carrying out force account work, should see that all costs are charged to the work. Most municipalities doing their own work make no charge for overhead and the use and repairing of outfit.

The State of Minnesota, at the last session of the Legislature, passed a law compelling municipal officials, when contemplating new construction, first to publish an estimate of the cost, and, while the work is under construction, to keep an accurate cost of it, and at the completion of the work publish the total cost. I believe if this law is faithfully carried out it will result in the taxpayers knowing how their money is actually expended.

Very truly yours,

R. A. SCHAFFNER, Chm. Publicity Comm., Northwestern Association of General Contractors.

Guardian Life Bldg., St. Paul, Minn., April 29, 1921.

USE OF LABOR SAVING EQUIPMENT ON MUNICIPAL AND COUNTY WORK

In the extensive construction programs now being developed by cities, counties and states, excellent use is being made of labor saving equipment.

The handling of concrete work on the $20,000,000 New York County Court House illustrates the efficient manner in which a Smith 1-yd. Tilting Mixer was used for pouring the substructure. This substructure alone represents a $2,000,000 expenditure for New York County. Careful selection, combination and installation of standard high class machinery so as to insure speedy and reliable completion of the work with minimum hand labor, was the problem studied out and efficiently solved by the engineers and contractors.

The mixer was installed about 10 ft. above the surface in the base of a wooden tower 35 ft. high, surmounted by a 10 yd. and a 20 yd. storage bin for sand and broken stone. The mixer discharges its mixed concrete directly into a 1 yd. quickshift bucket hoisted in an Insley steel 160 ft. tower. Clever arrangement of the chuting system gives a complete working radius of 210 ft. from the center of the building.

This single mixer produced at the rate of 470 yds. a day with a very small crew. The problem here was a difficult one but it was efficiently solved by modern machinery. It is particularly noteworthy that one mixer only was used on this big $2,000,000 foundation. This suggests that the use of efficient speedy machinery pays well in results attained.

Extensive sewerage work is being proceeded with by the city of Minneapolis. A Smith ½-yd. non-tilting mixer is being used on this work. Milwaukee is completing its sewage disposal system using Smith Tilting Mixers on the concreting of all its tunnels, etc.

The city of Detroit is doing considerable street paving and has added to its battery of pavers, one of the new 14-E Smith paving mixers, steam driven.

Los Angeles County, California, is building its own concrete roads and has just purchased a new 14-E Smith paving mixer, equipped with gasoline motor.

State work on roads is being done in many states by Smith paving mixers, the most popular size being the 21-E, with swivel chute delivery, multipedal traction, gasoline motor and the new Smith ball-bearing derrick.

Extensive use, by counties, is being made this year of the Smith excavator and loader in conection with road work. In Minnesota, St. Louis County, LeSeuer County and Freeborn County are using this unique machine with excellent results for cut-and-fill work, grading, excavating and loading gravel at their gravel pits, etc.

The County Commissioners of Beadle County, S. D., have just purchased one of these machines for similar work. Green Lake County, Wisconsin, has purchased two Smith excavators in the last month, for use in their gravel pits. Sheboygan County, Calumet County and Green County, Wisconsin, are all using the Smith excavator in connection with their road maintenance work and new construction.

An idea of the saving the county, city or state, can effect by the use of modern machinery is indicated in a letter from a user of a Smith excavator, who says: "The machine and two men take the place of 15 laborers, 1 foreman and 3 snatch teams. We now load 3 yds. to a wagon. Formerly we could not average 2 cu. yds. while making a 9 ft. excavation (Note: The Smith excavator and loader works at street level—not in the hole—loads at street level, so no snatch teams are required and heavier loads can be hauled). The excavator handles between 300 and 350 yds. per day. We have loaded 48 cu. yds.—wagon measurement—in one hour. The saving of horses each day would more than equal the cost of operating the machine."

SUGGESTED COMPOSITE STANDARD SPECIFICATIONS FOR EXTERIOR WOOD BLOCK PAVING

By S. M. Feinberg, C. E., Public Works Office, Building No. 13, U. S. Navy Yard, Brooklyn, N. Y.

I was very much pleased to read some of the articles on roadway work published in Municipal and County Engineering, especially the article on wood block pavements written by Mr. Herman von Shrenk in your issue of November, 1920, inasmuch as I am also engaged in the investigation of the problem of laying wood block pavements on bituminous cushions. The bituminous cushion idea is comparatively a new development and very little has been written on it in the engineering periodicals. Therefore, after a thorough study, using all available government information at my disposal, I drew up specifications covering the problem and sent a rough draft for comment and criticism to the principal promoters of wood blocks and coal-tar and asphalt.

The following specifications are a revised and corrected edition of the original rough draft, based on the constructive criticisms of a number of competent men, and are up-to-date, both in regard to materials used and methods of construction.

Inasmuch as the present season will see an appreciable amount of pavement construction, I hope the specifications as presented may prove timely and sufficiently adequate to be published in the columns of the Municipal and County Engineering.

Especial credit is to be given to the following parties who were kind enough to assist the writer in compiling the specifications:

(1) Philip P. Sharples, Manager, General Tarvia Dept., The Barrett Co.

(2) R. R. Barrett, Engineer, The Texas Co.

(3) J. E. Morris, Manager, Street & Road Dept., and C. N. Forrest, Manager, Technical Dept., The Barber Asphalt Paving Co.

(4) Prevost Hubbard, Chemical Engineer, The Asphalt Association,

(5) F. P. Allen, Manager Road Oil and Asphalt Department, The Standard Oil Co. (Ind.).

(6) H. S. Rinker, C. E., Expert Aide, U. S. Navy Yard, Brooklyn, N. Y.

(7) Lambert T. Ericson, Chief Engineer, the Jennison-Wright Co.

Likewise credit is due to Messrs. Herman von Schrenk, Consulting Timber Engineer, and W. W. Horner, Chief Engineer of Sewers and Paving, St. Louis, Mo., whose suggestions, published in the November, 1920, issue of this magazine, were adopted.

General.

1. *Scope of Work.* Work required includes the provision of all implements, machinery, equipment, tools, materials, and labor necessary for the proper installation of all wood block paving, in accordance with the drawings, this specification and intent thereof, and when completed, the work shall be left in a neat and finished condition.

2. *Materials and Workmanship.* All materials and workmanship shall be of the best quality of their respective kinds, unless other grades are specifically mentioned, and the acceptance of same is understood and agreed to be subject to approval of the engineer in charge.

3. *Samples Required of Contractor Before Work is Begun.* The contractor shall submit to the engineer in charge, for approval, samples of wood block, Portland cement, sand, bituminous materials, and such other samples of materials as may be required, whether specifically called for or not. Accepted samples may be used in the finished work. Materials shall conform to samples. The approval or acceptance of such samples shall not preclude the rejection of any material upon the discovery of defects previous to the acceptance of the completed work.

4. *Loading and Unloading.* All blocks shall be loaded and unloaded with care. They shall not be thrown from cars into wagons, dumped from wagons, nor shall they be piled in any location where they would likely become bespattered, covered with mud, or otherwise injured.

5. *Warranty.* The contractor shall warrant the entire work to be free from defects of workmanship or materials for a period of one year from date of acceptance. He shall furnish a written warranty, satisfactory to the engineer in charge, that he will make good at his own cost and expense any defects developing during that period.

Timber.

6. *Kind.* The wood from which the blocks are to be manufactured shall be thoroughly air seasoned, dry, Southern yellow pine.

7. *Quality.* The blocks shall be sound, well manufactured, square butted, square edged, free from unsound, loose or hollow knots, knot holes and other defects such as shakes, checks, etc., that would be detrimental to the life of the blocks, or interfere with the proper laying of same.

The number of annual rings in the inch which begins 2 ins. from the pith of the block shall not be less than six, measured radially, provided, however, that blocks containing between five and six rings in this inch shall be accepted if they contain 33 1/3% or more summerwood. In case the block does not contain the pith, the inch to be used shall begin 1 in. away from the ring which is nearest to the heart of the block. The blocks in each charge shall contain an average of at least 50% of heartwood. No one block shall be accepted that contains less than 25% of heartwood.

8. *Size of Blocks.* The blocks shall be from 5 to 10 ins. long, 3 and 3½ ins. in depth, for bituminous and non-bituminous cushions respectively, with the grain or fibre of the wood running in the direction of the depth. They shall be from 3 to 4 ins. in width, but in any one city block, they shall be of uniform width. A variation of 1/16 in. in depth, and ⅛ in. in width from the dimensions specified will be allowed.

9. *Lug Blocks.* In case lug wood blocks are used, they shall have two "V"-shaped lugs on the side of the block and one "V"-shaped lug on the end of the block. The lugs shall extend the full depth of the block and shall be an integral part of the block. The lugs shall extend outward from the block either ⅛ in. or 3/16 in. at the option of the engineer in charge, and shall be approximately ¼ in. in width at the base where they join onto

the block. The lugs on the side of the block shall be spaced approximately 5 ins. apart, center to center of lugs, or approximately 2½ ins. from center of the block, measured lengthwise. The lug on the end of the block shall be placed in the center of the block. The grain or fibre of the lug shall run in the same direction as the grain or fibre of the block.

Preservative.

10. *Kind.* The preservative to be used may be either a coal-tar paving oil "A", or a coal-tar distillate oil "B" as specified hereinbelow.

All tests for the preservative used shall be made in strict accordance with the Standard Methods of the American Wood Preservative Association.

11. *"A" Coal-Tar Creosote Paving Oil.* This oil shall be a coal-tar product of which at least 65% shall be distillate of coal gas tar or coke oven tar, and the remainder shall be refined or filtered coal gas tar or coke oven tar. It shall comply with the following requirements:

It shall not contain more than 3% of water.

It shall not contain more than 3% of matter insoluble in benzol.

The specific gravity of the oil at 38 deg. C., compared with water at 15.5 deg. C., shall not be less than 1.07 nor more than 1.14.

The distillates based on water free oil shall be within the following limits:

Up to 210 deg. C., not more than 5%.
Up to 235 deg. C., not more than 25%.

The residue above 355 deg. C., if it exceeds 35% shall have a float test of not more than 80 sec. at 70 deg. C.

The specific gravity of the fraction between 235 deg. and 315 C. shall not be less than 1.03 at 38 deg. C., compared with water at 15.5 deg. C.

The specific gravity of the fraction between 315 deg. and 355 deg. C., shall not be less than 1.10 at 38 deg. C., compared with water at 15.5 deg. C.

The oil shall not yield more than 10% of coke residue.

12. *"B" Coal-Tar Creosote Paving Oil.* This oil shall be a distillate of coal gas tar or coke oven tar and shall comply with the following requirements:

(Photograph by Courtesy The Barrett Co.)
LAYING WOOD BLOCK PAVEMENT OVER TAR-SAND CUSHION ON EAST WATER ST., SYRACUSE, N. Y.

It shall not contain more than 3% of water.

It shall not contain more than 0.5% of matter insoluble in benzol.

The specific gravity of the oil at 38 deg. C., compared with water at 15.5 deg. C., shall not be less than 1.06.

The distillates based on water free oil shall be within the following limits:

Up to 210 deg. C., not more than 5%.
Up to 235 deg. C., not more than 15%.

The residue above 355 deg. C., if it exceeds 10% shall have a float test of not more than 50 sec. at 70 deg. C.

The specific gravity of the fraction between 235 deg. C. and 315 deg. C. shall not be less than 1.03 at 38 deg. C., compared with water at 15.5 deg. C.

The specific gravity of the fraction between 315 deg. C. and 355 deg. C. shall not be less than 1.10 at 38 deg. C., compared with water at 15.5 deg. C.

The oil shall not yield more than 2% of coke residue.

Creosoting.

13. *Method "A."* (Full Cell Process.) The wood blocks after being cut and ready for treatment, shall be placed in a suitable iron receptacle or cylinder and there sterilized with dry steam under a pressure of not less than 30 lbs., and not more than 50 lbs. per square inch for not less than three hours and as much longer not to exceed seven hours, as the condition of the wood may require. The temperature within the cylinder during the process of steaming shall be between 250 and 280 deg. F. At intervals during this process the condensed steam, sap, and other liquid matter shall be drawn from the receptacle by means of valves. At the completion of the steaming process all condensed steam and other fluid matter shall be blown from the cylinder through an opening in its bottom and all the steam shall be caused to pass out through an opening in its top.

The drain and exhaust valves of the cylinder shall then be closed and a vacuum pump shall produce a vacuum of at least 24 ins., and as much more as may be necessary, as quickly as possible. The vacuum shall be maintained in the cylinder until the moisture and gases cease to escape therefrom. During this process the wood blocks within the cylinder shall be kept hot by means of steam coils.

Immediately thereafter, and while the vacuum still exists, creosote oil, having a temperature between 180 and 200 deg. F. shall be run into the cylinder and such pressure maintained that the wood blocks shall be impregnated with creosote oil to the amount of not less than 12 lbs. of creosote oil per cubic foot of timber. The excess of creosote oil in the cylinder shall then be withdrawn and the blocks drained and prepared for shipment.

14. *Method "B."* (Empty Cell Process.) The blocks shall be placed in an air-tight cylinder and subjected to an initial air pressure of not less than 40 lbs. nor more than 80 lbs. per square inch, depending upon the seasoned condition of the timber to be treated, until all the cells and cavities of the wood are filled with air.

While the initial air pressure is maintained, the creosote oil at a temperature of not less than 150 deg. F. shall be introduced into the cylinder at a still higher pressure. As the creosote oil is being forced into the cylinder, air shall be allowed to escape into an auxiliary air chamber through a valve located at the highest point of the cylinder in order to completely fill the cylinder with the hot creosote oil without reducing the initial pressure.

As soon as the blocks are completely covered and the cylinder entirely filled with the hot creosote oil, the initial pressure shall be gradually increased by forcing in additional quantities of creosote oil, until a maximum quantity of oil has been injected, under a total pressure of about 150 lbs. per square inch. The creosote oil shall be maintained at a temperature of not less than 150 deg. F. during the entire pressure period within the cylinder. In this way as much oil shall be forced into the timber as it is possible to inject under safe temperature and pressure.

The pressure shall then be cut off and the creosote oil discharged from the cylinder.

A vacuum of about 20 ins. shall then be applied after which the hot creosote oil shall again be allowed to fill the cylinder.

Hydraulic pressure of not less than 100 lbs. per square inch shall then be applied and maintained until a total quantity of not less than 12 lbs. of creosote oil per cubic foot of timber has been forced into the blocks. The temperature of the oil within the cylinder during this period shall be maintained at not less than 150 deg. F.

The pressure shall then be cut off and the creosote oil discharged from the cylinder.

Cushion Materials.

15. *Coal-Tar Pitch.* The pitch used for pitch paint coat, as described hereinafter, shall be a straight run residue obtained from the distillation of coal tar, and shall comply with the following requirements:

The melting point, determined by the American Society for Testing Materials Tentative Method, shall not be lower than 140 deg. F., nor higher than 150 deg. F.

It shall contain free carbon not less than 18% nor more than 37%, insoluble in hot chloroform and benzol.

The specific gravity at 77 deg. F., shall not be less than 1.22 nor more than 1.34.

The specific gravity of the distillate up to 355 deg. C., shall not be less than 1.07 at 38 deg. C., compared with water at 15.5 deg. C.

When 100 g. are distilled at 670 deg. F., by the A. S. T. M. method, using a 250 c.c. Engler Flask, the specific gravity of the distillate shall not be less than 1.07 at 100 deg. F.

The pitch shall be heated to a temperature not exceeding 325 deg. F., and shall be poured at a temperature between 250 deg. and 300 deg. F.

16. *Asphaltic Cement.* The asphaltic cement, used for asphalt sand mastic cushion, as described hereinafter, shall comply with the following requirements:

It shall be thoroughly homogeneous, free from water and shall not foam when heated to 350 deg. F.

It shall have a penetration at 77 deg. F. of from 50 to 60.

It shall not flash below 350 deg. F.

When 50 grams of the asphalt cement are heated for five hours at 325 deg. F., in a tin box 2¼ ins. in diameter and 1½ ins. deep, the loss shall not exceed 3% by weight of the penetration at 77 deg. F., and the residue left after such heating must not be less than the penetration at 77 deg. F. of the original sample before heating.

When the asphalt cement is made into a briquette (Dow Mound) it shall have a ductility of not less than 30 cms. at 77 deg. F.; the two ends of the briquette to be pulled apart at the uniform rate of 5 cms. per minute.

17. *Tar.* Tar for tar sand cushion, as described hereinafter, shall conform to the following requirements:

The specific gravity shall not be less than 1.14 nor more than 1.18 at 60 deg. F. (15.5 deg. C.).

The viscosity tested by the Standard Engler Viscosimeter shall not be more than 250 sec. nor less than 100 sec. for 100 c.c. at 104 deg. F. (40 deg. C.).

On distilling 100 c.c. of the material to 338 deg. F. (170 deg. C.), not more than 7% shall distill over. On continuing the distillation to 572 deg. F. (300 deg. C.) the residue shall be not less than 65 grams. This residue shall be a soft pitch at 60 deg. F. (15.5 deg. C.). If the residue appears hard, it shall be tested for melting point and the melting point shall not exceed 140 deg. F. (60 deg. C.) by the ½-in. cube method in water. The specific gravity of the entire distillate shall be not less than 1.01 at 60 deg. F. (15.5 deg. C.).

The free carbon shall be not less than 4% nor more than 12%.

In making the foregoing tests, the following methods shall be employed:

(a) Specific gravity. The specific gravity shall be determined by the use of a Hubbard type specific gravity bottle. The bottle shall be filled with the liquid material at a convenient temperature. The bottle shall then be kept in a water bath at 60 deg. F. (15.5 deg. C.), until the level of the liquid, after adjustment to the mark, shows no further contraction. The bottle shall then be weighed. The weight of the material, divided by the weight of the same volume of freshly boiled distilled water at 60 deg. F. (15.5 deg. C.) is the specific gravity.

(b) Distillation. A 250 c.c. Engler flask shall be used and 100 c.c. of the material taken for distillation. The apparatus shall be set up and the distillation conducted as provided for in the tentative method proposed by the American Society for Testing Materials.

The distillate shall be collected in weighed flasks and fractions shall be determined by weight.

Receivers shall be changed when the thermometer records a temperature of 338 deg. F. (170 deg. C.). When the thermometer records a temperature of 572 deg. F. (300 deg. C.) the flame shall be removed.

(c) Melting Point. A clean shaped ½-in. cube of the material shall be formed in the mould, placed on a hook of No. 12 (B&S guage) copper wire and suspended in a 600 c.c. beaker so that the bottom of the cube shall be 1 in. above the bottom of the beaker (a sheet of paper placed on the bottom of the beaker, and conveniently weighted, will prevent the pitch from sticking to the beaker when it drops off). The cube shall remain five minutes in 400 c.c. of freshly distilled water kept at a temperature of 40 deg. F. (4.5 deg. C.) before heat is applied. Heat shall be applied in such manner that the temperature of the water shall be raised 9 deg. F. (5 deg. C.) each minute. The temperature recorded by the thermometer at the instant the material touches the bottom of the beaker shall be the melting point.

(d) Free Carbon. The free carbon shall be determined by making a hot extraction of five to ten grams of material with C.P. Toluol followed by C.P. Benzol, or C.P. Benzol followed by chloroform as solvents. The extraction shall be made in a Soxhlet, Knorr Underwriters, or some other suitable extraction apparatus. The distillation of the solvent shall be continued until the washings run through practically colorless.

(e) Viscosity. The viscosity shall be determined in a standard Engler Viscosimeter at 104 deg. F. (40 deg. C.). Sufficient material shall be placed in the viscosimeter to bring the surface of the liquid to a level with the tops of the three levelling points. The time required to discharge 100 c.c. shall be recorded as the viscosity.

18. *Cement Sand Cushion.* The cement sand cushion shall be composed of 1 part of Portland cement and 4 parts of sand, meeting the following requirements:

(a) Portland Cement. All cement used in this work shall be Portland Cement, which shall conform to the latest standard specifications for Portland Cement adopted by the American Society for Testing Materials.

(b) Sand. The sand shall consist of hard, durable grains, absolutely free from stones or pebbles and free from vegetable and other deleterious substances. When dry it shall pass a ¼-in. laboratory screen and shall be well graded from coarse to fine. The material removed by the elutriation test, consisting chiefly of clay and loam, shall not exceed 5% by weight.

Filler Materials.

19. *Coal-Tar Pitch Filler.* The coal-tar pitch for filler shall be a coal-tar pitch as specified in paragraph No. 15.

20. *Asphalt Filler.* This filler, if used, shall be a bituminous material conforming to the following requirements:

It shall be homogeneous, free from water, and shall not foam when heated to 200 deg. C. (392 deg. F.).

Specific gravity at 25 deg./25 deg. C. (77 deg./77 deg. F.) shall be not less than 0.980.

Flash point shall be not less than 200 deg. C. (392 deg. F.).

Melting point shall be not less than 78 deg. C. (172 deg. F.).

Penetration at 25 deg. C. (77 deg. F.) 100 g., 5 sec. shall be from 30 to 50.

Penetration at 0 deg. C. (32 deg. F.) 200 g., 1 min., shall be from 10 to 20.

Penetration at 46.1 deg. C. (115 deg. F.) 50 g., 5 sec. shall be from 150 to 300.

When 50 grams are heated in an open tin to a temperature of 325 deg. F., for 5 hours, the loss shall not exceed 1 per cent, and the penetration at 77 deg. F. of the residue left after such heating shall not be less than two-thirds of the penetration of the original material before such heating, when tested at 77 deg. F.

Total bitumen (soluble in carbon disulphide) shall be not less than 95 per cent.

It shall show a ductility of not less than 30 centimeters when tested at 77 deg. F.

21. *Asphaltic Cement.* The asphaltic cement used for asphalt sand mastic filler shall be the same as specified in paragraph 16.

Construction.

22. *Subgrade.* The bottom of excavation and the top of fill shall be true to the lines, grades, and cross-sections given for the subgrade. After all drains have been laid and the subgrade has been shaped correctly, it shall be brought to a firm unyielding surface by rolling the entire area with a 10-ton roller. Any portion of the subgrade which is not accessible to a roller shall be compacted thoroughly with hand tampers, weighing not less than 50 lbs., the face of which shall not exceed 100 sq. ins. All soft and yielding material, and other portions of the subgrade which will not compact readily when rolled or tamped, shall be removed and all loose rock or boulders found in the excavation shall be removed or broken off to a depth of not less than 6 ins. below the surface of the subgrade. All holes or depressions so made shall be filled with suitable material and the whole surface shall be compacted uniformly. If settlement occurs or in case an old stone or gravel roadbed is encountered, the depressions and all loose portions of the roadbed shall be scarified, filled and rerolled until the surface is solid, uniform, and parallel with the required grade. In excavating, the ground shall not be plowed or disturbed below the surface of the subgrade, except as otherwise specified herein.

23. *Base Course.* All materials for and the construction of base courses, including all necessary drainage during construction, clearing, grubbing and all excavation for sub-base work, as specified hereinabove, shall be performed in strict accordance with the cross-sections and in the best possible manner for this type of construction.

The concrete base course, 6 ins. thick in its least depth, shall be composed of 1:3:5 and 1:3:6 mixture for bituminous and non-bituminous cushions respectively, and it shall be laid on a thoroughly compacted sub-base.

The crown of any base course shall not be less than ¼ in. nor more than ⅜ in. per foot of width.

If bituminous cushion is used, the surface shall be finished in one operation by means of a long-handled wooden float provided with up-turned ends in order to prevent ridging; the surface when finished shall be such, that when tested with a metal-shod straight-edge 5 ft. long, laid upon it in a direction parallel to the curb, it shall show no departure from this straight-edge greater than ¼ in. Projections greater than ¼ in. shall be trimmed down and all depressions shall be flushed even with a mortar consisting of 1 part of cement to 3 parts of sand.

If non-bituminous cushion is used, the base course shall be finished by screening with a template arranged to give the proper grade and crown; the surface when finished shall be such, that at no point it shall be above the theoretical finished surface. Depressions of small area, not more than ½ in. below this theoretical grade and not general in extent or occurrence, will be permitted and no attempt will be required to fill them to the general grade after the slab has set.

24. *Pitch Cushion.* (Pitch Paint Coat.) After the base course has hardened and is thoroughly dry, it shall be covered with a coat of pitch, as specified, under the heading for "Cushion Materials," not more than ⅛ in. in thickness. The pitch shall be applied at a temperature of not less than 250 nor greater than 300 deg. F., and it shall be allowed to cool and harden up before laying the blocks.

25. *Tar-Sand Cushion.* Tar-sand cushion composed of approximately 10% tar, as specified under the heading for "Cushion Materials," and 90% dry, clean sand shall be mixed cold and dumped on the base course. After raking, the mixture shall be spread uniformly over the base, without rolling, and after tamping to a thickness not less than ¾ in. nor more than 1½ in; the mixture shall remain uncovered for a period of not less than 24 hours, and then the blocks shall be laid thereon.

26. *Asphalt Sand Cushion.* Asphalt sand cushion shall consist of a mixture of asphaltic cement as specified in paragraph No. 16, and hot dry sand or hot dry stone chips mixed in the following proportions: asphaltic cement, 5 to 7% and stone or stone chips 93 to 95%. Not more than 3% of the sand or stone chips shall pass a screen having 200 meshes to the inch, and all shall pass a screen having 10 meshes to the inch. The aggregate shall be proportioned from fine to coarse so as to produce a minimum of voids.

The sand and asphaltic cement shall be heated in separate heaters to a temperature of not less than 325 deg. F., nor more than 350 deg. F. The asphalt heating kettle shall be properly equipped with an approved agitating device and thermometer so that the asphalt may be properly heated without injury to the material. The sand and asphalt or stone chips and asphalt shall be mixed thoroughly either in an approved hot mechanical mixer or in a concrete push car. The sand or stone chips and the asphalt shall be thoroughly mixed so that each particle of sand or stone chips shall be completely coated with the asphaltic cement until the whole mass is of a homogeneous consistency.

After the material has been thoroughly mixed it shall be immediately spread upon the base course, which shall be absolutely clean and dry, to an average thickness of not less than 3 nor more than 4 ins. The mixture shall be spread with hot rakes and brought to the proper contour, after which it shall be immediately rolled with a hand roller, weighing not less than 25 lbs. per inch width of wheel base. The surface of the roller shall be kept lightly oiled in order to prevent picking up the cushion.

After the cushion has been thoroughly shaped and compressed by means of the hot rakes and roller, the blocks shall be set while the cushion is still hot.

27. *Cement Sand Cushion.* Upon the prepared base course, which shall be cleared of all loose and foreign materials and dampened thoroughly, there shall be spread a mixture of 1:4 cement and dry sand to form a bed for the blocks, to a thickness of not less than ½ in. The cement and sand shall be mixed dry, to a uniform color, in an approved batch mixer, or if by hand, on a clean, tight surface. The cushion shall then be shaped carefully by means of an approved templet and the entire surface of the bed shall be rolled with a hand roller, which shall not be less than 36 ins. in diameter, 24 ins. in width, shall weigh not less than 10 lbs. per inch of width, and shall have a handle not less than 12 ft. in length. The rolled cushion shall be sprinkled, immediately in advance of the block laying, with hand sprinklers or hose with a spray nozzle. No more cement-sand shall be mixed or prepared than can be used within any continuous working period, and any bed upon which the blocks are not laid and rolled, during any continuous working period, shall be removed and replaced with fresh materials when work is resumed. Cement-sand cushion which is injured or dis-

placed by flow of water, rain, or by any other cause, shall be replaced with new material, to the full satisfaction of the engineer in charge. The workmen shall not walk upon the cushion after it has been shaped with the templet.

28. *Laying Blocks.* All blocks shall be laid carefully with the best face up, from one side of the pavement to the other side, in parallel straight courses at right angles to the center line, except at intersections and on curves where they shall be laid as directed by the engineer in charge. The blocks shall be laid with both ends and sides in contact, breaking joints not less than 2½ ins. The courses shall be straightened by striking lightly with a sledge on a 4 by 4-in. timber 3 ft. long, placed against every eighth course, all thick blocks being removed. At the ends, and where necessary between courses, closures shall be made by carefully placing blocks cut accurately to give close joints.

Cut or broken blocks shall be used only at the ends of courses placed with the cut end turned towards the adjacent whole block; the cut or broken blocks shall be not less than 3 ins. in length. While laying blocks, the pavers shall not walk or stand on the cushion, all the work of block laying being done over the blocks already laid. Tamping or wheeling upon the cushion will not be permitted. The spaces between the blocks shall be kept clean and open to the bottom until the filler is applied.

In no case shall blocks, chipped to wedge shape, be used except on curves where absolutely necessary and only when permitted by the engineer in charge. After laying, the blocks shall be inspected once more, culled and approved for rolling, all defective blocks being removed and replaced by perfect blocks.

Experienced blocklayers only shall be employed in laying, cutting and trimming blocks.

29. *Corrugated Card-Board Spacers.* In case plain rectangular blocks are used, the contractor may, at his option, use single-faced corrugated card-board spacers, approximately 3/16 in. thick and 1¼ in. deep, extending the full width of the pavement.

30. *Rolling Blocks.* Before rolling, the pavement shall be inspected carefully and all defective blocks culled out after which the surface of the blocks shall be swept clean. The pavement shall then be rolled with a tandem roller, weighing, unless otherwise specified, not less than 2½, nor more than 5 tons, commencing at the sides and proceeding slowly back and forth, parallel to the sides, until the center of the pavement is reached; then passing to the opposite side, the rolling shall be repeated in the same manner until the center is again reached, after which the speed may be increased, and the rolling continued until the blocks are bedded firmly. The rolling shall then be done, from one side of the pavement to the other side, at an angle of 45 deg., repeating this operation in the opposite direction. All blocks which are broken or injured during rolling shall be removed and replaced with perfect ones, which likewise shall be brought to the true surface. When a cement-sand bed is used, the surface shall be rolled immediately after laying, so as to complete it before the cushion begins to set. The blocks adjacent to curbing and other areas inaccessible to the roller shall be tamped to grade by the use of a hand tamper, applied upon a 2-in. plank. If the cushion is forced up between the blocks more than ½ in., the blocks shall be removed and the cushion reshaped.

After final rolling the pavement shall be tested with a 10-ft. straight-edge, laid parallel with the side of the pavement, and any depression exceeding ¼ in. shall be corrected, and if necessary, the entire surrounding surface again re-rolled.

31. *Filler.* Coal-tar pitch or asphalt filler, if used, shall be as hereinbefore specified under the heading for "Filler Materials," applied, unless otherwise specified, as described hereinafter for pitch-sand mastic filler.

The coal-tar pitch filler shall be applied at a temperature of not less than 250 deg. F., nor more than 300 deg. F.

The asphalt filler shall be applied at a temperature of not less than 350 deg. F., nor more than 400 deg. F.

32. *Pitch-Sand Mastic Filler.* The pitch-sand mastic filler shall be paving tar pitch as hereinbefore specified under the heading for "Cushion Materials," thoroughly mixed with as much hot, dry sand as the pitch will carry, but in no case shall the volume of the sand exceed the volume of the pitch. The sand shall be fine and clean, all of it passing a 20-mesh screen. It shall be heated to a temperature of not less than 300 deg. F., nor more than 400 deg. F., and shall be between these limits when mixed with the paving tar pitch, heated to not less than 250 deg. F., nor more than 300 deg. F.

The coal-tar pitch shall be heated in kettles, properly equipped with approved thermometers, registering the temperature of the tar pitch.

The mixture shall be flushed on the surface of the blocks and pushed rapidly into the joints while hot with squeegees or other suitable tools, subject to approval of the engineer in charge, reflushing or repouring, if necessary, in the opinion of the engineer in charge, until the joints remain permanently filled to approximately within ½ in. and 1 in. of the surface of the pavement, for non-bituminous and bituminous cushions respectively. All squeegeeing shall be done in one direction, without mopping back and forth and as little of the mixture as possible shall be left on the surface. No sand shall be swept into the joints between the blocks, prior to squeegeeing the mixture, unless so directed by the engineer in charge.

The pitch shall be delivered where directed by the engineer in charge in time to allow for examination and analysis.

In applying the filler, care shall be taken that the blocks are clean and dry, that the pavers are closely followed by the filler gang, and in no case shall the paving be left over night, or when work is stopped, without the filling of the joints being completed. In case rain stops the filler gang before its work is finished, the joints shall be protected by the use of tarpaulins, or other approved means, in order to keep out water. Under no circumstances shall the filler be poured into wet joints.

A top dressing of clean dry sand shall be swept into the unfilled space of the joints immediately after the filler is applied.

33. *Asphalt-Sand Mastic Filler.* Asphalt-sand mastic filler may be used in lieu of tar-pitch-sand mastic filler, as specified hereinbefore, except that in this case, asphaltic cement, as hereinbefore specified under the heading for "Filler Materials," shall be used and the sand shall be heated to not less than 400 deg. F., and the mixture shall be used only when it registers between 350 and 400 deg. F. All filler heated beyond 450 deg. F., will be rejected.

34. *Expansion Joints.* Expansion joints shall be formed along the edges of the pavement, next to curbs, against side walls of buildings and where street car or railroad tracks cross the streets transversely. In case non-bituminous cushion is used, transverse expansion joints, not less than 25 ft. apart shall be provided and installed. The joints shall be ½ in. in width, unless directed otherwise, and they shall be formed by placing together on edge two wedge-shaped wood strips 4 ins. in depth and each strip dressed on both faces. The strips shall be so cut that when placed in reverse positions, their total section shall be rectangular and of a thickness equal to the thickness of the required joint. The strip placed next to the pavement shall be set with the narrow edge up and the other one in the reverse position. These strips shall break joints and they shall be set true to grade with ends tight, the bottom pressed into the bed and the blocks laid lightly against them.

The wood strips shall be installed before the blocks are laid and the back one loosened up as soon as filling is started.

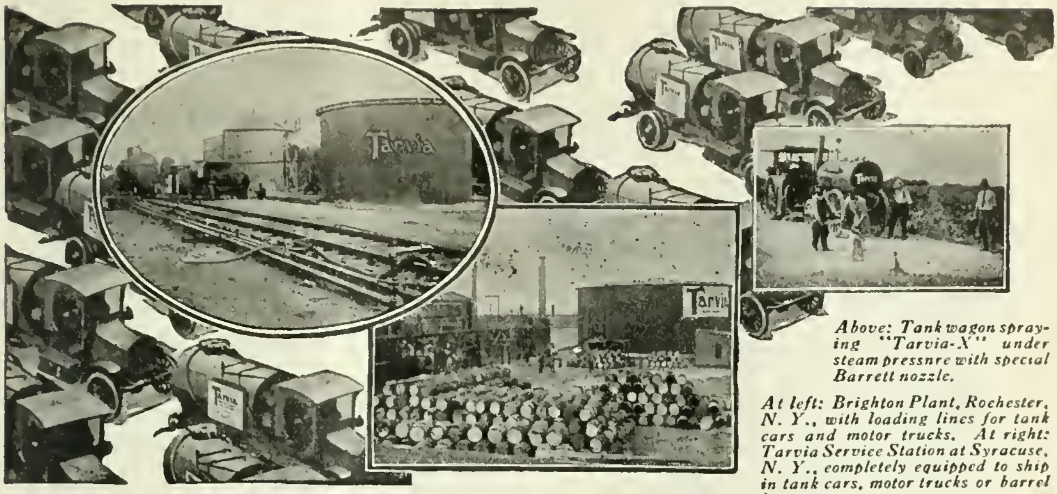
Care shall be exercised to make the joint uniform in width and not ragged.

Soon after the filler has been squeegeed into the interstices of the pavement, the expansion joint strips shall be removed carefully so as not to disturb the blocks or break the bond of the filler, the joints shall be cleaned thoroughly to their full depth and then they shall be poured full, immediately, with a hot bituminous filler. These joints shall be repoured when necessary in the opinion of the engineer in charge.

In case premolded strips of fiber matrix and bitumen or similar material of approved quality are used, the bitumen shall be heated from 225 deg. to 250 deg. F., at the time of its application. The joint material swabbed with hot bitumen on top shall extend through the entire thickness of the pavement. Care shall be observed in order to prevent the bitumen from spreading over the surface of the pavement for a width of more than 1 in. on either side of the joints. All joints shall be covered with clean, sharp sand before the pavement is opened to traffic.

35. *Blocks on Grades.* When the blocks are laid on grades of 4% or over, it is desirable that the method of separation for open joints on the sides of the block provide for a spacing between each course of 5/16 in.

36. *Curbs.* The curbs, where indicated, shall be constructed of 1:2:4 concrete, 18 ins. deep, 6 ins. wide on top and 10 ins. wide at the bottom. All curbs shall be built to the established grade in a continuous line, parallel with the center line of streets except at all intersections of streets and offsets to buildings, where curbs shall be rounded to such a radius



Above: Tank wagon spraying "Tarvia-X" under steam pressnre with special Barrett nozzle.

At left: Brighton Plant, Rochester, N. Y., with loading lines for tank cars and motor trucks. At right: Tarvia Service Station at Syracuse, N. Y., completely equipped to ship in tank cars, motor trucks or barrel lots.

Service!

CALL on our Special Service Department regarding your road problems or the conditions in your vicinity. We gladly put the skill and experience of our engineers at your disposal. This service is free for the asking. If you are interested in *better roads* and *lower taxes*, here is an organization that can be of real service to you.

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In road work, building or repair, nothing is more important than having material on hand *when* it is wanted. Delays and holdups on delivery are expensive. Tarvia Service can be depended upon. Tarvia Service is always "on the job."

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Back of Tarvia Service stands the great Barrett organization with its branches, placed all over the U. S. These branches are strategically located to afford efficient centers of distribution. You can always get Tarvia *where* you want it.

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Tarvia can be delivered by tank car, motor truck, tank wagon or in barrels. As a rule, Tarvia motor truck service is available within 40 miles of any Barrett Service Station or plant. When the size of the job warrants, motor trucks may be furnished at any distance from the plant or service station, the trucks operating from tank cars placed on sidings.

Motor truck distribution is faster and well worth the slight increase in price necessary to cover the use of the trucks, but equally good results may be obtained with the tank wagon—Barrett nozzle method—as shown in small illustration above.

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TARVIA is a coal tar preparation made in a number of grades to meet varying road conditions. It is the most popular road material in America and has solved the problem of low cost, traffic-proof roads and pavements for hundreds of towns throughout the country.

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as the engineer in charge may direct. The top and inside surface of curbs shall be given a smooth finish, complete, to the point of each day's work.

37. *Curb Guards.* Headers subjected to transverse traffic shall have steel corner mouldings, of a type subject to approval of the engineer in charge, forming a curved finish on the two exposed angular edges of the curb or header; where the curb is parallel to direction of traffic and above the grade of the roadway, similar steel mouldings shall be used, where indicated, in order to form a curved finish on the angular edge nearest to the roadway. The outer exposed edge may have a curved finish on the concrete, corresponding to that of the steel corner moulding used at the inner edge.

38. *Miscellaneous.* Especial attention is invited to construction at existing manholes and catch-basins and at points where railroad or street car tracks cross streets. Manholes and catch-basins shall be raised or lowered if found necessary, in the opinion of the engineer in charge. Where railroad or street car tracks cross streets, expansion joints shall be provided and installed as specified hereinbefore and as indicated.

39. *Protection.* Immediately after the spaces between the blocks have been filled and while the filler is still soft and pliable the pavement shall be covered with a layer of approved clean, coarse sand, not less than ¼ in. thick, which shall be heated if directed by the engineer in charge. No traffic whatsoever shall be permitted on the pavement until the filler has cooled to the air temperature. This covering, kept wet, shall remain on the pavement for such time as may be directed by the engineer in charge, after which it shall be removed in a manner satisfactory to the engineer in charge.

In case cement-sand bed is used, the pavement shall be protected against traffic for a period of time to be established by the engineer in charge.

40. *Inspection.* All materials herein specified and processes used in the manufacture and creosoting of the blocks shall be subject to tests and inspection, acceptance or rejection at the point of manufacture, where there shall be provided all the necessary gauges, appliances and facilities to enable the inspector to satisfy himself that the requirements of the specifications are fulfilled.

Attention is invited to the fact that a perfect penetration of every particle of sapwood is expected and a careful inspection of the blocks, after treatment, by sawing a number of the blocks, taken at random, through the center of the blocks and at right angles to the fibre, will be resorted to.

The purchaser shall have the further right to inspect the blocks after delivery upon the premises for the purpose of rejecting any blocks that do not meet these specifications, except that the plant inspection shall be final with respect to creosote oil and treatment.

41. *Items of Proposal.* Proposals shall be submitted to the engineer in charge upon the following items:

Item I for the use of tar-sand cushion in entire work, complete, in accordance with the drawing and this specification, based on plain wood blocks, coal-tar pitch cushion and either pure bitumen or bituminous sand mastic filler.

Item 2. Amount to be added to the net price stated under Item 1 for the use of lug wood blocks instead of plain wood blocks.

Item 3. Amount to be added to or deducted from the net price stated under Item 1 for the use of tar-sand cushion instead of coal-tar pitch cushion.

Item 4. Amount to be added to or deducted from the net price stated under Item 1 for the use of asphalt-sand cushion instead of coal-tar pitch cushion.

Item 5. Amount to be added to or deducted from the net price stated under Item 1 for the use of cement-sand cushion, instead of coal-tar pitch cushion.

NOTE: The specifications as drawn herein tend to cover average conditions only. Should circumstances warrant, other kinds of wood, such as North Carolina pine, Norway pine, black gum, tamarack, etc., may be used. Likewise, the melting point, penetration, etc., of the bituminous materials used should be modified to meet extreme climatic conditions. Should it become evident from laboratory tests conducted by the engineer that the moisture content in the blocks is higher than anticipated and there is a danger of shrinkage, the preliminary steaming treatment should be decreased, a fine sand filler, approximately ¼ in. in depth should be swept into the joints between the blocks, before the bituminous filler is poured, and the blocks themselves should be driven together as tight as possible, all in order to prevent trouble due to a possibility of shrinkage.

WATER WORKS SECTION

ANNUAL CONVENTION OF THE AMERICAN WATER WORKS ASSOCIATION

The best convention ever held by the American Water Works Association was its 41st annual meeting held June 6-10 in Cleveland, Ohio. Not only was the attendance greater than at any previous meeting, but the program was better balanced this year than ever before. A general feeling of genuine optimism was observed among the delegates and this reflects the improving trend in every aspect of the water supply business.

Papers were presented covering in detail every side of the Cleveland water supply works and their operation, as a preliminary to either group or individual visits by delegates to any desired feature of the works. During the convention the Cleveland Water Department maintained an information bureau at the convention office and provided conveyances to take members to view the works.

Among the more important phases of the water works business which occupied the attention of the convention were the following: Water waste; the cleaning of water mains; water rates; oil engines; meters; water storage; water filtration; water works publicity; construction equipment; the chemistry and bacteriology of water purification, etc. Entire sessions were devoted to some of these topics and a few of the papers presented are published in this issue.

A new feature at this convention was the meeting in small groups, on the first day, of those early in attendance, for the purpose of discussing various practical topics of common interest. Seven topics were chosen and members interested in a certain topic registered for assignment to the desired group. The object of these meetings was social as well as technical. Aside from these group meetings, the first day was devoted to registration and to committee meetings. On the second day the Cleveland works were thoroughly described as previously stated, and at the evening session the Water Works Manufacturers' Association had charge of the meeting and arranged the program. All of the papers at this session were by men engaged in the manufacture or sale of water works supplies. This meeting was an experiment, and a very successful one, and it is probable the producers of materials will be heard again by the users at an annual convention. It certainly is high time the producers were recognized in this way, and we hope they will not, on any occasion, abuse this new privilege by working sales talks into what should be impartial, studious efforts to learn the truth and make it known for the benefit of the water works fraternity.

Beekman C. Little, of Rochester, N. Y., the outgoing president, delivered the presidential address. Mr. Little expressed deep pride in the association and made confident predictions of its increasing usefulness. He urged water works men to let their lights shine so they would be better appreciated by the home folks. His suggestion that philanthropists use water systems in making bequests to humanity is novel and worthy of the notice of those of ample means and generous impulses.

The session on water filtration was devoted to a consideration of filtration from the operator's standpoint. On the fourth day there were two separate programs of papers: one for the superintendent and the other for the chemical and bacteriological section.

Professor Edward Bartow, of the Department of Chemistry at Iowa State University, was elected president of the Association for the coming year. W. S. Cramer, chief engineer for the Lexington Hydraulic & Manufacturing Co., of Lexington, Ky., was elected vice president; W. W. Brush, of New York City, was elected treasurer, and J. M. Diven, also of New York, was re-elected secretary.

The Council on Standardization, which was established by the Association at the Montreal convention in 1920, has been outlining its work by conference and correspondence during the past year. The work of the council is now considered by many, even at this early date, the most important work of the Association, and undoubtedly the report of the council was the outstanding feature of the Cleveland convention. We give herewith the major report of the council, of which Mr. George W. Fuller is chairman:

"The council has considered it much better to develop a working program which is flexible, yet comprehensive, rather than to have appointed at once a large number of committees without well-defined purposes and with personnel selected without the full consideration desirable. It has been certain from the outset that no program should be laid out which cannot be followed by committees with individual resources at the command of their members, by the help the Association can give, and by the assistance that reasonably can be expected from other sources.

"In general, the committees will find it useful to function in two ways. The first is to carry on actual investigations, which may not furnish much information except at intervals. The second is to prepare for publication in the Journal brief abstracts of the reports and papers on current developments of importance to the members. The publication of such abstracts can be made of high educational value, and their preparation is an excellent way to secure the co-operation of some of the younger members in committee work. It is suggested that the Association should compensate the members who do this work at the rate of about half a cent a word for the abstracts as printed. For some years it is probable that this abstracting of information will be the most productive educational features of the council's work.

"It is expected that each committee will first lay out a program for carrying on the work assigned to it, and will then take up this program with the council. When it has been developed to the satisfaction of the council, the latter will take steps to gain for it the support of the Association. The council believes that 'practical' committee work should be carried along simultaneously with research, so that water works operators will get the maximum possible benefit as early as practicable from the council's activities. Furthermore, this program will make it practicable for each committee to carry its work forward in the speediest way to the point where the experience of the practical water works men can be drawn upon in order to couple theory and practice in the most helpful way. In this manner a large number of our members will be joining co-operatively in improving water works practice.

"The council has held conferences at Cleveland and has reached the conclusion that the committee work outlined should be undertaken. In order to carry it on properly, the council has asked the Finance Committee to place $2,000 to its credit in the 1921-1922 budget.

"The council regards itself as a Committee on Committees for those subjects which involve standardization matters. It will be the committees and not the council which shall be given credit for actual performances, while to the council will fall the task of co-ordinating and stimulating action along practical lines and of avoiding duplication of effort. It is not to be expected that each committee will produce, year by year, reports of great importance, but it is hoped that all committees will put before the membership concrete statements of progress made in their respective fields, expressed in such a manner as to be readily understood by those interested in a practical way in these subjects.

"To get the abstracts under way a committee consisting of A. L. Fales, J. N. Chester, F. C. Jordan, R. S. Weston and A. Wolman has been appointed to report to the council by September 15, 1921.

"It is understood by the council that such portion of the funds to be reserved for its use as will not be actually necessary will be available for other activities authorized in the Association budget for the year 1921-1922."

Malcolm Pirnie, of Hazen, Whipple & Fuller, 30 East 42nd St., New York, will act as secretary of the council.

There are 15 committees engaged on the work of the council on standardization, considering the following subjects:

1. Standard Methods of Water Analysis.
2. Standards for Satisfactory Drinking Water.
3. Practical Ranges in Load Factors for Purification Plants.
4. Colloid Chemistry in Relation to Water Purification.
5. Watershed Protection.
6. Industrial Wastes in Relation to Water Supply.
7. Pumping Station Betterments.
8. Physical Standards for Distribution Systems.
9. Standardization of Services.
10. Sanitary Fountains.
11. Testing of Water Works Materials and Supplies.
12. Methods and Records of Water Waste Control.
13. Steps Toward Standardizing Stated Quantities for Slides in Meter Schedules.

14. Practical Standards of Rules and Regulations of Relations Between Water Works and Consumers.
15. Essential Data for Water Department Records and Reports. (A) Municipal Plants. (B) Privately Owned Plants.

These are the subjects which have held the attention of the Association in its conventions from year to year. These committees of the council are expected to co-ordinate and crystallize the more or less informal and disconnected talks previously given on the several subjects into something like a code of recommended practice. In other words, specific recommendations as to procedure are to be formulated for the guidance of the individual water works operator or engineer. That very great good will result from these labors cannot be doubted if the Association as a whole lives up to the opportunity now presented.

This year, as always, great interest was shown in selecting the next convention city. The following cities invited the Association to held its 1922 convention with them: Atlantic City, Baltimore, St. Joseph, Mo., Detroit, Philadelphia, Kansas City, New Orleans, Washington, D. C., and Dallas, Tex. The convention committee suggested that the choice be made between Baltimore, Kansas City and Philadelphia. After one ballot Kansas City withdrew in favor of Baltimore, but on the second ballot Philadelphia received a majority of all votes cast, so the 1922 convention will be held in Philadelphia.

WATER MAIN CLEANING IN KANSAS CITY, MO.

By Charles S. Foreman, First Assistant Engineer, Water Department, City Hall, Kansas City, Mo.

Water works engineers and superintendents usually know the necessity of cleaning certain water mains or feeder mains in the system which they may be operating but before they are able to obtain authorization and appropriations to cover such work, they are called upon to answer many questions which may be brought up before a board of commissioners.

The author believes that the publication of his experiences in the line of water main cleaning in Kansas City during the past three years will be of value to other water works superintendents desirous of instituting similar work in the system under their jurisdiction and that the following essential facts based upon his experiences will help to answer some of the questions which are usually asked.

Essential Facts Based on Experience

1. That the cleaning can be so arranged that a main need not be out of service longer than 12 hours for cleaning.

2. That the cleaning process is not injurious to the mains.

3. That an increase in carrying capacity of from 60 per cent to 85 per cent was obtained in large mains and that the carrying capacity of such mains was restored to that of new pipe.

4. That the saving in coal costs alone, derived from cleaning will pay the entire cost of cleaning within from 1 to 3 years.

5. That the laying of additional mains to obtain increased capacity can be postponed until the consumption demands are equal to the maximum capacity of the old main on the basis of new pipe.

6. That when taking as credits, such items as coal saving and postponement of obligatory laying of new mains, the entire cost of cleaning is saved within 6 months to 1 year.

Local Conditions Calling for Main Cleaning

In Kansas City, Missouri, for 2 or 3 years prior to the summer of 1918 there was always a lack of adequate pressure in the north and east portions of the city. This district is fed from the Turkey Creek Pumping Station through one 20 in. and one 30 in. cast iron water main. The question of laying additional feeder mains into these districts was abandoned because of the exceedingly high prices of material and the lack of funds. Therefore the proposition of increasing the carrying capacities of the old mains by the cleaning process was resorted to in the fall of 1918.

Preliminary Tests

Tests were run on the 30 in. high pressure discharge line extending from Turkey Creek Station to 17th and Baltimore, a distance of approximately 6,000 ft., for determining the interior condition and carrying capacity of this pipe, the pipe having been laid in 1886. The tests were made by making taps exactly 1,000 ft. apart upon a straight length of the main, there being no services or connections to the main between gauging points. At each of these points 1 in. corporation cocks were installed for inserting pitometers and additional corporation cocks for pressure lines . Two inch pipe was connected to each of these taps and 1,000 ft. of this pipe laid along the surface of the ground bringing the two together so that a U-tube could be connected in to measure the differential pressure between the two points. The 30 in. pipe was double traversed at each pit and the average traverse co-efficient obtained. A pitometer was then set at each pit for checking quantities flowing through the 30 in. main.

The scale on the differential U-tube was graduated in 0.01 ft. divisions and by using a liquid of specific gravity of 2 in this tube, the readings obtained were in feet loss of head per thousand feet.

The advantages inherent in this method are that it is not necessary to obtain the difference in elevation between the two points, and that it eliminates the use of spring gauges. Piezometers could not be used because of the high pressure. All of the lines being under pressure of 125 to 150 lbs. per square inch.

The pipe and connections for bringing the two pressures to the differential U-tube should be water tight for accurate results. However, we found no difficulty in making them up tight. We also found that with pipe of 1½ to 2 in. diameter a slight leak did not materially affect the results.

The test extended over a 24 hour period so that both maximum and minimum velocities in the pipe could be obtained.

The average pipe coefficient as computed by William & Hazen formula was 69.69, this being lower than that in the Williams & Hazen tables for pipe 40 years old. From these tests it was evident that the 30 in. line was far below the carrying capacity of new cast iron pipe. A contract was awarded to the Naional Water Main Cleaning Co., of New York City, for the cleaning of 6,000 feet of this 30 in. pipe.

Similar tests were run after the pipe had been cleaned. The average pipe coefficient was brought up to 116, and at low velocities as high as 120. The carrying capacity of this pipe having been restored to nearly that of new pipe.

Preliminary Work Leads to Contract for Extensive Cleaning

The cleaning of the 30 in. pipe gave such excellent results that a contract was let to the same company for the cleaning of additional feeder mains into the northeast section of the city, there being 30, 24, 20 and 16 in. pipe lines in this contract.

Similar tests were run on each of these pipe lines both before and after cleaning. In all of these cases the pipe after being cleaned was restored to carrying capacity and corresponding loss of head as indicated in Williams & Hazen tables under coefficient 120.

In making the test on the smaller lines, we were unable to place the gauging taps 1,000 ft. apart because of service connections and connections at street intersections. They were placed at 200 ft. 250 ft. and 500 ft. apart, depending upon conditions encountered.

The liquid used in the differential U-tube was a mixture of carbon tetra chloride and bromoform brought to the required specific gravity by the addition of gasoline. The specific gravity was varied in accordance with the variation in distance between taps on the line to be tested so that in each case the readings on the U-tube were directly in foot loss of head per thousand feet.

In the spring of 1919, similar tests were made on the 36 in. flow line from the low service station at Quindaro to the Kaw River Tunnel, a distance of 17,000 ft. It was found that the average pipe coefficient as computed by the Williams & Hazen formula was 71 5 and that by cleaning this line the coefficient was restored to 122.33.

The Methods Used in Cleaning

The methods used by the National Water Main Cleaning Company for cleaning large mains is a very simple one. The section of pipe to be cleaned is valved off and a cut made at each end sufficient to admit entering and removing the cleaning machine.

After cuts are made and the machine inserted the pipe is then sleeved up and the joints poured, after which the water is turned on behind the machine. After the machine once starts moving it travels very rapidly through the main (3 to 4 ft. per second), coming out at the open end of the section to be cleaned and bringing all the dirt and encrusting material out ahead of it.

The actual time any section of main is out of service depends almost entirely upon the speed which can be made in making the necessary cuts in the pipe and sleeving them up as the actual traveling of the machine from one end to the other of a section of pipe requires but very little time. Usually the cuts on large mains can be so arranged that they can be made and repaired in approximately 12 hours so that it is only necessary to have the main out of service for that length of time.

The actual cutting and repairing of the various mains was done by department forces while all of the other work such as excavating, backfilling, placing of machine, etc., was done by the contractor.

Cost of Cleaning Mains

The contractor's price for cleaning ranged from 26 cts. per foot for 16 in. pipe to 45 cts. per foot for 36 in. pipe and the total cost, including all expenses for operating valves, cutting and repairing pipe and for all necessary sleeves and material was $22,046.09 for 43,857 lin. ft. of pipe cleaned or 50.3 cts. per lineal foot for all sizes.

The total cost of cleaning the various sizes, including pavement repairs and operation of valves, etc., was as follows:

7,202 ft. of 16 in. pipe—$2,472.52 or 34.3 cts. per lin. ft.

7,280 ft. of 20 in. pipe—$3,056.80 or 41.9 cts. per lin. ft.

3,371 ft. of 24 in. pipe—$1,813.56 or 53.5 cts. per lin. ft.

8,984 ft. of 30 in. pipe—$5,604.93 or 62.3 cts. per lin. ft.

17,000 ft. of 36 in. pipe—$9,098.28 or 53.5 cts. per lin ft.

Increase in Carrying Capacity Due to Cleaning

The average flow through the 30 in. pipe from Turkey Creek Station to 17th and Baltimore before cleaning was 11.1 million gallons per day and the friction loss was 4.23 ft. per thousand feet. After being cleaned, with the same quantity of water passing through the pipe, there was a friction loss of 1.6 per thousand feet or a net gain of 2.62 ft. per thousand feet amounting to 15.78 ft. for a total of 6,000 ft. cleaned. This was also checked approximately with pressure gauges at each end of the line and is equivalent to a saving of 1,460 million foot pounds of work per 24 hours.

Had this been a line through which we desired to deliver 11.1 million gallons of water per day at a certain head, there would have been an actual saving in coal of $6.67 per day or $2,504 per year, so that the saving in 1 year of coal alone almost equals the cost of cleaning.

However, as we carry a constant station pressure of 150 lbs., the cleaning resulted, either in increasing the pressure in the down town district 15.78 ft. with the same quantity of water passing through the line or with the same loss of head as before cleaning, the quality delivered through the line would be approximately 19½ million gallons per 24 hours, or an increase in carring capacity of 8.4 million gallons per day or nearly 80 per cent.

To obtain the same increase in capacity as the cleaning of the 30 in. pipe resulted in, would mean the laying of an additional 24-in. feeder main. The estimated cost of such a line at that time was $88,800 and the annual interest on this amount at 5 per cent is $4,440, making a total annual saving of $6,944 as against a total cost for cleaning of $3,720.50.

In the case of high pressure distributing mains the cleaning of the 26,000 ft. of various sized pipe now enables the delivery to the northeast section of town of approximately 12 million gallons per day more water than before cleaning without increased head at the pumping station. Therefore, it will be readily seen that the laying of additional feeder mains can be postponed for some time by keeping the present mains up to their maximum carrying capacity.

In the case of the 36 in. flow line, it was found on the test before cleaning that with a loss of 2.7 ft. per thousand feet the line was flowing 16 million gallons per 24 hours. This was practically the minimum amount of water that it was possible to put through this line with the limiting head of 50 ft. on the Quindaro pumps. The test after cleaning indicated that with the same loss of head, the capacity had been increased to approximately 26 million gallons or 75 per cent.

In other words, this gave the department an increase in flow line capacity of approximately 10 million gallons per day, which was greatly needed during the periods of maximum consumption in the summer of 1919. Under normal conditions of consumption, the cleaning of this flow line actually resulted in a saving of 1.7 ft. of friction loss per thousand feet.

Annual Costs and Saving Before and After Cleaning

The accompanying tabulation shows the length of time in service, the annual operating cost for coal, before and after cleaning of the various sizes cleaned. Also the investment required and the annual interest thereon to obtain the increased capacity by laying new mains and the total annual saving all being based on 5,000 ft. of each size and on the normal flow through the pipe at time tests were made.

Inspection of the interior of the mains after cleaning discloses that the machine had no injurious effect upon the interior surface. The springs on the machine are not set stiffly enough to cut into the cast iron and in many instances, where inspection was made, it was found that the old tar coating was still in the grains of the iron. The machine in many instances was sent around sharp curves, some as much as 60 degree bends and also through open gate valves without injurious effect. It cleans the walls of the pipe very thoroughly and leaves it practically as smooth as new pipe.

TABULATION OF ANNUAL COSTS AND SAVINGS BEFORE AND AFTER CLEANING WATER MAINS AT KANSAS CITY, MO., WATER WORKS ON BASIS OF 5,000 FT. OF EACH SIZED PIPE.

Service Years	Size	M. G. D. Normal flow	Loss of Head Per 5,000 Ft. Uncleaned	Loss of Head Per 5,000 Ft. Cleaned	Annual Coal Cost To Operate Line Uncleaned	Annual Coal Cost To Operate Line Cleaned	Annual coal saving	Size req. to obtain increase in capacity if not cleaned	Estimated cost 5,000 ft.	Interest on expenditure 5%	Total annual saving	Total cost of cleaning
41	16-in.	2.4	24.00	7.50	$462.53	$144.53	$318.00	12-in.	$27,200.00	1360.00	1778.00	1715.00
42	20-in.	3.4	23.50	5.60	641.60	152.89	488.71	16-in.	33,100.00	1655.00	2143.71	2095.00
28	24-in.	5.0	12.60	5.25	505.90	210.79	295.11	16-in.	33,100.00	1655.00	1950.11	2675.00
33	30-in.	12.0	23.50	9.00	2264.46	867.24	1397.22	24-in.	70,000.00	3500.00	4897.22	3115.00
33	36-in.	16.0	15.25	6.00	3740.52	1471.68	2268.84	30-in.	73,500.00*	3675.00	9618.84	2675.00

Annual cost for fuel to pump one million gallons 1 foot high at Quindaro, $0.042.
Annual cost for fuel to pump one million gallons 1 foot high at Turkey Creek, $0.022.
*No pavement or rock.
Surface supply, Missouri River water.

Rapidity of Corrosion After Cleaning

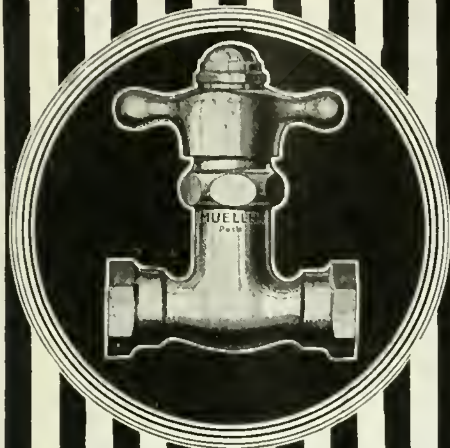
As to the question of how long the benefits derived from the cleaning of water mains may be expected to last, the author has heard it stated many times that after a pipe had once been cleaned the corrosive effect or the formation of barnacles was very much more rapid than before cleaning. In fact, the contractor stated that the carrying capacity might decrease the first year but would be less rapid thereafter. With a view to ascertaining what this effect would be on the 30 in. main, permanent pitometer pits were put in so that tests could be run from time to time after the cleaning. Accordingly pitometer and loss of head tests were run again in the fall of 1920 on this main. Two years after cleaning there was practically no change in results from the test run immediately after the pipe was cleaned. This would tend to indicate that the corrosive action is no faster after cleaning than an ordinary new pipe.

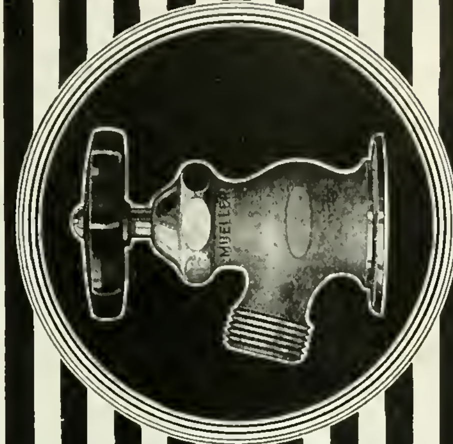
The author believes that in the designing and laying of new feeder mains, serious consideration should be given to the advisability of building permanent pits with removable sections of flanged pipe so that a main can be readily and cheaply cleaned from time to time.

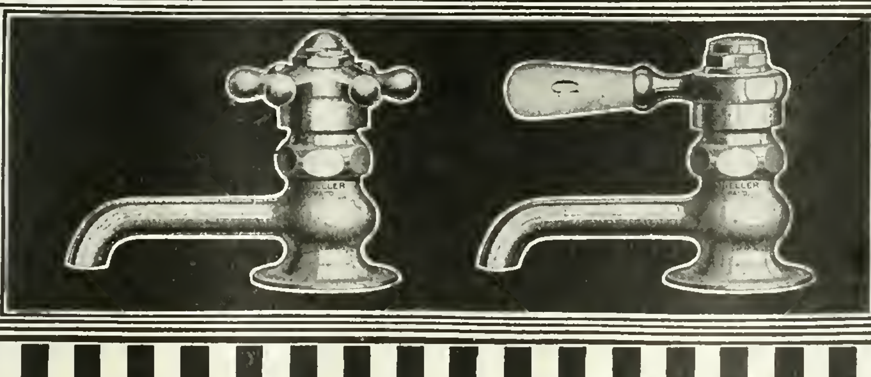
It is now the common practice among engineers, when computing the size of pipe required to deliver a certain quantity of water, to use the loss of head figures as given in Williams & Hazen tables under coefficient 100, thus providing a larger size than necessary under coefficient 120.

It can be readily seen that the interest on the saving in first cost between the smaller and larger pipe will far more than pay the cost of maintaining the smaller pipe at its maximum capacity by cleaning whenever necessary.

This paper by Mr. Foreman was presented at the 1921 meeting of the American Water Works Association.







RESULTS PRODUCED BY EXPERIMENTAL BAFFLES AT MONTEBELLO FILTERS OF BALTIMORE WATER WORKS

By James W. Armstrong, Filtration Engineer, Montebello Filters, Hillen Road, Baltimore, Md.

Montebello Filters are provided with two coagulating basins that are operated in parallel, apparently under similar conditions. Float observations and surveys of the mud deposits made at various times showed different results for each basin, and revealed the fact that different parts of the basins had different subsiding values, the heavier mud deposit coinciding closely with the maximum velocity of flow. The general tendency was to deposit silt heavily against the baffle wall on the incoming side, and against the outer wall on the outgoing side, the deposits sloping to a minimum depth in The water, as would naturally be expected, followed the line of least resistance; consequently as the basins silted up and became shallower, it passed through them at a more uniform velocity.

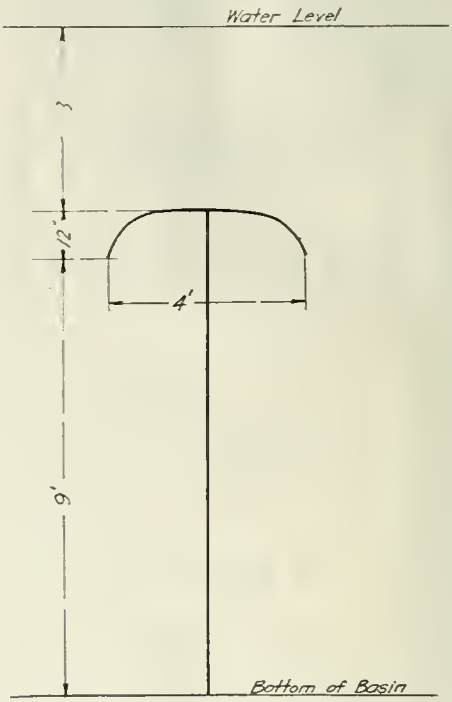
Each of the coagulating basins is 317 ft. long, 232 ft. wide, and has an average depth of about 15 ft.

A central baffle wall extends about three-quarters of the length of each basin. Water is admitted through five sluice gates, spaced at equal intervals, and after passing around the baffle, is withdrawn through a similar number of gates. The water passes over a baffle at the entrance and over a skimming wier at the exit.

In addition to the variations in velocity and the lack of uniformity in mud deposits, other irregularities were noticed in the functioning of the basins. As an illustration, it was noted on one occasion that Basin No. 1 gave decidedly better results than Basin No. 2, but upon making a slight change in the opening of one of the inlet gates, the condition was shortly reversed and Basin No. 2 gave markedly better results than Basin No. 1.

This phenomenon raised the question as to the possible effect of undercurrents upon the subsiding value of the basins. It was argued that if the elements of the water in moving through the basin could be kept in nearly parallel lines and if the movement could be confined to the surface of the water, leaving the lower stratum undisturbed, much greater subsiding value could be obtained.

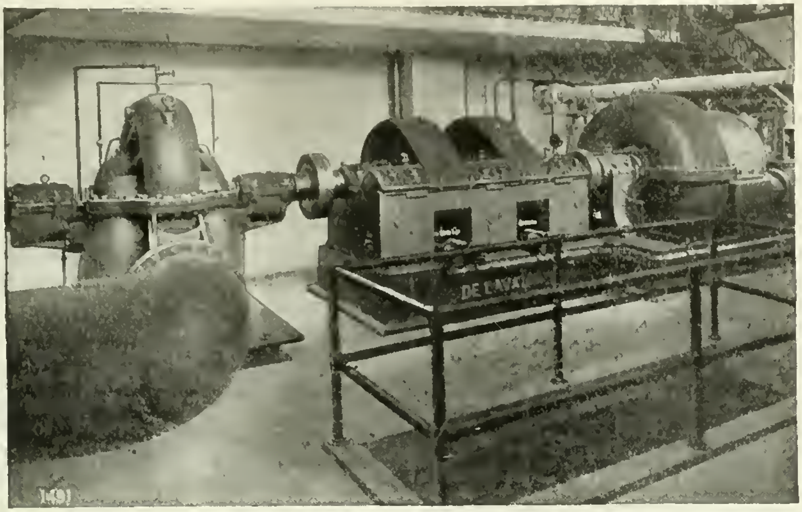
With the purpose of testing out this theory, some modifications were made in the existing entrance baffle, and an additional cross baffle was built in Basin No. 1. Basin No. 2 was not touched. In order to give a positive outward sweep to the water entering the basin, increase the surface velocity, and prevent returning undercurrents, a wooden apron about 2 ft. wide and sloping in an upward direction was attached to the top of the existing entrance baffle. No changes

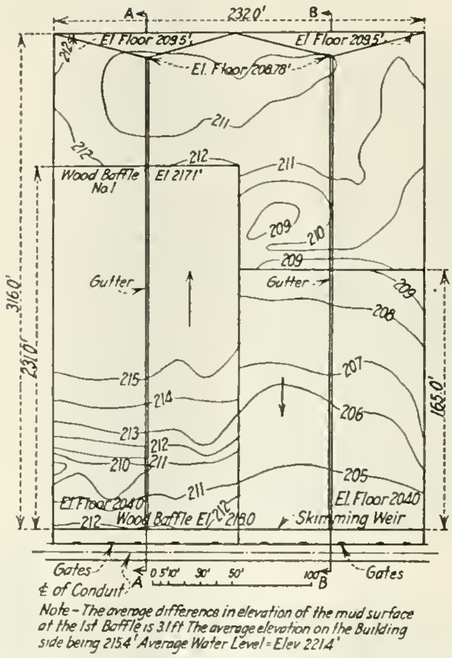


SKETCH SHOWING OUTLINE OF WOODEN BAFFLE ACROSS COAGULATING BASIN NO. 1, MARCH 20, 1919.

were made at the outlet skimming wier. At the end of the existing concrete baffle, about 240 ft. from the entrance, an additional wooden baffle was built entirely across the basin. This baffle was made of ⅞ in. flooring, and was thoroughly anchored to the concrete floor of the basin. As it was not designed to carry hydrostatic pressure, a number of swinging doors hinged at the top were provided to relieve the pressure at times of filling and cleaning. The new baffle was 10 ft. high and was capped with a top 4 ft. wide, which projected 2 ft. on each side. The top was curved downward at the ends in the form of a parabola. Water usually flowed about 3 ft. deep over the top of the baffle.

The following reasoning was respon-





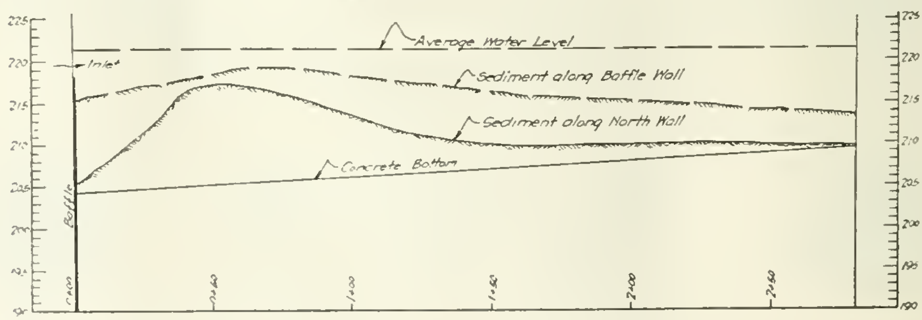
PLAN SHOWING SILT DEPOSIT IN COAGULATING BASIN NO. 1, ON DEC. 31, 1919.

sible for the building of the unusual type of cross baffle:

The reduction of the cross sectional area would tend to establish a more uniform flow across the top of the basin at the baffles, and would create a quiet zone near the bottom that would permit better sedimentation. It is well known that when flowing water meets an obstruction such as a baffle, there is a decided tendency to pick up sediment and carry it over the top, and it was reasoned from the known characteristics of a parabola to reflect rays of light in parallel lines, that the sediment in the rising currents of water, would, upon striking the parabola, be thrown downward and deposited, instead of being carried over into the next compartment. The curved top over the rear of the baffle is only useful in gradually reducing the velocity of water flowing over it.

After this baffle had been in service for a number of months, the basin was cleaned. It was found that the apron extending across the top of the baffle at the entrance of the basin had been built a little too near the surface, and the velocity of entering water was so great that it carried most of the sediment outward as far as the cross baffle. The results at the cross baffle, however, were most gratifying. The parabolic top had evidently acted exactly as had been anticipated, for the mud was deposited adjacent to the baffle, almost to its full height, and sloped gradually backward to the entrance of the basin. The baffle on the return side had not performed so well, probably owing to the fact that the water in passing over it was not flowing in a direction normal to its face.

The swinging gates placed in the wooden baffles for relieving them of hydrostatic pressure operated successfully when the basin was being filled, but when the time came for removing the mud it had become so firmly compacted against the baffles that the swinging gates could not operate and the baffles collapsed. As the accident happened in cold weather, no attept was made to repair the baffles until June, 1919, when No. 1 across the north half of the inlet side of the basin was rebuilt in its original position and the one in the south half was moved forward about 50 ft. In moving it forward, the sloping bottom of the floor had the effect of lowering the elevation of its top 1.2 ft. The position of the hinges on the swinging gates was changed from the top to the bottom and heavy wooden strips were secured to the top. The bouyancy of the wood shut the gates and held them in position as long



PROFILE SHOWING EXTENT OF SEDIMENTATION IN COAGULATING BASIN NO. 1, MARCH 18, 1919.

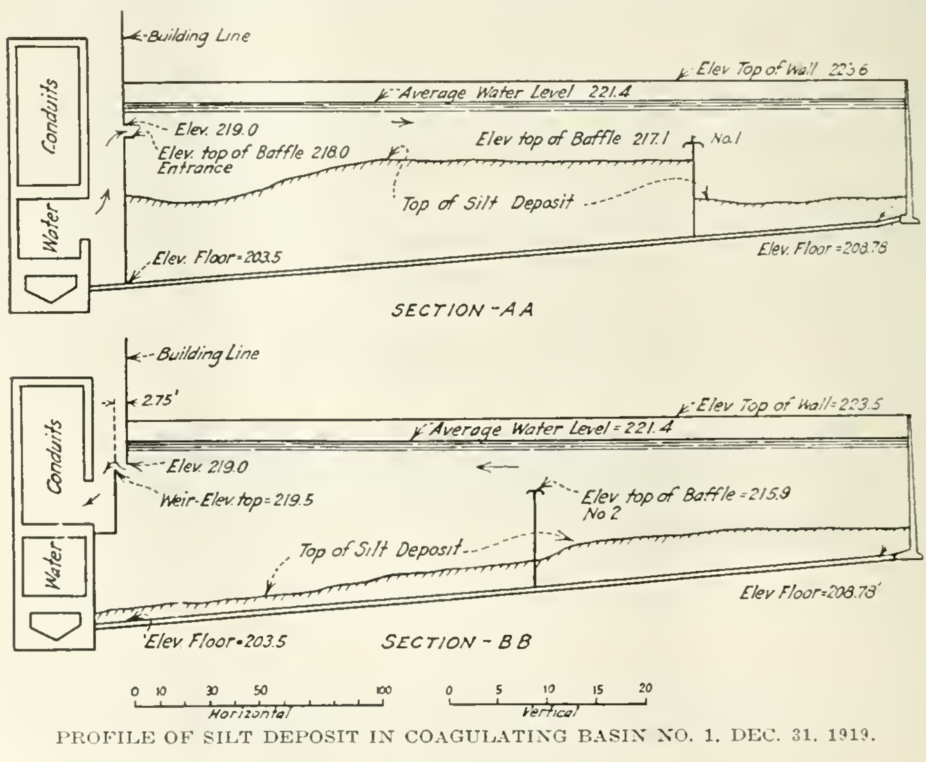
as water was in the basin, but as soon as the water was withdrawn below the top of the gates, the weight of wood on top and the pressure of water behind opened the gates. No further trouble was experienced when the basins were cleaned, although mud was packed solidly against the baffle No. 1 from top to bottom.

The plan and profile of the basin show the surface of the mud, and the location and elevation of the baffles on Dec. 31, 1919, when a careful survey of the mud surface was made. An inspection of these diagrams indicated that the sediment was carried forward for a distance of about 100 ft., and from that point to baffle No. 1 it was deposited very evenly. At the baffle there was an abrupt drop in the mud surface of about 3 ft., and from there on to baffle No. 2 there was some irregularity of deposit, as might be expected, due to the change in direction of the flow. From baffle No. 2 to the skimming weir the deposit was also fairly uniform.

During this period of service the rate of flow ranged from 80,000,000 to 154,000,000 gals. per day and averaged 114,000,000 gals. In the accompanying table the depth of water over the baffle and the velocities at various rates are given.

The velocity at the entrance baffle is too high to secure satisfactory subsidence as is evidenced by the fact that only the heavier particles of suspended matter settled out before the water had traveled nearly 100 ft. At baffle No. 1 the velocity ranged between 0.25 and 0.48 ft. per second with an average of 0.35 ft. The result is apparently quite satisfactory at this baffle, and the velocity must have been nearly equal across the entire basin, as the mud deposits were nearly level, in marked contrast to the sloping surface of the mud as shown when the reservoir was cleaned on various occasions prior to the placing of this baffle.

At baffle No. 2 the velocity is somewhat lower than at baffle No. 1 on account of its top being a greater depth below the water surface. The distribution of sediment at this baffle is not nearly so good as it is at baffle No. 1. The contour map shows the greater deposit on the south side of the basin. The indications are that the velocity over this baffle is a little too slow, and if its top had been raised from 1 ft. to 1½ ft. higher, the probability is that a more uniform deposit of sediment would have been secured. The velocity of the water in passing over the skimming weir va-



PROFILE OF SILT DEPOSIT IN COAGULATING BASIN NO. 1. DEC. 31, 1919.

VELOCITY OF WATER OVER MONTEBELLO BAFFLES IN FEET PER SECOND. March 30, 1921.

Basin No. 1

Rate of Pumping, Million Gallons Per Day	Baffle at Entrance: Average Depth of Water Over Baffle	Baffle at Entrance: Velocity Feet Per Second	Baffle No. 1: Average Depth of Water Over Baffle	Baffle No. 1: Velocity Feet Per Second	Baffle No. 2: Average Depth of Water Over Baffle	Baffle No. 2: Velocity Feet Per Second	Skimming Weir: Average Depth of Water Over Baffle	Skimming Weir: Velocity Feet Per Second
80,000,000	1 ft.	1.15	4.3 ft.	0.25	5.5 ft.	0.19	1.9 ft.	0.60
100,000,000	1 ft.	1.46	4.3 ft.	0.31	5.5 ft.	0.24	1.9 ft.	0.75
114,000,000	1 ft.	1.65	4.3 ft.	0.35	5.5 ft.	0.27	1.9 ft.	0.86
128,000,000	1 ft.	1.84	4.3 ft.	0.39	5.5 ft.	0.31	1.9 ft.	0.97
140,000,000	1 ft.	2.01	4.3 ft.	0.44	5.5 ft.	0.34	1.9 ft.	1.06
154,000,000	1 ft.	2.20	4.3 ft.	0.48	5.5 ft.	0.37	1.5 ft.	1.16

SUSPENDED MATTER.
In Parts Per Million.

1919.

Month	Coagulating Basin No. 1	Coagulating Basin No. 2
January	5.7	5.5
(Partially cleaned Feb. 9)		
February	8.0	8.2
March	7.6	7.9
April	6.7	6.9
May	5.7	3.8
		(Partially cleaned May 8)
June	4.6	6.7
(Cleaned June 11, Baffle reconstructed)		
July	3.0	3.9
August	3.9	6.1
September	4.2	5.0
October	4.7	4.4
November	4.8	5.9
December	4.5	6.9

Baffles rebuilt June, 1919.

1920.

Month	Coagulating Basin No. 1	Coagulating Basin No. 2
January	7.5	9.4
		(Partially cleaned Jan. 24)
February	12.0	9.9
	(Partially cleaned Feb. 15)	
March	7.0	12.2
April	5.2	6.5
May	3.5	3.8
June	3.7	5.6
July	9.0	11.0
August	11.1	7.5
		Partially cleaned Aug. 17)
September	5.1	6.4
	(Cleaned Sept. 11)	
October	4.7	5.7
November	4.2	8.0
		(Cleaned Nov. 30)
December	4.7	4.7

1921.

Month	Coagulating Basin No. 1	Coagulating Basin No. 2
January	3.6	3.8
February	4.1	4.4
March	3.5	3.7

ries from 0.6 to 1.16 ft. per second, and is undoubtedly too high for satisfactory results, as it was noticed on many occasions that sediment was picked up and carried over the weir. At times, when stop planks were removed from the baffles, a lighter and more uniform floc was noticed in the water as it passed through the gates to the filters.

In order to compare the subsiding values of Basins No. 1 and No. 2 which are practically identical with the exception of the new wooden baffles built in Basin No. 1, daily reports of suspended matter and turbidities have been kept, and a table has been prepared showing the suspended matter in the basins by monthly averages from January, 1919, to March, 1921. The water entering the two

basins is practically identical, the chemicals having been incorporated in a common mixing chamber before passing to the coagulating basins. The times of cleaning or partial cleaning the different basins is indicated. The word "cleaning" indicates that the sediment was entirely removed from the basin and it was thoroughly cleansed by hosing out with water under high pressure. "Partial cleaning" is accomplished by allowing the sediment to flow out through the drains without hosing. In this way approximately four-fifths of the sediment can be disposed of.

For the first five months in 1919, during which the wooden baffles in Basin No. 1 were in a partially collapsed condition, the two basins did almost the same amount of work, Basin No. 2 giving slightly better results. In June Basin No. 1 was thoroughly cleaned and the baffles rebuilt. From that date until December, 1919, when the survey was made, Basin No. 1 showed an average of 4.2 and Basin No. 2 an average of 5.4 parts per million of suspended matter going onto the filters. Beginning with 1920, due to cold weather and bad water, it was impractical to clean Basin No. 1. As a number of storms occurred, bringing very heavy sediment to the plant, Basin No. 1 was filled with mud to a height about the top of No. 1 baffle by the time it was cleaned on the 15th day of February. For a month and a half during this period of high turbidities Basin No. 1 did very much poorer work than No. 2, owing to the fact that it was nearly full of mud, but immediately after cleaning, it did very much better work than No. 2, as is shown by the results in the table.

The observations seem to indicate that a velocity from 0.35 to 0.4 of a ft. per second over the top of the baffle will give a fairly uniform flow, which will secure nearly equal subsiding values in all parts of the basin; that the velocity over the entrance baffle and skimming weir is too great ,and that better results would probably be secured if it were reduced; that the efficiency of Basin No. 1, even with the improper velocity at all the baffles except No. 1, is markedly better than No. 2, so much so, that at times of high turbidity the difference of effluent from the two basins is so great that it often presents a marked contrast to the eye.

Records made subsequent to Feb. 15, 1920, indicate that Basin No. 1 showed better results than No. 2, except at times when Basin No. 1 was very dirty and No. 2 fairly clean. This will become more apparent in studying the table showing the suspended residue in the effluent from each of the basins. The greater the turbidity of water entering a plant, the more important an efficient coagulating basin becomes, and it is at times of extremely bad water that they become indispensable, and their proper functioning is of the greatest importance. The monthly averages as shown, therefore, do not indicate the real value of the work done by the coagulating basins. For instance, in the early part of 1920, water came to the plant with a turbidity as low as 6. Under such conditions the coagulating basins could not remove any of the suspended matter and in most cases owing to the fact that they were not entirely clean, the suspended matter was actually increased in passing through the basins. In expressing the work of the basins in percentage, an increase would be shown, but at such times the coagulating basins are of no practical value. As an illustration of the work that can be done by coagulating basins: In March, 1920, for a period of nearly two weeks the river water ranged in turbidity from 200 to over 1,000, and during that period of time, the percentage of suspended matter removed by the basins was from 89 to 99 per cent. During the interval mentioned above, Basin No. 1 showed a removal of turbidity greater than Basin No. 2, although both were cleaned within a space of 21 days of one another.

COUNTY ESTABLISHES OWN STORAGE PLANT

Bergen County, New Jersey, has prepared plans for a complete storage plant for bituminous road materials used in road construction and surface treating, to be located at Hackensack, the county seat, and having a capacity of 1,500,000 gals. The plant will consist of four 50,000 gal. storage tanks, two 4,000 gal. heating tanks and a hollow tile storage warehouse 25 ft. by 40 ft. in size. The county officials expect to save large sums of money in storage costs through the erection of the new plant.

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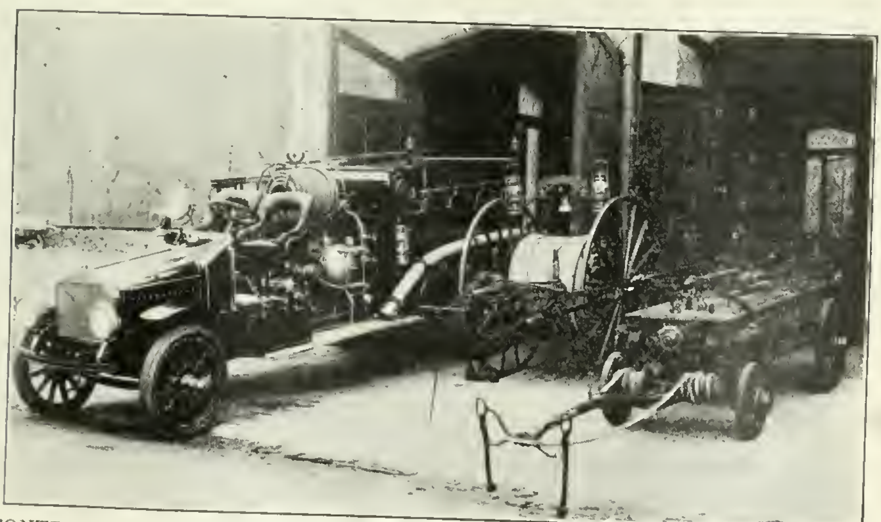
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



CONTRAST BETWEEN OLD HAND PUMPING FIRE ENGINE AND MODERN MOTOR FIRE EQUIPMENT AT YANTIC, CONN.

Motor Truck Operation and Accounting LXXI

MOTOR TRUCK NEWS NOTES

Motorization of Street Department of Salt Lake City

The horse has been almost entirely supplanted by the gas driven motor in the street department of Salt Lake City, says T. T. Burton, commissioner. It is true that in some of the clean up work where frequent steps are necessary, the horse is still in use, but in nearly every other line of endeavor motor equipment is used. The use of the motor in street cleaning and road building shows a great saving in time, money and labor.

In the line of gas driven motor trucks used almost exclusively for the building of gravel roads the department has in use at the present time five 5-ton Packard trucks, four 5-ton and one 2-ton Federal trucks and one 5-ton Mack truck. The 5-ton trucks have a capacity of 4 cu. yds. per load. During the month of March, 9,312 cu. yds. of gravel were hauled from the pit and used for road building. On an average haul from the city's gravel plant this fleet of trucks can deposit on the road 341 cu. yds. of material every working day of 8 hours. The next in importance to the building of streets, sidewalks and sewers, is the keeping of these improvements in a clean, sanitary condition. In addition to the ordinary horse drawn sprinklers used mostly in the outlying districts to lay the dust, the department is equipped with one 1,200 gal. and one 1,000 gal. capacity steel constructed flusher tanks with automatic pressure pumps attached set on a 5½ ton and 3½ ton Federal chassis, respectively. These tanks under pressure will sprinkle the whole width of a 100 ft. street, each tank doing the work of five team drawn sprinklers and doing it better.

Nevada Public Service Commission Rules in Favor of Truck

"I was greatly impressed by a typical case recently heard before the Public Service Commission of Nevada," says H. P. Branstetter, Chicago Kissel distributor.

"It illustrates the superiority of truck transportation in economy, utility and speed of operation.

"Two Italian brothers who have been operating a small motor truck haulage company for some time, applied to the commission for a certificate of public convenience. The application was opposed by a short line railway company operating on the same route as that served by the Italians.

"The railroad had a strong moral argument. It was in possession of right-of-way, had been operating satisfactorily, and was paying considerable taxes. The investment in the railroad was very large. It was estimated that its scrap value was $450,000. It was argued that the addition of a competing carrier would depreciate its revenue and would result in poorer service and higher charges. The railroad claimed that the truck company could not operate all the year round. It asked that the truck company be compelled to adhere to tariff schedules, to be made to erect depots and be ordered to deposit bonds in the amount of $10,000.

"The two Italian brothers simply argued service. Their partnership owned a few high grade motor trucks. With them they covered a 50 mile route in 3½ hours, picking up and delivering freight at residences, farms, mines, warehouses and stores. Deliveries were direct. Railway freight shipments took as many days as the truck took hours. The truck service had actually been affected less by weather conditions than the railroad. A great many customers supported the statements of the brothers, saying that the service rendered was superior to that of the railroad and that a volume of local business was dependent on the truck haulage, and the commission ruled that the truck service was necessary to the agricultural, live stock, mining and commercial industries of the community."

Assisting Truck Owners to Make More Money

It will surprise many truck owners to know that there are many agencies where co-operation, record of previous enterprises and statistics on motor truck operation may be obtained to assist them in making more money with their motor trucks, says Mr. M. L. Pulcher, vice-president and general manager of the Federal Motor Truck Company.

The Department of Agriculture at Washington, the National Automobile Chamber of Commerce, 366 Madison avenue, New York City, the research department of the big tire companies, and the traffic engineers of most of the larger truck concerns, all have information and data which will be of benefit to those motor truck owners who are interested in forming inter-city lines for the haulage of more goods, both freight and express, and any rural motor express work.

In addition to the above available sources of information for the truck owner, there are the local chambers of commerce in almost every city of 25,000 or more in the United States, as well as the more recently formed local transportation associations in many of the larger cities. Bulletins of various kinds, booklets unnumbered, and cost figures without end, may be obtained from these sources, which will enable a man or firm to form motor truck lines which will be profitable and a source of great convenience to the shippers.

A recent bulletin by the Firestone Tire Company says "A healthful state of inter-city haulage will be brought about when the truck manufacturer, truck dealer and truck owner, function as one." They also say that one great source of satisfaction to the truck owner is co-operation among themselves.

While the above is surely true, yet we can truthfully say that the manufacturer has co-operated to no small extent in the past to help the truck owner so arrange his business that the small items are kept track of, to the end that the operator can make money. Many dealers throughout the United States, at least our own, have spent a great deal of time and thought on the development of these motor truck routes, and so we believe that the prospective truck owner, or those who already own trucks, can immediately find a source of information without looking very far, which will help him in the present plans of securing more haulage for his trucks.

A recent bulletin issued by the National Automobile Chamber of Commerce is entitled "Motor Transport Cuts Time and Cost of Shipping in New England"—another, "Good Roads and Motor Transportation"—still another, "Motor Trucks Save 45 Hours Per Shipment for Bay State Manufacturers," Bulletin No. 931 of the United States Department of Agriculture is entitled "Corn Belt Farmers' Experience With Motor Trucks." Ontario Department of Agriculture, Canada, has issued Bulletin No. 277, entitled "Motor Transportation in Rural Ontario." All of these booklets and many others may be obtained from the above sources, and will be most profitable to those who are interested in motor trucking.

Certainly one of the greatest jobs in food and factory production is transportation, and the world needs just as much food as it ever did, and much of that food to be marketed properly must be transported quickly. Motor trucks can do this job better than any other form of transportation.

Business is coming back slowly but surely, and an increasing number of motor truck routes are a necessity if we must continue economy in haulage. "Federal Motor Truck Company and their traffic engineers," concludes Mr. Pulcher, "are at the service of motor truck owners whether they are Federal owners or not. We welcome inquiries as to the operation of trucks in any line of business. We will be glad to give any advice or suggestions desired to anyone. Other motor truck manufacturers, we know, are like-minded. With the government agencies and the National Automobile Chamber of Commerce sources, it ought to be easy to make motor trucks pay today."

Road Contractors Gain Time by Systematic Use of Fleet of Trucks

On one 15-mile project, Johnson, Drake & Piper, Minneapolis, Minn., road contractors, poured 830 ft. of 18-ft. roadway in a day. On the same job, 600 ft. per day was the average maintained for two weeks, 4 miles being the average length of haul for materials. Several hundred lineal feet of roadway were poured daily while another job lasted.

In each instance motor trucks were a big factor in enabling the contractors to accomplish the amount of work they did. Transportation of materials, Johnson, Drake & Piper consider, is one of the most important operations in road building. Therefore the care exercised to systematize this end of their work.

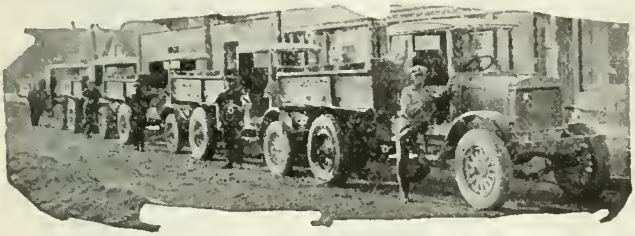
Six 2-ton, standard dump body White trucks were used on one project, calling for 3½ miles of new concrete highway. The trucks were operated by Day Bros., of Minneapolis, who held a sub-contract from Johnson, Drake & Piper.

The average haul from the central proportioning plant erected at the railroad siding was three miles. At the central proportioning plant a clam-shell derrick loaded cement, sand and rock into separate bins. From these bins the material was proportioned through chutes into

KISSEL

ROAD-BUILDERS' FLEETS

Fleet of special Kissel Road-Builders' trucks owned by C. F. Lytle, prominent Engineer and Contractor, Sioux City, Iowa.



Fleet of special Kissel Road-Builders' trucks employed by Appleton Construction Company on Chilton-Hilbert (Wisc.) road contract.

Fleet of special Kissel Road-Builders' trucks employed by Gross Construction Company on Slinger (Wisc.) road contract.

Fleet of Kissel Heavy Duty Road-Builders' trucks owned by Washington County (Wisc.) Highway Dept.

Fleet of special Kissel Road-Builders' trucks employed by Ogara Construction Company on Hartland (Wisc.) road contract.

Properly designed, constructed and powered trucks—plus proper loading equipment and turning of trucks—plus proper supervision—insures highest efficiency and saves time and money for the contractor. The Kissel Engineers, in meeting contractors' requirements, have designed and developed Kissel road-builders' trucks and equipment to the maximum efficiency in saving of time, labor and money.

We will forward engineering data showing actual cost per batch to all contractors and road builders requesting same. Address

KISSEL MOTOR CAR CO., Hartford, Wis., U. S. A.

measuring boxes. By means of center gates, the truck boxes were divided into equal compartments.

In loading, each motor truck, stopping under the rock bin just long enough to shift gears, received two separate batches of rock in its twin compartments; moved ahead about 12 ft. and received two separate batches of sand simultaneously; moved forward once more to receive the proper amounts of cement from another pair of chutes; and then started on its way to the mixer, the complete loading operation having consumed not over two minutes.

Traversing a ¾-mile stretch of dirt road to reach the main highway, the trucks finally reached their destination at whatever point along the main road the mixer happened to be located. The next move, then, was to unload. Backing up to the skip with body in dumping position, the trucks emptied one compartment. When the skip had hoisted the batch into the mixer, the trucks in turn dumped the remainder of their loads and were some distance away before the last batches were hoisted.

Each truck made 23 to 25 trips between the central proportioning plant and mixer —an average three-mile haul—in a 10-hour day. Six White 2-ton trucks, supplying a three-sack mixer, facilitated the pouring of 700 lin. ft. of 18-ft. roadway, concrete 7 ins. thick.

A fleet of 12 White trucks were used on the 15-mile job on which 830 ft. of roadway were poured daily. The 2-ton motor units, with their narrow, compact bodies, horizontal hoists, speed and turning ability, were particularly adapted to road-building work, according to Day Bros. and Johnson, Drake & Piper.

Federal 5-Ton Truck Performs Task in 1 Day Formerly Done by 28 Mules in 3 Days

Ten years ago it took 28 mules 3 days to transport one of these immense boilers of the type shown herewith 5,000 ft. up in the Sierras to the Madera Sugar Pine Mills, 60 miles from Madera, California, the nearest railroad point. Recently a 5-ton Federal performed the same task in one day, despite the prophecies that it would never negotiate the steep mountain grades.

When Harvey Shuman, the operator of the truck system which keeps this isolated camp supplied with the necessities of life and machinery for its work, declared he could get this huge boiler up to the camp with his Federal he was laughed at.

The roads are full of dangerous winding turns, often attaining a grade of 20%, and several times it was necessary to chop down a fair-sized tree and drag it behind the truck as an additional brake.

In another place, the flume, or wooden trough, in which the logs are floated 60 miles down the mountainside to Madera, had to be cut to allow the truck to pass under with its huge load.

FEDERAL 5-TON TRUCK HAULING BOILER UP THE SIERRAS IN 1 DAY, A JOB FORMERLY REQUIRING 28 MULES AND 3 DAYS.

A fleet of four Federals running on the average of 20,000 miles each per year, is in continuous use to keep in supplies the 800 men in this mountain town. Regardless of weather conditions, they are on the road approximately eight months out of the year, bringing machinery for the mills, and mail, food and clothing for the men.

Famous Run Shows 20-Year Advance of Truck Design

Progress achieved in a decade of motor truck manufacture was demonstrated dramatically on May 28, 1921, by the Pierce-Arrow Motor Car Company, of Buffalo, when the historic New York to Boston run made in 1911 by America's first worm-drive truck was repeated.

The identical truck which made the run in 1911, known as Pierce-Arrow truck No. 1, covered the route again. It was accompanied this time, however, by the latest product of the Pierce-Arrow Company, a Dual Valve 5-ton unit.

Although more than ten years old and with 175,000 miles of daily service to its credit, the veteran clipped two hours and 20 minutes from the 20-hour record made

ten years before. But the old-timer was no match for its modern brother, which made the 240-mile journey in 14 hours and 43 minutes, its engine governed to normal speed.

"Truck No. 1 performed just as its makers designed it to perform ten years ago," said Robert O. Patten, truck sales manager of the Pierce-Arrow Motor Car Company. "Old as it is, the truck fulfilled the speed, load-carrying and endurance specifications which it originally was designed to meet.

"But the record of the Dual-Valve truck presents a contrast which shows strikingly the advance of manufacture and design. The most powerful truck engine built carried the 5-ton load over the road in three hours' less time. High-gear speed on hills, even greater coasting ability and a faster normal speed told against the surprising performance of the veteran.

"Ease of control and driver-comfort were factors that counted in the test. Harry Ward, who, by the way, drove Truck No. 1 on its 1911 test, did not find it excessively fatiguing to make the New York-Boston run in the Dual-Valve model in one day, despite the fact that he now is not accustomed to steady truck driving. He left New York at dawn and not long after dark the same day he arrived in Boston.

"The old-time truck, which does not have the electric-lighting equipment now standard with Pierce-Arrow, remained over night in Worcester, arriving in Boston the following morning.

"Thus, to the qualities of durability and reliability, for which Pierce-Arrow always has been noted, we have added more power, greater speed, and greater utility."

Truck No. 1 is historic in automotive history. It is one of the famous "first fifty" group of Pierce-Arrow trucks, 48 of which outlasted nine years of service. Its tenth anniversary run between New York and Boston, which it just made, was not the first occasion on which it repeated its 1911 performance. It also made the run on its seventh anniversary in 1918, running fully loaded with its tool box sealed.

The veteran is privately owned by a Buffalo firm and has been returned to them for added years of active service.

Federal Announces New 5 to 6-Ton Truck

The new 5-6 ton model truck announced recently by the Federal Motor Truck Company of Detroit, Michigan, possesses a number of new and distinctive features, according to a statement made by M. L. Pulcher, vice-president and general manager of the company.

According to Mr. Pulcher, this new heavy model, which has been produced after many months of experimental and actual road test work, was brought out for the express purpose of meeting several demands of the heavy haulage business which have developed in the past few years. The first is a continually growing demand for a truck with sufficient power to pull itself out of the most difficult places, excavations, pits, bad roads, etc., with its full capacity load; and the second is for a greater road speed under full load than has heretofore been possible with the average full loaded heavy duty truck.

Among the features of this new model is the new 50-H. P. Continental motor, which was made especially for this model and in accordance with the designs and specifications of Federal engineers. By means of this motor the truck is able to attain an unusual speed on the road, and the manufacturers claim for it that they have never yet, in all their operating tests, been able to place the truck in a position where they could not spin its drive wheels, so powerful is its engine.

Trucks Battle Colorado Flood

Many harrowing tales have come out of the flooded areas of Colorado, telling of superhuman efforts that successfully combated the devastating elements. An incident that demonstrates the dependability of motor trucks meeting emergencies, is told in a letter received by Harry P. Branstetter, Chicago Kissel distributor.

This letter was written by John T. Garver, manager of the Turner Moving & Storage Company of Denver, who have employed Kissel trucks for four years, starting with five models and now owning a fleet of 22 Kissels.

A great deal of the Turner haulage business is in transporting furniture and household goods over the mountains from one city to another, with an average distance of 100 to 150 miles. Mr. Garver's story starts in the flooded district, Friday, June 3rd:

"When the storm broke, we had two trucks at Central City bringing loads to Denver. After getting within 10 miles of Denver, the water was so high that our 1½ ton loaded truck was picked up and landed against a fence. Our 2½ ton Kissel Freighter had 5,500 lbs. on, but the driver didn't hesitate to go to the assistance of the smaller truck that was in trouble, put the chains on and pulled it out. Now, When I tell you there was 4 ft. of hail that had fallen besides the water, I am telling you facts. The water got so high that the drivers had to take the trucks back to Lafayette, passing trucks of all makes that couldn't make the grade.

On Saturday, I took the drivers of the two trucks and went up to bring them in, if it was possible, as they were loaded with furniture and stood a chance of being damaged.

We had to come back over a make-shift road. When we got to one-half a mile of Clear Creek, on what is called the Picos Street Road, we met five trucks trying to climb the hill. There was a 2 ton truck of a prominent make in the lead, a 2½ ton Kissel behind it and another 2 ton truck behind the Kissel. The truck ahead was buried clean down to the differential. The Kissel truck had 4,500 lbs. on; the truck in the lead had a 4,000 lb. load on and the truck that the Kissel was dragging had on 4,000 lbs.

While the Kissel was dragging the truck behind with chains, it didn't hesitate to put the bumper against the back end of the truck ahead and got the whole three trucks with a combined load of 12,500 lbs. up over the hill.

Now, this doesn't seem reasonble, but it beat anything I ever saw. I would make an oath that this was true. We brought both Kissels into Denver that day without any trouble whatever, except at bridges that were very dangerous to cross."

Truck Falls 15 ft. Without Damage

During a trip through a rough mountain pass in the Kodaikanal Hills of Southern India a motor truck carrying two and one-half tons of baggage and eight passengers plunged over a fifteen-foot embankment to the rocks below. By some miracle no one was injured. Equally remarkable was the achievement of the truck, a Garford, which when lifted to the road again, three days later, was found to be undamaged and continued its trip to Kodaikanal without so much as a dusting off.

The town of Kodaikanal is 7,500 ft. above sea level and is reached by twenty-five miles of very picturesque but steep and rocky roads. A fleet of Garford trucks is employed in the operation of a regular passenger and mail service through this difficult and mountainous territory.

GARFORD TRUCK BEING HOISTED BACK TO ROAD AFTER 15-FT PLUNGE OVER EMBANKMENT AT KODAIKANL, INDIA. THE TRUCK WAS NOT DAMAGED.

The accompanying cut shows the truck being lifted to the road by an improvised derrick following the accident.

Assisting the Truck Buyer

The attention of the reader is called to the publisher's announcement on page 17 of this issue. As stated, our long study of the motor trucking problems of cities, counties, public works contractors and road-builders, and our equally long study of the types and sizes of motor equipment best calculated to solve those problems economically and successfully, enables us to render a distinctly helpful advisory service to readers who are now, or expect to be, in the market for motor trucks. This service will be rendered free of charge to workers in this field.

Advertising and Construction

Is there an Actual and Definite Relation Between the Two?

(Reprinted from "A Relation Between Advertising and Construction," by Harold K. Ferguson, President, The H. K. Ferguson Co., Engineers and Builders, Cleveland, Ohio.)

In a period covering many years of active personal effort in the engineering and construction business—particularly in the industrial field—one fact has recurred with such increasing regularity that it repeatedly compelled my attention.

From my first entry into construction, I found myself, time after time, dealing with concerns whose names are household words from coast to coast because of their continued and aggressive use of advertising. There have been times, in fact, when my business activities have been almost exclusively confined to such concerns.

The first result of this rubbing elbows with advertisers was one which is typical of human nature.

I imitated them.

At a time when almost every step was pure pioneering, with little or no precedent to guide me, it induced me to apply advertising to the sales-problems of engineering and contracting. It was the unswerving faith in advertising displayed by these notable advertisers, which convinced me that it was and is a force far more generally applicable to all business problems than the majority of my own associates then believed. Without conscious effort on their part, my customers unknowingly "sold" me on advertising and sold me sufficiently to induce me to make what my friends then believed to be a rash gamble.

At first this was the sole result of my contact with advertisers, as I did not then sense the full scope of the fact upon which I had stumbled.

The second step in my own advertising education came when I awoke to the fact that my past dealings with individual advertisers were merely an indication of the future. National advertisers, I found, could not build one plant for all time but were continually reappearing in my prospect file. It became increasingly self-evident that one of my biggest markets promised always to remain among my past customers of this national advertising group. Each succeeding year disclosed them to be the concerns most frequently in need of increased floor-space. Acting upon this discovery, I took precautions to urge each sales-representative to call upon every national advertiser in his territory.

The actual incident which led to this booklet, however, was the recent publication of the statement that 80 per cent. of all business failures in 1920 were of non-advertising concerns.

The emphatic nature of that percentage convinced me that it would prove worth-while to tabulate and check up my own experiences to discover whether a parallel truth was concealed in them. The figures thus obtained went far beyond even my own expectations in the degree to which they compel recognition of the power of advertising.

Selecting for convenience the first one-hundred factory contracts of The H. K. Ferguson Company, a detailed analysis, name by name, disclosed so definite a relation between advertising and construction that they seemed to me to demand publication. The figures, when listed and verified, analyzed as follows:

Total Contracts Listed			100
Advertisers	67		
Non-Advertisers	13		
		80	
New Companies	15		
Local Business Only	5		
		20	

When, for our present purpose, new companies not in production and those companies with only a local field of operation are excluded, the statistics, stated in percentages, become so pointed in their teachings that they merit the attention of any business executive who seeks to sell his product over a wide area.

Out of this "first hundred" the total number of firms building factories for the increased production of products to be sold on a nation-wide basis is 80.

The greatest single group in this 80 is that of national advertisers—i. e., those who advertise in magazines of general circulation to extend the sale of their product.

Out of the total operating on a nation-wide basis 48¾ per cent. are national advertisers.

Of the firms ordering more than one Ferguson factory in this period, there was only one outside of this national-advertising group.

Closely allied with this group are the firms whose advertising message, because of individual determining factors, is permanently or temporarily limited to those publications of selective circulation which are commonly known as class publications.

Taking the sum of these two advertising groups, we find that 83¾ per cent. of all Ferguson factories are erected for concerns which advertise.

The emphatic character of this percentage is further substantiated by the fact that the floor space furnished to advertisers totaled 2,423,000 sq. ft. as compared with 193,000 sq. ft. purchased for the production of non-advertised commodities (new concerns or manufacturers with local markets not being included in these figures).

The three figures thus separately secured, all agree convincingly as to the power of advertising.

Eighty-four per cent. of all business failures are non-advertisers.

Eighty-three and three-fourths per cent. of all Ferguson factories are purchased by advertisers.

Ninety-two and six-tenths per cent. of the total new floor space was required for the increased production of advertised commodities—or something more than twelve times the space purchased by non-advertisers.

Stated differently, the figures indicate that the manufacturer who advertises is five times as likely to stay in business as his non-advertising competitor, and is five times as likely to need more factory space which he will probably buy in two and one-half times the quantity required by the non-advertiser.

The lesson is so obvious that I believe it needs no enlargement or emphasis.

EDITORIALS

GREAT IS THE CONSTRUCTION INDUSTRY

It is a pleasure to note the appearance of a special bulletin on The Construction Industry issued recently by the U. S. Chamber of Commerce and reviewed briefly in this issue. That the construction industry has not been properly appreciated in the past was only too well demonstrated during the war period when so many obstacles were thrown in the way of workers in this field by officers of the federal government who classed construction among the nonessentials along with musical instruments and others of the frivolities and superfluities of life. It is distinctly pleasing, therefore, even at this late date to have the construction industry rated as a basic industry of prime importance by such an unbiased and competent authority as the U. S. Chamber of Commerce.

It is suggested that readers obtain copies of the special bulletin for preservation and use. Presumably this can be done by addressing the headquarters of the Chamber at Washington.

The bulletin provides a very exceptional opportunity for individual workers in the construction field to do some publicity work for the benefit of the entire industry. While we appreciate that our readers are not dependent on others for ideas or suggestions we believe they will receive from us the suggestion that it is highly advisable to make the facts set forth in the bulletin the subject matter of letters to newspaper editors on the extent and importance of the construction industry. Quite likely newspapers will publish editorials on this subject, also, if the information contained in the bulletin is brought to the attention of the editors. Such publicity is greatly needed by the industry and the opportunity to secure it is now readily at hand.

Some of the figures given in the bulletin are quoted in the brief summary published in this issue and reference is made to that summary for facts and figures. The impression made on the Chamber by its study of the industry is indicated by certain sentences here selected for quotation from the bulletin:

"Next to Agriculture the Construction Industry ranks beside the largest of the remaining groups."

"It is apparent that the classification 'Trade' must look to the prosperity of the Construction Industry for a large proportion of its business."

"Construction is a prerequisite to wealth accumulation and it is only by this means that the immense resources of this country are made available for everyday use. Progress is measured in terms of man's growing ability to overcome the forces of nature and to subject them to his will. It is because construction devices are brought into full play that a happier lot ultimately results for the human race."

"An industry that absorbs three-fifths of the proceeds from new financing and about half of the country's annual accumulations of capital, automatically places itself foremost in order of importance and deserves recognition as one of the most potent forces that shape our economic life."

"Public construction, such as streets, highways, sewers, etc., that has been postponed for a considerable length of time because of the prohibitive outlay involved at inflated levels, is again undertaken, and gradually the movement extends to home and office building, as investments become more profitable through lower costs. Construction reopens the trail and other industries slowly follow along the path. Gradually business recovers and the cycle begins anew."

"Thus Construction would seem to be the barometer of our industrial life. When depression strikes Construction it rocks the entire industrial structure and 'good times' undergo a process of metamorphosis which is conducive to acute conditions. But when the tide turns, Construction is the first to be carried with the rising flood, and other industries follow in its wake. It is, therefore, desirable that a better understanding of the Construction Industry and of general conditions surrounding it be had at the earliest possible moment, to form the groundwork upon which nation-wide industrial conditions may be stabilized."

While the fundamentals thus quoted are entirely familiar to our readers it is gratifying and helpful to have them appreciated by the U. S. Chamber of Commerce. Let us reveal this discovery of our industry to the public, especially to our solid but conservative friend the banker.

HIGHWAY PAVEMENT EDGING

Attention is called to the fact, by a writer in this issue, that: "A 12-in. bituminous macadam edging on each side of a brick pavement laid upon a rolled stone base furnishes a means of waterproofing the berm adjacent to the pavement and to widen the roadway. Vehicle traffic in getting on and off the berm in wet weather, due to insufficient width of pavement to permit two lines of traffic, will form ruts or grooves that permit the infiltration of water into the subgrade and artificial base. This type of edging also affords vehicles an easy approach from the berm to the pavement, as compared to a rigid curb or edging. The cost of maintaining this type of edging is an item to be considered, but its merit for the pavement design under consideration would appear to justify a small maintenance charge."

We are glad to endorse this suggested feature of design, for its advantages have been observed frequently in driving over narrow pavements of various types on country roads. With a properly formed shoulder of ample width and properly surfaced, a comparatively narrow roadway will serve two lines of traffic satisfactorily in many localities. If the pavement is so narrow that, in passing, the outer wheels of vehicles are forced to leave the pavement then the presence of a well-formed shoulder becomes essential to the satisfactory performance of the road. If, in leaving the pavement, vehicle wheels drop off into the mud the usefulness of the pavement is immediately lessened.

It is recommended, therefore, that in all cases where narrow pavements are used that some sort of gravel or macadam shoulders be provided and maintained to develop to the fullest extent the usefulness of the narrow paved roadway.

THE ULTIMATE GASP IN DETOURS

We have had occasion to remark before that "any discussion of present-day practice in laying out, marking and maintaining highway detours becomes an elaboration of the obvious, for it is the partial or complete failure to do what very obviously should be done with respect to detours that makes this a subject worthy of discussion."

Perhaps we have demonstrated the truth of the statement quoted, but if not we offer the following illustration by way of a clincher: Obviously after a road has been reopened to traffic and the detour abandoned the detour signs should be taken down. It is not expected that any sane adult will question this elemental truth. Yet we have the word of a man who has had much experience in country driving that on the first day of the present month in driving on a famous highway in a central state he came upon detour signs and followed them only to learn afterward that the main road was open to traffic and someone had neglected to take down the detour signs. True the barricade had been removed, but it does not require a horse-high, bull-strong and hog-tight barricade to turn a motorist of decent impulses off the highway; such a man respects an official detour sign, and, in this case, was penalized for observing the rule of the road.

Some of our readers may wonder why we consider the subject of detours of sufficient importance to discuss it editorially in three consecutive issues. Our observations on the subject have been quite impersonal; an effort has been made to present the viewpoint of the public by way of calling attention to a source of danger to the better highways movement.

When certain politicians, years ago, sensed the popular dislike of the railroads they launched one attack after another against them and the railways have not recovered from such attacks to this day. The railway employees in direct contact with the public were so uniformly discourteous, oftentimes to the point of insolence, that the public generally gradually became hostile, not only to the grouchy ticket seller and to the brass-bound and imperious individual who collected tickets, but to everybody and everything connected with the railroads.

It did not pay the railways to irritate the traveling public and it will not be well for the highway movement if the convenience of the public is set at naught in respect to detour practice. If other forms of transportation decide to wage war on highway transportation their battle will be half won before they strike a blow if a large section of the public has been turned against the highways as a result of avoidable pin-pricking irritations of one sort or another experienced in highway travel. Perhaps it is scarcely in true proportion to suggest that detours register as pin pricks, for many detours produce an effect on the motorist that is not unlike that of a series of wallops administered with a bed slat.

And that's that.

MOVEMENT TO AWARD ROAD CONTRACTS IN FALL INSTEAD OF SPRING

The following letter from Stanley D. Moore, of the Moore-Young Construction Co., Waterloo, Iowa, chairman of the Highway Division of the Associated General Contractors, to W. R. Neel, Atlanta, State Highway Engineer of Georgia, and chairman of the Conference Committee of the American Association of State Highway Officials, is self-explanatory. The subject of fall lettings of highway contracts is of great importance to all contractors, engineers, public officials and, of course, the general public. The policy advocated will cut down the lost time in each year from 6 months to 3 months: Mr. Moore's letter follows:

"I have just received from our Executive Board the necessary sanction for the promulgation of a policy that will require your quick and hearty co-operation, if it meets with your approval, together with that of the National Association of Railway Executives, National Coal Association, National Sand and Gravel Producers Association, and several other associations that are either directly interested in construction projects or are users of open-top railway equipment.

"There has already been some correspondence with individual members of some of these interests.

"Briefly, the idea is to change the custom which is just starting of letting highway contracts in the spring to a general plan of making such awards in September and October, particularly in the northern section of the country. The reasons are, of course, obvious to you, but in order to save your time I will review some of the arguments in support of the proposition.

The Peak Months

"1. There has been in the past and will be in the future, to a greatly increased degree, an acute shortage of open-top equipment during the months of September, October, and November, these being the three months during which the coal begins to move and being also the peak of the aggregate movement for highway and other large construction projects.

Storage and Unloading

"2. The closing of the contracts in the fall would enable the contractor to perfect his organization and arrange for his storage and unloading during the idle winter months, thus permitting the early movement of aggregate during March, April, May, and June before the coal starts.

Movement of Cement

"3. The same argument applies to the movement of cement in box cars before the grain movement begins, and to new contractors' equipment, the sale, production, and shipment of which is now crowded into May, June, and July.

Spreading Peak Load

"4. Instead of the maintenance of expensive lobbies and committees in Washington trying to get preferential rulings out of the Interstate Commerce Commission and generally quarreling over the car supply, a little co-operation along this line will have the effect of spreading the peak load and fundamentally removing the cause of the trouble. The ramifications of this feature are too many to cover in this short outline.

Production and Overhead

"5. From a contractor's standpoint, and reflected therefrom directly to the public in decreased cost of roads, it is obvious that any policy that will have a tendency to increase the possible number of days during which he can operate, will enable him to spread his fixed overhead over a greater production. For instance, on jobs where industrial track equipment is used, if the contractor can get enough grading ahead during the late fall and some track placed, there are probably 25 days between March 15 and May 15 on which he could lay concrete, but which would not be dry enough for organized grading operations. There are many road jobs which are truck propositions on which stock piles can be built before the frost goes out of the ground, enabling some operation in the early months that would otherwise be impossible.

Low-priced Roads

"6. To sum up the factors entering into this phase of the problem, it is only necessary to say that the goal of low-priced roads will be reached only by the route of increased production, and anything that is done to increase the output per unit, and spread the production over a longer period of time per year, will result in decreased cost of cement, aggregate, transportation, contractors' and supervising services.

Suggestions Desired

"If this thought appeals to you as it does to me, as being a really constructive move in the direction of solving one of our basic difficulties and well worthy of the associated efforts of everyone involved, I would like to have your suggestions as to how we can go about getting the idea before the necessary authorities in time to get it into partial operation before next year. While the situation will be there for us to work on the year after and for some time to come, it appears as though next summer would be the worst, and something might yet be accomplished this summer without waiting for the winter conventions."

SEWAGE TANKS AGAIN

By W. G. Kirchoffer, Sanitary and Hydraulic Engineer, 22 N. Carroll St., Madison, Wis.

In my previous discussions of this subject I have purposely avoided a statement or opinion of what I thought or expected the bacteriological or chemical action would be in any tank. But since Mr. G. Everett Hill has so kindly requested me through the columns of Municipal and County Engineering to discuss his views in the matters, which touch upon this phase of the subject, I will have to digress from my former purpose and enter into, to a limited extent, a discussion of this phase of the subject.

All that Mr. Hill says is of much interest and adds to our store of knowledge of this subject. I certainly appreciate his kindly comments on my type of tank. As to my views on the two story tank referred to in the February issue, those statements were made in answer to Mr. Coulter's communication and were made for the purpose of making it clear that I thought the slots over the first section of the lower chamber essential, as compared with his contentions that they were not essential in all installations of two story tanks. I have found in my experience, and I think that others working along similar lines will agree, that no type of tank, no matter how well designed, will work equally well on all sewages nor will any one type of tank give satisfactory results all of the time on the same sewage.

For illustration, a few years ago I was called upon to design a sewerage system for a small town in Wisconsin. The city officials had visited a neighboring town where a few years before a septic tank had been built. They were much impressed with the results that were being had with this tank. "The effluent was clear as water," they said. However, had they visited the tank three or four years later they would have been much impressed the other way. A state official of the Health Department was called upon to visit the town to remedy the nuisance the tank was creating. He asked me if I had seen it, said it was the worst nuisance he had ever seen from a tank.

In another case I converted an Imhoff tank into a modified "Kirdorthoff" tank. It worked fine until the combination of the waste from a woolen mill and a creamery destroyed its effectiveness.

Both of these tanks may have housed aerobic or anaerobic bacteria and possibly the conditions for their development at times may have been ideal, but time proved that conditions arose which produced effluents which were not up to the standard required for those localities. From observations made upon the tanks at Madison, Wis., over a period of four months, I would venture the opinion that the trouble with the first tank was that the bacteria produced enzymes in which they could not live and the tank was so constructed as to confine those by-products in the flowing current in the tanks. I doubt if any of us can say with assurance just what is going to take place in any tank we propose to design and install. I have designed a few Imhoff tanks that are giving fairly good results and are satisfactory to my clients, whereas others have proven failures. I am quite positive that the character of the waste, its state of freshness, be the difference ever so small, and any mechanical disturbance, such as pumping, greatly affects the results attained over a considerable period of time.

I believe that the chemical quality of the water supply of cities greatly affects the character of the sewage and the eventual results obtained. A water supply known to be high in sulphates produced a sewage that when detained in a septic tank gave off vile odors of hydrogen sulphide. It is well known in some localities that residential septic tanks give satisfactory effluents, whereas a municipal plant in the same city is a failure. The difference must lie in the difference in the character of the sewage which hinders or accelerates the growth of certain bacteria and not wholly in the design of the tank.

Mr. Hill's tank with flaring sides, as he says, will give satisfactory results. He has proved it, but can he guarantee that if he should install it where conditions have arisen, where other types of tanks have failed to produce the desired results, that it would give a satisfactory effluent?

I can scarcely agree with him that the slight difference in width of tank which would reduce the velocity about 2 to 3 in ratio would prove a means of sorting out food for different kinds of bacteria. It is possible that a plain box type septic tank would have given equally good results for an equal length of time.

I hardly approve of the inlet device of Mr. Hill's. I have found that too many small channels, crooks and turns in the inlet, where all of the coarser matter was present, tended to clogging, with the result that the sewage generally entered in a manner just contrary to the way we expected it to. In the smaller tanks a simple tee or ell looking down into the tank, or, in larger tanks a fairly deep baffle, will be found to give good results over a long period of time. If, as Mr. Hill says, it is a good principle to make the outlet end of the tank wide, why not make the tank circular, fairly shallow, but large in diameter with the inlet in the center, so that we would get a very large reduction in velocity without getting an extremely long rest period?

I cannot see wherein his tank is really comparable with my type as to the separation of the sludge and acum from the liquid portion. I think we can safely venture the statement on the theory of operation of the bacteria that any variety will kill themselves with their own enzymes if there is no provision made for carrying them away as fast as made and at the same time supplying more food from products which are not detrimental to bacterial life. An excessive use of a disinfectant in a sanitarium made the buildings and fixtures sanitary, but it stopped bacterial action in the disposal plant which caused the tanks to fill with sludge and the filters to clog.

I claim that the Kirdorthoff tank has the feature which tends to remove enzymes (bacterial poisons) and to supply the bacteria with fresh food and at the same time not disturb the contents of the tank to such an extent that sludge in a finely divided state, or otherwise, will be carried out of the tank. I fail to see how a single story tank, however designed, can accomplish both of these functions. Although I believe where tank treatment is necessary it will be found that the Kirdorthoff tank is a great improvement on other types of tanks, I am a believer in the idea that for the larger plants and for those treating industrial waste that we must resort to mechanical means as an aid to purification.

I have convinced myself, if not others, that the septic, Imhoff, or Kirdorthoff type of tank, is not suited to the treatment of a combination of creamery and woolen mill waste. These two wastes contain so much oil, grease and casein that the functions usually performed by tank action, sedimentation, bacterial and chemical action are almost entirely stopped and in some cases reversed.

The Dorr Co. has demonstrated quite conclusively, in some instances at least, that mechanical devices aid materially in the reduction of sludge and the purification of the effluent.

The sooner we all come to the conclusion that the universal purification of sewage by tank treatment is all a myth the sooner we will all get down to the real business of sewage purification. The notion that the septic tank was an absolutely sure method of sewage purification became so firmly fixed in the minds of the people that it is now hard to convince them that it is not in all cases a cure-all for the ills of sewage pollution. Only recently a college professor, editor of a college agricultural paper, told me with a great deal of firmness and expression of superior knowledge that there was no better tank for the purification of sewage than the septic tank. I believe that compressed air and mechanical devices such as screens, paddles, etc., are going to be the coming devices in sewage disposal.

At the Madison plant three years ago I raised the stability of the tank effluent from zero to 30 in two days of operation of a very simple air lift pump used to circulate the sludge. In sewage filtration we aim to oxidize the effluent, but in tank treatment we deoxidize it. Why not take the fresh sewage and start the process of oxidization at once instead of delaying it through the usual form of tank treatment?

Where financial or other considerations will not permit the installation of plants involving mechanical operation and constant attention, then we should select such a type of tank that will give the best results, in our judgment, and be within the means of the client, whether it be a Hill tank with flaring sides or a Kirdorthoff tank, or some other type should govern the selection. The inexperienced often say, "This tank is going to do so and so and the results will be ideal, etc.," but experience teaches a different lesson. If one is designing a tank on pure assumption, he would better leave it out and spread the sewage out on mother earth, where it surely will, in time, be purified.

CLAY PRODUCTS RESEARCH WORK LAUNCHED

Representatives of four national associations of manufacturers of burned clay products, namely, The American Face Brick Association, The Common Brick Manufacturers' Association, The Hollow Building Tile Association and The National Paving Brick Manufacturers' Association, together with the secretaries of these associations, representatives of the Federal Government, universities, and the American Ceramic Society, met in Chicago on June 16, 1921, to perfect an organization through which the cooperation of the Associations might be made effective in clay products research.

The Technical Committee reported a plan of research which was approved by the Executive Committee on behalf of the four associations. The plan follows:

The work will be divided into two parts. (1) Dealing with the study and investigation of commercial kilns, represented by the up-draft and the down-draft kilns, the continuous kiln of the straight tunnel type, the compartment continuous kiln, and the tunnel car kiln. (2) Dealing with the study of the water-smoking and dehydration process, by the Bureau of Standards, the study of heat absorption throughout all the burning stages by the Ceramic Department of the University of Illinois, the study of oxidation and vitrification stages by the Bureau of Mines, and experiments in the study of combustion and transmission of heat, in a semi-commercial kiln, by the Bureau of Mines at Columbus.

The first part will constitute by far the most extensive part of the program and will involve the detailed study of the different types of kilns, not only from the standpoint of fuel consumption but particularly with reference to the rise of temperature throughout the kiln and the actual rates of water smoking, oxidation and vitrification.

It is proposed to study also the draft conditions, the combustion as taking place in different types of furnaces, the various heat losses, and the influence of the kiln, flue and stack dimensions upon the burning process.

It is proposed that the Bureau of Mines send out well-trained experts to conduct this work at representative plants, selected for the purpose with special reference to securing a certain degree of freedom of action. By this is meant permission to be granted to make such burning changes as are apparent from the results obtained and to make notes of the effect of such changes. A complete study will be reported of each kiln examined, drawing from the observations made, all conclusions warranted by the facts.

In addition, a questionnaire will be sent out by the committee to the industries concerned, by means of which it is expected to obtain a certain amount of information which will help in drawing general conclusions.

All of this information will be collected and treated from the standpoint not hitherto presented to the industries. It is expected to present the information collected by means of definite statements or definite recommendations in language that can be understood by all.

The laboratory studies to be conducted at the Bureau of Standards and the University of Illinois are intended to furnish information concerning the methods of attack and the fundamental principles involved in the burning process and thus will supplement the kiln studies.

In those investigations all purely theoretical features have been eliminated and only such work will be done as will throw direct light upon the phenomena involved in the burning process.

Of particular interest will be the tests conducted on the semi-commercial kiln to be erected by the Bureau of Mines at Columbus. In this kiln all the factors entering into combustion will be under control, such as the volume of air used for combustion, the intensity of the draft, the maximum and exit temperatures, and the rate at which the heat is transmitted to the ware. Thus it is expected to determine the effect of heavy or light fuel beds, the effect of long flame versus short flame coal, and other factors.

It is to be noted, therefore, that the investigations will proceed along broad and comprehensive lines, and it is to be expected that the results will prove of interest and value to all of the ceramic industries.

It is perhaps not too much to say that some of the results that may be expected will be of a more fundamental character than it is possible to realize at the present time. It has always been the experience of such comprehensive investigations that many by-products, in the shape of important results that cannot be foreseen in the beginning, are obtained.

The Chairman of the Joint Research Committee is Mr. F. W. Butterworth, Western Brick Co., Danville, Ill., and the Secretary-Treasurer is Mr. Maurice B.

Greenough, 830 Engineers Bldg., Cleveland, Ohio.

CONSTRUCTION ANALYZED AND RATED AS BASIC INDUSTRY BY U. S. CHAMBER OF COMMERCE

In a special report issued June 17th by the Committee on Statistics and Standards of the United States Chamber of Commerce, of which A. W. Douglas of St. Louis is chairman, the total national wealth of the United States is estimated at $288,464,000,000, of which $77,321,000,000 or 26.8% is represented by the Construction Industry. The report presents an analysis of the relationship of construction to the basic industries of the nation, including manufacturing, mining, transportation, agriculture, trade and finance, and concludes that construction as a key industry should be classified separately as one of the nation's basic industries.

25 Per Cent of Manufacturing for Construction

The report shows that in 1914 one-quarter of the 276,000 manufacturing concerns employing 10,658,000 workers, with an annual payroll of $5,368,294,000 and an annual output worth $25,000,000,000, was devoted to construction products.

In 1920 90 per cent of all iron ore, copper and zinc, and 95 per cent of all lead mined was consumed by construction. Twenty per cent of the bituminous coal and five per cent of the anthracite coal mined was used by manufacturers of construction materials, by the railroads in transporting these products, and by traction lines and public service corporations in service to construction workers. A rough estimate of the value of these minerals is $4,400,000,000, engaging more than 1,000,000 workers at an annual wage of approximately $1,000,000,000.

Twenty-five per cent of the freight transported by the railroads is construction materials.

Eleven Millions Depend on Construction

Fully 11,000,000 persons, either as workers or as members of workers' families, are estimated to derive their living from construction, either directly or through manufacturing and mining products used in the Construction Industry. The support given to agriculture and to trade by the annual expenditures of this great number of persons is estimated at more than $5,000,000 000 for rent, fuel, food, clothing, furnishings, recreation, etc.

Half of New Capital Issues for Construction

New capital issues during 1920, so far as reported, totaled $4,545,000,000, consisting of state, municipal, railroad and industrial securities, of which it is estimated 50% were issued for construction in one form or another. A considerable portion of the new capitalization went to pay off maturing obligations, which were reflected, however, in past construction to a large extent.

Even this estimate does not cover the whole field. It excludes indebtedness of the Federal Government for construction, for which segregation is difficult, and does not include issues of foreign governments or municipalities in this country, the proceeds of which were to be used for improvement and extension of their public undertakings. This sum also is short a huge amount of expenditure for new construction because a great amount of expenditures for additions to plant, structures, etc., is paid out of earnings and surplus and does not figure in the investment market. With all these figures at hand it appears that 24% of the year's capital accumulations, and probably 50% of the national savings annually go to construction.

Construction—A Basic Industry

Based on this analysis, the report concludes that the Construction Industry is an unique barometer of the state of business in all industry and as such deserves a separate classification among the basic industries of the nation on a par with Agriculture, Mining, Manufacturing, Transportation and Communication, Commerce and Finance.

EFFICIENCY OF DIFFERENT TYPES OF CAR-STOP SAFETY ZONES

(Editor's Note.—This valuable progress report of the National Committee on Relative Efficiency of Different Types of Car-Stop Safety Zones and Their Relation to Parking was presented at the recent annual Convention of the National Highway Traffic Association. George A. Walters, Second Deputy Police Commissioner of Detroit is chairman.)

Detroit Experience With Elevated Platforms

The success of elevated platforms for safety zones has been demonstrated in Detroit where one located on Woodward Avenue at the intersection of Gratiot has accommodated approximately 10,000 car riders daily during the hour and half up to six o'clock p. m., for over a year without an accident. Many people use this safety zone rather than go to more convenient zones which are not elevated. This platform is 216 ft. long, 5½ ft. wide and 7½ ins. high, made of planks, and will be replaced with concrete. For the purpose of building elevated concrete safety zones the city has appropriated $15,000.

In addition to the elevated safety zone at Woodward and Gratiot, Detroit has two others, being at Woodward and the Seven Mile Road, and Gratiot at Riopelle Street. The zone at Woodward and the Seven Mile Road is 84 ft. 10 ins. long, 3 ft. 6 ins. wide and 6 ins. high. We received many complaints from car riders in this section who said their lives were jeopardized by motorists. The traffic there is growing tremendously and moves faster than in the down-town districts. This zone permits large interurban cars with trailers to handle passengers. It has given extreme satisfaction and the Woodward Avenue Improvement Association compliments the department.

The zone at Gratiot Avenue and Riopelle Street is 72 ft. 9 ins. long, 6 ft. wide and 7½ ins. high. At this location the streets run into Gratiot Avenue at such an angle that before this raised zone was established a dangerous condition existed. The traffic is very heavy at this point, it being a main trunk line near the Eastern Market where many thousands of vehicles and many people go every day. The installation of the zone has greatly relieved a dangerous traffic problem and has slowed down traffic and compelled drivers to make the proper turns in going in various directions from this location, and has been a great safeguard for people boarding and leaving street cars at this point.

Results of Inquiry in 15 Cities

In response to an inquiry which the committee sent to the chiefs of police of 15 American cities, the advisability of using elevated safety zones to protect pedestrians in the streets from motor vehicles was discussed. Ten cities favor elevated safety zones; five are opposed to their use. Those favoring it are Duluth, Los Angeles, Baltimore, Hartford, Pittsburgh, Cincinnati, Bridgeport, Minneapolis, Dayton and Washington. Those opposed are Buffalo, Rochester, Boston, Chicago and Cleveland.

The height favored ranges from 3 ins. to 12 ins., the latter being the recommendation of Pittsburgh; Washington favors 9½ ins. Widths from 3 to 6 ft. are recommended, Pittsburgh favoring 3 ft. and Washington 6 ft. Regarding the length, most of the cities think that two or three car lengths is about right.

On the question of whether or not the safety zones should be lighted by other means than the use of street lights, all of the cities answer an emphatic yes with the exception of Duluth and Buffalo, which maintain that street lights should be sufficiently adequate to make special lighting facilities unnecessary. Los Angeles says, "Special lights by all means," and Chief Quigley of Rochester says, "Street lights are not sufficient under any circumstances," but Chief Farrall of Hartford says, "In some places street lights might be sufficient." Pittsburgh says their elevated zones require lights at each end, and Minneapolis states that "Street lights never are sufficient."

Regarding the use of safety zones for pedestrians at other points than where car riders use them, Duluth, Los Angeles, Rochester, Cincinnati and Minneapolis answer: "No." Eight of the cities favor them on wide streets where traffic is heavy. Pittsburgh has them at boulevard "Ys" and Washington, at intersecting streets owing to the width of the crossing.

As to whether they should be used at crosswalks at or near the center of all wide streets where traffic is heavy, Duluth, Los Angeles and Rochester do not favor this, Chief Quigley of Rochester, remarking that he "prefers to have traffic move at right angles; no right or left hand turns." Boston suggests that they be placed near or in line with the crosswalks and Bridgeport recommends them at the center of all wide streets. Baltimore, Hartford, Pittsburgh, Cleveland, Dayton and Washington also favor them.

In reply to the inquiry regarding the advisability of using "Islands of Safety" extensively elsewhere than at street car stops, Duluth, Los Angeles, Rochester, Boston, Chicago, Cincinnati and Minneapolis reply in the negative, Mineapolis remarking that roadways should be unobstructed. Baltimore, Pittsburgh, Bridgeport, Cleveland and Washington favor them on very wide streets, and Hartford states that they can be used to advantage at any point where traffic is heavy. Dayton recommends them at street crossings close to schools.

Duluth at present is using safety zone standards with ropes; Chief of Police Major Pugh, however, favors the use of inlaid safety zones with edges beveled to pavement level.

Los Angeles' streets are too narrow to allow safety zones only at certain intersections. They use a standard with words "Keep to the Right" and use white paint to outline the zone.

Baltimore recommends that the safety zone platforms be either of concrete or wood with 1½ in. pipe standards connected from one to the other with a chain.

Chief Quigley of Rochester remarks that they "are using at street intersections a standard which seems to answer the purpose. It is placed in the center of the square of intersecting streets. In the day time a red flag is placed upon it, and during the night time a red light, which serves a warning to approaching vehicles to slow down and get vehicle under control. Our records show that at such points accidents have been reduced to a minimum. Placing these standards as above compel drivers of vehicles to keep close to the curb when entering the square of intersecting streets and to slow down when turning to the left. They also serve as a marker for the street center and pedestrians when crossing the street, standing on a line with them when vehicles are approaching, are protected from such vehicles as might, if they were not so placed, drive along the center of the street."

Boston has no safety zones. Commissioner Curtis favors iron posts as being the best type of safety zone marker, if any is used.

Our inquiry was referred by the Chief of Police of Chicago to Capt. Lavin of their Traffic Division, who is not in favor of elevated safety zones or islands of safety. Capt. Lavin remarks that "none used in this city because it is believed that an obstruction of this kind placed in the middle of any crowded thoroughfare not only adds to congestion by narrowing the useable width of the street, but is very dangerous to the driving public, at least this is the experience of some of the park systems which are under state control. I assume the theory of islands and raised safety zones is that it affords safety to those who are able to cross through the real danger zone, namely from the curb to the center of the street, but it is hard to see how they afford any protection to those passing over the most dangerous part of the street."

Since receiving the foregoing from Capt. Lavin the Chicago Common Council has passed an ordinance requiring that safety zones be established and a representative of the City Finance Committee visited Detroit recently to investigate the different types of safety zones, including those that are elevated, with a view of their use in Chicago.

Washington advises that they have found it necessary to establish zones adjacent to circles at intersecting streets for the safety of pedestrians.

Detroit Recommendations

Inspector Jackson, commanding the Detroit Police Traffic Division, recommends the following:

1. The use of elevated safety zones wherever traffic conditions will permit.

2. The dimensions as to height, width and length should be made to suit location, taking into consideration the traffic, number of people boarding street cars, and kind and style of cars that stop in the zone.

3. Safety zones should be lighted, either electrically or by acetylene or some other lighting device that would be dependable, but never with an inadequate light.

4. Street lights are not sufficiently adequate to light safety zones.

5. Elevated safety zones should not be erected at other points than where car riders use them. Zones for pedestrians at such places can be designated by markings on the surface of the street or some other substantial way, such as tile, different type of brick, and so forth. There are several locations in Detroit where exceptions to this rule have been found advisable.

6. Elevated safety zones should not be used at crosswalks at or near the center of wide streets where traffic is heavy.

7. "Islands of Safety" elsewhere than at a street car stop should not be erected, except where there is special need for them.

Inspector Jackson states that in his opinion it is advisable to have the raised zone protected by red lights; that there be abutments on each end and that there be no railings or other attachments except lighting connections near the surface of the zone.

Regarding Parking

The immediate vicinity of all safety zones should be kept clean of obstructions, including standing automobiles, so that moving vehicles will have no excuse for encroaching on the safety zones and endangering pedestrians. In order to accomplish this the legislative body must give the police definite authority to regulate the parking and ranking as related to safety zones. The following in effect is the provision contained in the traffic ordinances of most of the larger cities.

"No rule shall be deemed to prohibit a vehicle from parking at the curb of any street, while taking on or discharging passengers, freight or merchandise; but a vehicle may not stop for this purpose between a safety zone and the curb nearest thereto. No vehicle shall be parked between a safety zone and the curb nearest thereto at any time."

Parking should be prohibited at the curb alongside all safety zones a distance of about 10 ft. in addition to the length of the zone itself so as to afford more driving space between the parked vehicle and the entrance to the zone. If a safety zone is 150 ft. long, parking should be prohibited for a distance of 160 ft.

Loading and unloading of passengers or merchandise alongside of safety zones should be prohibited. This does not impose any hardship as the zones are almost always at the intersection of streets where there is other available space for this work without encroaching on the space alongside the safety zone.

Recommended Legislation

There should be a uniform law enacted in every state establishing and regulating safety zones for car riders at street car stops. The following is offered as a suggestion for this purpose:

"To provide for a state law that will prohibit driving through a safety zonè when it is occupied and that will designate a space for 6 ft. alongside the car track at all points where street cars stop for car riders, as comprising a safety zone, even though there are no marks or signs indicating that it is a safety zone." The Detroit traffic ordinance contains such a provision so that there is a safety zone for every car stop.

It should not be necessary that safety zones at car stops be elaborately marked with signs to notify the driver of the existence of such zones for the reason that any marking that is sufficient for car riders should be regarded as sufficient for motorists.

Effective Way of Enforcing Parking Regulations

The most effective way of enforcing parking regulations without using an excessive number of officers is by means of a law such as the Detroit traffic ordinance, the salient points of which are as follows:

An automobile pound to which can be towed vehicles parked on crosswalks, opposite safety zones and elsewhere where they are a serious obstruction; others which violate the regulations can be tagged. This tag notifies the motorist immediately to pay a fine: one dollar for the first offense, three for the second, five for the third and any subsequent violation, with the alternative of being summoned to court.

The parking of a single row of automobiles at each curb where parking is permitted for an indefinite period of time is not in any sense a police problem. It is immaterial to the Police Department whether a parking space be used by one automobile or by a dozen of them during the day. In business sections it does, however, interest the persons who are maintaining the business places and who want their customers to have access to the curb. It becomes a police problem only when over-time parking results in vehicles standing in the street outside of the permitted parking place, comprising double parking, so called. Such a congested condition is the cause of extensive delays and many accidents, to avoid which the enforcement of the parking time limit is necessary.

SOME ENGINEERING FEATURES OF BRICK PAVED ROADS

By James C. Travilla, Consulting Engineer, The Dunn Wire-Cut Lug Brick Co., 211 N. 7th St., St. Louis, Mo.

Brick paving, like the other types of surfacing, should be studied in the light of the economic, engineering and local problems involved for each particular road project. A careful analysis of the factors considered may justify the adoption of two or more types of wearing surface materials or pavement designs for a proposed improvement.

Preliminary Study

The preliminary road study should include the following items: Traffic census, to which should be added a liberal allowance for the increase in traffic and tonnage by reason of the proposed improvement; availability of natural and manufactured materials for wearing surface and artificial foundation, grades, drainage, subgrade soil, climatic conditions, taxable values of the property benefited by the proposed improvement, life of the bonds, first cost, annual cost based on the estimated life of the pavement, maintenance charge, etc.

Engineers are departing from a so-called standard design for brick pavements by reason of the number of types of artificial foundation and kinds of filler for the joint spaces between the brick that are adaptable for use.

Monolithic and Semi-Monolithic Designs

The following brick pavement designs are recognized as good engineering practice: The so-called monolithic design provides for a rigid pavement throughout. The brick are laid in the green concrete or upon an added cement-sand film for a bedding course; the joints between the brick are filled with a rich mixture of sand and cement applied at the consistency of thin cream. Before the cement grout is applied, the brick are thoroughly wet by sprinkling to temper the bedding course and to strengthen the bond of the cement filler to the brick. The design has the special merit of the pavement setting up as a unit, and in saving the expense of concrete curb or edging, as it is not required nor used.

The State and many County Engineers in Ohio, Indiana and Illinois have supervised a large mileage of highway construction, in accordance with the design described. The general practice is to use a 4-in. brick laid upon a 4-in. concrete foundation.

The semi-monolithic design is a modification of the monolithic. The concrete foundation is allowed to set before adding the dry mixture of cement and sand for the bedding course. The design is preferred to the monolithic type for pavements of more than 20 feet in width. On wide roadways it is difficult to draw the cutting template over the green concrete without developing an unevenness in the finished wearing surface.

The cost of monolithic or semi-monolithic brick pavements depends on the proximity of the supply of materials and to the labor scale. Under existing conditions, they will vary in price from $3.50 to $4.50 per square yard.

For the above described pavement designs it may be desirable to allow for temperature stresses. The placing of transverse expansion joints at the end of a day's run and at points of tangent on vertical curves generally is sufficient. Most troubles due to temperature stresses come from structural defects; a slanting joint at the end of a work period may cause the pavement to "blow up." Defective spots will occur when the cement grout filler bridges the joints between the brick. The consistency of the cement grout filler is a most important detail. It should fill the joints the full depth of the brick, otherwise the temperature stresses are not disturbed uniformly to the individual units, which may cause them to shear off at the top.

Preventing Cracks

The monolithic and semi-monolithic designs may result in the pavement developing longitudinal cracks, when the subgrade soil is a heavy clay. The cracks are the result of expansion in the foundation soil due to the infiltration of water and frost action. There elimination should be a matter of proper drainage and soil treatment. The effect of these factors on the slab type of pavements has directed special attention to the importance of soil treatment. A 4-in. bed of cinders placed over the subgrade, in a heavy clay soil, will aid in the elimination of longitudinal cracks. If cinders are not available, top soil or sand mixed with the clay will change its texture, increase its bearing power, and lower its capillarity.

Advantages of Bituminous Filler

A bituminous material for filling the joint spaces between the brick will permit the individual units to adjust themselves to the natural forces and stresses that tend to cause the "blowing up" and cracking in rigid pavements. The filler may be asphalt, pitch mastic or tar.

Foundation

The artificial foundation for a brick wearing surface and bituminous filler may be Portland cement concrete, bituminous macadam, rolled stone or a mixture of sand-clay. The bedding course for the brick may be a cement-sand, or sand and bitumen mixture, or stone screenings, or sand. The admixture of cement or bitumen prevents the sand particles from shifting or rolling, thereby aiding to maintain the true contour of the pavement.

The rolled bases must be thoroughly seasoned and compacted, if good results are to be obtained with the surfacing material. Old macadam roadways may be made adaptable for a brick surface. The thickness of a rolled base should be dependent on the bearing power of the subgrade soil, drainage and climatic conditions. Six or 8 ins. of compacted material, usually, will be found sufficient. The curb or edging may be cement concrete or bituminous macadam.

Edging

A 12-in. bituminous macadam edging on each side of the brick pavement laid upon a rolled base furnishes a means of waterproofing the berm adjacent to the pavement, and to widen the roadway. Vehicle traffic in getting on and off of the berm in wet weather, due to insufficient width of pavement to permit two lines of traffic, will form ruts or grooves, that permit the infiltration of water into the subgrade and artificial base. This type of edging also affords vehicles an easy approach from the berm to the pavement, as compared to a rigid curb or edging. The cost of maintaining this type of edging is an item to be considered, but its merit for the pavement design under consideration would appear to justify a small maintenance charge.

A brick pavement properly designed to meet the local requirements will not insure a satisfactory wearing surface unless the construction details are given proper attention.

The personal equation entering into road building is a factor that adds to the success or failure of materials built into a pavement of any type. Brick being a "ready made" material, the individual units may be inspected before being bonded into the pavement, thereby securing uniformity in the surfacing material. The word "uniformity" makes a good slogan to adopt for materials and methods of construction, as it directly applies to the life of the surfacing material and stability of the pavement as a unit.

The features of brick paved roads, as set forth, are general in character, but they direct the engineers' attention to the fact that brick pavement designs are local problems, and that designs should not be based on established customs adopted in the early stages of the use of brick as a wearing surface material.

The foregoing matter is from a paper by Mr. Travilla before the Kentucky State and County Road Engineers.

FIRE ALARM SYSTEMS IN SMALLER MUNICIPALITIES

Municipalities and private corporations have for many years recognized the necessity for providing a means for notifying the fire fighting forces when fire is known to exist and the results obtained through the use of reliable fire alarm telegraph systems have been such as to establish the alarm system as a most important factor in the general scheme of fire protection.

The prime function of a fire alarm system is to save time when time is most precious and the value of a modern fire alarm system must therefore be judged by the value of all investments in modern equipment.

A manufacturing establishment makes an investment in automatic machinery because it will save time, thereby reducing the labor cost, and the value of the machinery to the manufacturer is determined not by what he pays for it, but by the value of the time saved in the production of his product. The amount of the investment is necessarily governed by the earning power of the equipment, and it is considered good business practice to install all the time-saving machinery that will return a fair profit to the manufacturer.

A municipality makes a large investment in motor driven fighting apparatus primarily because of the time such apparatus will save in getting into action after the fire department receives the alarm, and, having equipped its department with motor driven apparatus, the municipality has done everything that our present knowledge can suggest along this line. It should be obvious, however, that the motor driven apparatus cannot be placed in motion until the fire department is notified of the existence and the exact location of fire. Unless such notice is conveyed without loss of time, the efficiency of the fire department and the value of the investment in fire fighting apparatus is depreciated in direct proportion to the inadequacy of the means employed for notifying and calling the fire department.

Time the Prime Factor

In recognition of the fact that time is the prime factor in reducing the fire loss, a majority of our municipalities have equipped their fire departments with motor driven apparatus, but in spite of the fact that they have thus employed the fastest known means of getting into action after alarms are received, the fire loss of the country continues steadily to increase and is now averaging well in excess of $300,000,000 a year for the entire country, or more than $3 per capita. These figures represent the actual fire loss only, and do not include the enormous sums annually spent for fire prevention and cost of insurance organizations, all of which must be added to the actual fire loss in order to arrive at the total cost of fire.

The cost is borne not only by those unfortunate enough to have fires, but in the form of insurance premiums is distributed and borne by all of us who directly or indirectly pay fire insurance premiums.

Statistics show that 98 per cent of all fires might be extinguished at their inception by a single bucket of water, consequently the excessive fire loss must be due, in a large measure, to the time consumed in bringing to bear the fire fighting resources of the municipalities, and it is apparent that having done everything possible toward saving time in getting to fires, the only way left still further to reduce the time element is to provide means for notifying the fire department more quickly after fire is known to exist.

Getting to the Fire

From information furnished by many fire departments as to the time fires have been in progress when the departments arrived on the scene, such time may be roughly averaged at from 12 to 15 minutes and delays in communicating the alarms to the fire departments are admitted to be largely responsible for this high average. The fact should also be taken into consideration that many of the most destructive fires have been burning for a much longer period.

Experience has shown that a properly planned telegraph fire alarm system provides the swiftest and most reliable means of notifying the fire department of the existence and location of fire and for reducing the elapsed time between its discovery and the bringing to bear of the fire fighting resources of a municipality.

Adequate Fire Alarm Protection

The question of what constitutes adequate fire alarm protection for any municipality, and the details of such a system, are matters which should properly be dealt with in another article; in a majority of cases the practical application of the principles of fire alarm telegraphy requires a careful survey of the fire district to be protected, but it is proper to state here that such a system should provide means for transmitting without appreciable loss of time, alarms of fire from every point within a fire district where fire is likely to originate, such means to include operating devices accessible to the general public of such a nature that their purpose cannot be mistaken; means of receiving and recording all alarms at the fire stations, and for properly notifying the fire fighting forces, whether paid men or volunteers, of the exact locations from which the alarms are received. In further recognition of the time element, the speed at which alarms are transmitted by the system after the initial manual operation of pulling the lever of a fire alarm box, should be as great as is consistent with the reliable operation of the alarm apparatus.

The argument has been frequently advanced that the greatest value of the telegraph alarm system is derived from the protection it affords to the manufacturing and other business districts of a municipality, and by reason of the lower property values generally and the fact that most residences are now equipped with commercial telephones by means of which alarms may be transmitted, it is unnecessary to have or at least the same degree of telegraph alarm protection is unnecessary in the residential districts as in commercial districts.

That such an argument is not in accordance with the facts is evidenced by the records of the state of Tennessee Fire Prevention Department for the year 1919, which show that of the fires occurring in residences within the municipal limits of cities and towns in that state 57 per cent resulted in total loss. The State of Tennessee is not taken as an example because of the high percentage of total loss resulting from fires in the residential districts, but on account of the fact that the exact statistics of other states are not available.

Using the average per capita fire loss as a basis, a city of 10,000 population would contribute annually to the actual fire loss over $30,000, plus the other items of fire prevention and insurance cost, and also plus the losses due to interrupted business and depreciation of taxable values.

We have on one hand, 98 per cent of all fires which can be quenched in their incipiency by a single bucket of water; on the other hand, the same fires by reason of the delay in bringing the fire extinguishing forces into action, resulting in an actual annual fire loss in excess of $300,000,000.

It is a fact that fires increase progressively in intensity and the values destroyed by fire range from insignificant sums during the first few minutes to heavy or total losses if not promptly checked. A reduction in the average time required to place the fire departments in position to act effectively would be followed as a natural consequence by a correspondingly greater reduction in the fire loss, and in the total cost resulting from fire.

When all the facts are taken into consideration, it would seem that the question of the value of a modern fire alarm telegraph system and the amount of the investment a municipality can afford to make for adequate fire alarm protection resolves itself into a simple mathematical problem.

The foregoing paper by Mr. Stover was presented at the 1921 meeting of the League of Michigan Municipalities.

EQUITABLE DISTRIBUTION OF COST OF CONSTRUCTING AND MAINTAINING STATE HIGHWAYS

(Editor's Note.—The final report of the National Committee on Equitable Distribution of the Cost of Construction and Maintenance of State Highways, of the National Highway Traffic Association, of which Herschel C. Smith, Consulting Engineer, Oklahoma City, Okla., is chairman, is here given in full as presented at the recent annual convention of the association.)

Introduction

In making this final report, the committee realizes that the subject matter is such as cannot properly be touched upon lightly. The committee believes the proper analysis and just distribution of the cost of construction and maintenance of state highways is one of the most important economical principles in the science of highway improvement. Capital in large amount must be secured with which to construct and maintain public thoroughfares, and these thoroughfares must justify this use of the billions of capital by supplying an economic need to the investor in proportion to the amount invested. This final report is submitted with the hope that the association will see fit to continue a committee investigation of this subject to the end that a just, unselfish, and sound influence may be exerted for the economical investment of capital in, and the proper maintenance of, public highways.

Principles Involved

The application of principles of sound investment of capital in various enterprises will necessarily vary according to the state of development of the industry in which the investment is made, but the underlying principles of some investments are narrowly defined and well recognized.

1. The justification of the investment of capital in an enterprise is in that the net economic return which comes to the investor in the form of all benefits derived from the use of the enterprise, is sufficient to reinburse the investor for the original capital plus a reasonable amount for the use of the capital invested, during the service life of the enterprise.

2. The underlying principle of cooperative investments is that a just division of returns is that which makes the return directly proportional to the capital invested. Or applying this same ratio inversely, a just distribution of costs must be directly proportional to the benefits derived.

Because of the total lack of uniformity among the various states in distributing highway cost, the policies varying from a state which has placed the total cost of the original investment in highways on automotive vehicles, to other states which almost ignore this source of revenue, the committee feels it necessary to accept the above commonly recognized principles of investment as the fundamentals on which to build an analysis.

Analysis of Benefits

Many of the benefits derived from the improvements of highways are so obvious that it is necessary only to enumerate them. The following is a list which might be further subdivided but need not be for the purpose of this report:

1. Development of commerce.
2. Development of industries.
3. Development of agriculture.
4. Development of natural resources.
5. Development of rural schools and churches.
6. Development of general intellectual and social life.
7. Improved appearance of roads.
8. Permanency of alignment and grade of highways.
9. Decrease in cost of transportation.
10. Development of methods of transportation.
11. Facility of travel.
12. Increase of land values.
13. Development of economic specialization.
14. Development of back-to-the farm movement.
15. Development of national power.

The above are benefits, all of which encourage the improvement of highways before there were automotive vehicles, and many of which have been recognized and considered adequate justification for the improvement of highways from two thousand years ago up to the present time. A realization of the inherent value of many of these benefits resulted in the development of state aid policies in New Jersey in 1891, and in Massachusetts in 1893, and several other states long before the motor vehicle had become a factor in highway traffic.

The development of tourist travel is a benefit which the committee treats separately because of the division of opinion in its regard. It is certainly a benefit resulting from highway improvement, which gives a net economic return, and the beneficiaries of the return should account for their portion of the capital required to make the benefit possible. The principal beneficiary, however, is the community being toured, where the tourist spends his money and no proof of this is more conclusive than the open recognition of this fact by all communities, expressed in their every attempt to encourage tourists to enter their territory.

The analysis of the development of motor truck traffic shows that it is a benefit resulting from the improvement of highways which accrues to the general public. The operator of a motor truck derives a benefit from the improvement of highways only in so far as it enables him to transport more advantageously than by other means. The benefit of the improvement coming through motor truck use eventually accrues to the producer and the consumer of the products hauled.

Distinction Between Construction and Maintenance Costs

The benefits from the construction of a highway accrue to the public served by the highway. It is never limited to those who use the highway. The storekeeper, farmer, or man retired from business receives these benefits even though they may never have a vehicle on the road. Nor does the benefit necessarily accrue to those using the road in proportion as they use it. The truth of this statement is evident by comparing the benefits derived by an owner of large tracts of land along the road who may use the road relatively little with the benefit derived by a truck gardener who owns little land, but who may use the road every day. While the benefits derived by individuals do not depend upon the extent of their use of the road, the benefits are only possible by virtue of the road being used. The cost of construction, then, should be distributed according to the benefits derived.

The equity of collecting the cost of maintenance directly from the same source is not so obvious. The cost of maintenance depends directly upon the amount and character of traffic to which the road is subject. Capital, properly invested in highways, should be maintained out of the return from the highways. The amount of maintenance, depending directly upon the use to which the road is put, should be assessed as nearly as possibly directly upon the use of the road.

Assuming that proper regulatory measures are enforced pertaining to the transportation of particularly heavy and destructive machinery over the highways, the maintenance of highways will depend, not entirely, but largely, upon the automotive vehicle traffic. The error in assuming that all maintenance on State Trunk Highways is due to the motor traffic is not great, due to the great predominance of that type of traffic, and that error is fast becoming more nearly negligible as motor traffic supplants horse drawn vehicles.

Conclusion

In this, its final report, the committee submits, for consideration by the members of the association, the following principles relative to the equitable distribution of the cost of construction and maintenance of state highways:

1. That the construction of state highways should be financed by general taxation.

2. That maintenance of state highways should be financed through the medium of license fees for the use of motor vehicles, provided the highways built are of types most economically suited to the traffic to be carried.

3. That the cost of maintenance of state highways should be so distributed as to encourage the fullest development of commercial use of the highways, as therein lies their greatest economic value.

IMPROVING GRAVEL STREETS IN GRAND RAPIDS, MICHIGAN

The Grand Rapids Engineering Society recently appointed a committee to investigate and report on methods of improving gravel streets with a permanent surface top, the committee consisting of H. H. Turner, Purritt A. Parks, Byron E. Parks, Theodore O. Williams, John F. Nellist, C. A. Paige, A. H. Apted and C. J. Wagner. After an exhaustive investigation the committee submitted a report in which it recommends the use of sheet asphalt or a bituminous penetration top. The report says:

The Gravel Streets

In 1898 the practice was started in Grand Rapids of building and improving gravel streets having a combination concrete curb and gutter or a vertical stone curb. The roadway on this type of street was built in four separate layers, totaling 10 ins. in depth. The lower layer consists of cobble stones or large gravel where this could be obtained, and the voids between these stones was filled in with smaller gravel and clay. On each succeeding layer smaller gravel was used and after this the gravel was spread, the clay binder was put on and then the entire course was properly rolled.

There also was a type of macadam street built which was of the same construction as the above described gravel street with the exception that crushed hard heads or limestone was used as the base and limestone dust used for a binder instead of clay as above described.

Auto Traffic Rendered Gravel Streets Obsolete

This type of street was an improvement in street construction over the old type of bank gravel street which was built simply by spreading a layer of gravel over an unimproved street and when it became full of holes another layer was spread. From 1898 until 1918 75 miles of this type of improved gravel streets were built, but as early as 1912 it was discovered that with the advent of the automobile, the surface of these improved gravel streets would not hold up under the traffic which the automobile produced.

The automobile traffic increased so rapidly during the last few years that in 1918 the practice of building gravel streets in Grand Rapids was discontinued and unimproved streets are now improved with either reinforced concrete, sheet asphalt on a concrete base, or brick on a concrete base.

On account of the uniform way in which these improved gravel and macadam streets were constructed, the only objection to this type of street is that the automobiles destroy the surface of the street, which, of course, is not as hard as concrete or sheet asphalt causing the streets to become badly pitted, very rough for traffic, and very dusty in the summer unless properly treated with dust preventing material.

The crushing strength of this type of street, or in other words its ability to carry satisfactorily a surface top which is not easily destroyed as is the gravel top itself, has been proven to be satisfactory under the modern auto and truck traffic and the object of this report pertaining to those Improved gravel streets is the following:

1. Recommendations as to the types of top surface with which these improved gravel streets may be covered.

2. An appeal to the citizens of Grand Rapids who live on these improved gravel streets to have these streets covered with a permanent top as soon as possible in order to improve generally the streets in the city of Grand Rapids.

Sheet Asphalt Top

The most satisfactory type of surface top which can be put on these gravel streets is that of sheet asphalt. In applying this the surface of the gravel street is first scarified and then rerolled in order to restore as near as possible the original contour of the street and to make its surface smooth in order to receive the top surface. After this surface has thoroughly dried the asphalt binder course of 1½ ins. is applied and following this the 1½ ins. of sheet asphalt topping is placed on the binder and the surface is then properly rolled to a smooth and even finish.

The cost of this type of topping is between $3 and $3.50 per running foot of property and arrangements may be made with the city to place this on a five year plan so that for a 40 ft. lot the approximate cost would be from $24 to $28 per year for five years.

With this type of topping it is safe to say that no maintenance work will be required on the street for at least 15 years after the top has been put on. There are sheet asphalt streets in the city which have been down for 24 years, and undoubtedly the next 24 years will be harder on city streets than the last, but conservatively speaking, 15 years is short enough estimate for the life of this asphalt topping.

Bituminous Penetration Top

A second kind of topping which may be used on this type of improved gravel or macadam street is a bituminous penetration top and may be either a tar or an asphalt type of topping.

In this type of top the base is prepared in the same way as above described for the sheet asphalt top, but after the base has been prepared and properly rolled it is covered with 2½ ins. of crushed hard heads or limestone. Following this hot asphalt or tar, as the case may be, is poured on this stone which fills the voids and acts as a binder to hold the stones together. Following this a layer of smaller stone is applied on the bituminous material and it is then properly rolled and the entire top is bound together with the tar or asphalt.

After this first rolling has been completed the entire surface is then covered with a coat of hot tar or asphalt and a layer of pea gravel is spread on this surface coat which after being properly rolled finishes the surface and produces a very presentable type of top.

The approximate cost of this is $1.75 to $2.25 per running foot of property which on a five year plan would cost the property owner for a 40 ft. lot approximately $14 to $18 per year for five years.

There is, however, a decided difference in the wearing qualities of this type of topping as compared with the sheet asphalt in that approximately every three years a new seal coat of pea gravel must be put on this type of top. The approximate cost of this seal coat is 25c per running foot of property so that in the course of 15 years in which nothing must be done with a sheet asphalt top, at least five seal coats must be applied.

Considering both types of pavements it may be said that the ultimate cost at the end of 15 years is approximately the same in each case, but during the 15 years the sheet asphalt pavement always presents a much better appearance and it is more satisfactory in every respect than the penetration type of street.

It is safe to say, therefore, that between the two types of pavement the sheet asphalt in the long run is the most satisfactory and economical, although the initial cost is somewhat greater than that of the penetration top.

All of the members of the committee who have signed this report have made a personal investigation of the gravel street situation in Grand Rapids and are unanimously of the opinion that the report as rendered is the correct method of handling this large mileage of improved gravel streets which is being worn by automobile traffic. They are also of the opinion that this should be done as soon as possible in order to improve the general street condition in Grand Rapids.

THE COST FACTORS OF CONSULTING ENGINEERING PRACTICE

By Charles H. Young, President Central States Engineering Co., Muscatine, Ia.

(Editor's Note: We were greatly interested in the following paper, presented by Mr. Young before the 1921 meeting of the Iowa Engineering Society, as it gives an exceptionally concise summary of the cost of conducting a consulting engineering business. Inasmuch as we have a great many valued readers among the consulting engineers we especially invite discussion of and comment upon this article. The discussions may, of course, take any direction that our readers may elect. It is hoped, also, that municipal and county engineers and other officials will read this article and thereby appreciate the cost of a service which, to be satisfactory, must always be accorded adequate compensation.)

In attempting to analyze the subject of cost factors in engineering practice it was discovered that the cost factors are of a great variety and are dependent upon the class of service that an engineer in practice performs. There is involved, also, the kind of organization, the kind and extent of trade area tributary to the locality within which the engineer functions and the amount of energy spent in educational work of clients and of the engineer, himself, in continuance of business, the manner of development and the period of development.

It seems that there is no general method of procedure adopted by the various engineers, so that a standardization of factors could not be made applicable to each and every case.

Classes of Consulting Engineers

It is therefore necessary to divide the engineers into seven (7) classes:

Class A, an engineer who may or may not have a technical education, who has office at home and operates a one man practice.

Class B, an engineer who has a small office and employs assistants part time and operates balance of time in one man practice.

Class C, an engineer who has business organization, stenographer, chief engineer, and departments, employing a number of men in order that he may perform various classes of service.

Class D, an engineer who holds some position which provides office equipment and salary and devotes part time to private practice.

Class E, a professor who devotes excess time to private practice in order that he may gain such experience as will make him better qualified to teach the subject which he has in hand.

Class F, an engineer who consults only on special projects and confines himself to development on only large projects along a particular line.

Class G, an engineer who does some contracting and fills in his time practicing engineering.

Cost of Engineering Education

It might seem proper at this time to discuss somewhat the cost of an engineering education because this is the foundation for a lasting superstructure of engineering practice. Considering that the cost of a college education is $500 per year and that some classes of engineers would require a four-year course and some six years, some engineers would acquire a larger part of their education from their personal ability to study out problems in their own way. Really when you consider education in engineering, the practical education is the important part.

Billy Sunday's diagnosis of an educated man is, a man who knows a little and knows where to get what he wants when he wants it and knows how to use what he gets when he gets it. So the factor of education would fluctuate in that it would depend upon a man's ability to apply his knowledge practically before it could be ascertained what the value is of that knowledge to his business. In general, however,

Class A would require 4 years at $2,000, practical experience $1,000.

Class B would require 4 years at $2,000, practical experience $1,500.

Class C would require 4 years at $2,000, practical experience $3,000.

Class D would require 4 years at $2,000, practical experience $5,000.

Class E would require 6 years at $3,000, practical experience $3,000.

Class F would require 6 years at $3,000, practical experience $3,000.

Class G would require 4 years at $2,000, practical experience $2,000.

It has been computed that 25 per cent of their time is all that classes D and E could devote to practice because of other duties. In considering practical experience, a five-year period has been used.

Necessary Equipment

Class A, tools and fixtures, transportation facilities, $2,000.

Class B, tools and fixtures, transportation facilities, $3,000.

Class C, tools and fixtures, transportation facilities $1,500.

Class D, tools and fixtures, transportation facilities $3,000.

Class E, tools and fixtures, transportation facilities $1,000.

Class F, tools and fixtures, transportation facilities $2,000.

Class G, tools and fixtures, transportation facilities $3,000.

Continuance of Business

Ordinarily, the first year of Class A's time furnishes him 50 to 70 per cent employment; second year, 60 to 80 per cent employment; third year, full time. After the third year he usually enters into Class B and continues with 50 per cent assistants the fourth year, 75 per cent assistants the fifth year, and full time assistants the sixth year. If he is successful and energetic and has the personality and natural ability he will enter the seventh year with more than one assistant and be in Class C. In the tenth year of practice he has good chances of operating three or four departments, if he is energetic.

It may be necessary some time during this career for him to enter Class D in order to fill in part time in some position or he may be sidetracked into Class E for a time or permanently. There is also a chance of sidetracking into Class G, but very few engineers reach Class F until after long years of experience. Very often Class E starts in Class A and develops more rapidly, arriving usually in Class F after he has the business ability. It seemed necessary to discuss this question because these facts are the foundation for considering the cost factors in engineering practice, and it almost seems as though any formula which might be

CENTRAL STATES ENG. CO.

DAILY REPORT

Client's Name ______________ Date ______

Employee's Name ______________ Hrs. Worked ______

Nature of Work ______________________________

Expense	Amt.	Paid	Remarks
Auto			
R. R. Fare			
Transfer			
Brdg. Toll			
Meals			
Lodging			
Stakes			
Stationery			
Misc.			

Remarks ______________________________

FIG. 1. DAILY JOB TICKET FOR KEEPING COST OF CONSULTING ENGINEERING WORK.

created would consist almost wholly of variables and very few constants. In solving for X, which would represent the income of the various classes, only general statements can be made which would be modified by the various conditions entered into. It can be said, however, that there are items which enter into almost every practice, which might be enumerated as follows:

Promotion Expense

This item covers the expense of promoting jobs, dues to associations, etc. It is necessary for the engineer to keep up with the times in order that he can better serve his clients, just the same as any lawyer, dentist, or doctor, who is a professional man, must acquaint himself with the newest ideas. He must, also, watch the change of personnel of different bodies of men and keep them in touch with his qualifications in the work he is doing in order that the best interests of his business might be perpetuated.

Bonds

bonds, which amounts to 1 per cent of the penalty of the bond or 1 per cent of the bond required. As the amount of the bond furnished is fixed by the parties requiring the bond, this is an indefinite expenditure. The amount of the bond is paid by the engineer and is an item of expense.

Insurance

This item represents the cost of working men's compensation, which is compulsory under the State Law. It is 71c per hundred for surveyors, 9 per cent for draftsmen, 2½ per cent for engineers on tile ditches, $3.75 per hundred for engineers on floating dredge work, $3.45 per hundred for engineers on suction dredges and other classes. This item fluctuates from time to time.

Traveling Expense

This item represents the expense of traveling to jobs you do not get and visiting jobs under construction in order to ascertain information. There are many trips necessary in order to get final settlement on the work after it is completed. This, also, includes expenses to society meetings in order to keep up with the times.

War Tax

This item must be an item on all costs, as it represents the tax not only on profits but also on telephone, telegraph, and express bills.

Interest on Investment

This item must be a part of all estimates of cost amounting at present to 7 per cent.

Interest on Jobs

This is not interest on investment but interest only on money borrowed to carry on jobs during the process of the work. That is, engineers must receive their wages and expenses must be paid regardless of whether or not collections are made. Very few assistant engineers have enough money to wait until preliminary expense is paid. Again, a great many warrants must be discounted from 1 to 4 per cent, dependent upon the credit of the project, before the banks will cash them, because the banks have to hold these warrants until the bond issue is put through. Many warrants are marked "Not Paid for Lack of Funds."

Discount

As mentioned above, it is necessary sometimes to discount warrants and hold bills between board meetings. Sometimes one cannot cash these warrants for several years.

Job Expense

This item includes miscellaneous transportation of men, expense of lost time for men receiving steady pay, storage, job office rent, etc.

Repairs

This includes the cost of repairs to tools and equipment and tools lost or stolen.

Depreciation

Every engineer has depreciation on his equipment which amounts to 10 per cent per annum on the cost of equipment. In some cases this should be doubled.

Risk

This factor is indeterminate. Sometimes during preliminary surveys the bills are not paid. The preliminary bond sometimes is insufficient or the work is held up by legal procedure so as to be detrimental to the engineer's pay. The money must oftentimes be borrowed for an indefinite time to carry on business and discounts. Fees for testimony at

CENTRAL STATES ENGINEERING CO.

OF MUSCATINE, IOWA

IN ACCOUNT WITH

Year Month	Date		Chief Engineer	Asst. Engineer	Draughtsman	Field Helper	Transportation	Meals Lodging	Miscellaneous	TOTAL

FIG. 2. COST KEEPING FORM FOR CONSULTING ENGINEERS.

$1.35 to $4 per day can be enforced by law.

Office Expense

This item represents stenographer, rent, light, heat, janitor, postage, telephone, telegraph, control systems, books, supplies, advertising, and expenses of like nature which every business must pay.

Salaries

This question of salaries would be a local one and be easily determined by a summation of the salaries paid during the year, but it is hard to anticipate just what salaries should be paid on any particular job because of the fluctuation of the other factors involved. One can only draw general conclusions after a definite experience in a particular locality and after a careful computation of costs and the various factors involved, before he can determine what is a fair amount to pay in salaries. It is often hard to tell until several months into the next year's business what the profit of the business is, until all the collections have been made for the previous year up to January first. Sometimes accounts of one year will not be paid for months after the year's work has been completed. Therefore the determination of profit cannot definitely be ascertained until one knows whether or not he had any bad accounts. Many a business has failed, not because the profit was not in the procedure of the work, but because the accounts of the business could not be collected.

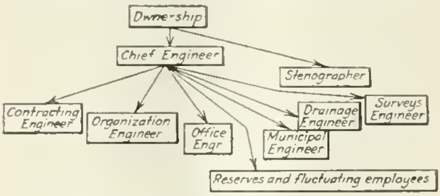


FIG. 3. ORGANIZATION OUTLINE FOR CONSULTING ENGINEERS.

Method of Cost Keeping

The method of cost keeping which we have adopted is to make out a ticket in duplicate for each job performed each day. We file one of these tickets under the client's name and one ticket under the employee's name. From these tickets under the employee's name we make up his salary and from the tickets under the client's name we make up the client's bill, which might consist of the work of several men. These tickets are 3x5 ins. and can be filed away in an ordinary 3x5-in. card index box. They are made up in little books, 50 to a book, and each man makes out his own ticket. Fig. 1 is a copy of the form which we use

In transferring this item to the client's bill it is itemized in columns of Chief Engineer, Assistant Engineer, etc., as shown in Fig. 2.

No material is secured without an order and this keeps the amount of materials purchased on the stubs of our order book. This way we are able to keep an itemized account of every transaction and every item, whether it be transportation, time on promotion, traveling expense or any of the items above enumerated.

One factor that is indeterminable but must be taken into account is the loyalty of the employee and his adherence to the ethics of the profession. Oftentimes this item is very large when one has to keep training men over and over again to fill the different departments of the work. While it is always a source of gratification to see one's employees advance there often becomes a limit to the amount of salary that can be profitably paid. Often one year is a good year and another year is a bad year, so that the cost of doing business fluctuates with business conditions, and the employee not having the facts at hand may jump at conclusions and often attempt to supplant the employer after he had been nursed and fed to a healthy condition by a well meaning parent. As a usual thing, this class of employee receives the same treatment when, in later years, he fills the shoes of his employer.

Profit Sharing Plan

Whether or not the employer would receive an apportionment of the profit would depend upon his loyalty, his attention to business and the success of his work, and the class of service the engineer performed. And again it would depend upon the value of business over a period of years, taking the good years with the bad years, the successful collections of accounts, and the education of clients. This factor of education of clients would fluctuate greatly with the need for the same. However, any business needs to educate its clients. Very few clients understand the functions of an engineer, because they would almost need to be engineers themselves in order to realize what is necessary to produce certain results. The clients of an engineer are just like any ordinary man who goes to our legislature. They cannot be expected to be versed in every question from the boll-weavil to the flying machine. but they must inform themselves upon various subjects in order to determine their course in voting. Likewise, if an engineer does not give his clients a concep-

tion of engineering service, then he cannot expect much business. It is my opinion that the education of clients is one of the largest factors of cost which enters into the engineering practice.

Organization Outlines

Engineers operating in Class C, especially, must devise some operating plan or method of operation and feed it down to the different departments in some systematic method. There is a cost factor here, then, of devising ways and means economically to transmit the responsibility to the various departments. Quite a bit of money can be saved clients where men in different departments are eperienced and advanced in a particular class of work, thus rendering competent service which could not be otherwise rendered by one engineer who would not be versed in all kinds of engineering business. This factor, then, would aid in the economic carrying out of a project of larger magnitude. We are showing in Fig. 3 an organization outline which might be a factor in successful operation, consequently a factor of cost.

Summary

An attempt has been made in the foregoing discussion to present the factors of cost in order that any engineer in business may apply those factors of a cost keeping system and thus over a period of years localize different cost factors to the class of business he performs and to the community in which he operates. An attempt has also been made to set out as nearly as possible the separation of cost factors encountered in each class of business enumerated. It is needless to say that it is necessary to estimate a number of these factors, but with the factors at hand any engineer will be able to fill in his own table and to recognize that such factors exist if he has not previously realized it. Some of the factors may not be involved in some classes of business, but the engineer in practice can select those factors which are applicable to his particular class and ultimately arrive at his own conclusions. It has been recognized that the reason why computations vary in engineering lines is because engineers do not operate on the same basis and do not perform the same service for a given price. Engineers do not all have the same will power to put projects across under adverse conditions. So the percentage of "I will do it" which a man possesses would be a factor in the cost. This is a larger factor than might be anticipated at first sight. It has been said that if all engineers engaged their services on the same basis that ultimately the engineering profession would receive what it is justly entitled to for services rendered and the clients would better understand what they were receiving for the price they paid. The existence of this condition has caused the writer to attempt to analyze cost factors in order that a basis for standardization could be arrived at with a view to rendering some small service to the engineering profession as a whole and to the general public as well.

PLANTING TREES ALONG PENNSYLVANIA HIGHWAYS

During the last few weeks the Pennsylvania State Highway Department has planted a large number of American elms and sugar maples along State Route No. 123, between Gettysburg and Harrisburg. The planting of several miles of trees was under the direction of attaches of the State Forestry Department.

"It is our aim eventually," said Highway Commissioner Sadler, "to beautify the main highway routes in Pennsylvania through the intelligent planting of shade trees."

A tentative plan has been worked out with the Forestry Department whereby a comprehensive system of planting trees along State Highway Routes will be taken up. The Highway Commissioner will designate the highway to be planted and the particular section involved.

The Commissioner of Forestry will make a survey of the planting site, recommending the species to be planted; and giving in detail the planting operation, such as distance, care of stock, size and depth of holes, setting of the trees, fertilizers, staking of the trees, planting crew, necessary tools, approximate time required and other details.

The State Foresters will direct operation and inspect the trees from time to time, giving instructions concerning the subsequent care and treatment.

In order to make a real success of this work it will be necessary to obtain the complete co-operation of the adjacent land owners, obtaining their permission to remove undesirable trees along the highways right-of-way which are 4 ins. or over in diameter 2 ft. above the ground. The co-operation of companies operating overhead service lines will also be necessary. The trees will be furnished by the Forestry Department as fast as they become available from the State Nursery.

WATER WORKS SECTION

WATER TREATMENT FOR SMALL MUNICIPALITIES

By E. M. Partridge, Chief Chemist, The Refinite Co., Omaha, Nebraska.

As the possibilities and benefits of improving water supplies become better known, water treatment is becoming more common among the smaller towns and cities. The first consideration is to make certain that the water is a safe one to drink and free from disease producing organisms. However, the water need not be hygienically unsafe before treatment is desirable. A "safe" water may be so muddy or colored as to be distasteful. The removal of suspended matter and color and, at times, iron and dissolved gases as well, will improve its appearance and give it a pleasing taste and smell. At times, it is necessary to neutralize acid mine waters or to counteract pollution from neighboring cities or industrial plants. As the industrial value and other advantages of soft water become better known, the inclusion of softening as one of the objects of treatment is more common.

The treatment necessary varies with the conditions, but always involves the employment of certain fundamental practices to accomplish the various results desired. Depending upon the amount and nature of impurities present, the methods or combination of methods chosen varies. The impurities present will be either in suspension or solution. If they be in solution, means must be found to precipitate them in insoluble form when they may be handled in the same manner as the matter already in suspension. Matter in suspension is removed through sedimentation and filtration. Sedimentation or filtration are assisted by the aid of chemicals which, acting as coagulants, draw the finer particles together into larger aggregates and allow them either to settle more rapidly or be more easily filtered. In the processes of sedimentation and filtering, or softening and filtering, if properly handled, it is possible to get an almost complete removal of bacteria from the water. To insure complete sterilization of the water, additional treatment in the form of chlorination, ozonation or the rays of ultra violet light may be given.

Water Treatment Processes

The various processes may be listed as follows. They do not necessarily come in the sequence given, nor are they all necessary for any given water.

1. Aeration—Allows dissolved gases to escape and oxidizes iron present in solution to an insoluble form which may then be handled as suspended matter.

2. Addition of lime and soda—To render soluble impurities insoluble, so that they can be removed by sedimentation and filtration. Removes iron and hardness and serves as coagulant.

3. Addition of coagulants—To collect the fine floating particles into larger masses so that they will settle and filter with greater ease. May be used to correct alkalinity after lime-soda treatment.

4. Sedimentation.

5. Filtration.

6. After treatment by ultra-violet light, chlorination or ozonation.

Treatment of Surface Waters

Many water treating plants are in the main, filtration plants alone. The water is handled first in settling basins where, with the aid of a coagulant, a large part of the suspended matter present is settled out and deposits on the floor of the settling basins. It is then passed to a sand filtration plant either of the gravity or pressure type.

There have been many articles written on the subject of sand filtration. The art is well understood and in application in numerous instances. In the list of possible steps in water treatment given, it will be noticed that the third, fourth and fifth steps mentioned are stressed in this form of treatment namely: Addition of coagulants; sedimentation; and filtration.

The addition of lime and soda may occur and result in some softening action on the water, but when the plant is intended primarily as a filtration plant, these chemicals are added if at all, to insure a sufficient alkalinity in the water properly to decompose the coagulants added. The coagulants used are soluble salts, which, when brought in contact with alkaline salts, are decomposed with the formation of an insoluble hydrate which acts as the coagulating medium. When alum or sulphate of alumina is used, the native alkalinity of the water serves as the decomposing agent, or if this be insufficient, soda may be added. When sulphate of iron is used as the coagulant, it is necessary to add hydrated lime, since iron sulphate does not react very satisfactorily with natural alkalinity in water. The point to be observed is that but relatively small amounts of chemicals are added, just sufficient to form a coagulum which aids in settling out the suspended matter before the water is filtered. This coagulum serves the further purpose of building up of a gelatinous coating on the sand particles in the upper portion of the filter bed. This coating of gelatinous matter on the sand particles increases materially the efficiency of the sand bed; with it present the filter can remove the finest suspended matter and also absorb coloring matter, odor and tastes.

This type of treatment is especially adapted to the betterment of surface supply waters which are very apt to carry more or less silt, clay and other matter giving it often a high turbidity. It is the ordinary form of treatment for river waters and is now used with satisfactory results at many cities located on the banks of streams. Such waters are generally more or less soft, the waters handled being often but a few grains hard and generally less than ten grains hard.

Disadvantages of Many Well Waters

Many of our smaller cities, however, are not located on streams which will give them water of a desirable type. They find it necessary to depend on water pumped from driven wells. They may be fortunate enough to locate a water supply which is entirely suitable for use but well water is very apt to have certain disadvantages. It is likely to be charged with an excess of carbon dioxide which causes the water to dissolve iron from the iron piping used to carry it, making "red water" and giving rise to stains on the plumbing fixtures. It often contains considerable iron in solution when drawn; the water will be clear at first, but on standing will turn yellow through precipitation of the iron on the escape of the carbon dioxide gas which held it in solution in its natural state.

Again such water is often undesirably hard, the lime and magnesia in the water rendering it very unsatisfactory for use. It consumes large amounts of soap before a lather can be formed with it and gives large amounts of gummy soap curds. The hardness causes scale in boilers and water heaters, sometimes closing hot water pipes entirely. It cannot be used to manufacture good, clear ice and proves itself objectionable in numerous other ways. Well waters of this type are not apt to be contaminated with objectionable bacteria and organic matter in solution, their faults are more apt to be in their corrosiveness, iron content and hardness.

Aeration

If it be desired to remove only the iron and corrosive properties of the water, thorough aeration followed by sedimentation and filtration may be all that is needed. Aeration may be given by spraying the water into a settling basin or by allowing it to trickle down over a series of baffle plates. The effect is to release the carbon dioxide from the water and throw the iron out of solution so that it may be readily filtered off by a sand filter. Enough carbon dioxide escapes during the process to reduce the corrosive properties of the water to a negligible degree.

Water Softening

This treatment does not soften the water. If in addition, it is desired to soften the water, this treatment will not suffice. A treatment approximately that first outlined involving the steps of (1) the addition of coagulants, (2) sedimentation and (3) filtration is necessary. The treatment differs in that instead of adding just the chemicals which cause coagulation, sufficient lime or lime and soda is added materially to reduce the hardness of the water. Softening may be very desirable, but the cost of softening too high to be practical and the water after softening of undesirable quality.

The question of whether or not softening is practical and desirable must be settled on the score of the nature of the water. The method of treatment is to add sufficient lime and soda to the water to react with the hardness and effect the desired softening, to pass the water into a properly designed sedimentation tank where the precipitate formed may settle out, to add sufficient iron sulphate, niter cake or similar substance to neutralize the excess alkalinity of the softened water and prevent after precipitation from it and finally to filter and deliver it for use. The addition of lime and soda to water to soften it is now a well known process, but a brief explanation of the process may not be out of place.

The Lime and Soda Process

Hardness in water is due to the presence of dissolved salts of lime and magnesium. The salts commonly found are the bicarbonates and the sulphates of lime and magnesium. Occasionally, chlorides are present in considerable amount. In addition to these salts causing hardness, we may find the bicarbonates, sulphates or chlorides of sodium. In large amounts they are objectionable, but they do not destroy soap or form scale as do the hardening salts. When calcium and magnesium are present in the bicarbonate form, they are in effect present as insoluble limestone or dolomite made soluble and held in solution by carbon dioxide. For instance, calcium carbonate or limestone, an almost insoluble substance, dissolves readily in water containing an excess of carbon dioxide, the carbon dioxide uniting with it to form soluble calcium bicarbonate. Any process which will remove this carbon dioxide will render the limestone again insoluble.

Temporary Hardness

If we heat the water, it will be driven off and the limestone becoming insoluble, will settle out of the water. This is the cause of the "furring" of kettles and because bicarbonate hardness is thus easily removed by boiling, it is called temporary hardness. The addition of lime to unite with the carbon dioxide will effect the same result. The lime unites with the carbon dioxide to form a fresh amount of limestone and this, together with the limestone already present and now made insoluble through losing its carbon dioxide, comes out of solution. When temporary hardness is thus removed by the addition of lime, not only does the lime added come out of the water as an insoluble precipitate, but something in the water, the calcium bicarbonate, is removed, the total dissolved content of the water being less after treatment than before.

Permanent Hardness

If any sulphate or chloride hardness be present, boiling the water will not affect it. It is, therefore, called permanent hardness. For instance, a water containing dissolved calcium sulphate or gypsum will have just as much of this substance present after boiling, as before, and in unchanged form. The addition of lime does not affect it either.

To soften water containing calcium sulphate we add soda. The calcium sulphate and soda possess together chemical groupings from which insoluble calcium carbonate or limestone can be formed. The calcium sulphate furnishes the calcium and the soda which is sodium carbonate, furnishes the carbonate radical. When they are mixed a white cloud appears which is the calcium carbonate forming and precipitating, but the fact must be remembered that something remains in the water. The remainder of the soda and of the calcium sulphate or gypsum form sodium sulphate (Glauber's Salts) and remain in solution. This happens whenever permanent hardness is softened by the addition of soda. The hardness is removed but a soluble though non-hardening salt appears in its place. This is different from softening temporary hardness with lime when a removal of the hardness is effected without a substitution of a corresponding sodium salt. In case the temporary or permanent hardness present is due to magnesium salts instead of calcium salts, the processes involved are exactly the same except that lime is first added to change the magnesium salt to a calcium salt.

Treatments for Temporary and Permanent Hardness

Thus, in general it may be said that temporary hardness requires lime treatment, and permanent hardness requires soda treatment, while lime in addition is required when the hardness is due to magnesium salts whether present as temporary or permanent hardness. Furthermore, when temporary hardness is treated, it is removed from the water but when permanent hardness is treated, it is rather converted into an equivalent amount of a non-hardening salt, no actual reduction in the total solid content of the water occurring. It is apparent that the cost of chemicals to treat the water will vary, not only in proportion to the hardness of the water, but also according to the kind of treatment that must be given, whether chiefly lime treatment or chiefly soda treatment since soda is more expensive than lime. Furthermore, the desirability of treatment when a large amount of permanent hardness is present so that considerable sodium salts will be left in the water after treatment is a matter of doubt.

Waters of Equal Hardness Vary in Treatment Cost

To illustrate how waters of almost equal hardness may vary as regards cost of treatment, depending on the form in which the hardness is present, we will cite two examples.

A well at Ross, Florida, analyzes as follows:

Substance	Grains per Gal.
Calcium bicarbonate	15.38
Calcium sulphate	3.54
Magnesium sulphate	10.43
Sodium sulphate	2.74
Sodium chloride	2.30
Aluminum oxide	.26
Iron oxide	.03
Silica	1.54
Carbon dioxide	.70

Requires for treatment per 1,000 gallons—2.56 lbs. hydrated lime @ 8c	$2.048
1.91 lbs. soda @ 2c	3.82
Cost treatment per 1,000 gals.	$5.868

In terms of calcium carbonate, it has a total of 20.79 grains per gallon.

Compare with this, the water from a well at Lafayette, Indiana:

Substance	Grains per Gal.
Calcium bicarbonate	22.10
Magnesium bicarbonate	9.76
Magnesium sulphate	.44
Sodium sulphate	3.04
Sodium chloride	1.30
Aluminum oxide	.20
Iron oxide	.18
Silica	.89
Carbon dioxide	1.00

Requires for treatment per 1,000 * gallons—3.47 lbs. hydrated lime @ 8c	$2.776
.06 lbs. soda @ 2c	.12
Cost treatment per 1,000 gals.	$2.896

In terms of calcium carbonate, it has a total hardness of 20.57.

Here then we have two waters, one 20.79 grains hard, the other 20.57 grains hard. It will be noted, however, that a relatively large part of the hardness in the first water is sulphate hardness, while the hardness of the second water is mainly carbonate hardness. The first water will require 2.56 lbs. of lime and 1.91 lbs. of soda for treatment of each 1,000 gals. The second water will require 3.47 lbs. of lime and .06 lbs. of soda for each 1,000 gals. At $16 a ton for hydrated lime and $40 a ton for soda this would make the cost of treating the first water 5.868 cts. per 1,000 gals. and 2.896 cts. per 1,000 gals. on the second water, or in other words, with two waters of the same total hardness, the cost of chemicals to treat them may be twice as much in one instance as the other. With waters of greater hardness, the cost of treatment is proportionally greater. When estimating total cost of treatment by this method a fair amount to consider for treatment is a million gallons a day.

The cost of handling this amount of water aside from the cost of the chemicals but allowing for attendants to operate the plant, depreciation on the equipment, maintenance and power for operation will be close to 2 cts. per 1,000 gals. If we consider handling the more favorable of the two waters mentioned above we may expect then a cost of approximately 5 cts. per 1,000 gals. with an initial investment of $15,000 for the softening equipment when the plant is to be built to handle 1,000,000 gals. per day of 20 grain water in which the hardness is mainly temporary hardness.

made before stating a price show necessity of considering local conditions before an exact cost can be determined. The prospect outlined shows that the cost is not so great but that when the advantages of soft water become more fully appreciated we may expect to see a great development along this line. The lime-soda treatment will leave the water in an alkaline condition which is objectionable in taste to some people. This feature can, however, be eliminated by the addition of neutralizing chemicals after the softening is completed.

The many conditions which must be

Cost of Treatment

The cost of treating a water in this manner is thus not prohibitive. The exact cost will vary with local conditions but an approximation from figures at hand may be made as follows. A city of 6,000 inhabitants using on an average of 160 gals. of water per capita per day might be rated as using 1,000,000 gals. of water per day. A lime-soda water softener complete with chemical tanks to add the necessary chemicals, of sufficient size to allow ample settling space and with a filter which with proper handling will deliver a clear, softened water free from objectionable taste can be built for not more than $15,000.

ECONOMIES OF THE BOILER ROOM

By John M. Drabell, Mechanical and Electrical Engineer, Iowa Railway and Light Co., Cedar Rapids, Iowa.

It is my intention to sketch, briefly, some of the things that can be done in every boiler plant in order to better its operation and economies. Boilers in general divide themselves into two classes; water tube, in which the water is contained inside the tube and the gases from the furnace pass over the outside of the tube and the horizontal return tubular boiler in which the water surrounds the tube and the hot furnace gases are exposed to the shell of the boiler and also pass through these tubes, or flues as they are called. In discussing economies that can be effected, the writer will point out at different times the relative effects of different conditions on each type of boiler.

In the design of a great many power plants, both very small and very large, the boiler room has not received the attention that it should have received, with the result that it has not been a particularly desirable place to work and a great many operators of power plants have been too prone to consider that any old kind of labor was good enough for the boiler room, that all it required was a strong back and a weak mind, and that if the man could merely shovel in a large quantity of coal during the working hours, he was a good fireman.

Ventilation, light, fresh-air, lockers, and washing facilities for the men cost but little and go a long way toward raising the morale of the boiler room force. A clean, light, airy boiler room will attract good men, whereas a dirty, dark hole in the ground will attract no one who can get a job anywhere else, so if you want to build up the efficiency of the boiler plant, first provide some decent working conditions for the men and an attractive wage. A fireman can waste in one day in a power plant his entire month's wage, so pay somewhat more than common labor's wages and you will start to bring about the desired results.

Causes of Losses

What are the losses that occur in a boiler plant? They may be enumerated as follows:

Dirt

Both inside and out on boiler tubes: Accumulation of scale on boiler shells and drums. This is indicated by a high flue gas temperature and also can be readily observed by even the slightest inspection.

Air Leaks in Boiler Settings

Too much attention cannot be paid to cracks in boiler settings and as soon as one is noted, it should be immediately plastered up. There are many good makes of plastic compound carried on the market for sealing up boiler settings and maintaining them permanently tight.

Ash Pits

On stoker fired boilers, the ash pits and doors must be as tight as the settings for if not, air will leak in and cause a loss in efficiency. On hand-fired boilers, the ash pit doors should be removed as there is a tendency for the firemen to attempt to regulate the amount of steam the boiler is developing by opening and closing these doors, whereas they should use the damper provided in the up-take from the boiler. There is no quicker way of wasting a large amount of fuel than attempting to regulate the steam pressure by opening ash pit doors on hand-fired boilers.

Baffle Walls

In the water tube type of boiler, the flow of gases from the furnace to the breeching is direct by a series of baffles constructed of fire proof material. In removing tubes, and in the normal use of the boiler, these baffles oftentimes become broken and leaky, consequently the gases "short circuit" or do not complete their full path and travel giving high flue gas temperature at the up-take of the boiler and a consequently high loss in boiler efficiency.

Bridge Walls

On water tube boilers, the bridge wall should be carefully maintained, especially at the point where it comes in contact with the first directing baffle, or as it is known to the boiler room force, the first pass. On hand-fired return tubular boilers it was the practice in the past to build the bridge wall up very close to the shell of the boiler on the theory that the flame from the fire would thereby impinge on the boiler surface and give a much better evaporation. This old worn-out theory has been completely done away with. It is found that the relatively cold surface of the boiler chills the gases to a point where they will not again reignite. On the properties of the Iowa Railway and Light Company, this bridge wall is only high enough to keep the coal from falling from the grate over into the combustion chamber.

Careless Firing

This divides itself up into many different phases. With stoker fired boilers the tendency of the firemen is usually to run several short fires rather than two good long full fires on a three-boiler plant and use the third boiler merely for regulating purposes. Owing to the nature of the chain grate stoker a large amount of air enters the furnace from the uncovered portion of the grate causing a very serious loss in efficiency. On hand-fired boilers, the one-shovel method of firing is the best, but the most difficult really to put into effect. The tendency of a fireman is to fill up a furnace and then sit down. This means a large quantity of green fire introduced into the fire and consequently heavy black smoke indicating that a large amount of unconsumed gases are passing out of the boiler into the stack. I know of one case in a railroad shop where a gang of Greeks were employed as firemen and a rather ingenious master mechanic fixed up a clock which closed a contact, ringing a bell and flashing a red light every 20 minutes. When the bell began to ring and the light to burn, the Greeks all opened the fire doors and proceeded to fill them up. As soon as they had shoveled all the fire boxes would hold, they then sat down and enjoyed a little rest and visit. This was about the most wasteful boiler plant practice that I have ever seen. The banking of boilers also comes under the head of careless firing and it is very difficult to lay down any rule for this. It is simply a case of getting the men interested and seeing just what is the minimum amount of coal that they can bank a boiler with. Fires very clearly show that it is a case of individual effort rather than any hard and fast rule.

Feed Water Temperatures

One of the most common losses in the boiler plant is the failure to maintain proper feed water temperatures. These temperatures can be kept up by keeping the proper amount of steam auxiliaries running around the plant so as to supply sufficient steam to the feed water heater and then at the same time the heater must be kept clean. For example if feed water has been heated to 200 deg. F. each pound of water delivered to the boilers as received is 200 B. T. U. more heat than pumped into the boiler at the average temperature of 60 deg. F., assuming that the boiler pressure is 125 lbs. per square inch. The heat required to make a pound of steam from the original temperature of 60 deg. is 1164 B. T. U., therefore we have saved 200 plus 1164, or 17 per cent of the heat that would have been required for the generation of steam from 60 deg. water and thus the saving directly reflected in a corresponding reduction in the coal consumed. An approximate rule is that 1 per cent of the coal is saved for each 11 deg. rise in the feed water temperature, provided this is accomplished by heat that otherwise would have been wasted or thrown away.

Methods of Building Up Efficiency

I have discussed at some length the various losses and will now give some of the methods outside of better working conditions, that can be applied to building up the efficiency of the boiler plant. Boiler plants should be provided, if water tube, with a first-class high grade tube cleaner and of such a diameter that it will just pass into the tube, otherwise careless workmen will not properly clean the tube if the cleaner is of small diameter and will leave a considerable amount of scale. For cleaning the outside tube surface of a boiler, a very successful method has been developed by the Iowa Railway and Light Company which consists, when the boiler is down for cleaning, of taking an ordinary garden hose and nozzle and spraying water over the outside tube surface. The garden hose nozzle should be so regulated that the water comes out of it in a fine spray or mist. This will pass down through the boiler and soften up the accumulated soot and scale, and at the end of 24 hours, it can be easily knocked off. In cleaning return tubular boilers, a good type of hammer cleaner should be provided and some form of a steam jet soot blower.

The soot blower problem has been quite well worked out particularly for water tube boilers. The soot blower is about one of the cheapest efficiency devices that can be provided. It is, however, necessary to see that they are used regularly on each 8-hour shift and kept in proper repair.

For stopping leaks in settings, a good form of plastic cement should be applied and it has been found very desirable and has been standardized by the Iowa Railway and Light Company, a covering of Johns-Manville cement No. 400, 1½ ins. thick over all of the brick work of the boiler. We have found by actual test that this plastering increases the efficiency of the boiler and cuts down the air leakage giving us a high CO^2 content to the flue gases.

A regular and careful inspection should be made of the ash pit and ash pit doors as before mentioned and whenever a boiler is taken out of service, these pits should be thoroughly inspected.

Dampers

For regulating the boiler, a damper in the uptake flue should be provided. Under no circumstances should the firemen be permitted to regulate by means of the ash pit doors.

Baffle Walls

These should be regularly inspected, using a strong high power electric light in the combustion chamber so that any leaks or cracks can be readily detected by the light shining through. High temperature cement should be applied such as Johns-Manville No. 26 or high tempite for stopping these cracks and leaks.

Arches

Arches on chain grate stokers have received a great deal of attention in the last 18 months and much has been accomplished in its design. In general it may be stated that it is impossible satisfactorily and economically to burn Iowa coal except with a high angle arch. The "sprung" arch, originally introduced into this state, flat and laying down on top of the fire, served but one purpose, that of putting the fire out. In the various power plants of the Iowa Railway and Light Company we have standardized on a 7-ft. arch, having a pitch of 2½ ins. to the foot and setting 13 ft. above the grate at the feed gate end of the stoker. This seems to give the most satisfactory results.

Feed Water Temperatures

In practically every state institution a large amount of steam is used for cooking and heating purposes. The use of steam in the engines of the electric plant is generally a small proportion of the total amount of steam generated by the boiler plant. It is of very great importance, therefore, that all of these drips be so piped up that all of this water is returned to the boiler plant to a hotwell or surge tank so that it can be pumped into the feed water. This water contains a very large amount of heat and besides it is condensed steam and free from scale, whereas raw water taken from wells or rivers is not. It is therefore of great importance that these drips be all returned to the boilers.

From now on the writer will mention certain percentages of fuel saved. These percentages are in weights of coal and not in dollars and cents, for unfortunately in spite of everything that could be done with improved appliances and methods, the coal men have been able to mark up the percentage of price increase faster than automatic devices could bring down the utmost cost, and it should be remembered that these percentages apply to weights of coal and not the cost of coal in dollars.

Boiler Room Appliances

There are many devices on the market, good, bad and indifferent, offered for sale for the purpose of producing economies in boiler room operation. The following named instruments are really commercial, reliable and thoroughly practicable and are named in the order of their importance:

Recording pressure gauge.

Recording thermometers for feed water temperatures.

Draft gauges.

Flow Meters

First for metering the amount of water going into the boilers, and if a further refinement is desired, the boiler flow meter can also be used. This gives an indication of horse power of what each boiler is doing.

Scales for Weighing Coal

With a water meter and weight of coal known, the evaporation, which is the measure of efficiency of the boiler plant, can be readily determined from day to day. This is of the utmost importance.

Automatic Feed Water Regulators

This involves two regulating devices, first the automatic regulator on the boiler for feed water into the boiler as it is needed. The Iowa Railway and Light Company have 47 Copes automatic feed water regulators in daily service and giving excellent satisfaction. These devices we know have reduced our coal consumption from 2 to 5 per cent in the various stations over hand-regulation of boiler feed water. In order, however, to make this device operate satisfactorily, it is necessary to employ on the boiler feed pump a device known as an excess pressure boiler feed line regulator. The function of this valve is to maintain a constant differential pressure between the steam pressure in the boiler and the water pressure in the feed lines, thereby maintaining a constant hydraulic head across the valve of the automatic regulator. Unless this is done, results with the automatic feed water regulator can be even poorer than hand regulation.

Damper Regulators

The damper regulator is a very successful operating device, operated by steam pressure from the boiler which opens and closes the damper in the up-take as the steam pressure in the boiler varies which in turn is a measure of the demand upon boiler plants. There are many satisfactory forms of damper regulators. We have, on the Iowa Railway and Light Company standardized the Mason No. 8 automatic damper regulator.

In general it may be stated that stoker firing is applicable to plants of 200 horse power boilers and above. Below this the size of the stoker becomes so small that it is anything but economical and a good hand-fireman can give better results than the stoker. Above 200 horse power, however, it is difficult to get men to handle boilers by hand on account of the effort and work required in doing it with the result that the boilers are filled full of coal periodically and the fuel results are very poor. Furthermore, the automatic stoker is a means of reducing labor.

Coal and Ash Handling Plants

Another very fruitful source of labor wasted around power plants, is due to improperly designed coal and ash handling systems. Too much attention and consideration cannot be given to this problem in both old plants and new plants that may some day be built.

The foregoing matter is from a paper by Mr. Drabel in a recent issue of the Iowa Bulletin of State Institutions.

MAXIMUM DEMAND CONTROLLER FOR LARGE WATER CONSUMERS

By E. C. Mayer, of Geo. H. Gibson Co., Consulting Engineers, Tribune Bldg., New York, N. Y.

Some water supply systems are required to furnish an adequate minimum pressure for fire protection. If they also have one or more large consumers, whose demands are so great as to equal nearly the pipe line capacity, the pressure available for other purposes may be reduced seriously.

This condition is graphically represented by Fig. 1, wherein the pressures at communities A and B are at times too low because the large water consumer at the end of the line is drawing full pipe capacity.

The pipe line can, however, furnish the full amount needed by the large consumer without affecting the pressures at A and B if the large quantity of water be delivered at a reasonable rate. For this purpose, a maximum demand or rate of flow controller, made by the Simplex Valve & Meter Company, Philadelphia, and illustrated in Fig. 2, has been developed. It prevents the drop in pressure due to excessive peak demands on the water supply line.

When the controller is installed, the minimum hydraulic gradient experienced is represented by the upper gradient line in Fig. 1.

The maximum demand controller remains open at the predetermined setting until the rate of flow reaches the prescribed maximum. From this point on, the opening of the controller is just sufficient to permit the specified rate of flow, and no more, to take place.

The controller can be by-passed in case of an emergency, and the line permitted to deliver its full capacity. Two maximum demand controllers can be arranged in parallel, each one carrying half of the full amount of flow. Either of the two controllers may be used separately to supply the demand.

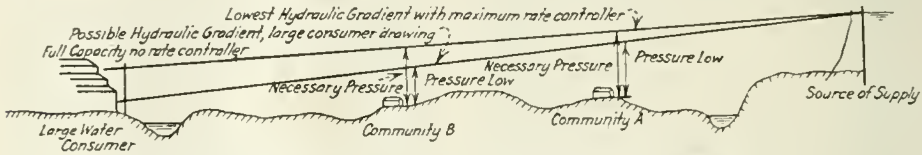


FIG. 1—HYDRAULIC GRADIENT IN A WATER SUPPLY SYSTEM BOTH WITH AND WITHOUT A MAXIMUM DEMAND CONTROLLER INSTALLED.

The principle of operation of the maximum demand controller is readily understood by referring to Fig. 2. Briefly, it consists of a Venturi Tube with the discharge flange connected to a valve body provided with a double-disk-type balanced valve. The valve stem is guided in the upper and lower covers, engages a diaphragm near the bottom of the valve

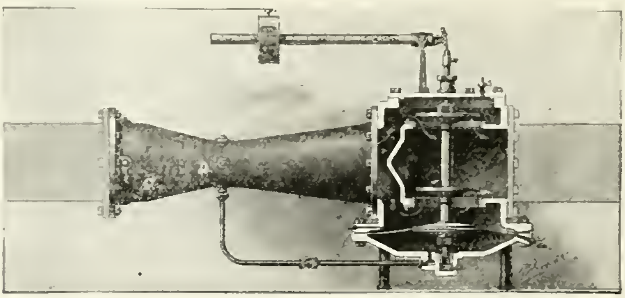


FIG. 2—SECTIONAL VIEW OF THE SIMPLEX MAXIMUM DEMAND CONTROLLER.

body, and at the top is attached through a flexible connection to the short arm of a lever or scale beam.

For any given rate of flow, there exists a certain difference between the water pressure in the valve body and that in the throat of the Venturi tube, due to the difference between velocities at these points. The downward pressure on top of the diaphragm is greater than the upward pressure below, and for this reason there is transmitted to the short arm of the scale beam a downward pull that is balanced by the counter-weight on the longer arm of the scale beam. This balance of the counter-weight and diaphragm load limits the maximum rate of discharge through the controller. This fact is obvious, since, if the rate of flow should momentarily increase beyond the allowable maximum, the diaphragm load would also increase, thus diminishing the valve opening until the balance is automatically restored.

Altering the position of the counter-weight on the longer beam arm changes the maximum permissible rate of flow.

The maximum demand meter illustrated employs a Venturi Tube which can also be used in connection with a metering device for purposes of indicating, recording, or registering the flow.

WATER WORKS REPORTS AND WHAT THEY SHOULD CONTAIN

By Robert E. McDonnell, of Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo.

Some water works superintendents, and occasionally city officials, may question the value of a water works report and doubt if its cost is money well spent. The answer to this question is simple. It depends upon the report.

One of my favorite indoor sports is to examine water works reports; the good ones being read with much interest and filed for frequent reference and the bad ones being consigned to the waste basket.

Water works reports reflect exactly what the superintendent or manager is. Invariably a good superintendent issues a good report. When one examines, as I have recently, a report that contained page after page of fire hydrant locations, and another report where pages were devoted to statistics 15 to 20 years old, it doesn't require an efficiency expert to figure out the loss and waste of time and money by issuing such a document. The printer's proofreader was probably the only person who read the entire document. My criticism of water works reports comes from reading them and, therefore, from the standpoint of the consumer, I am going to mention briefly a few features of reports that have made them especially interesting to me.

Why Should a Report Be Made?

A water plant is one of the chief assets of a city; in value it ranks well toward the top of all the city investments, whether owned by the city or company. The success and continued operation of all other industries, factories, etc., are dependent entirely upon the water works. The health, growth and prosperity of the city are entirely dependent upon the purity and cleanliness of its water supply. Its customers extend over the entire city; its commodity is standardized and is of one quality. When city owned, every citizen of the town is a stockholder and, therefore, a report to the public is due; and the public, further, has a right to demand a real water works report in keeping with the importance of the utility.

Appearanee of Report

Reports, like people, are often judged by appearances and, therefore, it should have an attractive cover and be of a good quality of paper and printing. Like a girl's skirt, it should be long enough to cover the subject, yet short enough to be interesting. The pictures accompanying a magazine article always produce a desire to read the article and photographs and cuts should be freely used to relieve the monotony in text and statistics.

What It Should Contain

A brief historical sketch, giving date of purchase or date when built and the present value of the property, is always of interest to new customers.

Statistics themselves are rarely read by the layman and these should be converted into graphical diagrams, which are understood at a glance.

A concise tabulation of operating costs, annual revenue, fuel costs, increase in number of connections, etc., shown both by figures and graphical charts, are always interesting and these should not cover more than a ten-year period, as old statistics are of little interest or value.

A population curve and water consumption curve are always well worth the making, as it shows what future provision for growth should be made.

A plain statement from health authorities regarding purity of water, with percentage of bacteria removed, with cuts or illustrations of bacterial comparison of raw water and treated water, is the best kind of advertising a report can contain, for one must not forget that his business is selling water and the reports help sell the customer. People always like to know how their money is spent and a graphical diagram showing what part of a dollar goes for interest, labor, fuel and operation, is enlightening.

Illustrations showing losses by leaky faucets, bad plumbing and unregulated flush tanks or sewers, are helpful in bringing about reforms. Showing customers how much their own bills could be reduced by eliminating all wastage, is convincing.

The reduced pumpage, reduced fuel or power bills and increased revenue by universal meter system are features that can and should be shown in every water works report, for even in this enlightened day we find a few communities who still sell, or rather give water away, without meter measurement.

The city, corporation or individual doesn't exist that can make a success of selling any commodity without measurement of the amount sold. The report should show or account for the loss between water delivered and water sold, and if this doesn't show a yearly improvement, something is radically wrong and needs correction.

A water works plant is never finished or completed and the needed extensions, betterments and improvements ought always be prominently shown in a report, then there are no shocks or surprises, and if bonds are needed there is nothing gained by concealing the fact. Show in the report why the improvements are needed and what advantages and results will be gained by them.

Every report ought to show the cost of delivering water per 1,000 gals., including interest, depreciation, sinking fund reserve, etc. This information is not always known by the superintendent himself and when he figures it out, he will, in many towns, find that large users, railroads especially, are getting their water at less than its cost of production. When one glances at his own railroad and Pullman expenses these times, it causes the reflection that railroads ought to have sufficient funds available at least to pay for the cost of furnishing water. In these days of regulation of rates, one cardinal law acknowledged by all is that the rates of each utility, whether a water plant, light plant, or railroad, should be based on its value and cost of operation. The railroads or other large users are not institutions, with rates made because of their being a special aid or help to a town. Every report should show what the rates should be to earn this interest, depreciation and operating expenses.

Value of a Report

A report is of much advertising value to the entire community, so much so that many commercial clubs are joining in the expense of printing and circulating water works reports. Every live water works superintendent knows the advertising value to himself of getting out a good report. It places him in a favorable light before many other communities, where opportunities for advancement exist.

The educational value is of greatest importance. It acts as an aid in getting bonds for needed improvements, as a basis for argument for equalizing rates or in securing a raise of rates it is of much value.

How Presented

A report to be of any value must be interesting, for if not interesting it will never be read. The author of the report or some water works official should personally present a resume of his report before every civic organization of the town, not omitting the women's clubs.

In Glasgow, Scotland, which city prides itself on being the best governed city in the world, the head of each utility or department is required to give at a mass meeting a public accounting of his utility. For example, the water department head gives the workings of the department, its needs, etc. I listened one night to an address by Thosmas Melvin, manager of the sewerage department, on the subject of "The Cleansing of the Clyde River." He told how the Clyde River had been transformed from a foul sewer-like stream to a beautiful river, abounding in fish and lined with house boats. The lecture, or really his report, was illustrated with slides and was of much interest. These reports, thus presented, kept before the public their needs and caused a keen interest in their own utilities. Extracts from reports are desired by the local papers and should be given them. Send each customer one by the meter reader, or hand them out by the window collector. Exchange your reports with the officials of other cities of your state.

The water works plant is the chief asset of the city, but the lack of general

knowledge concerning it is a fault we can largely correct by getting out and presenting a genuinely interesting report. Whether it pays or not depends on the report and its presentation.

The foregoing paper by Mr. McDonnell was presented at the 1921 meeting of the Southwest Water Works Association.

MEASURING DEPTH TO WATER IN WELL

To the Editor:

I note on p. 195 of your May, 1921, issue, description of apparatus for measuring deep well, by Lawrence W. Cox, of Des Moines, Iowa, which he developed in 1915.

I am sending herewith description of apparatus which I have used since 1911 or 1912. We have used this tester on depths as high as 300 ft., where a space of about 1 in. between the drop pipe and the well was available.

Thought you would be interested in knowing about this, as it antedates the one described in your May issue.

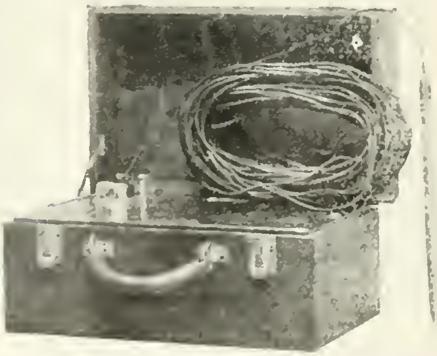
Very truly yours,
CHARLES BROSSMAN,
Consulting Engineer.
Merchants Bank Bldg.,
Indianapolis, Ind., May 31, 1921.

The apparatus to which Mr. Brossman makes reference is herewith illustrated and described:

The Well Tester

The instrument is used to find the level of water in deep wells. It can be used to measure the depth of water below the surface while pumping or while running tests or to measure the static head in the well.

In making tests of deep well pumps it

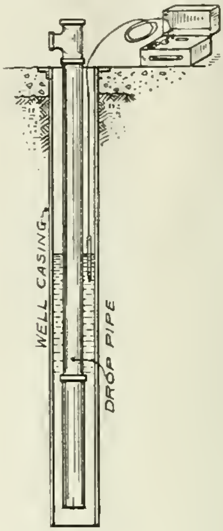


INSTRUMENT TO MEASURE DEPTH TO WATER IN WELL.

enables one to know exactly where the water stands in the well for any quantity pumped. It enables one to keep track of the condition of wells and strainers by showing the level of water. Good wells are often discarded because their condition is not known.

How the Well Tester Is Used

The contact tube is lowered into the well between the drop pipe and well cas-



SKETCH ILLUSTRATING USE OF WELL TESTER.

ing. On being immersed in the water the buzzer on the battery box will be thrown into circuit. There should be 11/16 in. space between the drop pipe and outside of well. As the water lowers in the well the tester is also lowered to maintain contact with the water.

WHAT HAPPENED IN A "ONE MAN" WATER PLANT

By J. F. Christy, Manager City Water and Light Plant, 106 W. Washington Ave., Jonesboro, Arkansas.

(Editor's Note.—The following useful illustration of the unwisdom of a too highly centralized utility operating organization is from a paper by Mr. Christy before the Southwestern Water Works Association.)

There was once a man who had direct charge (as chief engineer) of the operation of a reasonably large water works plant; he was an excellent fellow personally and was very well posted; he had acquired his knowledge by hard knocks

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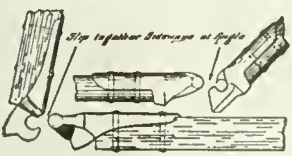

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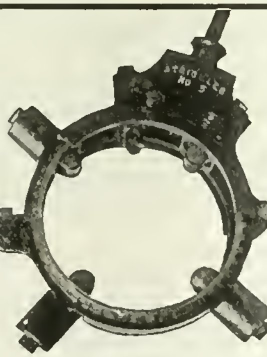

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and long experience. The men under him were apparently competent and his production cost seemed to be satisfactory to his superiors.

Only by intimate association and close observation was it discovered that here was a case of one man endeavoring to attend to all the details in connection with the plant operation. No one about the power house had the slightest authority, excepting himself; he required the night crew to report to him as well as those who worked in the day time. He learned thoroughly the operating characteristics of each new piece of equipment as it was installed, and understood his older machines as a mother does her child, but he never imparted any of his knowledge to his men. He wanted to be supreme in authority, he wanted to be called upon to straighten out things in times of trouble; he prided himself upon being called out, at all hours of the night, to correct mistakes, to remedy accidents, or to repair trouble that any properly instructed operator should have avoided, or at least taken care of without assistance.

This man had the mistaken idea that so long as he himself understood his plant thoroughly all would be well.

Each year when this chief engineer took his vacation, the plant operation was supervised by an assistant engineer. It so happened, on one occasion, that an accident occurred which should not have resulted seriously; but in consequence of the ignorance of the operator who was on duty at the time (and who had not his chief to call upon) a mistake was made which brought about a catastrophe that cost the company thousands of dollars to say nothing of the lost revenue and inconvenienced patrons.

As soon as normal conditions were restored, the supervising engineer instituted an investigation to determine the cause of the calamity. He soon discovered that lack of sufficient knowledge alone, on the part of the operator, had been the direct cause, and much to his surprise he found that none of the other operators was any better informed.

When his report of the disaster with its inexecusable cause and other findings was noted to his superiors an upheaval resulted. The young supervising engineer was put in charge of the power plant and the old chief, upon his return, was relieved of his duties forthwith.

The new chief immediately proceeded to instruct his men; every man was placed in the position for which he was best suited and soon learned all there was to know about his work. Up to the present time, after several years have elapsed, there has been not the slightest kind of a shut down and no serious trouble in that plant. The young chief has his men well trained now and devotes only a small portion of his time to the plant operation; in fact, he is also maintaining most of his former work in the engineering department. By properly instructing and training his operators, he greatly increased their efficiency, and has materially reduced production costs.

WATER PURIFICATION FOR TOWNS ON TIDAL RIVERS

The method by which Uncle Sam, acting through the U. S. Public Health Service, purifies the drinking water for his model village and reservation at Perryville, Md., though not altogether new, carries some interesting lessons for the country at large and particularly for towns situated along tidal rivers.

The raw water, which is pumped from the Susquehanna River through 30-in. mains to settling tanks, is subject to rapid changes in turbidity ranging from 10 to 100 parts per million; and the amount of aluminum sulphate to be added as a coagulant and precipitant must be varied to suit. Samples of the water entering the mains are taken every two hours; and the amount of coagulant to be added is determined by the chart based on the amount of water and its turbidity; for instance 0.6 grain of the alum is added for 10 parts per million of turbidity. This amount, however, is also governed by the alkalinity, which may vary greatly during the day; when it drops below 14 parts per million, soda ash is added.

Two hours are allowed for settlement in the tanks, after which the water flows by gravity through mechanical rapid sand filters, passing through 3 ft. of sand and 8 ins. of stone and gravel at the rate of 2 ins. in 55 seconds. Later the water is treated with liquid chlorine, the amount depending on bacteriological examination of the raw and the chlorinated water. This treatment reduces the bacteria from an average of 2,630 (maximum 7,860) per cubic centimeter to less than one.

The condition of the water at Perryville is affected by the geological formation of the country, by the daily conflict of the tide and the river current, and by the strong winds which often cause terrific wind action on the low flats, all of which necessitate very effective treatment.

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Construction News and Equipment

ECONOMIC CHOICE OF ROAD CONSTRUCTION PLANT UNITS AND LAYOUTS

By B. H. Piepmeier, Engineer of Construction, Illinois Division of Highways, State House, Springfield, Ill.

Successful road work offers more possibilities for different types of plants than perhaps any other single line of building construction, and every section of road to be built is a field for intensive study and investigation by the engineer and contractor. A thorough examination of the road plants in operation for the past few years shows clearly the need of more careful study of plant problems than is ordinarily given by engineer or contractor.

Past Conditions Favorable to Small Plants

In general, the building of a system of roads requires the installation of a number of small plants in preference to a few large plants. This has been particularly true in the past on account of (1) the contractor's inability to secure experienced and capable superintendents for handling large-plant operations; (2) railroad transportation falling short in the delivery of sufficient materials to keep large plants working efficiently; and (3) frequent breaking of the machinery required in large road-construction plants—the break-down of one machine very often delaying the entire plant operations and causing undue expense.

The small construction unit necessitates doing many operations by hand at somewhat greater expense than if done with machinery; however, when the final analysis is made, the small unit will show considerable efficiency on account of the possibility of its operating many times independent of any one particular machine out of service through breakdown.

Normal Conditions Favorable to Large Plants

Conditions existing during the past few years have made it impossible for the contractor with a large plant layout to show a fair profit. As soon as labor and transportation conditions become more stabilized, the large plant will show a much greater efficiency.

Often Economical to Duplicate Machines

Contractors must give considerably more thought to the design of road plant so that its successful operation may not be wholly dependent upon one piece of machinery. Many successful road contractors realize already that to insure a constant and uniform output, it is economy in many instances to duplicate machines. Some contractors have installed a duplicate pumping system for the water supply, which is vital to the successful and economical operation of the road plant, and the additional cost of the duplicate unit is small compared to the advantage of being able to operate the plant without a delay.

In many instances duplicating concrete mixers has prevented a complete shutdown of operations. The average road job may not always justify a duplication of the mechanical units, but where a large season's work is required, a serious investigation of the advantage of the duplicate units should be made.

Transportation Problem in Road Building

The transportation problem in road building is one of the most important factors in the economical construction of roads. Consequently this part of the plant operation should be given a great deal of study. The transportation cost should not only be estimated on the basis of the ton-mile cost but the effect it may have on the cost of operation of the remainder of the construction plant should be taken into consideration. Hauling cost varies from 20 to 40 cts. per ton-mile. In a season's work a saving, therefore, of but a few cents per ton-mile may amount to several thousand dollars. The actual hauling costs may be exceedingly low, yet if the delivery affects the maximum output of the remainder of the plant, the inefficiency of the plant should naturally be charged against the transportation cost.

Industrial Railway or Truck

Inasmuch as most specifications now prohibit storing road materials upon the subgrade, the road contractor is compelled to provide for transportation in one of two ways. He must deliver ma-

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terials from his material yard to the road by industrial railroad equipment or by truck. The industrial equipment, while expensive in first cost, will enable the contractor to complete his work with a minimum amount of trouble under normal conditions and regardless of weather. The average industrial equipment will insure a more uniform delivery of materials than any other unit that may be used. The chief objection to the industrial unit is that it is limited to road construction with grades ordinarily less than 4 per cent and a minimum number of railroad crossings. Further objection would be that the high initial cost demands a large mileage of roads be built each year in order to absorb the interest on the investment and the depreciation.

The other method of delivery is by truck or team. In recent years truck delivery has superseded team delivery, being more rapid and delivering material to a paving mixer or from a mixer direct to the road with less disturbance to the road-bed. Truck transportation of road materials is very flexible and therefore suited to more different sections of work than perhaps any other method of transportation. It is especially suited to the delivery of mixed concrete from a central plant to the road being improved, and to the delivery of proportioned batches direct to the paving mixer or to a point at which the batch boxes may be transferred to a short industrial line which in turn delivers them to the paving mixer.

Delivery of Mixed Concrete

During the past few years the delivery of mixed concrete from a central mixing plant direct to the job has been attracting considerable attention. This method is worthy of study, as it enables the contractor to centralize operations and in many instances to economize in plant and operating expenses. The central mixing plant should be reasonably uniform in design and simple in operation. A study of the central mixing plants in use during the past two years shows no two very similar in design. It would seem possible that unloading aggregate and cement from railroad cars, mixing the materials to the desired proportions and consistency and turning out a mixed concrete, could be standardized to such an extent that central plants could be simplified and made more economical in operation. It is hoped that the mechanical engineer and the equipment designer will assist in the design of a practical and economical central-mixing-plant unit.

Although central mixing plants may be fairly uniform in design, the delivery of the concrete from the plant to the road will vary considerably to suit the existing local conditions. Mixed concrete may be delivered by industrial equipment, provided the hauls are reasonably short and the equipment is designed for small loads with considerable speed in transportation. The small pneumatic-tired truck will usually prove the most efficient machine for delivery of mixed concrete, taking the individual batch of mixed concrete direct from the mixer to the road being improved in the least possible time here.

The Pneumatic-Tired Truck

The pneumatic-tired truck is essential when speed is an important factor in delivery and where it is necessary to do considerable hauling over the subgrade. This truck will usually reduce the load on the subgrade to less than 125 lbs. per sq. in. of surface, and it has been found that this pressure, even though frequently applied, does not seriously injure or displace a prepared subgrade having average soil conditions.

It is true that it is practically impossible to deliver materials over earth roads with trucks when the roads are muddy or during rainy periods. However, the road may be materially improved and the truck used practically the entire construction season if the road is constantly maintained by the use of the road drag and given an application of half a gallon of oil per square yard surface early in the construction season.

The light pneumatic-tired truck may also be used for the delivery of proportioned batches of aggregates direct to the paving mixer on the road being improved. There are now on the market many types of batch boxes and dump bodies which permit the batches to be dumped directly into the skip of the paving mixer. This method has proved to be very satisfactory. It differs from the delivery of mixed concrete in that a paving mixer is used instead of a stationary building mixer, and most of the operations of the contractor are out on the job where the road is actually being laid.

It seems possible that a very material improvement can be made in the present railroad transportation equipment. Practically all road contractors now unload aggregates from open-top cars by means of clam shells. This method is not always the most economical, but the contractor is forced to use it, as he cannot secure all hopper-bottom cars he might desire. On account of the large

"Old Bess Needs No Sleep!"

OUT in the Sacramento Valley of California four P & H Excavator-Cranes working 24 hours a day digging irrigation and drainage ditches, sunk into four to six inches of water, handled as much as 22,000 yards of dirt a month.

In the south San Joaquin Irrigation District, near Manteca, two P & H Excavators dug and cleared the ditches. Merced County used them for unloading crushed rock and gravel from cars for the county highways.

A. E. Conell, county engineer, Livingston, unloaded eight cars of rock and sand in a day, stock piles along the track.

All the levees and filling walls for the flood control project at Long Beach was accomplished by the United Dredging Co. through a P & H "Old Bess" (as this reliable excavating, handling, and power crane is often called), tore up the old concrete roads, graded, made cuts and fills, built approaches to new bridges, working continuously day and night, month after month. It earned its cost many times over on this one job alone.

Peter Ferry, constructing a highway at Harbor City, California, used a P & H in a similar manner. First, "Old Bess" graded, built approaches, cut and filled. When surfacing was started, she was run to the siding to unload rock and sand from cars to bunkers. Measured batches were lifted from trucks to paver later.

The Los Angeles County Flood Control District is also using a P & H to complete the canals and laterals to take off the flood waters.

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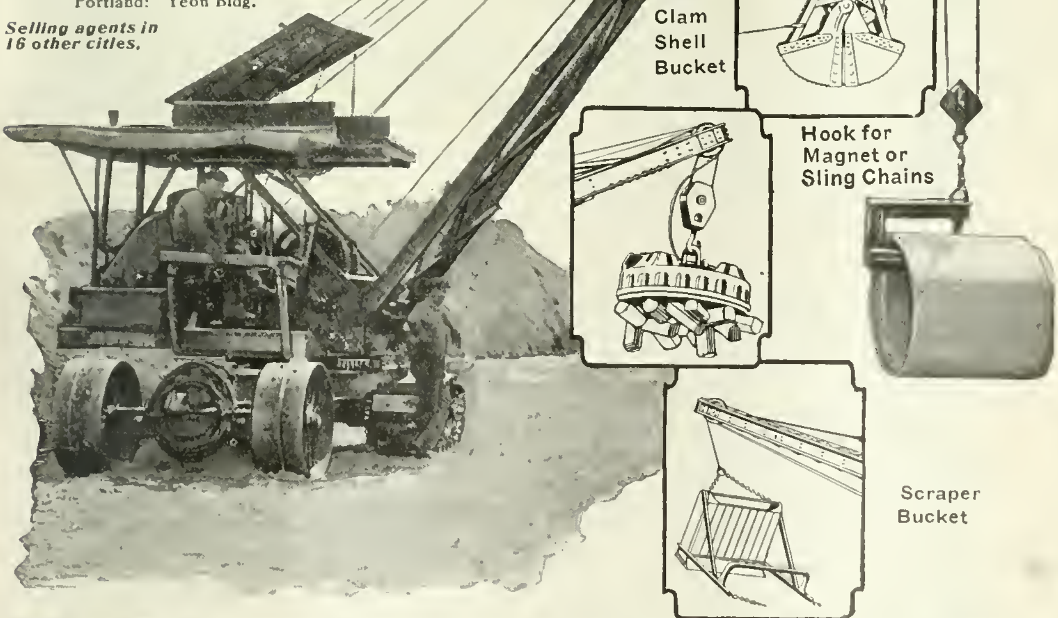

P&H EXCAVATOR-CRANE

volume of road materials to be delivered by railroad cars, some type of car should be designed that would permit of more rapid unloading by more economical methods. If this is not done, it is hoped at least that open-top car manufacturers will improve the design of their cars and make them so that they can be more easily unloaded with clam-shell equipment. Not only would such improvement aid the individual unloading the car, but the railroad company would add to the life of its equipment.

Many open-top cars are now designed with projecting angles, rivets, bolts, braces, timbers, etc., which interfere with the efficient operation of the clam shell. It is difficult to understand why railroad cars could not be designed so that the interior of the car would be perfectly smooth. In fact, it would be practicable and economical for all open-top cars to be built with a fillet having a radius of about 18 ins. in the bottom angle at the end of the car. The curved bottom angles would permit the cars to be emptied more rapidly and economically either with hand shovels or clam shells.

Further investigation should also be made of the use of open-top removable batch boxes for railroad transportation of materials. While the substitution of standardized batch boxes for open-top cars would be a very radical departure from present equipment, the average construction plant could be designed to handle the boxes much more economically than the loose materials.

The foregoing discussion is from a paper by Mr. Piepmeier before the Spring meeting of the American Society of Mechanical Engineers, May, 1921.

PLANNING AND ORGANIZING A ROAD CONSTRUCTION JOB

By C. D. Curtis, Assistant to Chief, U. S. Bureau of Highways, Washington, D. C.

While everyone will concede that all construction jobs should be carefully planned and well organized for the handling of materials, it must be admitted that this is not always done. In the past, too little thought and study have been given to this preliminary phase of the work. Until recently, however, road work has been handled on a comparatively small scale, and the cheaper types of construction prevailed. An extensive plant was not required and the evolution brought about by the general adoption of higher types of construction and the growth of construction programs is still under way. It is unfortunate, but nevertheless a fact, that most jobs are equipped without giving to their planning and organization a proper amount of careful study. As a result expected profits shrink and may even become actual losses.

Improperly Equipped Jobs

Improperly equipped jobs can be classified under three heads.

1. Too much plant.
2. Lack of plant, and
3. Unbalanced plant.

With too much plant on a job efficiency of operation is lowered, and although fairly satisfactory progress may be made the cost will be too high. Rental, or interest on investment and depreciation charges, continue regardless of output. On an underequipped job it is necesary to resort to labor which may be less efficient and more expensive. The progress of the work is likely to be delayed and total costs increased.

Of all the improperly equipped jobs the ones that have an unbalanced plant are probably most common. They are the inevitable result of equipping without planning. The several units making up the plant may be efficient mechanically, when considered alone but totally incapable of being worked smoothly and continuously together. On such jobs efficient operation cannot be secured. The plant investment might, and probably would, be higher than for a balanced plant. The season's profits, however, are certain to be lower than anticipated.

Road Jobs Classified

In my opinion a classification of road construction jobs based on the desirable and practicable rate of progress is feasible and would aid the contractor or engineer in selecting the proper plant. In determining on such a classification several factors would enter into the consideration, chief of which would be the size or length of the project. Another factor would be the problem of satisfactory detours and the probable economic loss to traffic.

The cost, of course, would be affected by the classification. Ordinarily a higher rate of progress would be required on a large job than on a small one. The extra cost then of assembling and operating a large plant capable of rapid progress would be spread over a large yardage. It might easily happen, however, that the economic conditions would warrant requiring very rapid progress on a comparatively small job. This would change

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the classification and increase the cost of the work, but the bidder would know just what to expect.

Suggested Classification of Concrete Road Jobs

In connection with concrete road jobs there might be three classes such as,

(A) Jobs on which equipment with a daily capacity of 1,000 ft. of 18 ft. roadway would be required.

(B) Jobs on which equipment with a daily capacity of 500 ft. of 18 ft. roadway would be required, and

(C) Jobs on which equipment with a daily capacity of 250 ft. of 18 ft. roadway would be required.

In the case of Class A jobs it would ordinarily be desirable to equip with at least two complete operating units. This would insure continued even though retarded progress in the event of a breakdown of one unit.

Such operations would, of course, be contingent on the weather and other conditions beyond the contractor's control, but the classification would give a more definite idea of the requirements and enable the engineer and all bidders to estimate on the same basis. The classification conditions should be covered fully in the specifications.

Influence of Specifications on Construction Plant

Unnecessary refinements in specifications which are met at times, usually lead to difficulties in operation and should in my opinion be avoided, especially where their enforcement increases the cost of operation for minor or questionable benefits. At the present time there are but few arbitrary requirements in specifications directly affecting the selection of equipment. There are, however, certain limitations which make necessary an intimate knowledge of the specifications under which work is to be performed. Examples of these limitations are:

1. Time limit on depositing of concrete after mixing. This limit would have a direct bearing on the location of central mixing plants and the equipment required for handling both the aggregate and the concrete.

2. Definite requirements relative to concrete mixers such as water measuring devices, boom and bottom dumping bucket, etc. Such requirements are small details but must be met and so must be considered in selecting equipment.

3. Materials for concrete not allowed on subgrade. This feature is very important and makes necessary a careful study of the project in the field. Several alternate methods of handling the materials may be possible and the most economical and efficient one can only be determined after a consideration of all the conditions.

One location might be well adapted to the use of industrial railway equipment, while in another location this method might be entirely impracticable and hauling of proportioned batches of aggregate and cement in trucks the most feasible. The central mixing plant method might be the proper selection in some other location. In the case of a large job conditions may vary considerably on different sections of the same job.

General Factors to Be Considered in Selecting Plant Units

In selecting equipment for a project, everything bearing on the situation should be considered. The source of materials to be used, whether local or imported, condition of roads to be hauled over, width of available right of way, trackage and storage facilities available at receiving points for materials requiring rail transportation, maximum grades, water supply, availability for common labor and teams, and length of working season are some of the factors which should be looked into and studied before deciding on the type of plant to be used.

In this connection the engineer may and should render all possible aid to the contractors. The preliminary investigations and detailed surveys made by the engineer give him much more information than the contractor can secure readily in his preliminary field inspection of the project. If the engineer knows that the conditions even though not apparent make the use of certain types of plant impracticable this information should be given to the contractor.

A feature which perhaps is not germane to this discussion, but which is very important and deserves a few words, is the desirability of considering the source of the materials to be used with respect to the possibility of continuous rail transportation service. Without a reasonable assurance of a continuous supply of materials throughout the working season an elaborate plant layout may become much more of a liability than an asset.

By arranging to ship and store materials, during the season of light demand for open top cars, for use during periods of car shortage a continuous supply of materials can be secured. Such an arrangement may considerably alter the selection of equipment for handling the material. Strong arguments may be made against the plan of advance storage of

materials in the states where estimates for materials delivered are now allowed, but the extra cost of storing materials may be more than offset by the gain due to continuous operation during the construction season.

It is desirable of course when possible, to avoid all unnecessary rehandling of materials. Where the materials can be unloaded from cars or loaded from the quarry or pit directly into containers for transportation to the job and in addition can be deposited in the mixer, in the case of concrete, without touching the ground, a great advantage is gained. In addition to being kept free from mixture with foreign matter, the item of waste is very greatly reduced.

Room for the Small Contractor

In some states, by adopting the practice of letting large contracts for long stretches of construction work, large contracting companies have been induced to enter the highway field. They have brought trained operating organizations to the work and have put extensive road building plants on their jobs. There is wisdom in such procedure whenever possible for, of necessity, a great many road jobs are and will continue, for a variety of reasons, to be of comparatively short length. Letting contracts in both large and small sections gives both the small and the large contractor a field of operation, and greatly expedites the carrying forward of a large program. The small contractor, acting as his own superintendent and operating with but little mechanical equipment, has but little overhead and can compete on a small job with the large contractor operating a large plant and carrying heavy overhead expenses.

Road building differs from most other construction activities in that the operations are conducted along an extended narrow path. The failure of one link may interrupt the work of a whole operating chain. This fact makes the present tendency toward the development of large individual units somewhat questionable in my opinion. When a large unit is used every precaution should be taken to insure its continuous operation.

Holding an Organization Together

One of the greatest handicaps which the road builder encounters in the northern states is the short construction season. Continuous operation is impossible and each season it is necessary to organize new construction forces. It takes some little time to organize a new outfit so that the work will proceed satisfactorily. In the case of the skilled mechanics and firemen an attempt should be made to retain their services the year around. They can be utilized during the winter in repairing equipment and putting it in first class condition for the next season's work. It may even be necessary to furlough them for a time with pay but the investment will bring big returns in added loyalty to the company and increased devotion to duty. The average man appreciates a square deal and will show it in increased efficiency. The use of an extensive plant requires skilled operators and, once trained, their services should be retained. Efficiency of operation in road work depends on the proper functioning of all the separate units. The mechanical units function properly only when properly handled.

On large jobs where more than one plant or complete operating unit is used, the spirit of the organization can be kept up by introducing friendly competition. The rivalry between two outfits to reduce costs and increase yardage has a very healthful effect on progress and incidentally on profits. I recall a bituminous concrete construction project on which four separate mixing plants were used. One of the plants was an old, makeshift affair but was handled by an energetic superintendent who had old and loyal employes of the company as foremen and mechanics. The output and costs compared more than favorably with the new plants, due entirely to the better morale of the men. It pays to retain loyal and efficient employes.

The foregoing is the major portion of a paper presented by Mr. Curtis at the spring meeting of the American Society of Mechanical Engineers, May, 1921.

OBITUARIES

Mr. Thomas L. Smith, founder, director and chief stockholder of the T. L. Smith Company, died Friday, April 29, 1921, at his home in Milwaukee.

Although Mr. Smith brought out a number of successful inventions during his life, he is probably best known as the inventor and manufacturer of the line of Smith tilting mixers. Because of his activities in designing and producing mixers, pavers, excavators, crushers, etc., his career has a unique significance in the field of construction and engineering.

Born in England, June 6, 1855, he came to this country with his parents at the age of four, received his early schooling at St. James Episcopal Parochial School, Milwaukee, and while still a boy, moved to Watertown, Wis., where his father had established a machine shop and foundry. In his father's shop he learned the machinist trade.

In 1873 he entered Iowa State College at Ames, Iowa. Although he had no high school education, he graduated in 1877 with the highest marks ever awarded an Ames student up to that time, including fifteen perfect grades for full terms. It

T. L. SMITH

was apparent that he was a "natural born engineer." During his four years at Ames he acted as instructor in the college machine shop, thus paying his own way and contributing to the support of his parents at home, as well.

After his graduation, at the age of 22, he was appointed instructor of the college in mathematics and bookkeeping. After several years in that capacity he went to Boston, where he completed his engineering education in the Massachusetts Institute of Technology.

In 1920, Iowa State College conferred upon him the Honorary Degree of Doctor of Engineering, in recognition of his accomplishments.

The early part of his career, immediately following his college life, was spent in drafting and engineering work with some of Milwaukee's large manufacturers, including Allis-Chalmers Co., Filer & Stowell Mfg. Co., Pawling & Harnischfeger Co., C. J. Smith & Sons Co., and Kempsmith Mfg. Co. D. J. Murray Mfg. Co., Wausau, Wis., manufacturers of logging machinery, also employed him as chief engineer. During this period he invented the first really successful wood-carving machine.

His interest in concrete mixers developed in 1898 and '99, when he was conducting a school of engineering and mechanical drawing in Milwaukee. Mr. D. W. Cutter, a large contractor, had impressed him with the need for a successful mixer. No thoroughly practical machine was known at that time. In 1899 Mr. Smith's invention of the Smith tilting mixer took definite form and the first machine was manufactured in 1900. It was a complete success from the very beginning. This first mixer gave ten years of hard service.

That machine was the beginning of his success as a manufacturer. He took out patents and built additional machines. With assets of only $500 in 1900, the business grew so rapidly that in 1905 he organized a corporation known as the T. L. Smith Company, which today has assets of over $1,200,000.

The T. L. Smith Company represents only one of his successful business ventures. When the Sterling Wheelbarrow Company, West Allis, Wis., was a small struggling concern on the verge of bankruptcy, Mr. Smith purchased a controlling interest and within a few years developed that business to the point where it was the largest and most successful of all his holdings at the time of his death.

The Smith Engineering Works, Milwaukee, manufacturers of Telsmith Rock and Ore Crushers, is another company organized and developed to a high degree of success by the inventive genius and business ability of T. L. Smith.

His career was successful not only from a business standpoint but also from that higher standpoint of personal success. He never for one moment permitted his business success to interfere with his love and sense of duty for home, family and community. His rise in civic, Masonic and religious affairs kept pace with his business achievements. All worthy charity endeavors found him a cheerful and willing contributor. He loved music, art and literature and these were always his chief sources of pleasure and recreation. His purest treasure was his spotless reputation.

Samuel Theodore Morse, city engineer of Carlinville, Illinois, and former county surveyor, was instantly killed on June 3 when his automobile was struck by a Chicago and Alton passenger train at Rainey crossing, three miles south of Carlinville. He was driving from Carlinville to Macoupin Lake on business and was alone in the car when the accident happened. As the crossing is a fairly good one, friends are unable to understand how the accident occurred. Mr. Morse, who was 49 years old, is survived by a wife and ten children. He was a contributor to engineering journals and to the proceedings of engineering societies. He was a graduate of the University of Illinois and was very influential and prominent in Macoupin County.

GRADING BOTH SIDES OF ROAD AT ONCE

Grading both sides of a road at once is the newest thing in maintenance. Blade graders have been pulled singly and in tandem behind tractors, but to pull two abreast is quite a new idea. The illustration shows the outfit of Commissioner Moore of Janesville, Wisconsin, at work on the Milton-Johnstown center road in Wisconsin. The equipment consists of a 10-ton "caterpillar" tractor pulling two 8-ft. Quick Lift Graders, grading an average of 30 miles of road per 10-hour day.

"CATERPILLAR" TRACTOR PULLING TWO ROAD GRADERS ABREAST.

A small drag can be added to the tail end to smooth off the crown after the graders have passed, leaving a smooth even surface from shoulder to shoulder. The cable is used as a tow-line in crossing bridges too narrow to take both graders abreast.

UNIQUE EXPORTING

On March 19th the Austin Machinery Corporation of Chicago received an urgent Mexican shipment order from the New England Fuel Company. This called for an Austin Model 6-T crane rigged for clamshell bucket operation.

This machine was loaded at Toledo immediately and on arrival at ship's side at Port Arthur, was met by a big tanker, awaiting the crane's arrival, with steam up. A little gasoline and oil were put into the engine,—it was cranked up once, —the engine turned over, and the machine walked off the freight car under its own power, across the dock, across two 12 by 12 in. timbers laid between the dock and the boat, crawling directly onto the deck of the tanker, which was all ready to put to sea. The tanker's derrick picked up the boom of the crane from the flat car, set it on the deck, and the machine and boom were lashed down on the deck the same afternoon and the tanker immediately got under way. The run to Tampico was made in a few days, the lashings were cast off, and again the machine walked off the deck of the tanker under its own power onto the private dock of the oil company. The tanker's derrick again picked up the boom, loaded it on the dock, the boom was fitted to the crane and it immediately walked to its working location and started doing its job just 26 days from the day order was placed.

The Austin Machinery Corporation believe this is a record in delivery of a machine from factory to working operation in the export field, and this crane has been on the job giving overtime service every day since.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

ACME COMBINATION HOSE AND CHEMICAL FIRE TRUCK OF THE BERLIN, N. J., FIRE DEPARTMENT

Motor Truck Operation and Accounting—72

THE MOTOR TRUCK NEEDS THE NATION'S GOOD WILL

By M. L. Pulcher, Vice-President and General Manager, The Federal Motor Truck Co., Detroit, Mich.

Everyone who buys something from someone else is served today by motor truck transportation. You cannot name an article of food, clothing, comfort, or amusement of yours, which has not, somewhere in its process of production, been hauled over the highways by gasoline propelled commercial cars. Indeed, from the first to the last stage of transit to the ultimate consumer, goods are usually hauled many times by truck.

Many people, quite thoughtlessly, seeing a truck lumbering along the road, say aloud or to themselves, "Why don't they keep those big trucks off our roads? They block traffic when we are in a hurry, and they spoil our roads for passenger travel."

Those same people are most impatient if the ice cream is late for dinner, and totally out of sorts if their trunk does not arrive at the shore hotel so that they can dress for dinner, or real put out if non-arrival of materials delays the completion of their home or factory, or entirely disgusted if their garage man doesn't get the parts or tires for their car in double-quick time. All of these commodities and thousands more are absolutely dependent on the motor truck as their delivery method.

The real facts are, the motor trucks are just as important to our well being as the passenger cars or railroads, and everybody employs trucks to haul for them directly or through their merchants. Just block all the roads that lead to you and me for one week, and see all that will be missed and mourned.

If this be true, then should not each one of us, every individual benefitting, help to build and maintain the highways over which our own personal things must be trucked?

Further, if they help our bodily health and comfort, should the trucks be forced off the highways by excessive fees and taxes?

The National Highway Traffic Association, in a meeting in Detroit recently, took the decided stand that the cost of highway construction should be paid by general taxation, and that maintenance cost should be pro-rated among users of the roads as such.

But they also said, and rightly, that the cost of maintenance should not be assessed against a type of vehicle for which the highway is inadequate. The next time you come to a highway look at it through new eyes. See it with critical, yet far visioning, glasses. See in it a great ever-growing channel of commerce. See it as an artery of lifeblood in the form of food for thousands.

Who built this road? Who is maintaining it, and will it withstand all of the transportation that must pass over it for the good of the nation?

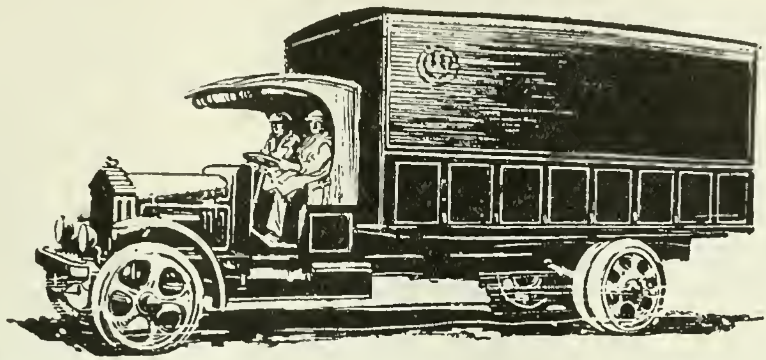
Should the men who transport the goods for you and others over it pay all the cost of building and maintaining it? If so, how much does that increase the cost of the goods to us, or should general taxation maintain this road for general use? And should every truck man that has a great, big truck have to stay off this road and let the goods spoil because the road is too pitifully weak to carry him? Or should the state and nation in which this road lies assess this truck man so much to carry your goods over this road that he has to let his expensive truck lie idle because he knows you won't pay the price which this necessitates?

Why not be reasonable and give motor truck transportation, so vital to every one of us, a sporting chance? Let's let the truck owner do his work without so many laws and fees, and in return ask him to be honest and fair in load and speed. The nation needs the motor truck, and the motor truck needs the nation's good will.

Have a Thought for the Road

Motor truck operators must have a constant thought for the road and its traffic limits in order to avoid further anti-truck legislation.

One of the largest office buildings in the world was recently erected in Detroit. An immense amount of yardage of earth had to be removed quickly. Result: contractors insisted on every truck hauling an overload. Three and one-half ton trucks carried 5 or 6 tons. Five and 6 ton trucks were forced to load to 8 and 10 tons. Result, the absolute destruction of about 20



blocks of heretofore adequate pavement on one street. No truck on this job was sufficiently tired for the loads they carried. So the pavement was pounded into debris in a few weeks. Result, a more drastic ordinance, but surprisingly fair in view of the destruction caused by the penurious contractors who were willing to spend the public's money for new roads and the truck owner's money for repairs to put a few dollars in their own pockets.

This story has been duplicated many, many times all over the country. The truck owner is not always wholly to blame, although he is in the end responsible.

The comparatively few trucks on such jobs create a sentiment against all reasonable truck owners, and with city fathers, legislators and congressmen so anxious to find objects of regulation—the result is oftentimes unreasonable and frequently ruinous legislation against the motor truck.

It is time to be more thoughtful and less greedy. The commerce of the nation absolutely depends on motor truck transportation. Roads and bridges, happily, are being properly built and strengthened to carry the loads which good business demands of highway transportation. But it is high time for abuses to stop. Arrived is the moment to have some regard for our neighbors. There are other men, women and children depending on motor haulage for their living besides you and yours. There are little ones by the thousand who must have milk. If you dig a hole in the pavement or highway with your overload—some one may demand that all trucks the size of yours be kept off the road. That may stop the milk supply or the fresh vegetables, or the coal or any one of a hundred other necessities that we must have continuously delivered.

Have a thought for the road. Remember your neighbor. Be fair—be reasonable, so that trucks will be fairly treated on the statute and tax books.

MOTOR TRUCK NEWS NOTES

Trucks Favored by Live Stock Raisers

A. F. Stryker, secretary and traffic manager of the Omaha Live Stock Exchange, in testifying at the freight rate hearing on live stock before the Interstate Commerce Commission in Chicago during the week of June 13th, stated: "The high freight rates are forcing live stock producers to ship by truck; 20 per cent of the hogs in one day's receipts at Omaha were delivered by truck. On Monday, June 6th, 50 per cent of the sheep received at the St. Joseph market came by truck."

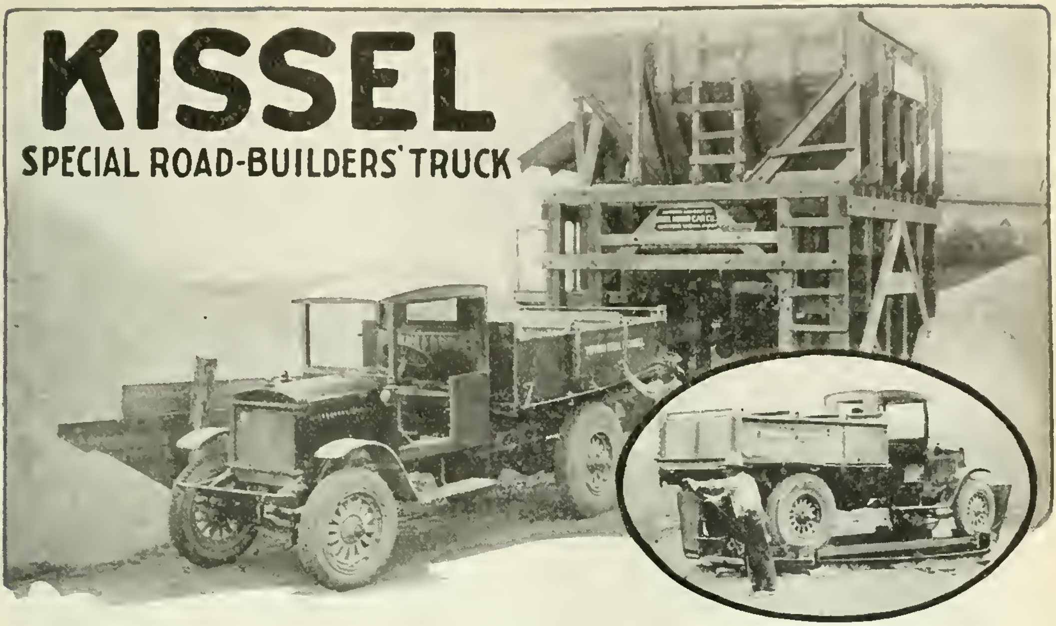
It is estimated that more than 3,000,000 head of cattle, hogs and sheep will be transported by motor truck direct from "farm to yards" during 1921, this being based on 1920 figures from 17 stock yards in the corn belt.

It is predicted that if it were possible to get the actual figures covering the number of head transported by truck from farm to rail siding and then by rail to stock yards, as well as the number of head arriving by motor truck at the dozen of smaller stock yards where no record is kept on stock arriving in this manner, the grand total for 1921 conservatively estimated, would surely reach 6,000,000.

In commenting on this conclusive evidence of the adaptability and dependability of the motor truck for raisers of live-stock, Harry P. Branstetter, Chicago Kissel distributor, states, "The use of the motor truck in transporting live-stock has a number of economical advantages, such as being the quickest and the cheapest method of delivery, because it prevents shrinkage to a large degree. This is especially important in farm to railroad siding to yards delivery because a freight car may not be spotted for several days after it is ordered—consequently the producer can keep his stock on his farm until a few hours before the car is set for loading. This ability of the motor truck for speedy delivery eliminates the necessity of stock waiting in the loading pens, which should always be avoided if possible.

"In the case of a direct 'farm to yards' haul the truck enables the producer to get his stock to the yards when the market price is highest. Also the stock can be shipped when it is in the best marketable condition instead of having to ship whenever the freight car arrives, irrespective of the condition of the stock.

"The live stock business of the country is dominated by four markets—Chicago, Kansas City, Omaha and St. Louis, and it is in these four centers that the use of the motor truck in the live stock business reaches its highest point. Some idea of the importance of these markets can be gained from the fact that live stock farmers receive an average of nearly $6,000,000 every business day in the year for live-stock marketed at these four centers."



Special Kissel Road-builder's truck ready to back under Kissel Combination Hopper that dumps three batches of correctly measured sand and gravel by one trip of lever in less than three seconds.

Kissel Road-builder's truck on specially designed turntable, turning loaded truck around in less than ten seconds—saving time, labor and depreciation on truck.

Kissel Engineering Efficiency enables Peppard, Burill & Connell, prominent Minneapolis contractors, to establish increased road-building efficiency

TIME CONSUMED IN OPERATING KISSEL TRUCKS AND EQUIPMENT

(Johnson Creek, Wisconsin, Road Contract)

Loading, raising and emptying 1¼ cu. yd. clam into bin	35 seconds
Charging 9 measuring boxes (6 boxes of 18 cu. ft. gravel; 3 boxes 10 cu. ft. sand)	12 seconds
Locking truck partitions—backing under hopper—receiving load and starting on trip averages	25 seconds
Discharging 9 measuring boxes into truck	2 seconds
Speed of Kissel truck—loaded with 3 batches	25 M.P.H.
Speed of Kissel truck—unloaded	30 M.P.H.
Turning loaded truck on turntable	10 seconds
Backing to mixer, dumping 3 batches into skip end and starting on return trip	4 minutes

To build about five miles of concrete road—18 feet wide—connecting Watertown with Johnson Creek, Wisconsin, in about two months (started July 6th, up to August 8th reached half-way mark), Peppard, Burill & Connell employed the following Kissel road-building equipment:

1—Kissel designed and built combination hopper and measuring box.

2—Nine special Kissel Road-builder's trucks of 3-yard capacity each (averaging about six trucks for entire contract).

3—Special designed turntable for turning loaded trucks.

4—Proper supervision.

How this work was carried out and systematized by the Kissel road division, enabling Peppard, Burill & Connell to establish increased ***road-building*** efficiency, such as laying 855 feet of concrete road on July 29th, is told in a specially illustrated folder showing each step from hopper to mixer, which we will forward to reputable contractors and road builders.

In addition we have in preparation engineering data from different Kissel engineered and equipped road-building jobs—showing actual cost per batch on various length and graded hauls. Address

KISSEL MOTOR CAR COMPANY

HARTFORD, WIS., U. S. A.

Truck Ownership

"I recently had an entirely new aspect of motor truck utility presented to me," says H. P. Branstetter, Chicago Kissel distributor.

"The successful concern of today, whether a large corporation dealing in millions or a one man outfit dealing in hundreds, prefers to own its equipment and facilities. It doesn't rent its factory, store, office or farm. Much less does it rent equipment in continual use, such as typewriters or machinery. Such a policy would be uneconomical, because renting implies payment of profit to the owner of the thing rented, a profit paid by the user. It does not pay to rent any facilitity that is in use continually.

"Every business, every farm, is continually using short haul transportation, that is, transportation under one hundred miles. Why not own the facilities for your transportation rather than rent them, or hire them from the railroad, especially when the modern facility, the motor truck, is much more economical and vastly superior to the rented facility for hauls under one hundred miles? In addition, ownership implies complete control, the rendering of service particularly adaptable to the business, impossible of rendition by public service companies."

Factors Influencing the Truck Buyer

"Trucks are not bought according to price alone," says Harry P. Branstetter, Chicago Kissel distributor.

"Many other factors are considered by the motor truck buyer of today. The truck must be of right size and capacity to fit the individual requirement for only then will the following advantages result:

"Lowest cost per mile, low gasoline and oil consumption, minimum wear on tires, maximum power at the lowest expense, most efficient operation of all fixed or moving units, minimized wear and depreciation, big saving in time and labor, elimination of breakage from overstrain, lowest service expense, small capital invested in parts stock.

"And for the same reason fleet owners today are standardizing their fleets of trucks, not necessarily all of one size but decidedly all of the same make.

"Buyers of trucks today are depending more and more on the helpful analysis of their needs by the dealers and salesmen of motor trucks. Trucks for long freight hauls have come to stay. Their position is unassailable.

Guarding Truck Fleets Against Robbery

Intercity motor haulage has now reached that stage of development where its possibilities are appreciated by all classes of people including highway robbers. Of course this menace exists only where the traffic is heavy and in such cases steps are being taken for the provision of a safeguarding constabulary. The following article on this topic is reprinted from a recent issue of "Greater New York," the official bulletin of the Merchants' Association of New York:

Highway robbery of merchandise shipped by truck between New York City and outside points has become so serious that a guard of deputy United States marshals has been organized to convoy shipments.

Brigandage on Philadelphia Route

The plan adopted was laid before the Board of Directors of the Merchants' Association with a request for co-operation on the part of the members of the Association. The immediate situation which brought about action was the condition that exists along the motor highway between New York and Philadelphia, where losses have become so great that the adoption of a protective plan was deemed imperative.

The only plan believed to be feasible was the adoption of some system of armed protection for trucks and cargoes and the elimination of collusion between drivers and thieves. To this end deputy United States marshals have been employed as guards to protect truck fleets.

Truck Fleets Guarded

There is a definite meeting place in Jersey City and another in Philadelphia where all trucks going in convoy assemble at a certain hour of the night. At these points they are met by the guards who remain with them until they arrive at their destination.

In order to keep the convoy together and to eliminate stragglers, a rule has been established that any truck that may become disabled shall be taken in tow by the other trucking convoy until it has been brought under the protection of the nearest organized police department.

Cuts Down Expenses

The cost of protection thus afforded is said to be small and it is expected that it will be still further reduced, if it receives the support of shippers.

Arrangements have been made with an insurance company to give reduced

rates on conveyed merchandise so that, instead of an additional charge, there is actually a considerable saving on each trip.

The directors assume that any member of the Merchants' Association who desires to avail himself of this service will arrange his insurance through his own broker.

EFFECTS OF SOLID AND PNEUMATIC TRUCK TIRES ON THE SUBGRADE

To the Editor:

We have heard from several sources propaganda directed at state highway engineers and county commissioners in the endeavor to induce them to restrict trucks engaged in the construction of highways to the use of pneumatic tires. This agitation is ostensibly created on the basis that the penumatic tire will not damage the incompleted road surface or subgrade to the extent that will a solid or cushion tire.

Let us investigate the fact, however: Assuming a 7½ ton truck to be used, we will find the weight on the rear wheels, taking into consideration the distribution of load, weight of the body and the like, to be a total of approximately 17,000 lbs., or 8,500 lbs. on each wheel. The biggest pneumatic tire yet developed, and which has not as yet proved a commercial success, is the 48x12 in. size, the manufacturers of which allow at present a load capacity of just 8,500 lbs., provided this tire is inflated to an air pressure of 140 lbs. This means that the weight per square inch of road contact will be 140 lbs. and that the area of contact will be 61 sq. ins.

This same truck would doubtless be equipped with 14 in. cushion or solid tires which would have a capacity of 12,000 lbs., or 3,500 lbs. more per wheel than the pneumatic. Tests have also shown that the weight per inch of contact of solid-tired wheels is 105 lbs. as against 140 lbs. in the case of the pneumatic. We would, therefore, find that the area of contact of the non-resilient solid tire is practically 81 sq. ins. as compared with the 61 sq. ins. of the pneumatic.

Inasmuch as road damage, rutting and the like is entirely a factor of weight per square inch of road contact, it is easy to see that the properly-selected solid tire will in reality cause less road damage to a soft surface than will a properly-inflated pneumatic tire. If we consider the semi-solid or cushion type of tire in which the area of contact is considerably increased above that of the solid, we will find the ideal equipment for soft or uncompleted road surfaces.

This is an important matter and yet is one which has been too hastily investigated by many road commissioners. It is simply a question of elementary mathematics. Very truly yours,

H. W. Slauson.
Engineering Service Manager,
Kelly-Springfield Tire Co.

1710 Broadway, New York,
July 13, 1921.

(The foregoing letter commenting on a subject of great importance to highway engineers and contractors, motor truck and tire manufacturers, is published to draw out a discussion on the merits of solid and pneumatic truck tires on road construction work. Correspondence is invited from all interested firms and individuals and letters received for publication will appear in the September issue of this magazine.—Editor.)

ADVANTAGES OF OILING SUBGRADES BEFORE PAVING

To the Editor:

It is very evident, after studying the large number of earth roads which are being oiled in Illinois, that it is possible and economical to oil roads preparatory to construction. We oiled 1½ miles of road preparatory to the construction of some of our Frankfort day labor work. The road, however, had just been graded and the subgrade shaped, hence the oil was not as effective as it would have been had the road bed become compacted before the oil was applied. We also used three-ton trucks on the subgrade for the delivery of materials and it is generally admitted that trucks of this weight are too heavy for the average earth road. The road, therefore, was rutted about as badly as if no oil had been used.

Where it is possible to do all of the grading a few months in advance of the paving so that the subgrade will become thoroughly compacted, the oiling will undoubtedly be a success. This is especially true where pneumatic tired trucks are used for the hauling of materials. Thus far we have not been successful in getting a contractor to oil the subgrade where conditions of this kind exist.

In addition to the advantage of hauling materials over an oiled road bed there will be no sprinkling of the subgrade necessary preparatory to the laying of the pavement. The oiled earth road would prevent the earth from absorbing the moisture from the concrete. The oil will also have some advantage in that it will prevent capillary attraction of the subsoil moisture, thereby maintaining a drier subgrade beneath the pavement. In one or two cases we have oiled the subgrade before laying the pavement, but we have not had sufficient time to determine its full advantages. Very truly yours,

B. H. PIEPMEIER,
Engineer of Construction, Illinois
Division of Highways.

Springfield, Ill., July 18, 1921.

HIGHWAYS ENTERING LARGER PENNSYLVANIA CITIES WILL BE WIDENED

While no immediate construction activities will result, the State Highway Department of Pennsylvania for the last two years has been making a study of traffic conditions on thoroughfares leading to important municipalities of Pennsylvania and eventually steps will be taken to increase the width of the arteries leading into the larger cities of the state.

It is apparent that with the normal increase in the registration of motor vehicles the present width of highways will be entirely inadequate within a few years. At the instance of the State Highway Department the 1921 legislature gave consideration to this matter and enacted legislation which received the approval of the Governor and which will give the State Highway Department power to extend the width of important thoroughfares so that they will be adequate for the safety of road users.

It is not the purpose of the State Highway Department immediately to widen these highways, but merely to make a survey of possible future traffic so that lines may be laid down for the guidance of individuals or others who are contemplating improvements along these routes. The proceeding is similar to that followed by municipalities which establish building lines along undeveloped streets.

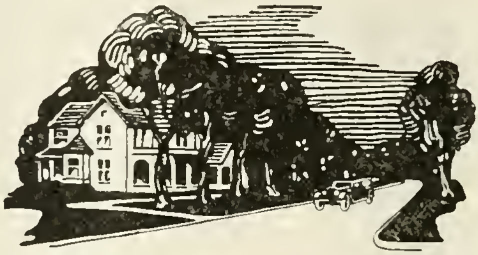
The State Highway Department hopes by this procedure to save the enormous expenditure which will necessarily be entailed in widening arterial roadways after improvements have been completed. To this end it is working in conjunction with the Suburban Association of the Main Line, whose membership is composed of students of the highway problem in Philadelphia and the adjacent counties of Delaware, Montgomery and Bucks.

Commissioner Sadler and the engineering forces of the department are looking ahead 15 and 20 years to the traffic which will then be using the roads of Pennsylvania. The recent legislature gave the department authority to extend the width of highways to 120 feet. That a number of arterial thoroughfares will be extended to that width eventually is a certainty. If this were postponed and owners of adjoining property had made improvements, the cost would be extraordinarily high, as was the cost of opening the parkway in Philadelphia several years ago. Commissioner Sadler believes that by setting the lines now property owners, if they build, will build back of those lines.

The great increase in motor vehicle traffic within the limits of the larger municipalities of Pennsylvania will eventually necessitate the building of thoroughfares skirting these municipalities and wide enough to accommodate several streams of traffic going in both directions. Within a few years it will be unwise to send heavy trans-Pennsylvania traffic into Philadelphia and Pittsburgh, for example, inasmuch as addition of this traffic will add to the congestion of the down-town districts. Consequently wide roads must be provided around the larger cities so that traffic may be accommodated.

CALIFORNIA TAXPAYERS MUST PAY FOR CAR TRACK PAVING

It is reported that a number of southern California cities are rushing delayed street paving projects in anticipation of the law which will relieve street railway companies from the obligation now imposed upon them to pave their rights of way. This legislation was enacted at the recent session of the California legislature and has been approved by Governor Stephens. Street paving has been a heavy burden on the railway companies and they contended that inasmuch as the bus lines were permitted to use the streets in competition with them without sharing any responsibility for paving, the railway companies should, in all fairness, be relieved of the burden. In the future property owners will be required to pave the entire width of streets on which railway tracks are laid.



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Write for Street Booklet R-4

EDITORIALS

RUBBER ROAD ROLLERS

A suggestion that road rollers be made of rubber would be greeted with derision. Probably everybody would agree that rubber lacks every property a material fitted for use in the manufacture of road rollers should possess, including durability, hardness, weight, cheapness, etc. Notwithstanding all this, in many localities rubber road rollers are being used. True, they are not called by that name, although they are forced to attempt the service for which rollers are made and provided. These rubber rollers are commonly known as automobile tirse.

When all vehicles were horse-drawn and iron-tired it was a common practice to spread loose gravel or stone on the road surface and to depend on the grinding and rolling action of the iron tires and the tamping action of the horses' feet gradually to level off and solidify the surfacing material. This was, perhaps, all well enough for its time and place. There may be, and probably are, still many roads used almost exclusively by the old type of traffic described, and on such roads the old method may still be employed where funds are low and the need for some sort of road surfacing is urgent. But the method becomes an extreme case of the survival of the unfit when employed on roads carrying a heavy, modern, rubber-tired motor traffic.

In the first place, the modern type of traffic is inferior to the older type, for the purpose under discussion, as the rubber tires are decidedly less efficient than iron tires in their crushing and rolling action. Then, too, with motor traffic the entire contact with the road, such as it is, is confined to narrow wheel tracks or ruts; there is nothing left to perform the tamping action of the horses' feet, which gradually compressed all the loose material between the wheel tracks. Thus, from the standpoint of efficiency, the rubber-tired motor vehicle is not well suited to this obsolescent type of road construction.

In the second place, it is a very uneconomic practice to attempt to compact comparatively inexpensive loose road material with expensive rubber tires. There probably are limits within which this practice is defensible, but it is certain there are limits outside of which the practice is indefensible. Occasionally the motorist runs into miles of coarse, crushed limestone, loosely spread over the road, and is forced to drive his car over it, although he knows that the sharp corners of the stone are cutting his tires with every turn of the wheel. This is, indeed, very poor economy.

Where gravel is used, consisting of round pebbles and sand grains, the damage to rubber tires is much less than in the case of crushed stone in large sizes, and, of course, if stone screenings are spread over the crushed stone this also serves to protect the tires. It is for this reason we say that there may be limits within which the practice is permissible from the standpoint of good engineering, and we hope that technicians will establish these limits and make them known to local road-building authorities.

We are very sure that the practice of spreading out coarse, crushed stone over the road surface, without the saving presence of fine-grained material, is deserving of total condemnation and should be made illegal.

OUR UNDEVELOPED CITIES

It is customary to assume that our cities are well improved with water works, sewers, pavements, street lights, bridges, etc. As a matter of fact, our cities are very imperfectly developed with these and similar improvements.

Take an important secondary city, of some hundreds of thousands of population, of great industries and great wealth, as an example. The public water supply is of excellent quality from the bacteriological standpoint, but not up to desirable physical standards, possessing properties, as delivered, which require household treatment to make it satisfactory for domestic use. Some surface wells are still in use within two miles of the city hall.

The politest assumption of all is that our cities are well sewered. In the city selected as an example many houses are not connected to the public sewers. On some premises may still be seen that type of structure which told "the night-o'er-taken tramp that human life was near." Other houses are sewered, but discharge into natural water courses which flow through public parks and playgrounds. The surroundings of these water courses, with respect to planting and seeding, are as beautiful as one could wish, but the water in the streams is obviously defiled by household and trade wastes.

Many streets, otherwise fully developed, are not paved at all. Many existing pavements are in such poor condition that a good dirt road would be preferable to them.

The bridges are of excellent design, both from the utilitarian and aesthetic standpoints, but the bridge floors, as a rule, are not in good repair, many being difficult, if not dangerous, to drive over.

Railway tracks are elevated in some places, but elsewhere grade crossings are still in use, many of them unprotected, and they are rougher, on the average, than railway grade crossings on country roads.

The city is exceptionally fortunate in having many fine trees along its streets. This should call for exceptional street lighting facilities, but the street lights are dim and widely separated.

Other deficiencies might be enumerated, but enough have been mentioned to illustrate the point, namely: even our large cities are in need of intensive development with respect to public improvements to bring them up to the standards wealthy and progressive communities set for themselves. There are many loose ends to be gathered up which city boosters would do well to consider.

ENGINEERS' VIEW OF FALL CONTRACT AWARDS

Contractors favor awarding road construction contracts in September and October, and a movement is on foot, sponsored by contractors, to change the custom, now in vogue, of letting contracts in the spring. The reasons underlying this suggested change are well understood and were stated in an article published in our July issue.

In this issue we publish letters from many of the state highway engineers, in the Northern states, commenting on the merits of fall awards.

The reader will find the letters of live interest and it is our purpose, here, merely to call attention to them. It will be noted that the engineers are not in full agreement, thus demonstrating, at once, the value and need of this discussion.

Other things being equal, everybody would favor the fall awards, but other things, it seems, are seldom equal—but the letters tell the story in full.

One point only, made by the engineers, is selected for emphasis here: If contractors expect to change the present scheme they must make good when they have opportunity. On some contracts, awarded in the fall, the successful contractors have loafed all winter, doing nothing at all, apparently, before the regulation time in the spring. They cannot expect to reshape matters by following that line of inaction.

THE RAILWAYS ARE "COMING BACK"

Readers will appreciate the article in this number on the railway situation: past, present and future. It holds forth much encouragement to believe that the railways are gradually "coming back."

There are numerous evidences of a return of the old railroad spirit. For one thing, excursions are being featured again.

The old esprit de corps is again in evidence, also; the old zip and dash on the part of the men who run the trains. May we present an example of this?

Some months ago a notorious gunman in a large city, with a long record of homicides to his discredit, was apprehended by five policemen, and, in the business of escaping, shot one of the policemen. Never happy in the selection of his victims, he was particularly unhappy in this case, and the entire police force of the great city determined to recapture him. The co-operation of the police of other cities was secured in searching for him, but for many months he evaded arrest.

Not long ago, it is reported, he boarded a passenger train as it was pulling into the yards, and, drawing one of his three loaded revolvers, confronted the porter. The porter was unarmed, but did not hesitate to take a gun from the bad man, call for help, and swing a mean left to the gunman's jaw. The fugitive jumped from the train and tried to scramble aboard a locomotive standing on the next track. The engineer kicked him deftly in the face and knocked him down. The engineer's name is not reported. We suspect it is Casey Jones. It seems he had never heard of the gunman.

Then the bad man started running, and the conductor, yes, even the conductor, started to chase him, caught him, threw him and sat on his stomach until the police arrived.

The railways are coming back.

STATE HIGHWAY ENGINEERS COMMENT ON PROSPOSAL TO AWARD CONTRACTS IN FALL

The statement of the case favoring the awarding of highway contracts in September and October, instead of in the spring, was very well presented in the July issue of MUNICIPAL AND COUNTY ENGINEERING. The editor asked several state highway engineers to express their opinions on the merits of this proposal, as fostered by the Associated General Contractors and other business interests, and we publish their letters herewith. We shall be glad to publish letters of comment on the points here made by the engineers:

Colorado

Mr. L. D. Blauvelt, State Highway Engineer, Denver, Colo., writes:

"I am certainly in sympathy with the plan of letting contracts in the fall of the year, in order that preliminary steps may be taken and the work gotten under way early in the spring, with the chance of completing same during the summer season."

Idaho

Mr. D. P. Olson, Director Bureau of Highways, Boise, Idaho, writes:

"In practically all sections of the state it would be advantageous to the contractors as well as to the department to award the contracts in the fall. However, there are other portions of the state in which this would be practically impossible, but taking the state as a whole it is the opinion of the department that the awarding of contracts should be made in the fall instead of the spring.

"I do not believe it necessary that I should go into the arguments relative to the decision of the department in this matter, as the conditions surrounding the same are too well known to require any lengthy discussion on our part."

Illinois

Mr. Clifford Older, Chief Highway Engineer, Springfield, Ill., writes:

"In my judgment the best policy as to the time for awarding contracts on a large scale varies from year to year, depending upon general conditions.

"I am speaking, of course, from the point of view of the owner or builder. Ordinarily the contractor, who has perhaps 50 per cent. or more of the road equipment needed for a given job, is able to secure the balance of the equipment and be ready to start work in approximately 60 days. This would indicate that in this latitude and as far as the contractor's ability to start work at the beginning of the season is concerned, the award of contracts in February or March would be satisfactory.

"Such an arrangement, however, would not, of course, enable equipment manufacturers to forecast very definitely the demand for the next season's construction, and they would be obliged to use less definite data in anticipating the demand for manufacturing equipment during the winter months. The advantage of the earlier knowledge of the demand for equipment might easily be offset by labor and material conditions, which cannot definitely be foreseen six months in advance.

"From the point of view of the state, therefore, it is my opinion that the awarding of contracts in the fall in preference to the spring must largely be based on an estimate of labor and material conditions which may prevail during the early part of the succeeding construction season."

Indiana

Mr. G. R. Hass, Office Engineer, Indiana State Highway Commission, Indianapolis, writes:

"It is now the policy of the Commission not to let any contracts for road surfacing until after the first of the next year. It is, however, our policy to let contracts for grading and structures this fall on projects that require heavy grading so that they may have the winter in which to become compacted, and so we may let surfacing contracts on them next year.

"I cannot give, as an opinion of the department, a statement regarding whether our Commission approves awarding contracts in September and October, instead of the spring months, but do feel that wherever we have heavy grading on a contract that it should be let at such a time as will least interfere with traffic and also will get the subgrade prepared for a period previous to paving, so that it will become thoroughly compacted and not settle or shrink after the pavement has been laid."

Iowa

Mr. F. R. White, Chief Engineer, Ames, Iowa, writes: "We believe it to be a good policy to let highway contracts in the fall for construction the following spring, rather than waiting until spring to let the contracts. Of course it is not always possible to follow out this policy, due to the fact that it may be impossible to get the surveys made and the plans prepared and other necessary preliminaries taken care of in time to let contracts in the fall."

Kansas

Mr. M. W. Watson, State Highway Engineer, Topeka, Kans., writes:

"I can see considerable merit in awarding contracts in September and October if the contractors proceed to make their necessary arrangements for early spring construction as soon as the contract is awarded. It is especially desirable in this state in view of the fact that a considerable portion of the earthwork and culverts can be completed before spring, giving the contractor more freedom in the handling of his pavement work.

"We have found, however, in a number of instances in this state that it made very little difference in the results produced. The contractors simply felt that they had such a long time to prepare for the spring work that they put it off until time to start construction just as if the contract had been advertised and let during the latter part of winter and early spring. The matter depends upon the attitude taken by the contractor after the contract is awarded."

Kentucky

Mr. Joe S. Boggs, State Highway Engineer, Frankfort, Kentucky, writes:

"I am not in sympathy with the movement being fostered by the Associated General Contractors and other business interests to have all highway contracts awarded in September and October instead of the spring months. On account of the volume of work now being handled by the various highway departments of the country it is impossible to concentrate the awarding of contracts to such a short period of time in the year."

Maine

Mr. Paul D. Sargent, Chief Engineer, Augusta, Maine, writes:

"If labor and material conditions were stabilized I should be very much in favor of letting contracts during the fall months for work to be executed during the following season. Under present conditions I do not believe that method will return to the states full value, on account of the fact that labor prices and material prices are declining constantly and there is apt to be considerable difference in the cost of these two items between September or October of one year and April or May of the next.

"We have tried this method on two or three good sized contracts and we have not received results which we expected. In the fall of 1919 we let two big contracts, and as far as I am aware no preparation was made by the contractors during the winter and neither contract was completed in 1920, and neither one is completed yet, although the prospects are that they will both be finished by the first of the coming September. These contracts were bid substantially on the peak of the labor market and labor has declined here from 35 to 40 per cent since those contracts were let."

Maryland

Mr. John N. Mackall, chairman and Chief Engineer, Baltimore, Md., writes:

"I don't believe any general good will result from the awarding of contracts in the fall instead of in the spring. In fact, I think that every day the awarding of contracts is delayed brings down the price. If the contractor has work in the fall for the next year he is not interested in cutting wages, but if when the spring comes he has no work he is decidedly interested in cutting wages; and really the cutting of wages is the key to the high cost of road construction."

Massachusetts

Mr. A. W. Dean, Chief Engineer, Boston, Mass., writes:

"When we are having continuous normal conditions in labor and material prices I consider that it is good business to let as many contracts as possible in the months of November and December, so that work may commence very early in the following spring.

"I do not consider it good business, however, to let contracts in September or October and permit contractors to do any work during the fall months that would interfere with the use of the road during the winter months.

"It was not good business to let contracts in November, 1920, for work to be done in 1921, as the prices of labor and materials were very much less in 1921 than they were in 1920. It is for this reason that I qualified my first statement as to 'continuous normal conditions.'"

Michigan

Mr. Frank F. Rogers, State Highway Commissioner, Lansing, Mich., writes:

"In regard to the awarding of contracts in the fall for the following year's construction: It is my opinion that if conditions are normal this would certainly be a proper thing. However, no one has been able to predict during the past few years, or at least since previous to entering the World War, what the conditions would be the following year. We would certainly not care to let contracts under uncertain conditions, as while it might be very fortunate for the contractor to take a contract and then reap the benefit of a declining market, it would be just as disastrous for him to take a contract and then suffer because of a rising market. It does not appear that there would be any particular advantage for certain types of construction such as so-called low type roads, but there is no question but what there would be advantage for pavement work, as it would allow the contractors to get all of their equipment and a large stock of materials on the ground.

"This department is not in a position this year to let contracts so far in advance. However, it is expected that contracts will be let early in 1922."

Minnesota

Mr. John H. Mullen, Chief Engineer, St. Paul, Minn., writes:

"On a number of our projects we found that the businesslike way to handle this was to let contracts in the fall so that material and equipment may be delivered and in readiness for work in the spring. In some cases this has been taken care of by the state purchasing equipment and stock piled, but that is not always satisfactory, for the reason that it is difficult to anticipate the layout for contractors' organization. We have no fixed policy in regard to fall letting of contracts, the determination being made on the merits of each individual case."

Missouri

Mr. Alexander W. Graham, State Highway Engineer, Jefferson City, Mo., writes:

"I think this plan of awarding highway contracts in September and October instead of the spring months a very good one indeed, and if it were possible for us to do so I would be glad to see our contracts advertised for letting during the above mentioned months, but so far we have had to let our work as rapidly as we could get it ready. However, in the future some such plan as mentioned in your letter might be adopted by this department."

Montana

John N. Edy, Chief Engineer, Helena, Mont., writes:

"This Commission is fully in sympathy with the movement fostered by the Associated General Contractors, to secure the award of contracts in the fall instead of the spring, but it is not always possible for us to arrange our program accordingly. We propose to continue the awarding of contracts throughout the fall and winter, whenever it is possible, thereby permitting the contractors to secure their materials and make their other arrangements so as to begin the construction work as early in the spring as feasible."

Nebraska

Mr. George K. Leonard, Assistant Secretary, Department of Public Works, Lincoln, Nebraska, writes:

"We agree with the contractors when they say that from their standpoint it is desirable to let contracts in the fall. Without doubt this gives them a chance to organize their work for the coming spring and at the same time permits the engineer to dispose of some of the preliminary work.

"From the engineer's standpoint, however, we feel that this method of letting contracts would have a tendency to keep prices up. We feel that the competition would not be as keen in the fall as it is in the spring, when all contractors are anxious to sign up for their season's work.

"For these reasons this Department will not award any highway contracts in the fall."

Nevada

Mr. C. C. Cottrell, State Highway Engineer, Carson City, Nevada, writes:

"We are in thorough accord with the awarding of contracts during the late fall and winter months. However, there are matters governing this such as financing, which unfortunately cannot be arranged until it is possible to do the work. We are doing everything in our power to assist in this matter."

New Hampshire

Mr. F. H. Colburn, Assistant State Engineer, Concord, New Hampshire, writes:

"Regarding the desirability of awarding highway contracts in September and October instead of the spring months: This plan is without doubt an excellent one, but I feel that it is impracticable in some of the northern states, such as New Hampshire, as our highway funds are available for two-year periods only, and it is impossible to forecast what legislative action may be taken. Contracts could not be awarded in the fall hinging on a doubtful appropriation during the following winter."

New York

Mr. Herbert S. Sisson, Commissioner of Highways, Albany, N. Y., writes:

"I am entirely in sympathy with the movement fostered by the Associated General Contractors and other business interests to award highway contracts in September and October instead of in the spring months. However, owing to the conditions that confront this department, especially as to appropriations to be made by the Legislature, it will be impossible for us to let over 50 per cent of the highway work that we expect to put under contract to be built during the season of 1922 before April or May of that year. Our Legislature meets yearly and convenes on January 1st for the annual session. Appropriation bills are very rarely passed before March 1st, and at least 50 per cent of the work to be undertaken next year must await the action of the Legislature providing money to cover the cost of construction to be undertaken.

"We shall use every effort in this department to let as many contracts in the fall and early winter as possible, and to prepare plans for the remainder so that as soon as the appropriations are made and other details attended to we may contract for the work to be awarded as soon as possible in the spring."

North Dakota

Mr. J. E. Kaulfuss, Assistant Chief Engineer, Bismarck, N. D., writes:

"In a general way it would appear to be commonly more satisfactory to let contracts in the fall rather than in the spring, although there are some reasons for not doing so.

"In the case of shipment of materials, etc., it might be advantageous, on account of the freight car situation, etc., for materials to be delivered during the winter months, thus equalizing the freight traffic.

"The state highway work in North Dakota up to the present time has been, and probably for some time in the future will be, such that the quantity of materials required will be relatively small. Our work consists mostly of grading and drainage.

"It has been our experience that the contracting field in North Dakota has been so limited and is composed of such relatively small contractors that not a great many of our projects, even when let in early spring, are finished before the season is over. In most cases the projects run over into two seasons.

"We have endeavored to assist the contractor by dividing our projects into small sections of four, five and six miles with a separate contract for each section, so that on a large project he will be relieved of each section and given payment in full as he completes his several contracts.

"The situation in the past, during the war, and possibly even now, is such that it is most advantageous for the contracts to be let very shortly before the work can be begun and readily finished. There is some advantage in letting the contracts very early in spring instead of late the preceding fall, especially during the period of adjustment. The principal handicap, however, in early spring letting is that in northern states the ground is covered with snow and ice, which makes examination of the work difficult.

"It appears that a contractor bidding on work, especially in northern states, about seven months before actual work is intended to be begun, would bid higher because of the uncertainties that might result within the next half year."

Ohio

Mr. E. C. Blosser, State Highway Engineer, Columbus, Ohio, writes:

"Our engineers in the field are always so busy during the summer months with contract work that it is not feasible to get our surveys until some time in the fall; and it is always easier to work up the plans and estimates during the winter months than any other time of the year. And then, again, we do not desire to have our roads torn up during the winter months any more than is absolutely necessary. So that, considered as a general proposition, I would say that we are not in sympathy with the movement to award highway construction in September and October exclusively."

Rhode Island

Mr. I. W. Patterson, Chief Engineer, Providence, R. I., writes:

"I am very much in favor of awarding contracts in the fall rather than in the spring. It is not always possible for this department to award contracts in the fall because as a rule we are financed by appropriations made annually. Occasionally, however, special appropriations are made for expenditure during a period of years. When this is done, almost invariably we let our contracts in the fall."

Wisconsin

Mr. A. R. Hirst, State Highway Engineer, Madison, Wis., writes:

"I will say, very briefly, that we are not in sympathy with the movement under way to award highway contracts in September and October, for the following reasons:

"First, the prices for labor, teams, machinery and materials for the following year are not known as early as September and October. Both the contractors and the public are gambling with too many unknown factors when they let contracts so far in advance of the actual time of construction.

"Second, mechanically it is almost impossible to have the plans ready so far in advance of the time of construction, because in northern states such as Wisconsin the surveys are made in the open season, and the engineering force is maintained through the winter by working on plans from the surveys made when it was possible to survey to advantage.

"Of course it might be said that the department could work two years ahead, but very few departments are financed two years ahead, and surveys made two years in advance would be apt to be obsolete before used.

"I have been chief engineer of a state highway department for fourteen years, and it is my absolute opinion that the plan suggested by the Associated General Contractors is impracticable.

"We are making every effort to let our contracts as early in the year as possible. We started lettings in January, and practically all of the contract lettings under our control had been made before May 1. It has been mechanically impossible to get out the plans any earlier, and even if it were not, we do not believe it good policy to start lettings for the year's work before January 1. The motto of the Wisconsin Highway Commission is "Build each year the work awarded that year." There are a few exceptions to this rule in our practice, but very few indeed."

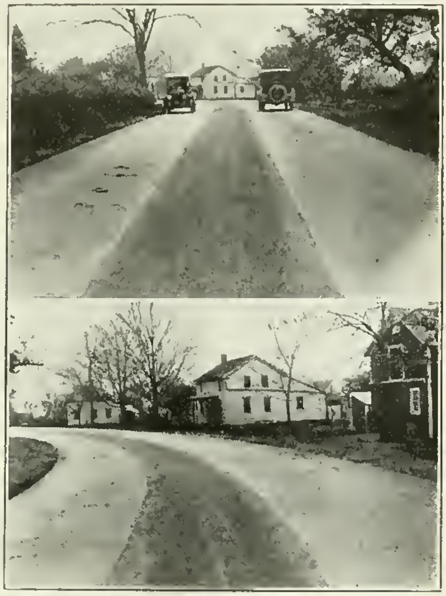
ADVANTAGES OF NEW YORK DUAL TYPE (MACADAM AND CONCRETE) ROAD

By H. G. Hotchkiss, Jr., Second Deputy Commissioner, New York Commission of Highways, State House, Albany, N. Y.

The dual type of road, consisting of macadam and concrete, has been used in the reconstruction of old macadam pavements to a small extent in four different counties of the state; namely, Dutchess, Livingston, Montgomery and Rensselaer, with the result that we now have in use five and one-half miles, all located on main heavily traveled routes and we anticipate the construction of a few additional miles during the present season.

The type in general consists of the placing of two strips, each 9 ft. in width, of concrete 1:1½:3½ mix of 6 in. uniform thickness reinforced with metal mesh separated by a strip of bituminous macadam penetration method, 6 ft. in width.

The advantages of this type are obvious. The width is ample to take care of present and probable future traffic on our main routes. The black strip of bituminous macadam tends strongly to keep traffic on its proper side of the pavement. Slow moving heavy trucks will drive on the concrete on the side of the



VIEWS OF MACADAM - CONCRETE DUAL TYPE OF HIGHWAY ON MAIN TRAVELED ROAD BETWEEN ALBANY AND NEW YORK, N. Y.

pavement not monopolizing the center as is common on ordinary hard surfaced pavements. This permits fast moving pleasure or transportation vehicles readily to pass the slower moving vehicles. Traffic in general is confined to the concrete which is able to support and carry it without injury.

In reconstruction work, there is no necessity of closing the road to traffic during the progress of the work, as the strip of concrete is completed on one side of the center line and opened to traffic prior to the laying of the second strip of concrete.

Ample width of right of way and embankment or cut is required.

Reconstruction of old macadam pavements with this type of pavement costs approximately $40,000 per mile.

In the establishment of the new grade or profile, we endeavor to preserve and utilize as a foundation as much of the old macadam pavement as is feasible.

Herewith are two views showing sections of the Schodack Center-Valatie, Pt. 3, Highway No. 5084, Rensselaer County, reconstructed in 1920, using this type of construction. This highway is located on the main traveled route between Albany and New York City. The photograph showing the touring car on one side with motor truck on the other illustrates well the opportunity for fast traveling vehicles to pass other vehicles going slower or standing still on the pavement.

CARIBOU HYDRO-ELECTRIC DEVELOPMENT OF THE GREAT WESTERN POWER COMPANY ON FEATHER RIVER

By Howard L. Rogers, Director of Division of Construction and Engineering, Stone & Webster, Inc., 147 Milk St., Boston, Mass.

The Great Western Power Co. of California has just put into operation a 60,000 horse power hydro-electric plant in Plumas County, California, serving Central and Northern California.

Power Possibilities of the Feather River

It is the second plant to be constructed in a comprehensive scheme for the development of power along 75 miles of the Feather River, which stream possesses unusual power possibilities.

Rising in the Sierra Nevada Mountains, the north fork of this river meanders across a great mountain meadow miles in length at an elevation of almost a mile above the ocean. Upon leaving the meadow it plunges abruptly into the Feather River Canyon and for 75 miles tumbles over one cascade and rapid after another until it finally reaches the gently sloping Central Valley system of California near Oroville. In this distance the river has fallen 4,285 ft., constituting a power zone within which, it is calculated, 640,000 horse power will ultimately be developed.

The plant just completed is known as the Caribou development. It receives its name from the century old trail along the river made by the caribou in their yearly migrations from the mountain tops to the warmer valleys.

Big Meadows Reservoir

The Big Meadows Reservoir is the key to the whole situation; it acts as a regulator for the two existing plants and will do so equally well for the five yet to be developed on the stream below. With an hydraulically sluiced earth dam built some 10 years ago across the neck of the valley, a lake 44 square miles in extent has been brought into existence. In this the flood waters from the higher mountains can be stored, to be released as needed during the dry California summers. Thus, a constant flow can be maintained, assuring a steady and reliable production of power.

The plant is located about 10 miles from the Big Meadows reservoir and is reached by a 10 mile construction railroad branching from the Great Western Railroad at Belden, Cal.

Essential Features

The development consists of the construction of two tunnels, each about 2 miles long, a small earth dam, the penstocks, power house and transmission lines.

The Big Meadows reservoir is tapped by a tunnel which conveys the water 2 miles to spill it into the valley of Butt Creek. After following the course of the gently sloping Butt Creek for about 10 miles, a low earth dam turns the water into the second tunnel about two miles long, which runs direct to the penstocks at the power house.

Driving the Tunnel

The driving of the tunnel which taps the Big Meadows reservoir was unusually difficult work, as there was a strong flow of water through the slate and jointed lava beds in which the tunnel was excavated. To keep it unwatered during construction, electrically driven pumps were employed. A duplicate set of steam pumps always stood ready to carry on at a moment's notice in the event of sudden failure of power. At one of the shafts 7,000,000 gals. per day were pumped constantly for more than a year. The second tunnel was much drier and more easily constructed.

Largest Impulse Wheels Yet Constructed

The Caribou development is notable even in this California region of high head power developments, in that the impulse wheels installed are the largest yet constructed. With a net effective head of 1,008 ft., each wheel is designed to absorb and transmit 15,000 horse power to the generator from the 11 in. jet of rushing water. Each of the 21 buckets of the wheel weighs 1,000 lbs., and is struck by a solid bar of water 11 ins. thick, shooting from the nozzle at a speed of 175 miles per hour. The wheel revolves at 171.4 revolutions per minute, receiving 60 blows every second, each one of which strikes with a force of 84,000 lbs. The energy delivered to each wheel is equivalent to the crashing impact of 2 passenger locomotives, each weighing 100 tons and speeding at 42 miles per hour with but one second of headway between each locomotive.

Highest Transmission Line Voltage Yet Attempted

The transmission line is 185 miles long and will carry power at 165,000 volts, which is the highest transmission line voltage yet attempted.

The plant was designed and built by Stone & Webster, Inc., of Boston, under the direct supervision of S. L. Shuffleton, Western Manager, with W. D. Shannon as General Superintendent.

General Data Caribou Power Plant

The general data pertaining to the plant follow:

Great Western Power Company of California.

Work started June, 1919. In operation May 7, 1921.

Installed capacity, 59,000 horse power. Ultimate capacity, 167,000 horse power.

Location: Ten miles below Lake Almanor (Big Meadows Reservoir) on North Fork of Feather River, in Plumas County.

Power house construction: Reinforced concrete. Height, 105 ft.; width, 104 ft.; present length, 176 ft.; ultimate length, 308 ft.

Present installation: Two 30,000 horse power units, consisting of two overhung impulse wheels, each with 21 buckets, operating under a head of 1,008 ft., with a speed of 171.4 revolutions a minute. Each of the buckets on these wheels weighs 1,000 lbs. The diameter of the jet which strikes them is 11 ins. These two wheels and generator constitute a unit. Each unit weighs 290 tons; the revolving element of each unit weighs 170 tons.

Transmission: Aluminum cables, nearly 1 in. in diameter, transmit the power generated at the Caribou plant over double steel tower transmission lines 186 miles to the San Francisco Bay district distributing area. The voltage is 165,000, a world's record in transmission voltage.

Water supply: Water from Lake Almanor and Butt Valley is fed to the Caribou's power plant through three tunnels as follows:

Tunnel No. 1. Located between Lake Almanor and Butt Creek. Area, 46 sq. ft. Section rectangular. Slope, 1 per cent. Length, 11,200 ft., with three shafts. Lining, part concrete and part wood. Capacity, 800 cu. ft. of water per second. Equipped with two 7-ft. electrically controlled gates at its entrance.

Tunnel No. 2. Located between the south end of Butt Valley and the crest of the river gorge. Area, 78.50 sq. ft. Section, circular. Diameter, 10 ft. Slope, eight-tenths of 1 per cent. Length, 9,200 ft. Number of shafts and adits, two. Lining, concrete. Capacity, 1,400 cu. ft. of water per second. Equipped with a 9-ft. electrically controlled gate at the entrance.

Pressure Tunnel. Located between the crest of the gorge and a point under the ridge 550 ft. below. The area of the pressure tunnel is 63.62 sq. ft. Section, circular. Diameter, 9 ft. Length, 550 ft. Lining, combination steel and concrete.

Pipe Lines. Located partly in tunnels and partly on hillside between lower end of pressure tunnel and power house; 2,755 ft. of 60-in. steel pipe, 3,372 ft. of 42-in. pipe. Sixty-inch pipe is approximately ½ in. thick, and 42-in. pipe is approximately 1 in. thick.

A surge chamber 30 ft. in diameter and 175 ft deep, to take care of water suddenly backed up when the volume flowing through the generating units is reduced, is situated at the junction of Tunnel No. 2 and Tunnel No. 3.

The water used at the Caribou plant is used over again at the Big Bend power plant and ultimately will be used in all seven times at seven different power stations before reaching the Oroville or Sacramento Valley level, when it becomes available for irrigation.

EFFECT OF AGE ON STRENGTH OF CONCRETE

By Duff A. Abrams, Professor in Charge Structural Research Laboratory, Lewis Institute, 1951 W. Madison St., Chicago, Ill.

(Editor's Note: This discussion by Professor Abrams was prompted by certain comments in the recent report entitled: "A Study of the California Highway System," by the U. S. Bureau of Public Roads. It will be noted that Professor Abrams disagrees entirely with the authors as to the interpretation of the diagram printed on page 114, of the report mentioned, from which they conclude that the tests carried out show a tendency for the concrete to decrease in strength with age.)

Figure 1 is reproduced from "A Study of the California Highway System," by the U. S. Bureau of Public Roads, 1920, page 114. Compression tests were made on 4½-in. concrete cores cut from the pavements. The strengths have been corrected for length of specimen as compared

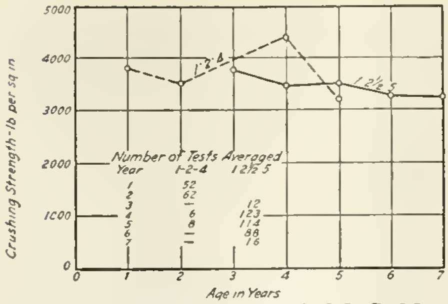


FIG. 1—FROM "STUDY OF CALIFORNIA HIGHWAY SYSTEM" BY THE U. S. BUREAU OF PUBLIC ROADS; 1920, page 114.

with their diameter and weighted on the basis of the number of tests included in a given average. The report contains the following comments on these tests:

"The strength of the concrete is very nearly constant for all pavement classes, and, with the exception of Class A, the average for 1-2-4 concrete for the various classes is higher than for the 1-2½-5. The general average for both 1-2½-5 and 1-2-4 concrete decreases with age with a single exception of 1-2-4 concrete at 4 years and 1-2½-5 concrete at 5 years. In the case of 1-2-4 concrete only 6 specimens were tests at the age of 4 years, which may account for the comparatively high results. In general, there seems a slight tendency for the concrete to decrease in strength with age. This general tendency follows also within the various pavement classes, although there are several exceptions."

The same diagram appeared in "Public Roads" for April, 1921, in an abstract of the above-mentioned report, with the following comments:

"(b) That since the average corrected testing strength of concrete cores is above 3,000 lbs. to the square inch the concrete itself is not generally defective in strength nor does it show any wear by traffic.

"(c) The average class condition of all concrete pavement indicates a slow progressive deterioration with the age of the pavement, and indicates also that the type built tends to reach its approximate stage of classification comparatively soon and thereafter to change more slowly.

"(d) The diagram showing average strength as determined by cores tested from concrete laid during the various years indicates that there may be a slow progressive deterioration of the concrete itself, or 'fatigue' in a thin slab subject to excessive flexure."

It seems to the writer that the authors of the above-mentioned reports have misinterpreted this diagram when they state that these tests show "a slight tendency for the concrete to decrease in strength with age" and "that there may be a slow progressive deterioration of the concrete itself, or 'fatigue' in a thin slab subject to excessive flexure."

The writer can find no evidence either in the reports of the Bureau of Public Roads or elsewhere to indicate that the compressive strength of this concrete was reduced by "fatigue in a thin slab, due to excessive flexure." The first evidence of excessive flexure would be a tension crack in the concrete. It seems extremely unlikely that enough of these cores contained such cracks, even if in incipient form, to cause a material reduction in compressive strength, especially when we consider that the cores were loaded at right angles to the flexural stresses.

The writer places an entirely different interpretation on the tests in Fig. 1. Instead of showing a progressive deterioration of the concrete, it shows that there has been a *progressive improvement in the quality of the concrete* during the period covered by the work of the California Highway Department—sufficient improvement in fact to more than counteract the advantages of age on part of the older concrete pavements. Although all the work was done under the same specification, it is probable that increased experience on the part of contractors, more careful preparation and proportioning of materials, better inspection, and other factors of this kind are responsible for the marked improvement in quality of the concrete.

The notion that the strength of concrete deteriorates with age is based on the results of tension tests of mortar briquets. In a paper on the "Effect of Age on the Strength of Concrete," published in the Proc. American Society for Testing Materials, 1918, Part II, the writer showed that briquet tests of mortars gave entirely erroneous results, due to the shape of the specimen in which (as pointed out by Johnson in 1898 and by Coker in 1912) the stress across the section is far from uniform. In other words, the falling-off in strength of mortar briquets is due to the *form of specimen* and does not reflect the true properties of concrete. Tension tests of briquets practically always show this result both for water or air storage. On the other hand concrete which is in contact with moisture continues to increase in strength indefinitely. Tests were cited in the above-mentioned report up to 9 years. (See "Concrete-Steel Construction" by Morsch.) Under these conditions the strength is a logarithmic function of the age; in other words the strength is proportional to the logarithm of the age, expressed in weeks or months.

Water is necessary for the continued hydration of cement. Consequently, if the concrete *dries out* there is little or no further increase in strength. This shows the importance of keeping concrete moist for several days after it is placed. Tests reported in our Bulletin 2, "Effect of Curing Conditions on the Wear and Strength of Concrete," showed that the presence of moisture during the first few days exerted a most important influence on both the strength and wearing resistance of concrete.

A study of a large number of tests made in the Structural Materials Research Laboratory gives the relations between age and strength of concrete cured under different conditions, shown in Table 1 and Fig. 2. The values are platted to

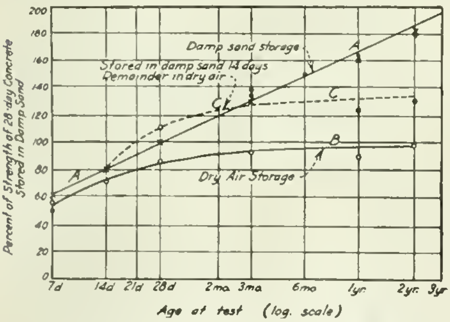


FIG. 2—RELATIONS BETWEEN AGE AND STRENGTH OF CONCRETE CURED UNDER DIFFERENT CONDITIONS.

a logarithmic scale of ages. Each of the values for damp sand or moist air storage (Curve A) is based on about 100 tests made in 6 different series made over a period of about 5 years. The points for Curves B and C are each the average of 15 tests. The concrete was of mixtures similar to that used in road construction.

Curve A illustrates the point made above to the effect that so long as moisture is present the strength of the concrete is proportional to the logarithm of its age. Both Curves B and C show that no material increase in strength may be expected after the concrete has fully dried out. The strengths due to intermediate conditions of storage will fall somewhere in the region between Curves A and B.

If concrete is exposed to moisture at any time after being dried out, the hydration of the cement is resumed, as shown by the increase in strength of the concrete. The process of hardening is simply arrested during the period when the concrete is dry. It was shown by tests made at the University of Illinois and reported by Prof. H. F. Gonnerman in Proc. American Concrete Institute, 1918, p. 101, that specimens which had been in dry air for 2 years showed a rapid increase in strength when placed in damp sand. In these tests there was little or no increase in strength in the air-stored specimens between 1 month and 2 years.

Another valuable report will be found in a recent paper entitled, "Effect of Age and Curing Conditions on Concrete—Results of 10-year Tests," by Prof. M. O. Mithey, published in the Wisconsin Engineer, Nov. 1920, and in Engineering and Contracting, Nov. 24, 1920. These tests showed that concrete cylinders stored in forms for 3 days, sprinkled daily until 14 days old, then placed outdoors with ends in contact with damp soil, gave strengths up to 10 years which were only slightly less than for similar specimens stored in water for the entire period.

In roads where the concrete may receive moisture from the damp sub-grade and from seasonal rains and snows we would expect to find a gradual ascent in the age-strength curve for an indefinite period of years. There is no reason to anticipate a reduction in strength with age, even in arid regions. After a careful study of all available data on the subject the writer can state with the utmost confidence that under normal conditions *concrete in roads does not deteriorate in strength with age.*

TABLE I—EFFECT OF AGE ON THE STRENGTH OF CONCRETE.

Compression tests of 6 by 12-in. cylinders.
28-day strength of specimens stored in damp sand (or moist air) considered as 100 per cent.
Mixtures 1-5 and 1-4; aggregates, sand and pebbles graded up to 1½ in.; consistency similar to that used in road construction.
(A), (B) and (C) refer to corresponding curves in Fig. 2.

Relative Strengths of Concrete for Different Curing Conditions

Age at Test	Damp Sand or Moist Air (A)	Dry Air (B)	Damp Sand 14 Days Remainder in Dry Air (C)
3 days	25%	30%	25%
7 days	60%	55%	60%
14 days	80%	70%	80%
28 days	100%	85%	110%
2 months	120%	92%	125%
3 months	130%	93%	127%
6 months	150%	95%	130%
1 year	165%	95%	130%
2 years	185%	96%	130%
3 years	195%	....	......

AND YET ONCE MORE—SEWAGE TANKS

To the Editor:

Since my communication regarding sewage tanks appeared in your February issue I have been watching and hoping for further comment from Mr. Kirchoffer. Today, upon the receipt of the July magazine, I was rewarded. I thank Mr. Kirchoffer for his interesting and courteous criticism no less than for his expressions of appreciation.

I fear, however, that in my former letter I did not make clear the advantages which, I firmly believe, are possessed by the tank with diverging side walls over the tank with parallel side walls. Mr. Kirchoffer says:

"I can scarcely agree with him that the slight difference in width of tank which would reduce the velocity about 2 to 3 in ratio would prove a means of sorting out food for different kinds of bacteria."

The inference from this seems to be that the reduction of velocity is too slight (only 33 per cent) to accomplish much in the way of improved sedimentation. For the benefit of the lay reader (Mr. Kirchoffer of course knows it) let me explain that the transporting power of moving water varies—not as the velocity, but as the sixth power of the velocity. I quote from LeConte's "Elements of Geology":

"The *Erosive* power of water, or its power of overcoming cohesion, varies as the square of the velocity of the current.

"The *transporting* power of a current varies as the sixth power of the velocity. . . . If the velocity, therefore, be increased 10 times, the transporting power is increased 1,000,000 times. A current running 3 ft. per second, or about 2 miles per hour, will move fragments of stone of the size of a hen's egg, or about 3 ounces weight. It follows from the above law that a current of 10 miles an hour will bear fragments of 1½ tons, and a torrent of 20 miles an hour will carry fragments of 100 tons. We can thus easily understand the destructive effects of mountain torrents when swollen by floods."*

A reduction of *velocity* in a 3 to 2 ratio therefore means a reduction in *transporting power*—and a consequent variation affecting the settling of suspended matter—covering a 729 to 64 ratio, or something more than 11 to 1, surely enough to effect a decided classification or "sorting out" of the deposited solids. Compared with the mean velocity—that is with a velocity through a tank of the same length, depth and capacity and with parallel walls—the lower velocity *at the outlet end* cuts the transporting power to almost one-third, for the ratio becomes 729 to 224. Because of this the tank is able to withhold much light flocculent matter that would be carried through and out by the current in a parallel-walled tank.

Mr. Kirchoffer continues:

"It is possible that a plain box type septic tank would have given equally good results for an equal length of time."

I think he has overlooked my statement that the expressed opinion was based upon "prolonged tests of such a tank, side by side with one of equal capacity but with parallel walls." The two tanks were fed equally and simultaneously with sewage from the same pipe; and the flaring tank proved the better.

As for the question

"Can he guarantee that if he should install it where conditions have arisen, where other types of tanks have failed to produce the desired results, that it would give a satisfactory effluent?"

I cannot answer better than by repeating and emphasizing Mr. Kirchoffer's own words:

"No type of tank, no matter how well designed, will work equally well on all sewages, nor will any one type of tank give satisfactory results all of the time on the same sewage."

I heartily concur in the opinion that the chemical quality of the water supply is an important factor in the behavior of sewage disposal units. Foreign elements, even in minute amounts, often have far-reaching effects. I have frequently found it expedient to use coke as a filtering medium, and I soon learned that a sulphur content in this material of more than one per cent caused foul odors, black deposits and a darkened effluent, when all other conditions were right for high standard service.

I believe the Kirdorthoff tank is as good as its designer claims; but where the construction of deep tanks is going to prove unduly costly—as in quicksand or rock, I think I am still likely to build single-story tanks and make them as efficient as I can. Very truly yours,

G. Everett Hill,
Vice President and Chief Engineer,
City-Wastes Disposal Co.
45 7th Ave., New York, Aug. 18, 1921.

*See also Flynn's "Flow of Water in Irrigation Canals," Moore's "Sanitary Engineering" and Metcalf and Eddy's "American Sewerage Practice."

OLD ROMAN ROAD DISCOVERED

Discovery has been made in England of another old Roman road hitherto unknown. Workmen who were digging manholes in the Alton road, where the latter joins the roads to Bentley and Bordon, near Farnham, Surrey, unearthed, 5 ft. below the surface, part of what appears to be an old Roman road that ran from London to Manchester. The road was in an excellent state of preservation, the surface layer being a foot in thickness and composed of flints. In order to penetrate the surface the workmen had to use drills and steel wedges. Research has demonstrated that not only the Romans used bituminous materials, including asphalt, but the ancient Sumerians, Persians, Babylonians, Greeks and Egyptians as well. The road discovered in England, according to engineers, was capable of carrying traffic heavier than any to which modern roads are now put.

ASPHALT PAVING IN THE DISTRICT OF COLUMBIA

By F. S. Besson, Major, Corps of Engineers, U. S. A. Assistant to the Engineer Commissioner, District of Columbia, District Bldg., Washington, D. C.

The City of Washington occupies an outstanding position in the development of bituminous pavements, particularly of that type known as sheet asphalt. In 1876, Pennsylvania Avenue from the Capitol to the Treasury was paved with a surface of asphalt on a concrete base. That section of the avenue between First and Sixth streets was laid by the Neuchatel Paving Company. This pavement was of the same character as those laid on the roadways in Paris about that time. It was composed of natural bituminous limestone brought from Switzerland, placed on the street in the form of powder, and compressed with iron rammers. The pavement used on the section from Sixth Street to Fifteenth Street differed from that of the Neuchatel Company in that the surface was an artificial mixture, the investigations and practice in Washington thereby taking on an entirely different line than those in Paris. A mixture of sand and limestone powder was made into a mastic by the use of an asphalt cement which was a combination of native asphalt, known as "mineral bitumen" and petroleum oil. The asphalt cement was used in about the proportion of 15 of cement to 85 of sand and limestone dust. This was the first use in the District of what is known today as sheet asphalt.

Early Bituminous Concrete Pavements

Prior to 1875, many so-called concrete pavements were laid of which the cementing substance was a product of coal tar oftentimes mixed with a certain proportion of asphalt. The construction of these pavements was covered by various patents. It appears that there were more than 150 such patents. Some of the pavements laid were purely experimental. In many the coal tar was hardened by the application of sulphuric acid, either the acid or powdered sulphur in its crude state, in the belief that the pavement was thereby vulcanized. When asphalt was mixed with the coal tar it was usually Cuban, as, in those early days, it was believed by many that Trinidad was too brittle for pavements. Some of these early patented pavements went to pieces almost immediately, most of them required continuous and excessive maintenance, and a few still remain serving as base for asphalt surfaces.

Early Nomenclature

In view of discussion today as to the nomenclature that should be used relative to Portland cement concrete and asphalt cement concrete, it is interesting to note that this old bituminous construction was known as "concrete pavement," and that which most of us at present think of as concrete was habitually spoken of as "hydraulic cement concrete."

An early District of Columbia report states that on the first of January, 1881, there were 360,000 sq. yds. of asphalt pavements on hydraulic concrete base and 700,000 sq. yds. of concrete pavements with a bituminous cementing substance, giving a total of 1,060,000 sq. yds. of monolithic or smooth surface pavements extending over a length of 44 miles. The report further states: "This is considerably more than exists on the roadways of all other cities in the world taken together; the amounts for other cities being as follows:

	Square Yards	Miles
Paris	370,000	19¾
London	150,000	6½
New York	20,000	1
Other cities (estim'd)	60,000	2¾
	600,000	30

Pavement Performance in Washington

The use of a concrete base for the asphalt pavement on Pennsylvania Avenue was the initiation of a standard the value of which today is attested by almost a half century of practice. Lieutenant F. V. Greene, Assistant to the first Engineer Commissioner of the District, spoke 40 years ago of this type of pavement as one with "a solid base of concrete masonry, practically imperishable, and a comparatively thin and smooth wearing surface which can be replaced when it is worn out—say every 15 or 20 years." It is seldom that a predictive statement such as this in the field of road construction withstands the test of time. It has been said that there is nothing permanent about a road except its right of way. Surely Washington's experience has shown that a properly constructed concrete base is permanent. The original one in Pennsylvania Avenue was resurfaced with new asphalt in 1890. The sections between Third and Fifteenth Streets were again resurfaced between 1907 and 1912. The 1890 surface still exists between First and Third Streets. Generally it has been found that asphalt pavements on concrete base require replacement of the asphalt after it has given an average service of from 25 to 30 years. Of today's total of 3,334,157 sq. yds. of asphalt surface in Washington there are 670,000 sq. yds. beyond 25 years of age.

Early Construction Methods

Asphalt paving work of today differs greatly from the practice when Pennsylvania Avenue was first surfaced. At that time asphalt cement was prepared and combined with the aggregate by primitive methods. When spread upon the street it was thought that the hot mixture could not be rolled. Old residents state that it was an interesting sight to see a row of darkies stretched across the avenue standing on planks and compressing the asphalt with hot tampers, followed by another string of darkies with smoothing irons. Natural hydraulic cement was used in the concrete base, the mixing of which was done by hand.

Modern Construction Methods

Figure 1 shows a plan and typical section of the plant of a Washington contractor. This plant is located on the river front and the haul to the various streets in a season's contract usually averages about 2½ miles. Not only does this plant serve as a central mixing station for asphalt mixtures, but also for concrete. Hauling is done by 5-ton motor trucks, the development of which has done as much for the expediting of road construction as any other one item. Aggregate, both for concrete and asphalt mixtures, is hoisted from barges to a transfer hopper by means of a clam shell bucket and delivered in automatic dump cars to the storage bins by gravity, counterweights returning the cars to the hopper.

For concrete a mixer is used with a rated capacity of 8 cu. ft. of mixed concrete. A batch for the base mixture contains 1 bag of cement, 3 cu. ft. of sand, and 7 cu. ft. of gravel. The motor trucks drive directly under the mixture discharge and eight batches fill a truck, making a load of slightly more than 2 cu. yds. of mixed concrete weighing about five tons. A 16 cu. ft. mixer, which is twice the size of the present one, is being installed, the use of which will materially cut down the idle time of the trucks waiting for full load, with a commensurate reduction in hauling costs. The maximum time for a truck from the mixer to the job has been not more than one hour and a quarter. A relatively dry concrete is used, the slump being less than 1½ ins., when tested with a truncated cone the base of which is 8 ins., the top 4 ins. and the height 12 ins.

Unit Cost Data

A truck load lays approximately 12 sq. yds. of base 6 ins. thick. The average laid in a day of eight hours totals 750 sq. yds. Concrete is dumped on the subgrade, spread and tamped by hand. Grades are followed by the old grade peg method, as no entirely satisfactory substitute therefor has been found. The concrete gang on the street consists of 1 foreman, 4 men adjusting grade and miscellaneous work, 4 spreaders and 2 tampers. On the basis of a daily total of 750 sq. yds., the following analysis may be made:

.161 bbls. Cement	@ $2.00	= .419	per sq. yd.
.07 cu. yd. Sand	@ .80	= .056	per sq. yd.
.165 cu. yd. Gravel	@ 1.20	= .198	per sq. yd.
Total for Material		$0.673	per sq. yd.
Hauling		0.250	

1 Foreman	@ $45 per week	= $ 7.50 per day
5 Laborers	@ $4.50 per day	= 22.50
5 Laborers	@ $4.00 per day	= 20.00
		$50.00 per day

Total for men on the street, 750 sq. yds.	= .067 per sq. yd.
Concrete Cost, Total Outside of Plant	$0.99 per sq. yd.

There are three asphalt mixers of the open top bin type with the mixing blades of teeth bolted to a horizontal shaft. Bins for the heated aggregate are located directly over the mixers, and attached to the bins are accurately measured boxes so that the correct amount of aggregate may be added to each batch. Hot Asphalt Cement is brought to measuring buckets at each mixer from the melting kettles by compressed air. The mixers discharge directly into motor trucks on the driveway beneath them.

The Binder

The composition of binder by weight, as given by the average of a number of tests during the past year, is as shown in Table I.

For one mixer batch a predetermined amount approximately 25 lbs. of asphalt cement and 8.2 cu. ft. of binder stone are used. Binder shrinks in the mixing so that the resultant batch measures but 7.6 cu. ft. Fourteen batches fill a truck giving a load of 106 cu. ft., weighing about 5 tons. This amount lays 84 sq. yds. of 2 in. binder which compresses by rolling to 1½ ins.

The Top Mixture

An average analysis of topping mixture is as given in Table II.

A batch for the mixer consists of 8 cu. ft. of sand, 75 lbs. of limestone dust and 100 lbs. of asphalt cement. Twelve batches, 96 cu. ft., make a truck load weighing approximately 5 tons. This amount lays 66 sq. yds. of 2½ in. topping which compresses under rolling to slightly more than 1½ ins.

The asphalt gang on the street consists of 1 foreman, 8 spreaders, 4 rakers and 2 tampers, with a 5-ton and a 10-ton roller. A batch of binder lays 6 sq. yds. and of topping 5.50 sq. yds., therefore on the basis of a daily total averaging 1200 sq. yds., comprising both binder and topping, the cost per square yard of asphalt surface may be analyzed as shown in Table III.

The separate units in the plant are not described herein since descriptions of such installations are readily obtainable in various reference books. Of primary interest is the combination of units or plant layout which is shown in sufficient detail in the drawing. The unit prices used in the cost data are current ones and not necessarily those paid by the contractor. No attempt can here be made to set down in itemized form the cost of a contractor's plant operation and depreciation, overhead and other similar charges. The probable cost of asphalt surface per square yard may be obtained by adding to the figures thus far given in the present article known data pertaining to the operation of District of Columbia plant. Such plant is small and figures relative thereto are at least conservative when applied to a larger plant. The data would be as in Table IV.

Factors Favorable to Construction

The cost per square yard estimated in the preceding paragraph is approximately

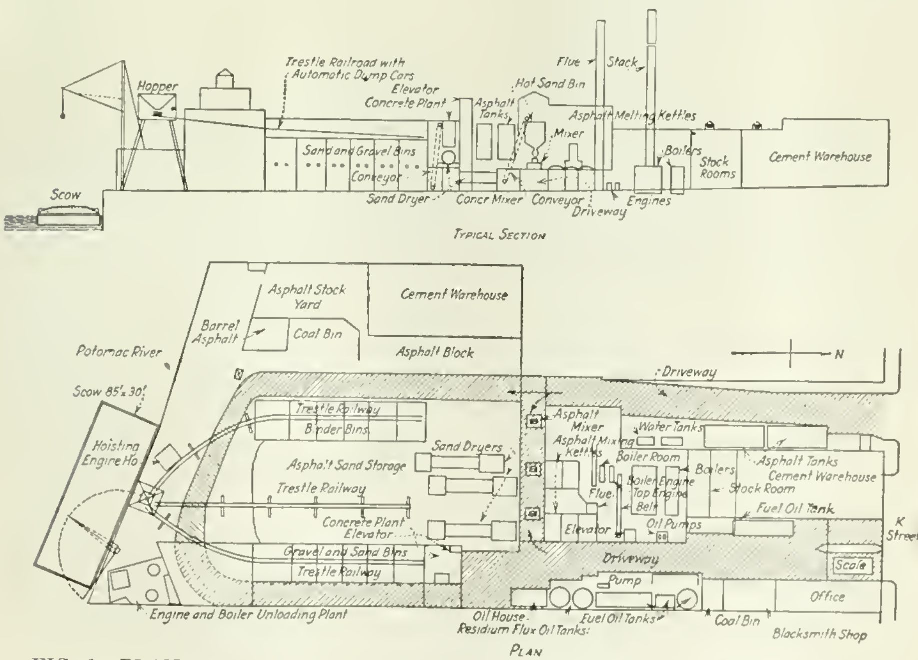


FIG. 1—PLAN AND TYPICAL SECTION OF PLANT OF A WASHINGTON, D. C., ASPHALT PAVING CONTRACTOR.

TABLE I—COMPOSITION OF BINDER BY WEIGHT.

Per cent passing the following mesh:

% Bit.	1½	1	¾	½	¼	10	20	30	40	50	80	100	200	Total
3.9	1.4	15.9	26.2	32.1	14.2	1.7	.7	.6	.5	.8	.3	1.4	1.3	100%

TABLE II—AVERAGE ANALYSIS OF TOPPING MIXTURE.

Per cent passing the following mesh:

% Bit.	1	¾	½	¼	10	20	30	40	50	80	100	200	Total
11.3	0	0	0	0	4.9	9.8	10.2	17.1	18.5	9.6	12.8	5.8	100%

TABLE III—COST PER SQUARE YARD OF ASPHALT SURFACE.

4.16 lbs. Asphalt Cement @ $18 per ton	= .037	
1.37 cu. ft. Binder Stone @ $2.88 cu. yd	= .146	
Total Material Cost for Binder		.183 per sq. yd.
18.18 lbs. Asphalt Cement @ $18 per ton	= .164	
13.63 lbs. Lime Stone Dust @ $4 50 per ton	= .031	
1.46 cu. ft. Sand @ $2.08 cu. yd	= .112	
Total Material Cost for Topping		.307 per sq. yd.
Hauling		.100 per sq. yd.
One Foreman @ $46.00 per week	$7 50 per day	
Ten Laborers @ $4.00 per day	40.00 per day	
Four Rakers @ $4.80 per day	19.20 per day	
	$66.70 per day	
Total for labor on street, 1,200 sq. yds		.055 per sq. yd.
Rolling		.030 per sq. yd.
Asphalt cost total outside of plant		.675 per sq. yd.

TABLE IV—UNIT COSTS FOR ASPHALT PAVEMENTS.

Concrete Base, Cost outside of Plant	$0.99 per sq. yd.
Asphalt Surface, Cost outside of Plant	0.68 per sq. yd.
Concrete Plant charges and operation	0.20 per sq. yd.
Asphalt Plant charges and operation	0.40 per sq. yd.
10% Overhead and 10% Contingencies	.45
	$2.72
15% Profit for Contractor	.48
Probable Contractor's Bid	$3.20 per sq. yd.

70 cts. less than usual bids during the late summer and fall of 1920. Many uncertainties have passed. Men, instead of bartering for higher wages, are anxiously seeking employment. Last summer contractors bought their materials subject to problematical increases because of freight rates. Shipments were erratic and contractors' forces were greatly slowed up thereby. Construction risks were at a maximum. Today conditions have changed; contractors are looking for work and an estimated reduction of 70 cents per sq. yd. is justified.

Sheet Asphalt on Concrete Base Meets Washington Conditions

For new construction, it appears that sheet asphalt on a concrete base meets Washington conditions, practically to the exclusion of other types. Of course, every possible protection is given the large investment represented by the great number of existing macadam streets, but all new work is habitually carried out with the sheet asphalt on concrete base standard in mind. In residential districts of a suburban nature and where it is desired to hold down present assessments, instead of a complete asphalt pavement concrete alone is laid, the mixture of cement and aggregate being much richer than that in the usual base for asphalt. These concrete streets are placed using the same crown formula as is used for asphalt construction, and additional height of curb above the roadway is shown over that for asphalt surfaces. This is in order that just prior to the appearance in the concrete of material signs of wear and after profitable use has been obtained, it may be surfaced with sheet asphalt. Thereafter the resurfacing cycle is expected to repeat every 25 or 30 years, the concrete itself being everlasting. However, the question of pavement types is one of design, a subject broad enough to require discussion in a separate article, and which it is hoped to treat of in the near future upon the completion of certain investigations now under way.

THE RAILROAD SITUATION YESTERDAY, TODAY AND TOMORROW

By E. A. Hadley, Chief Engineer, Missouri Pacific Railroad Co., St. Louis, Mo.

(Editor's Note: The following admirable and informative discussion of the railroad situation, which is of immediate concern to every citizen, was presented by Mr. Hadley before the Associated Engineering Societies of St. Louis on May 18, 1921, and printed in the Journal of The Engineer's Club of St. Louis for April, May, June, 1921. This discussion is so remarkably free from the customary partisan political and other forms of bias and prejudice and, withal, is so wholesome and refreshing in its tone that we consider it a credit to the engineering profession. The text is the author's; the editor assumes responsibility for the center headings.)

The three periods of time into which I propose to divide this discussion of the railroad situation places "Yesterday" as that period prior to March 1, 1920, "Today" as the period subsequent to that date up to the present moment, and "Tomorrow" as the future into which we can see but dimly and can only at best express our opinions and hopes based upon our past experience and the generally forward progress of our nation.

Amount of Railway Property

The first charter granted for the construction of a railroad, for the purpose of handling freight and passenger business, was in the year 1827, but it was nearly 20 years later before the real period of railroad construction was started in the United States and since which time a vast number of railroad companies have been formed, some of which are still operating lines of railroads and others of which have passed out of existence.

At the present time there are more than 1800 independent companies reporting to and under the control of the Interstate Commerce Commission in accordance with the Transportation Act of 1920, comprising a total main line trackage of about 265,000 miles.

Of these 1800 independent companies about 200 have an annual revenue in excess of $1,000,000.

During these 75 years, which period is within the life span of many persons who are still living and can remember the early days of railroads in this country, the business has grown to a point where the railroads together own about 2,400,000 freight cars, 69,000 locomotives and 57,000 cars designed for passenger service, and the total combined value of all railroad property is about $20,000,000,000.

Except for some assistance from the national government in the way of land grants and the assumption of certain obligations by some communities which expected to be benefited by the construction of a particular line of railroad, these properties have been built up almost wholly from private funds furnished in expectation of a satisfactory return on the money so invested.

Railway Regulation

Constructed under a competitive system, the service and rates in the earlier years were largely to the satisfaction of the railroads, the shippers and the public, but with the growth of the country and the rapid increase in the extent and power of some of the railroads, laws were passed discouraging further combinations and the Sherman Act and other similar laws practically stopped, not only the consolidation of competing railroads into one system, but also brought to a practical standstill those possible combinations which would result in more efficiently and economically serving certain large territories.

From a situation of practically no regulation or restraint under the law at their beginning, the railroads reached a point some eight or ten years ago, where they were so bound up and restricted by both federal and state laws and regulations, in some cases directly contradictory in adjoining states, that their operations were seriously handicapped and the situation was at least becoming uncomfortable.

Serious Plight of Railroads Just Prior to Federal Control

It is doubtless true that regulation was required in many cases, perhaps due to the ill-advised action of some railroad officials and financiers, but with one government body regulating the rates which might be charged on interstate movements of freight and passenger traffic and many of the state commissions trying to enforce rates on intrastate traffic, which were lower than the interstate rates, and therefore of supposed advantage to the citizens of such states, together with the multitude of general and specific laws aimed at railroads by the several state legislatures on the one hand and the demands of organized labor and the rising material market on the other hand, the plight of the railroads in the period just prior to federal control was indeed serious.

While some thought was given, previous to federal control of the railroads, to large consolidations of railroads into continental systems, the first real step of this kind came in the early part of 1917, when the railroads established their "war board" in an endeavor to co-ordinate the efforts of all railroads along proper lines to provide for the great increase in transportation of men and materials made necessary due to the entry of this country into the world war.

Financial "Breakdown"

A remark quite commonly heard in the early part of our participation in the war was that the transportation systems of the country had broken down under private management, making it necessary for the government to take over and operate the railroads.

I submit that if the railroads were broken down it was financially, due in a large part to unwise legislation and rates too low for profitable operation rather than physically, or in their ability to handle traffic, which conclusion is supported by the following facts:

In 1917 the railroads carried 127,000,000,000 ton miles more than they carried in 1915, and at the same time handled 200,000 empty cars, regardless of ownership, from one part of the country to another for war purposes.

Late in 1917, there was an excessive accumulation of loaded cars on the eastern seaboard, due in part to the severe weather conditions, but more largely to the fact that the railroads were delivering a greater tonnage than the capacity of the ships available for export and for our own manufacturers to handle.

War-Time Federal Control of Railroads a Wise and Necessary Measure

I believe, that under the then existing conditions, federal control of the railroads was a wise and necessary thing and prevented a more serious condition which otherwise would have prevailed, both physically and financially, as it firmly established the credit of the companies by the backing of our government at a time when most sorely needed.

This, in itself, to my mind, was sufficient justification for the action taken by the President of the United States in placing the railroads of the country under federal control on January 1, 1918.

Further, the director general of railroads appointed by the President was given full authority to consolidate railroads or separate them into two or more parts; to co-ordinate and operate them as he saw fit, regardless of federal or state laws which had so hampered the efforts of the private owners in their handling of traffic.

Priority Orders Created Confusion

Several branches of the government had also so encumbered the situation in the last months of 1917 by the issuance of "priority orders" for special and preferred movement of materials intended for war purposes that the utmost confusion was inevitable if this practice were further continued, as each department was insisting that its material be given preference in movement over that for all others.

Under the conditions of full control by the director general, there was moved in 1918 about 2 per cent more ton miles, and in 1919 about 7 per cent less ton miles of freight than were moved by the railroads themselves in 1917 under the direction of their self-constituted war board, but it is an open question as to what the railroads might have been able to accomplish if left to struggle along unaided and without relief from the burdensome laws and regulations with which they were hedged about.

Personally, I can readily imagine they might have been much worse off at the close of the war than the owners found them on their release from government control.

The act of Congress providing for federal control of the railroads stipulated that for the use of its property the railroad owners should be compensated in the same annual amount as its average net earnings per year for the three years ending June 30, 1917, and that the properties should be fully maintained by the government and returned to the owners at the termination of federal control in substantially as good condition in both roadway and equipment as when taken over on January 1, 1918, either by actual physical reparation or by payment to the railroad company the cost of such work as the director general failed to do, so that it might subsequently be done by the owners of the property.

Federal Control an Aid to Proper Maintenance

Taken as a whole, the railroads, while under the control of the government, even with increased freight and passenger rates, which it placed in effect, failed to earn the total amount of the compensation guaranteed by the Act and also the director general failed to fully maintain the properties, perhaps, due to causes beyond his control. However, it is estimated by the present director general that the cost to the government for the twenty-six months of federal control was about $1,200,000,000, of which amount a part has been paid and the balance must be paid from the national treasury.

No one can positively say that the railroads, if operated independently, would have been able better to maintain the physical condition of their property than did the director general with the full resources of the nation at his command, but it is my opinion that they would, as a whole, have been in much worse condition without this help.

Present Conditions

We now come to that period, beginning with March 1, 1920, which I have designated in this discussion as "Today," when the owners resumed operation of the railroads under the so-called "Transportation Act of 1920," which guaranteed to the railroad companies for a six months period ending September 1, 1920, the same average net return as they had reeceived during the federal control period. So far as I can ascertain, no reliable estimates have as yet been prepared which will show the total amount which the government owes the railroads for this six months "guarantee period," but it is safe to say that it will run into the hundreds of millions of dollars.

Subsequent to September 1, 1920, the carriers were to be permitted to earn as a whole a 6 per cent return upon their fair value, but not, as many supposed, a guaranteed return of 6 per cent on the value of any individual carrier.

Any net earnings of an individual railroad above 6 per cent are to be divided equally between it and the government, but if any railroad is unable to earn the full 6 per cent with earnings from the regularly established rates, that is its misfortune and it has nothing further coming to it from the government, but it may be permitted to borrow money at a reasonable rate of interest from the government fund expected to be accumulated from excess earnings of other roads to enable such weaker road to so improve its property and equipment as to enable it, if possible, to earn 6 per cent on its value.

A Greatly Increased Pay Roll Returned to the Railroads

The railroad administration passed on to the railroads, and the wage board, created by the Transportation Act, further added thereto, a greatly increased payroll brought about by an increase in the total average number of employes of 19 per cent, or from 1,753,000 in 1917 to 2,054,000 in 1920, and an increase in the total wages paid of 115 per cent, or from $1,739,482,000 in 1917, to $3,742,487,000 in 1920, and had the increase been in the entire year of 1920 instead of from May 1st, it would have amounted to 128 per cent.

Rate Increases

These wage increases and the high cost of materials and supplies made necessary a further increase in freight and passenger rates to an extent which the Interstate Commerce Commission felt would provide the 6 per cent earnings on the value of all railroad properties, which it placed at a total of $18,900,000,000, as against a value of $21,000,000,000 claimed by the railroads as represented by their combined capital accounts.

These rate increases were made in an amount ranging from 25 to 40 per cent and were made effective September 1, 1920.

Present Rates Have Not Contributed to Depression

Statements have been made to the effect that the present freight rates are so high as to restrict and even prevent the movement of traffic and have, to a large extent, contributed to the business depression now existing in the country.

Permit me to call your attention to the fact that the total increase in freight rates, compared to the average commodity value per ton of freight handled, is only two-tenths of one per cent greater than it was in 1914, before the world war.

With the tremendously heavy financial burdens added to the cost of running the railroads, such as increased wages, increased taxes, higher rates of interest on borrowed money, etc., I contend that two-tenths of one per cent net increase over 1914 freight rates equated to 1920 values of commodities shipped is not excessive nor is it so great as to appreciably add to the cost of commodities to the ultimate consumer or to restrict or prevent shipments of freight.

Railways Efficiently Handled Since Return to Owners

It has also been said that the railroads have not been efficiently handled since their return to private operation, but the facts show very conclusively to the contrary.

The best record ever made for any year before 1920, with respect to the average movement of all freight cars per day, was in 1917, under private operation, the average distance being 26.1 miles.

In 1918, under government control, this fell to 24.9 miles, and in 1919, still under government control, it fell to 23.1 miles.

For the year 1920 this movement was steadily improved, giving an average for the year of 24.9 miles, the average for the last four months being as follows:

September	28.1 miles
October	28.5 miles
November	26.8 miles
December	24.8 miles

The average number of tons per loaded freight car was greater in 1920 than in either of the three previous years. These averages were as follows:

1917	27.0 tons
1918	29.1 tons
1919	27.8 tons
1920	29.3 tons

As the increase of car movement of but a single mile a day is equivalent to the addition of 100,000 new freight cars, this improved mileage, together with the increase loading per car, does not indicate inefficient management or restriction of transportation facilities.

Again, the best average train load for any month previous to 1920 was in September, 1919, under government control, when the average train carried 778 tons.

Eleven months later, however, under private control, in August, 1920, the record was again broken, the average train load in the United States for that month being 788 tons.

It has also been said that the railroads have not been properly managed since their return to private control and that operating expenses have not been properly controlled and have been excessive.

Why Operating Costs Are Excessive

I agree that the operating costs have been excessive, but properly to place the responsibility for such results, the underlying conditions must be known and understood.

The government, under the law, prescribes the charges from which operating revenue must come and likewise fixes the wages, through the government wage board, which wage constituted 64 cts. of every dollar of operating expenses in the year 1920.

Out of every dollar of operating expenses during that year 30 cts. were paid out for material and supplies.

The government operated the roads for two months of 1920 and, accordingly, agreed to the prices of materials and supplies for these months, as well as incurring all the operating expenses for these months.

The government also purchased or contracted for large quantities of materials and supplies which were passed over to the carriers on the return of the roads to private operation and these materials and supplies were, of necessity, charged into operating expenses for 1920 at prices fixed for the carriers by the government in making the purchases.

It is conservatively estimated that one-half of the materials and supplies used in the year 1920 were thus charged into operating expenses for that year at prices fixed by the government. Thus it is evident that 15 cts. out of every dollar of 1920 operating expenses for material and supplies was also fixed by the government.

All operating expenses (other than for labor, material and supplies) for the first two months of 1920 amounted to about 3.5 cts. of every dollar of operating expenses for the full year.

These were incurred by the government and not by the carriers.

Summing up, this means that 64 cts. for labor, 15 cts. for material and 3.5 cts. for other expenses, a total of 82.5 cts. out of every dollar of operating expenses for the year 1920 were paid out at prices directly fixed by the government.

The balance of the materials and supplies used during the year 1920 were purchased by the carriers at prices fixed by general market conditions, beyond their power to control, and which cost another 15 cts. out of every dollar expended.

In short, prices fixed by the government and by market conditions cover 97.5 cts. out of every dollar of operating expenses for the calendar year 1920.

This analysis, I believe, makes clear the very narrow limits within which efficiency of management might be used to control the remaining 2.5 per cent of the operating expenses, including transportation costs, and I think establishes the fact that by far the largest contributing cause to the abnormal amount of operating expenses for 1920 is the cost of labor.

The Future

Now, as to the future, the "Tomorrow" which I have heretofore mentioned. Railroads are subject to the same economic laws as is any other business and the decline in traffic and the failure of many commodities to move is not due to high freight rates, as above demonstrated, or any fault of the railroads who are suffering with others in a period of depression following a period of tremendous inflation. This is a situation of world-wide incidents arising from understandable causes, most of them having their origin in the world war.

Either rates must be further increased or operating expenses must be reduced; if possible, to a point where rates can be lowered. This means wage reductions for railroad employes and such changes in the present indefensible working agreements as will promote efficiency and insure a full day's work for a full day's pay.

These changes, with a probable falling market for material and supplies, should bring about a greater and necessary margin between revenue and expenses, which is absolutely essential if the railroads are to continue to operate properly and expand to meet the needs of this growing country of ours.

That government body having control over the revenue of the carriers must also be charged with responsibility for the wage schedules which go to make up so large a part of the operating expenses if we are to continue to have railroad wages regulated by the government, instead of by the natural laws of supply and demand, otherwise we will continue to see the rates which provide the revenue following the lead of the wage board, thus giving that board far greater control over the ultimate cost of transportation than I believe the Congress of the United States ever intended it should have when the Transportation Act of 1920 was passed.

The credit of the railroads must be maintained by allowing reasonable net earnings.

There will mature in the four years, including 1921, the following obligations of the railroads, which constitute a part of their funded debt and which must be paid off or refunded.

1921	$322,473,000
1922	136,196,000
1923	82,648,000
1924	19,900,000

It would seem that if we can safely get through the present year, the worst of the financial situation will be over, but relief from the present situation must be speedily secured.

Predicts Consolidation Into Large Competitive Systems

I believe that the comparatively near future will see consolidations of the railroads into large competitive systems of from 15,000 to 20,000 miles each along the lines suggested in the Transportation Act of 1920, and that such consolidations will be worked out in spite of the seemingly almost insurmountable difficulties involved in the way of financial and legal complications.

The growth and development of our nation demands such co-ordination of our transportation facilities as will retain the good features of a centrally controlled railroad system for the entire country and still have the benefits which are the result of healthy competition between the carriers.

I believe that the railroads are about to pass out of the most trying situation which has ever confronted them and that they will shortly be on a substantial and satisfactory basis, following and perhaps leading in the general recovery of business and that we will continue to have, as at present and in the past, the most efficient railroads in the world operated at the lowest cost for freight and passenger movement.

HIGHWAY RESEARCH ON A NATIONAL BASIS

By Alfred D. Flinn, Vice-Chairman, Advisory Board on Highway Research.

The Advisory Board on Highway Research, of the National Research Council, announces that it has engaged as director, William Kendrick Hatt, Professor of Civil Engineering and Director of Materials Testing Laboratory, Purdue University, Lafayette, Ind. He is a member of the American Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association and other technical societies. His work as an investigator in organizing the timber investigations of the U. S. Forest Service, and in other engineering and scientific fields for the past 20 years, is well known. Director Hatt began his duties July 1. His office is in the building of the National Research Council, 1701 Massachusetts avenue, Washington, D. C.

How the Advisory Board Was Established.

This Advisory Board was established by the Division of Engineering, of National Research Council, with the co-operation of Engineering Foundation, as the result of a conference held in New York, Engineering Societies Building, last November, attended by many representatives of national engineering societies, associations of vehicle and road materials manufacturers, Federal Bureau of Public Roads, State Highway Departments and universities.

By the terms of the by-laws, the membership of the Advisory Board is composed of those organizations of national importance interested in design, construction, economics, maintenance and financing of highways, in materials and equipment therefor, and in vehicles used on highways; governmental departments and bureaus of similar interests, and higher educational institutions.

Organization Members.

The present organization members are:

American Association of State Highway Officials.

American Concrete Institute.

American Institute of Consulting Engineers.

American Society of Civil Engineers.

American Society of Mechanical Engineers.

American Society for Municipal Improvements.

American Society for Testing Materials.

Association of American State Geologists.

Bureau of Public Roads, U. S. Department of Agriculture.

Corps of Engineers, U. S. Army.

Engineering Foundation.

Federal Highway Council.

National Automobile Chamber of Commerce.

National Highway Traffic Association.

Society of Automotive Engineers.

Officers and Purposes of the Board.

The officers of the Board are: Anson Marston, Chairman, Director, American Society of Civil Engineers, member of Iowa State Highway Commission, and Dean of Engineering, Iowa State College; Alfred D. Flinn, Vice-Chairman, Secretary, Engineering Foundation, and Vice-Chairman, Division of Engineering, National Research Council. Other members of the Executive Committee are Thomas H. MacDonald, Chief, Bureau of Public Roads, Department of Agriculture; George S .Webster, President, American Society of Civil Engineers, Consulting Engineer, formerly Director, Department of Wharves, Docks and Ferries, Philadelphia; Henry M. Crane, Chairman, Research Committee, Society of Automotive Engineers; W. H. Hatt, Director.

In addition to the member organizations, 13 State highway departments and more than 40 universities have definitely signified their interest in the work of the Advisory Board and their willingness to co-operate.

The purposes of the Board are:

(a) To assist existing organizations in outlining a comprehensive national program of highway research and co-ordinating their activities thereunder.

(b) To organize committees for specific problems.

(c) To act in a general advisory capacity.

(d) To serve as a clearing house for highway research information.

Three Technical Committees Already at Work.

Three technical committees have been at work for a number of months. These are:

1. Committee on Economic Theory of Highway Improvement, Chairman, Professor T. R. Agg, Iowa State College.

2. Committee on Character and Use of Road Materials, Chairman, H. S. Mattimore, Engineer of Tests, Pennsylvania State Highway Department.

3. Committee on Structural Design of Roads, Chairman, A. T. Goldbeck, Engineer of Tests, Bureau of Public Roads, Department of Agriculture.

The Executive Committee of the Advisory Board has the creation of additional committees under advisement, such as Committees on Vehicle Design as Related to a Road, on Economics and Cost of Transport, on Financing Highway Improvements, on Traffic Studies, and on Organization of Construction Plants.

Much valuable experimental research work is being done by the Bureau of Public Roads, the U. S. Army, several State highway departments, the universities, and a few associations of manufacturers of vehicles and materials.

Two of the most important elements of the strength of the Advisory Board are the membership and the active participation of the Bureau of Public Roads and the Army Engineers. The Bureau is represented by its Chief, Thomas H. MacDonald, who is supporting the research work most loyally and intelligently. To represent the Engineer Corps of the Army, the Chief of Engineers appointed Colonel E. Eveleth Winslow, stationed at New York, and the appointment was officially confirmed by the Secretary of War. Major Mark L. Ireland, of the Quartermaster's Corps, is a member of the Committee on Economic Theory of Highway Improvement. During the summer, with the cooperation of the Massachusets Institute of Technology, Major Ireland will conduct at Cambridge, Mass., an important series of tests on the traction resistance of vehicles and of road surfaces. Equipment and supplies have been provided and the necessary assistants assigned by the army.

Comprehensive Plan for Highway Research

Director Hatt's work is expected to stimulate experimental work by such organizations to much greater activity, just as the work of the existing committees of the Board has already had a stimulating effect. The Director, in consultation with the Advisory Board, will prepare a comprehensive plan of the field of highway research, including Economics, Design, Construction and Administration, and will arrange a program of committee work for those fields that need to be occupied immediately.

The personnel of these committees will include active research workers within the state highway commissions, the universities, the governmental departments and other research organizations. A census will be taken of the research work completed and current, and the various research agencies will be invited to cooperate in an attack on those urgent problems upon the solution of which the future success of highway transport depends.

Direction, Not Duplication, of Effort

The Advisory Board will not duplicate the efforts of existing research groups. Indeed, it will not do any research work directly, but will act rather to promote a co-ordinated effort in a consistent national program, suggesting problems to those organizations best fitted to attack them. It will also serve as a clearing house for information.

As one Highway Commissioner has expressed the present need, "I have $10,000,000 to spend on roads in my state this year. I know that I could save $500,000 by properly directed research studies. If your board will tell me what other states are finding out and what research work I should do to supplement their efforts, I will supply all the necessary men and funds." When it is considered that the funds available for the road construction program alone in the United States represent the expenditure of $1,000,000,000, the cost of the overhead organization, such as that of the National Research Council, to unify research, is insignificant. There is abundant money available for the research itself. The Advisory Board on Highway Research, of the National Research Council, is in a position to co-ordinate such expenditures in a comprehensive national program.

An informational service, giving the results of current studies and advances in the art, will be supplied to various cooperating bodies at frequent intervals.

The program for highway research will not be limited to problems concerned with the construction and maintenance of roads from the ordinary engineering standpoint. It will also consider those important problems of economics of transport upon highways in relation to other transport agencies, the relation of the design of vehicles to the character of road construction, and the important problems of administration involving traffic regulation, fees and maintenance.

This is the first effort seriously to attack the whole problem of highway transport. With the earnest desire of all interested to co-operate, the efforts of the National Research Council, seconded by Engineering Foundation and the national societies of engineers, should be effective.

WHAT AN EMPLOYER REQUIRES WHEN ENGAGING AN ENGINEER

By Frank D. Chase, of Frank D. Chase, Inc., Engineers, 645 North Michigan Ave., Chicago.

(Editor's Note: This very helpful talk, on a subject of vital interest to all engineers, was given by Mr. Chase at the Employment Conference held in Chicago under the auspices of the American Association of Engineers.)

The employer divides his resources into material and labor. Material in any form whatever is represented by capital or represents capital.

The inventory or list of assets of any firm take cognizance only of material as representing capital investment. The banker looks at the inventory before making his loan, corporations are financed on the inventory and all the plans of a going concern are based on inventory, or some form of material investment.

I have to speak briefly of the other of these two subdivisions of industry; that is, labor, and specifically of the engineer and of his being employed—in other words, I am to discuss what an employer requires when engaging an engineer.

It is quite true that material forms the basis of inventory or a value measure of a going concern, but an important although intangible thing is the element of labor. By labor I do not mean merely manual or physical effort—labor is defined as mental or physical activity.

It is quite true that the banker looks at the physical inventory when making his loan, but it is also true that without the consideration of labor, or personnel, the inventory does not go very far with the banker, nor does it go very far with the average business man; in other words, the labor or personnel of an establishment or institution is quite as important as the material element and frequently far exceeds it in importance.

The U. S. Steel Corporation, with its hundreds of millions of invested capital, would be a failure as a going concern without the guiding master mind of Judge Gary and his able subordinates who execute the policy of the corporation. Without the personnel who comprise the management of this corporation it would consist of merely an aggregation of large manufacturing plants, which might or might not produce profitably and which could not exist were it not for the intellectual labor which controls and executes.

The men, then, who execute and form the big part of the personnel of the organization must be considered as of the utmost importance and their selection carefully studied in order to secure a proper personnel.

The apprentice of today is the executive of tomorrow, and the necessity of care in the selection of men is recognized by the modern employer, regardless of the character of the position or its relative importance in the organization. The large corporations frequently make the same complete investigations and analysis in the employment of an office boy that is made in the selection of a ten-thousand-dollar man.

What I have said may be considered in the light of a generality, but it is not; I have merely stated a few fundamentals, and they apply with equal force to the employment of the engineer. This is particularly true in the light of present-day practice of using engineers or men of engineering training and some engineering experience in responsible positions in almost every line of industrial activity.

Realizing the importance of the proper personnel of an organization, the employer who does not formulate a very definite plan for the employment of his assistants is making a very serious mistake, and I shall outline briefly, from my own experience, what appears to me as being the important considerations.

It seems rather unscientific to speak of "hunches," but when I interview a man for employment it takes me considerably less time than it has taken me to say it to size up a man and place him. Subsequent conversation and data serve to corroborate or verify my first impression. The first size-up naturally separates itself into two divisions; first, the physical qualifications of the man; second, the mental qualifications. Physical qualifications should include good health, which is reflected by an upright, alert bearing, and personal appearance as indicated by clothing and the way it is worn. In 99 times out of a hundred, a man's physical appearance does indicate to a great measure his mental characteristics and qualifications and thereby reflects his personality, of which I shall speak later.

A man's mental attitude is reflected by the style of his greeting and one can determine a man's ability of presentation by the way he presents himself.

Characteristics which one notes are aggressiveness, tempered by good taste or breeding, straightforwardness, or clear or logical thinking which is exhibited by a man's ability to state his case briefly and without undue loquaciousness. His mental qualifications and mental capacity are indicated at the outset by these manifestations, all of which may be determined within a minute's time. The facts may then be brought out which are essential in any engineer, and these include:

First—Loyalty.
Second—Personality.
Third—Experience.
Fourth—Education.

I have outlined these four principal items in the order in which they appear to me as being essential and in this order can the facts be determined when employing a man. I place loyalty first. This word is susceptible of rather a broad interpretation and this is the interpretation I put upon it. Loyalty means loyalty or honesty of conviction or purpose, first, to one's self. If one is loyal to his own conviction of right he is loyal to his employer.

When I started out a few years ago as a cub engineer I took the attitude that I had no boss but my own conscience and ambition. It has been my experience ever since leaving college, and beginning as a rodman, that I have been in responsible charge of work without coming in contact personally with a boss. My first job, as I say, was a rodman. As a matter of fact, I had a small party of men in the field, and it was my pleasure, although not necessary, to report about once a week to the engineer in the division, comprising about 300 miles, outlining to him what I had done during the past week or so and what I proposed to do. The execution of that work was in my hands entirely—I could work all day, play all day, and nobody was the wiser, and it was strictly up to me. I was governed entirely by a sense of loyalty, and when I say loyalty to myself and my feeling that I had no boss, I mean it was simply up to me to make good for my own best interests, because therein lay the best interests of my employer. I figured that if I made good for myself I was making good for my employer. Of course this is true—if I make good for my employer I make good for myself, but as an individualist I put it the other way around, and we are all individualists in the last analysis. We are all out for what we can get—nearly all of us with the thought of getting it honestly—some, and they are few fortunately, with the thought of getting it dishonestly.

Loyalty to one's self and one's employer means honest work, and its reward, promotion, increase of responsibility and salary—and the men who have the ambition to attain these are the men we are looking for.

The simple test for loyalty is to get the applicant to talk about his present or former employers—the man with a grievance should be watched, and the man who criticises his treatment and lack of opportunity is usually lacking in loyalty. I believe that it is the exception rather than the rule that a man fails to get proper consideration of his services and opportunities for advancement. Opportunities abound; the average man is waiting for the opportunity for advancement to be given him. It won't be, but he can, in a million ways, seize the opportunity and profit thereby.

My second classification is *personality*—rather difficult to define, but to me it means the expression, outwardly, of one's self. We speak of an agreeable, a strong, dominant or compelling, or an intelligent personality. All the knowledge in the world is of no avail if one cannot apply it and use it for the benefit of those whom he is paid to work with.

The right personality permits a man not only to do himself and his work justice, but to co-operate with his fellow-men, developing thereby teamwork—a vital necessity for the proper functioning of any organization.

A man's personality is reflected by his every act and speech, oral or written, and therefore can be observed at any and all times, and easily studied during an interview.

My third qualification is experience. I grant that without experience, loyalty and personality are without value, but mere experience is a drug on the market. There are too many men who can teach us the contents of all the engineering text-books in the library, and they call themselves engineers—I do not so consider them. It takes more than mere technical knowledge to earn the title engineer. For a given job, however, certain experience is essential, and it is an easy matter to determine whether or not an applicant fits, so far as experience goes. References as to experience and other capabilities are, in my opinion, of little value, and I place little value upon them. It is a rare occasion for me to condemn a man in such a way that I interfere with his chances for employment, and I believe that is true of most of us.

Experience is not always a matter of years—there again does personality enter, and one man's work for a year may better fit him for a similar line of work with greater responsibility than five years' work by another man.

Experience is a splendid, if somewhat costly, teacher, but the man of judgment learns rapidly.

Education is the last of my qualifications, and the least important. It's not what a man has learned, but what he knows, and his ability to apply his knowledge. By application I mean, for instance, the knowledge of where to find specific data—that's better than burdening the mind with masses of statistics which cannot be relied upon.

The college man has a splendid advantage, or a serious handicap, depending on how he makes use of his education. The man who digs out his education in a night school better appreciates what he has—he got it because he wanted it—not because it was handed to him. The percentage of successful correspondence or night school graduates is high, I imagine.

These four qualifications are all susceptible of record, and a record can be made of each, and many large corporations are giving keen study and analysis to the men whom they employ. These records are used not merely as an entrance requirement, but are the basis of transfer and promotion. In other words, the employment of men is being put on a scientific basis—a good job for the engineer.

In closing I want to say, without apology, that I have treated this subject briefly, but have, I believe, covered the essentials. The points discussed are, I believe, fundamental.

Whether you agree with me or not, I do not think there is much difference in the fundamental analysis required, whether we are employing engineers or street-sweepers.

It's a matter of common sense, which Professor Swain used to say should be called "uncommon sense"—it is so rare. Engineering is merely the application of common sense to a specific field of human endeavor, and we want men, not automatons.

VALUABLE TRADE LITERATURE

Ladder Type Excavators.—Bulletin 25X is a new 16-page publication of the Pawling & Harnischfeger Co., of Milwaukee, describing P. & H. Ladder Type Excavators. Specifications and descriptions of all parts of these trench digging machines are included as well as many illustrations of work done and excavators in action on various jobs. Brief reference is also made to the new P. & H. "206" Excavator-Crane with full corduroy traction.

Shovel Attachment for Excavator Cranes.—The new P. & H. Shovel Attachment for use with standard P. & H. types 205 and 206 Excavator-Cranes is described in a Pamphlet SX just published by the Pawling & Harnischfeger Co., of Milwaukee. Illustrations of the shovel attachment in use are shown and the economy of being able to use either the 30-ft. crane boom or the shovel boom is pointed out. With the extra expense of only the shovel attachment, the number of applications of this material-handling and digging machine is increased—the shovel, it is said, having the ability to do the work of any steam shovel of equal weight.

Asphalt Mixing Plants.—The several types of asphalt mixing plants produced by the Iroquois Department of the Barber Asphalt Paving Co. are illustrated and described in a booklet recently issued by that company.

Waterproofing of Concrete.—The waterproofing of concrete is a subject on which there is not an over-abundance of information in textbooks. In Technical Pamphlet No. 8, The Truscon Laboratories of Detroit, Mich., an effort is made to supply a textbook on the fundamentals of this important subject. It has the advantage of brevity. It can be read in half an hour. The pamphlet will be sent free to any architect, engineer or builder so requesting.

What is Your Highway Problem?—A beautifully bound portfolio entitled, "What is Your Highway Problem," has just been issued by the Asphalt Sales Department of The Texas Company. This portfolio describes briefly and concisely, yet thoroughly, the steps in the construction of the various types of asphaltic pavements and roads. Each type of construction is thoroughly illustrated with photographs, and some of these photographs are supplemented by drawings and cross sections.

The types of asphaltic construction discussed are Sheet Asphalt, Asphaltic Concrete, Asphalt Macadam, Asphalt for Surface Treatment, Asphaltic Road Oils, Asphalt Filler, Asphalt Foundation, the use of Asphalt to Resurface Worn Block and to Resurface Cement Concrete. The portfolio begins with a description of Texaco Highway Service and concludes with a list of Texaco products and their various uses.

This booklet may be obtained free by addressing The Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Modern Road Building and Maintenance.—This book has been prepared for the use of engineers, contractors, road officials, students and all who are interested in the rational and economic solution of the many problems connected with our public roads and traffic they are required to carry. The book was written by Andrew P. Anderson, Highway Engineer of the Bureau of Public Roads. It contains chapters on Planning the Road; Road Materials; Road Construction; Road Maintenance and Repair and Use of Explosives. A copy will be sent free to anyone making a written request to the Hercules Powder Company, Wilmington, Del.

DETERMINATION OF BEARING POWER OF SUBGRADE UNDER REPEATED LOADS

By H. F. Clemmer, Testing Engineer, Illinois Division of Highways, State House, Springfield, Ill.

In an attempt to determine the action of the subgrade under hard-surfaced roads when subjected to repeated loads, such as would be caused by the movement of heavy vehicles on the surface, the Illinois Testing Laboratory has designed a new apparatus termed the Repeating Load Bearing Power Determinator.

It has been found that the pressures to which a subgrade under a hard-surfaced road is subjected, can be of three kinds, depending upon the way in which the load is applied to the surface. If the surface is rough or if a truck wheel hits an obstruction an impact force is produced, while if a truck stops for any appreciable length of time a static load is occasioned on the subgrade.

The action of the subgrade under these two classes of loads is being studied by use of the Goldbeck Impact Bearing Power Determinator and the Illinois Static Load Bearing Power Determinator.

Hopwood to Brownfield Road, Fayette Co., Pa., built with "Tarvia-X" penetration method in 1917

A substantial Slag Road built with Tarvia—

The photograph above shows a section of the Hopwood to Brownfield Road, South Union Township, Fayette County, Pa.

This road was built over an old water-bound base by the Township Supervisors with their own forces. A five-inch course of Dunbar Bank slag was used as road metal. The slag was bound with "Tarvia-X" applied by the penetration method. A deferred "Tarvia-B" seal coat was applied two months after completion.

This is now a mighty fine piece of road that is proof against heavy traffic. With occasional Tarvia maintenance, it will last for many years, forming a mudless, dustless, automobile-proof highway of which any community might well be proud.

This is just another example of the fact that no matter what sort of a road problem town or highway officials encounter, they can turn to Tarvia with the comfortable knowledge that there is a grade and a method of application of this versatile coal-tar preparation to help them out.

Illustrated booklets describing the various Tarvia treatments, free on request.

Tarvia

For Road Construction Repair and Maintenance

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 any one interested. If you will write to the nearest office regarding road problems and conditions in your vicinity, the matter will be given prompt attention.

New York, Chicago, Philadelphia, Boston, Detroit, New Orleans, Birmingham, Kansas City, Salt Lake City, Seattle, Peoria, Atlanta, Johnstown, Lebanon, Youngstown, Toledo, Elizabeth, Buffalo, Baltimore, Omaha

The Barrett Company

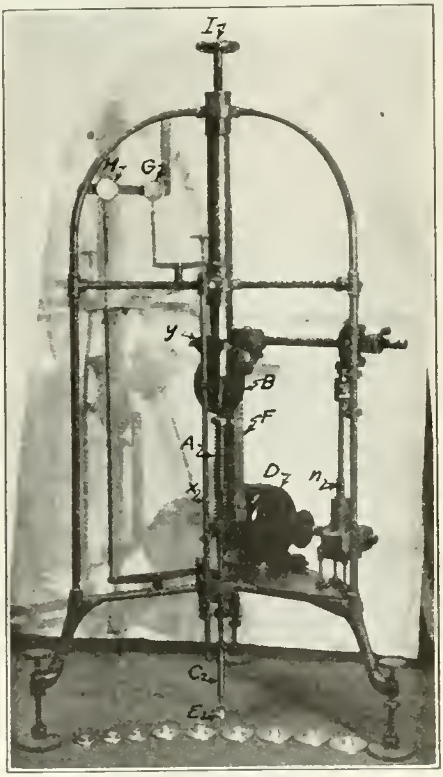
St. Louis, Minneapolis, Duluth, Columbus, Jacksonville, Cleveland, Dallas, Milwaukee, Richmond, Houston, Cincinnati, Nashville, Bangor, Latrobe, Denver, Pittsburgh, Syracuse, Washington, Bethlehem

THE BARRETT COMPANY, Limited: Montreal, Toronto, Winnipeg, Vancouver, St. John, N. B., Halifax, N. S.

The Illinois Repeating Load Bearing Power Determinator is being used for making a study of the subgrade when subjected to a third condition—that of a great number of vehicles passing over the surface. The first two devices allow a study of the subgrade when subjected to impact and static loads, while with the repeating load device the subgrade action can be noted when subjected to a load increasing from zero to a maximum and then back to zero again, in approximately the same time and of the same magnitude as would be occasioned by a heavy motor truck wheel moving over a rigid surface.

The Determinator

Briefly described, the Determinator, shown in the accompanying illustration, consists mainly of a pipe frame in which



VIEW OF ILLINOIS REPEATING LOAD BEARING POWER DETERMINATOR.

is mounted: a spring (A) for producing pressure; a cam (B) which varies this pressure; a plunger (C) which transmits this pressure to the soil; a 1/6-h.p. D.C. motor (D), which drives the cam at a constant speed of six revolutions per minute; a footing (E) which is attached to the bottom of the plunger and distributes the pressure to the soil (footings of different areas are shown at the bottom of the machine in the illustration); a scale (F) upon which the pressure desired is set; an Ames dial (H) which registers the action of the soil under the repeating loads; a wheel (I) which lowers the cam section, and a second Ames dial (G) which registers the vertical movement of this section. Motor power is furnished by a power unit carried on the truck which transports the Demonstrator.

Action of the Apparatus

The machine is leveled up so that the plane of the footing on the bottom of the plunger is parallel with the surface of the soil. By means of loosening setscrew (n) and applying a crank to shaft leading to the cam, the pointer on the upper end of the spring is set approximately to the pressure desired. Fine adjustment of the pressure can be made by turning the lower bearing upon which the spring rests. Setscrew (n) is then tightened and the power unit attached. The motor, in causing the cam to revolve, varies the pressure on the soil from zero to a maximum and then back to zero six times per minute. As the soil is deflected under the pressure applied, it is necessary to lower the cam section in order that the pressure remain constant. This lowering movement is accomplished by turning wheel (I), and is registered on dial (G). Dial (H) registers to the 10,000th part of an inch the action of the soil beneath the footing.

In order that the soil might be permitted to recover from the pressure without being opposed by the dead load of the plunger-section, it was necessary to design an attachment which would carry this load immediately after the pressure was released. A shaft (x) and a counter-cam (y) were attached to the frame to pick up this load and carry it until just before the pressure was again applied.

Variable sized footings are being used in order to get some relationship between the action of soil under loads applied to different areas. The loads applied to these footings vary between 5 and 50 lbs. per square inch.

This apparatus is at present being used in the subgrade investigational work carried on in connection with the Bates Experimental Road. With the co-operation of the U. S. Bureau of Public Roads an attempt is being made to correlate the results obtained in the field with the soil-bearing power values as indicated by the experiments carried on in the laboratory at Washington.

WATER WORKS SECTION

SWIMMING POOL OF THE LOUISVILLE WATER COMPANY, LOUISVILLE, KY.

By James B. Wilson, Chief Engineer and Superintendent, Louisville Water Co., Louisville, Ky.

Realizing the growing popularity of swimming, not only as a sport and recreation, but the interest of the public in the necessity of learning to swim, the Louisville Water Company conceived the idea of building a pool and bath house on their property at the Crescent Hill Reservoir Park for the general use of the citizens of Louisville. Plans were developed during the winter months and a contract let April 1, 1919, for the lump sum of $93,000. The pool was completed and opened to the public July 25, 1919, at a total cost of $115,000.

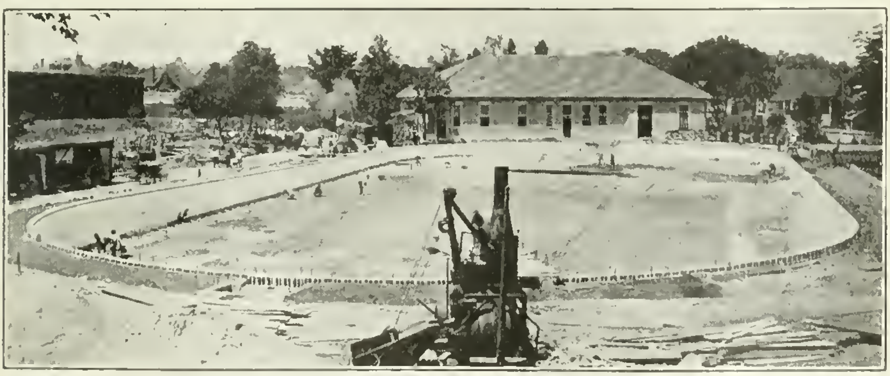
The works consist of a bath house 60x125 ft., constructed of hollow tile walls, stuccoed; cement floor; steel roof trusses and tile roof, and a swimming pool, rectangular in shape, with rounded ends, 120 ft. wide by 275 ft. long. For a distance of 60 ft. at the shallow end the water is 3 ft. 6 in. deep and slopes uniformly over the entire width of the pool to the deep end, where the water is 8 ft. deep. Around the entire pool are two concrete walkways, each 6 ft. wide; one for the swimmers, the other for the spectators, and separated by two lines of 3-in. pipe railing with 8-in. concrete posts on 6-ft. centers.

The walls of the pool were designed as cantilevers on spread footings and reinforced both horizontally and vertically. There is sufficient horizontal steel in the walls safely to take care of a change in

INTERIOR OF BATH HOUSE AT THE SWIMMING POOL OF THE LOUISVILLE WATER CO.

temperature of 120 degrees, and no cracking has developed. The concrete was waterproofed with integral waterproofing and is entirely watertight.

The conspicuous feature of the design is the bottom of the pool, which is a solid slab of concrete 8 ins. thick and reinforced with ½ in. square rods, 12 ins. center to center. The bottom was poured in one operation. Where the bottom joins



CONSTRUCTION VIEW OF CONCRETE SWIMMING POOL BUILT BY LOUISVILLE WATER CO.

the vertical walls of the pool a 1-in. expansion joint was filled with asphaltum around its entire periphery. With this exception there are no expansion joints in the structure.

The pool was built in a swamp which at one time had been a small lake, so that securing good foundations was difficult. The bottom slab of the pool, however, was laid on soft mud taken from the old lake excavation. While there is considerable difference in pressure on the bottom due to the depth of the water, there has been no settlement and the entire pool is watertight. The bottom of the pool was float finished and the sides covered with white enameled brick, including enameled terra cotta life rail at the top. The water level of the pool is maintained within 6 ins. of the sidewalk around the pool.

No provision was made for taking off the surface water at intervals around the edge of the pool. The water enters at one end and flows to the opposite, where it is discharged through eight openings in the life rail into a small lake 6 ft. below. Daily tests were run of the pool water, in the laboratories of the Water Company, and at no time was the water found unsafe for drinking purposes. This was controlled by increasing the water supply to the pool and varied from 250,000 gals. to 750,000 gals. per day. The entire pool holds 1,200,000 gals.

Dressing rooms are arranged on each side of a general lobby for men and women. One thousand lockers are provided for the men and 600 for the women, and supplemented with two check rooms where clothes are checked after being hung on coat hangers placed in paper bags. The keys for lockers are kept in the check rooms and an attendant opens and closes all lockers. By this method few articles of clothing are lost and little confusion exists. All valuables and money are checked in the general lobby before entering the bath rooms.

As many as 1,800 have been in the pool at one time and the average attendance was approximated at 2,200 per day. The general admission is 25c for adults and 15c for children. This charge includes bathing suit, soap and bath towel.

Four maids are on constant duty in the women's dressing rooms; in the men's dressing rooms and showers there are six attendants, including two janitors. On the pool are six life guards who are on duty from the opening till the closing hours of the pool; that is, from 10 a. m. to 10 p. m.

VIEW OF THE FINISHED CONCRETE SWIMMING POOL, LOUISVILLE WATER CO.

PUBLIC WATER SUPPLIES FROM SMALL STREAMS

By James P. Wells, Hydraulic Engineer, Cutler Bldg., Rochester, N. Y.

The construction of storage reservoirs has largely been in connection with hydraulic works of considerable magnitude. Nearly everyone is familiar with the large storage reservoirs recently constructed by the city of New York and other large cities of the country, yet not enough attention has been paid to the possibilities of obtaining in the same way adequate supplies of water for small cities.

There are many small cities of from five to fifty thousand people in population which could obtain a much more economical and better supply of water than they now get by pumping water, by the construction of reservoirs on small streams and by making these reservoirs large enough to conserve practically the entire runoff of the stream.

The writer has been asked on a number of occasions to make some suggestions as to improving the water supplies of such cities, and has in several cases found that it was entirely possible to get a very economical gravity supply from small streams which were practically dry during the summer months. While they were dry in the summer months, yet in the spring of the year they were for a very short period raging torrents, and the writer knows of several instances where sufficient water has passed down a stream with a very small watershed in three or four days completely to fill a large reservoir. These streams have never been considered or never thought as possible sources of water supply because of the extreme low water conditions during the summer months.

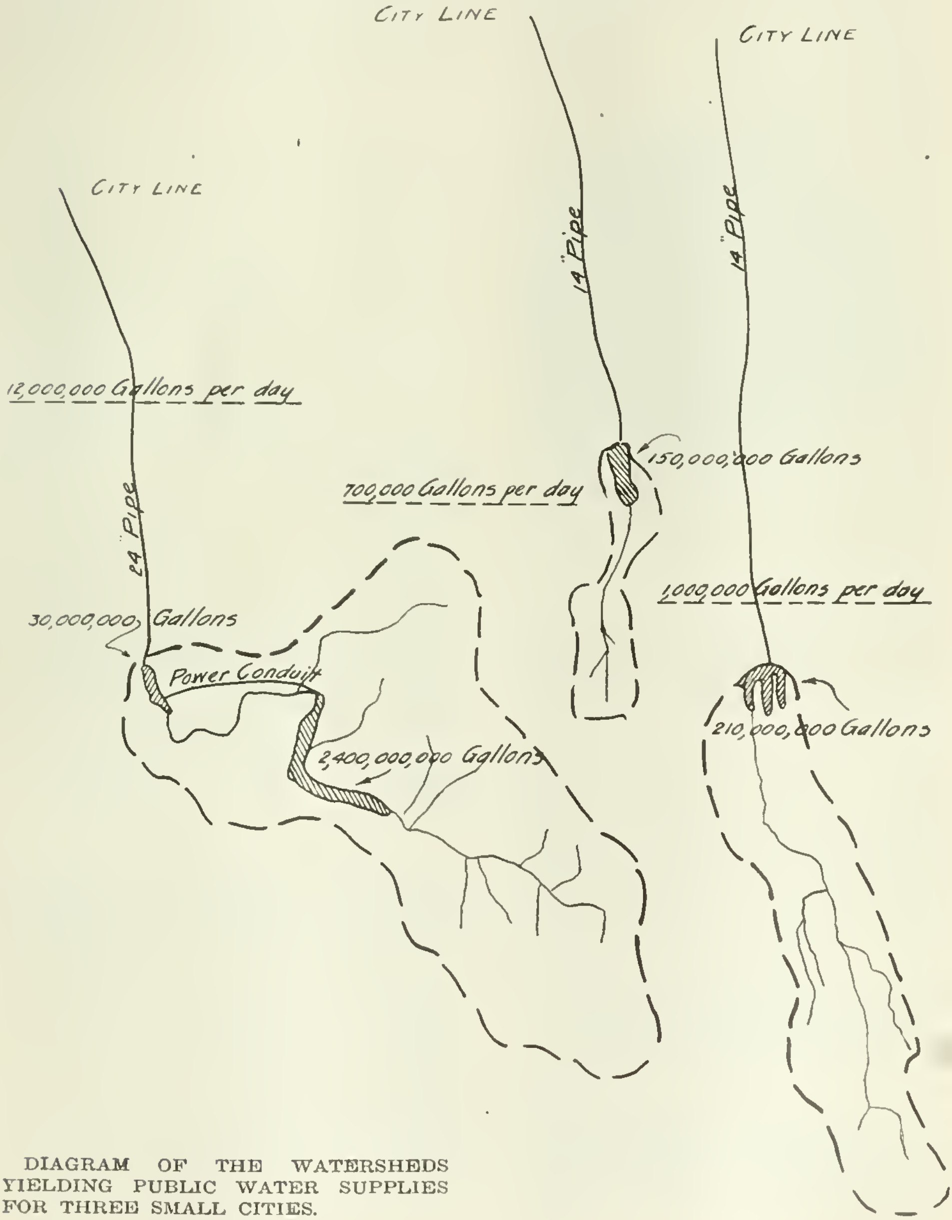


DIAGRAM OF THE WATERSHEDS YIELDING PUBLIC WATER SUPPLIES FOR THREE SMALL CITIES.

The accompanying diagram shows the watersheds of two such supplies, for which the writer prepared plans, which have been built and are in successful operation, also another supply for which plans are under way. An adequate supply created in such a manner, that is by the construction of a very large storage reservoir, will never fail to provide a sufficient quantity of water, if there is sufficient watershed and the reservoir is large enough. The size of the watershed can generally be determined from existing maps, and the runoff of the stream from the records of stream flow either on the stream under consideration or upon some adjacent watershed, with due consideration for the different conditions existing on the respective watersheds.

The smallest of the watersheds shown in the diagram is only one and one-half square miles. The size of the reservoir is 150 million gallons. This reservoir has produced practically complete regulation of the stream and will provide continuously even in an extreme low year a flow of 7000,000 gals. per day. In this particular case the stream supplying the reservoir is in some years totally dry for a period of six months. It is the flood flow which fills the reservoir.

The largest watershed, that of 17 square miles, will provide 12 million gallons of water a day. In that case the storage is 2,400,000,000 gals. Some hydro-electric power will also be developed in connection with this project. In all cases the water furnished to the cities has been of the very highest quality. In cases where there are dwellings on the watershed the writer has provided for filtration plants, to be absolutely sure of no contamination.

In those cities where the problem of a good water supply is a serious one, and where the supply is obtained by pumping water at a large annual cost, it will be well worth while for the city officials to investigate possible gravity supplies from storage reservoirs, even though these have never been previously suggested or considered.

SOME EXPERIENCES IN THE DEVELOPMENT OF THE OIL ENGINE

By F. B. Leopold, Vice President, Pittsburgh Filter and Engineering Co., Farmers' Bank Bldg., Pittsburgh, Pa.

I will try to give some of the things I have learned in the course of a year and a half contact with the development of the internal combustion heavy oil engine, said Mr. Leopold in addressing the 1921 convention of the American Water Works Association.

Historical Notes

I might say in starting that it is generally recognized that Dr. Diesel, a German engineer, is looked upon as the father of the internal combustion engine using heavy oil, and his original patent is dated 1892, although there were various attempts made in the line of development for many years previous to that time.

According to historical records there was actually built an engine in 1680. This engine, however, did not prove a success, but was probably the first step in its development.

In 1791, an Englishman, John Barber, built an engine made to use gas distilled from coal, and from that time on to 1866, when Otto Diesel obtained his first patent, there were several attempts made. Diesel, however, was undoubtedly the father of the present successfully developed engine, and, although his first patents were obtained in 1892, it was not until 1898 that a commercial engine was produced.

In 1898 Mr. Adolphus Busch became interested in this engine, and secured the rights for the United States. The first engine built being a 60 h. p. engine. During the first few years, however, the progress was very slow, and the results unsatisfactory. It is really only in the last ten or twelve years that this type of engine has come into its own in European countries, and is just beginning to be recognized as the coming power unit in this country. It is altogether probable that the abnormal increase in the price of coal, caused by the war conditions, was the greatest single element in arousing interest in the heavy oil engine, and has made for a tremendous impetus in its development.

Number of Builders

Up to five years ago there were probably not to exceed four or five concerns in this country building internal combustion engines, using heavy oil as their fuel. At the present time there are 16 builders of Diesel engines and 35 establishments building various types of so-called semi-Diesel, or low compression heavy oil engines. Some of them have been on the market for a number of years, and are now turning out engines in large quantities, operating with great success. Others are in various stages of development work.

Among the main successful builders of

the Diesel type of engine are the Busch-Sullzer Co., who were the first to engage in this work; McIntosh & Seymour Co., William Graff & Sons, New York Ship Building Co., and others who are building engines ranging from 200 h. p. to as high as 2,000 h. p. each.

Of the builders of the semi-Diesel type, the oldest concerns in the development of this work are the August Mietz Corporation, Fairbanks Morse Co., Bessemer Manufacturing Co., the Burnoil Engine Co., and St. Marys Engine Co. Of the 35 concerns building the so-called semi-Diesel engine, 12 are operating under the Hvid-Bronz patents, and this is the type of engine that the writer has had such experience with as he possesses.

The Hvid-Bronz Type

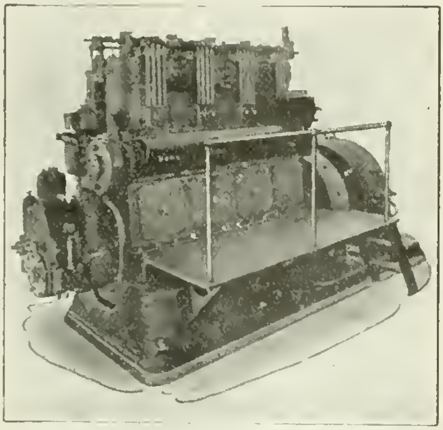
This type of engine is different in its principles of operation from either the Diesel or the semi-Diesel. The essential features of difference are in the method of supplying the fuel. In all cases the fuel is ignited by the heat of compression, but the method of starting and applying the fuel to the various types is essentially different. In the full Diesel the fuel is applied with a pump at extremely high pressure, through a needle valve, through which the fuel is forced by an air pressure varying from 800 to 1,000 lbs., which breaks it up into fine particles, so that when the heat of compression is applied it is completely consumed.

In the semi-Diesel, so-called, the fuel is dropped onto a pan or bulb which is heated. The fuel is vaporized by the heat. After the engine is started this bulb is maintained at a high temperature by the heat of compression sufficient continuously to vaporize the fuel, but in starting it often requires from ten minutes to half an hour to heat the bulb by a torch sufficiently so that the fuel might be vaporized when coming in contact with it.

The Hvid-Bronz type of engine, with which our experience was connected, draws the fuel into the cylinder on the suction stroke of the engine, or rather it draws it through a small valve into a cup. The compression stroke then heats up this cup and generates a pressure inside of the cup, which blows the fuel out and atomizes it into the cylinder, when it is ignited. The semi-Diesel engines operate on a lower compression pressure, but are not as economical in fuel consumption as the Bronz-Hvid or Diesel type.

The writer became interested in this proposition by reason of having become interested in a shop, which at the time was manufacturing material for war purposes, and it became essential to find some product for permanent development. In looking over the field, the future of the oil engine seemed extremely promising, and it is the writer's belief that this industry is just in its infancy.

The great advantages of this type of motor for both stationary and marine purposes is so obvious that temporary discouragement can not hold back its development. On the other hand, there are many problems to be solved. Those, apparently, who have given it the greatest technical and practical study of many years, find difficulties which they are unable to foresee, and which, while small in themselves, are of the most vital importance in the successful operation of the engine.



FRONT VIEW OF FOUR-CYLINDER 100 H. P. PITTSBURGH HEAVY DUTY OIL ENGINE.

The illustration given here of a four-cylinder engine is the first engine built by us, and the design of the completed engine is exactly as it was on the drawing board, as far as all outward appearances are concerned. All the changes that have been made in the development and experimental work have been entirely on the method of applying the fuel to secure the determined calculated exact distribution and consumption, which means success in the operation, and efficiency of the completed machine.

Preliminary Investigations

In our preliminary investigations in the oil engine field, after reaching a determination that this was a promising business for development, the writer, in connection with our engineers, looked over many different types of engines that were being developed and being built. We secured the services of an engineer who had had many years' experience, both in European and American practice, in the design of Diesel engines, and who I believe is today one of the best oil engine engineers in the country.

We were desirous of looking into the future possibilities, and while up to that time the hot bulb or low compression type of engine was most favorably known, and had been built and used to greater extent than any other type of heavy oil engine in this country, we finally concluded that on account of its higher economy and apparently more satisfactory operation that the Hvid-Bronz type of engine had the greater future promise.

This engine is comparatively new, but had been built by one concern for about three years previously, and by one or two others for a shorter period and had been marketed in considerable quantity, and as far as we could learn was giving a very satisfactory account of itself.

Most of these engines were built in small single cylinder units, although one concern was building a vertical multiple-unit engine, which seemed to be fairly satisfactory. Several others were developing a multiple cylinder engine of this type. We, therefore, after a thorough canvass of the field, decided on a Bronz-Hvid type of engine of this multiple cylinder type, and it was our desire and intention to build the highest class engine of this type that could be built.

Initial Experiments

In our initial experiments and investigations, we purchased a small single cylinder engine of five or six horse power, and made a very long series of experiments with this engine, with results that were absolutely convincing, and although our engineer felt it was far from being perfected, the operation of it was entirely satisfactory from a practical standpoint. This engine would operate on practically any kind of fuel oil that would flow in it, and in fact in our experiments we attached four or five different fuel vessels to the supply line to the engine, ranging from kerosene of the highest grade to the heaviest of crude oil, and it operated apparently equally well on any of them; in fact we would often switch from one oil to the other during the period of operation.

This engine has no carburetors or electric spark plugs, nothing at all but the compression heat generated in the cylinders to ignite the fuel. The simplicity of its construction and operation was the appealing feature.

Our investigation work was cleared up during the war period and the engine completely designed, but no work accomplished until after the close of the war. The patterns were made and the engines built completely in accordance with the designs and not a single change was made in its construction, as far as the general features were concerned. On its completion the engine was started in operation and was, apparently, a completed piece of mechanism. During this period we had the co-operation and advice of the patentee, and on the day of completion, when we were ready to place it on the test block for operation, he was more than pleased with the way it started. As the writer had never seen an engine start before on the testing block, he was, naturally, very much elated, as, apparently, it was going to go right, from the start, and we were ready to do business and take orders.

However, it was more than a year later before our engineers were ready to place the seal of their approval upon this engine, and during that period we spent many anxious days and nights in endeavoring to determine just what was required to make a successful machine out of it.

The Fuel Feed Difficulty

The principal difficulty, in fact the only difficulty, was apparently the inability properly to supply the fuel, so that a complete combustion could be secured, and in the initial run, although we had followed fully as we felt the instructions and directions and formulae given us by the patentee, the exhaust discharge was a black column of smoke that might be seen for miles, and at night this was superseded by a continual spurt of flame.

It did not require much knowledge of engineering to comprehend that this condition would not allow of operation for a very extended period of time, and in fact a few hours operation found the fuel cups completely clogged with carbon. Then began our real work, and this dragged over a period of approximately a year.

During this period of time we had many engineers visiting our works and offering suggestions, many who seemed to think that our troubles were trivial and might be corrected in a few days' investigation.

The inventor himself, or patentee rather, laughed them away. However, the difficulties were multiplied by the number of cylinders, and the class of machine which we desired to build.

We discovered that there was a vast difference between building an engine of a single cylinder which would be satisfactory for ordinary power purposes, or the small factory, oil well or farm, and building a multiple cylinder engine for a continuous 24-hour service, where the greatest nicety of speed regulation was required, and where the possibilities of the engine being out of service at any time, might be reduced to a minimum.

The introduction of the fuel into a single-cylinder engine was a comparatively simple proposition. The introduction of an equal amount of fuel into each cylinder of a multiple-cylinder engine, to maintain the same amount of work on each cylinder and thereby maintain uniformity of speed and power, was a very complicated proposition. We, very often, found that we would get practically perfect combustion in one cylinder, and in the next cylinder we were unable to operate for any length of time without completely filling with carbon.

Many and various were the methods we used for equal distribution of the fuel to the cylinders, for the principal of the Hvid engine is a gravity feed, the fuel being taken into the cylinder on the suction stroke of the engine. We found that with a multiplicity of cylinders the fuel charge would vary in each cylinder in this manner, and we finally abandoned this method, as it was impossible to get a sufficiently equal charge necessary to secure regulation.

We started pumping the fuel against the compression stroke on a somewhat modified principle from the Diesel, and we tried a hundred other methods. In the end we used a pump that is practically a measuring device, but using a separate pump for each cylinder, which delivers the oil charge equally to each cylinder valve. It is then drawn in the cylinder on the suction stroke of the engine.

We discovered that there was an absolute and definite ratio of the size cups to be used, and the holes through which the fuel was discharged from the cups into the cylinder, and that these ratios would vary somewhat with different characters of fuel, and the very slightest variation from the determined areas, either of the cups or the holes, or the location of the holes, would affect the operation of the engine to a great extent.

The Fuel Cups

It was only, however, after experimenting with hundreds of different sizes of cups, and methods of adjustment, that we finally arrived at a definite formula for making these fuel cups, together with the sizes of holes they contain.

During the period while our engineers were making these various experiments, the writer became vitally interested in determining whether our experience was at variance to any great extent from others in this line o. endeavor.

I found that other engine builders whom we had visited in our preliminary investigations, and who I had supposed were building marketable engines from the start, had gone through the same grievous experience, in fact, that some had spent thousands of dollars where we had spent hundreds. I found that several concerns, after spending upwards of a million dollars experimenting on the problems, trying to work out a successful engine, had finally been compelled to abandon it. Others had kept on until they had surmounted all difficulties and are now reaping the harvest, and will in the end have their money returned to them many times over.

The only satisfaction that I have been able to derive from this phase of the matter is that we were able, finally, to produce an engine which has been pronounced the finest engine that has been produced in this country of the Bronz-Hvid type, and I have no doubt that many concerns entering this field have brilliant prospects of future returns from the money that they may invest. I would, however, warn any one from entering this work with the idea that they will design an engine, even on well known principles, and expect it to be a success from the start, unless they simply reproduce the patterns in detail of some engine that is already on the market. This means that they must provide a large sum that can, if necessary, be devoted to the carrying of development work to a successful issue.

The possibilities of a heavy oil engine are limitless. In addition to the ordinary uses for central power stations, electric light plants, driving pumping units and general power purposes for marine work, all of which require, of course, units of fair size, there is untouched the vast use for the automobile, truck and locomotive.

Advantages of the Oil Engine

The actual cost of producing a horse power of work with the Diesel engine is about one-third the cost of producing in a steam engine. The initial cost of a power plant for stationary purposes, considering the cost of building, land, boiler and engine, would be practically the same. There are, however, many situations where the space occupied by a steam plant is unavailable. An oil engine will take up on an average from one-half to three-fourths of the same space that a steam engine would occupy, with the entire saving of space occupied by boilers, accessories and coal storage. The oil may be stored in a tank under ground and the space required for it need receive no consideration whatever, ordinarily.

The oil engine of the Bronz-Hvid type can be started instantly and stopped when you are through with the operation. The steam engine requires time to get up steam, and the first must be kept ready for service continuously. For marine work the space occupied in a ship, and the weight of the plant is very much less, giving the same size vessel the additional cargo space, as well as economy in operation. This is being realized very rapidly in marine service, and many ships are now being fitted with this type of motor.

Marine Uses of Oil Engines

In 1914 there were probably not to exceed 20 motor ships, as ships driven by oil engines are known. Today there are upwards of 500, and every day sees additions thereto, many vessels of ten to twelve thousand tons.

In the April issue of the "Motorship" is given an account of the operation of 7,500 motor ship "Borgland," totalling 95,000 miles, and nearly two and one-half years time without a stop on account of engine trouble. The writer states that "It is a somewhat ironical circumstance that one of the first cargoes that the Borgland carried was a load of 7,290 tons of coal from Norfolk, Va., to San Francisco, Cal." Also "preference among officers of the merchant marine for motor ships is significant, and in conversation with the 'Borgland's' captain he remarked that the motor ship is far ahead of any vessel driven by steam machinery, from the point of view of reliability, and referred to the fact that should one cylinder of the plant of an ordinary twin-screw Diesel engine give out, it is a comparatively simple proposition to put the cylinder out of action and carry on with the remainder at reduced speed, which is so inconsiderable as to be negligible. As regards fuel tanks the bulk of the oil is carried in four double bottoms, holding about 900 tons of oil. The fuel consumption is about seven tons per day, under normal conditions. It will thus be seen that the ship has a range of nearly 130 days without rebunkering."

As the average speed of this vessel is given at 10 knots per hour, it will thus be seen that she carries enough fuel to travel 31,200 knots, or 35,900 miles, or completely around the world, and nearly one-half the distance further. To do this with coal would leave little cargo space.

For steam plants, electric plants or pumping plants that are isolated from the coal fields, what a wonderful proposition it will be.

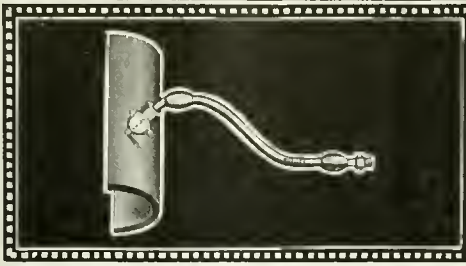
An oil engine will develop a horse power on one-half a pound of fuel oil per hour. A boiler requires four pounds of coal per hour, and some water works pumping plants require twice that much. This means from one-eighth to one-twentieth the weight of fuel to provide for.

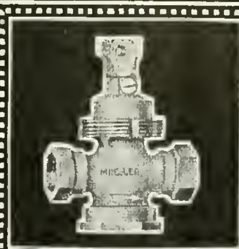
In times such as we have gone through in the past two or three years, what a strain off the minds of many plant engineers it would be to know that their storage capacity for fuel might be multipled many times in less space than is now available.

While this type of engine has not been developed successfully to take the place of the gasoline motor for automobiles, many engineers are working to this end, and it is but a question of time before it is accomplished. Considering the number of automobiles in the country, what a wonderful opportunity there is for the development of this type of motor to replace the gas motor for this work, doing away with electric spark plugs, carburetors and all the troubles attendant thereto.

There is also the railway locomotive and this phase is now being considered, I know, by one of the largest locomotive builders in the country, who has for the last year or more been studying the possibilities of this engine as a motive power for railroad locomotives, and undoubtedly the time is not far distant when we shall see it in use.

Tables I, II and III are given by Mr. Herbert Hass, in a paper issued by the Department of Interior, Bureau of Mines, Bulletin No. 166. This bulletin contains some very interesting information on this type of engine, and I would recommend




MUELLER


MUELLER

TABLE I—HEAT CONSUMPTION AND THERMAL EFFICIENCIES OF DIFFERENT TYPES OF PRIME MOVERS AT CONTINUOUS FULL LOAD.

Type of prime mover.	Heat consumption per brake H.P. hr. B. t. u.	Over-all thermal efficiency	Superiority of diesel engine. a
Noncondensing steam engine. b	40,000-28,000	6.30- 9.1	5.6 -3.6
Condensing steam engine using superheated steam. b	28,000-16,500	9.1 -15.4	3.6 -2.3
Locomobile engine with superheated steam and reheater, condensing. b	17,000-15,200	14.9 -16.7	2.4 -2.1
Steam turbine, superheated steam 200 to 2,000 H.P. b	24,000-15,500	10.6 -16.2	3.2 -2.2
Steam turbine, superheated steam, 2,000 to 10,000 H.P. b	15,500-14,000	16.2 -18.1	2.2 -1.95
Gas engine without producer	10,400- 9,300	24.4 -27.5	1.33-1.28
Suction gas engine. c	14,000-11,200	18.1 -22.7	1.95-1.55
Diesel engine	8,000- 7,200	32. -35.3	....

a. Figures in this column are to be used as factors with which to multiply values in preceding column.
b. Figures include boiler losses.
c. Figures include producer losses.

COMPARATIVE COST DATA

Table II, following, presents fuel-cost data covering the operation of the prime movers represented in Table I.

TABLE II.—COMPARATIVE OPERATING COSTS OF DIFFERENT TYPES OF PRIME MOVERS.

Type of prime mover.	Kind of fuel	Average cost per 1,000,000 B.t.u. Cents	Cost of 1,000,000 B. t. u. effective work Cents	Heat cost per one effective H.P. hour Cents
Noncondensing steam engine. a	Coal	12	191-132	0.48-0.34
Condensing steam engine using superheated steam. a	Coal	12	132- 78	.34- .20
Locomobile engine with superheated steam and reheater, condensing. a	Coal	12	81- 72	.21- .18
Steam turbine, superheated steam, 200 to 2,000 H. P. a	Coal & anthracite	12	113- 74	.29- .19
		11	104- 68	.27- .17
Steam turbine, superheated steam, 2,000 to 10,000 H.P. a	Coal & anthracite	12	74- 67	.19- .19
		11	68- 61	.17- .155
Gas engine without producer	Natural gas, coke-	15	62- 55	.16- .14
	oven, gas or furnace gas	7	27-	7.
Suction gas engine. b	Anthracite	11	61- 49	.16- .14
Diesel engine	Petroleum	15-18	56- 43	.14- .11

a. Figures include boiler losses. b. Figures include producer losses.

COST OF FUEL.

Cost data covering the various types of fuel used in the prime movers represented in Tables I and II are presented in Table III.

TABLE III.—COST OF VARIOUS TYPES OF FUEL.

Kind of fuel. Price of fuel.	Heating value per pound B. t. u.	Absolute heat cost per 1,000,000 B. t. u. Cents	Average heat cost per 1,000,000 B.t.u. Cents
Lignite, $1.00 to $2.50 ton of 2,000 lbs.	5,000- 9,000	10 -14	15
Bituminous coal, $2.00 to $4.00 ton of 2,000 lbs.	11,000-14,200	9 -14	12
Anthracite, $2.50 to $4.00 ton of 2,000 lbs.	14,500	8.6-13.8	11
Fuel oil (petroleum), 75c to $2.25 barrel	18,000-19,000	12.5-37.5	15-18
Natural gas, .10 to .75 1,000 cu. ft.	900- 1,000	11 -75	15
Blast furnace gas, .05 to .01 1,000 cu. ft.	90	5.5-11	7
Coke-oven gas, .02 to .05 1,000 cu. ft.	450	4.4-11	7

Data regarding amount of work performed by different types of pumping equipment.

Type of pumping plant.	Work performed in lifting water Foots-pounds per 1 B. t. u.	Over-all efficiency Percent.
Steam; good operating conditions	54.5	7
Steam; best operating conditions	77.8	10
Steam; superheated steam used	93.4	12
Suction gas engine; good operating conditions	116.7	15
Suction gas engine; special conditions	147.8	19
Humphreys gas pump; special conditions	171.2	22
Humphreys gas pump; good operating conditions	156	20.1
Diesel engine; good operating conditions	225.6	29

it to anybody who is interested in securing real information as to what may be accomplished with the oil engine.

I have tried to give in a brief general way, without getting beyond my depth, some slight idea of the heavy oil engine, its development and possibilities as a power unit. What little knowledge we

have, has been acquired at a very considerable cost, and while I am just as thoroughly satisfied now as I was in the beginning that any successful engine of this type will return splendid profits on any investment involved, I also know that there is much still to be learned, and I would advise anyone who may be considering this field, either to acquire something that is completed, or be prepared to spend a fair sized fortune before expecting to see clear sailing ahead.

TREATMENT OF SWIMMING POOL WATER

By G. R. Shaw, Manager of R. U. V. Dept., James B. Clow & Sons, 534 S. Franklin St., Chicago, Ill.

The swimming pool is becoming so generally popular for schools, clubs and municipalities that a great deal of attention and study is being given to methods that may be used to keep the water of the pool in a sanitary condition so that it will not be a menace to the bathers. The very great danger with a swimming pool is that contamination of the water starts immediately the first bather enters and this contamination tends to increase with the subsequent use unless some positive method is provided to eliminate the dangerous pollution.

Studies and practical tests have shown that the most efficient method for eliminating the pathogenic bacteria is by the use of an Ultra Violet Ray Sterilizer on the circulating line in connection with a sand filter. The Ultra Violet Ray Sterilizer is, briefly, a water compartment through which is placed a mercury vapor quartz lamp so arranged that the water in its passage through the compartment is forced to flow around the lamp and is always exposed to the ultra violet rays produced in great intensity by the lamp. For some unknown reason the ultra violet rays, which are invisible and of extremely short wave length, are very detrimental to germ-life and exposure of any water borne bacteria to them results in the complete elimination not only of the pathogenic, or disease producing, bacteria but of the spore-formers as well. This is accomplished without in any way changing the taste, odor, color, temperature, chemical or mineral composition of the water treated and has the added advantage that there is no danger of overdosing the water, rendering it objectionable to the taste, or of underdosing it, resulting in all bacteria not being eliminated. If the water flows through the sterilizer within its rated capacity complete sterilization of the water will result.

The treatment of swimming pool waters is very necessary, as it is impossible for any bather to enter the pool without taking some water into the system. When it is considered that the average swimming pool is cared for entirely by an untrained attendant so that it is impossible for the condition of the water to be definitely known at all times, it is realized that the only safe method of treatment is by some automatic and positive means which will result in only a water free from all dangerous bacteria being introduced into the pool at all times. This is assured with the Ultra Violet Ray Sterilizer installed on the circulating line.

It has been found that the ultra violet ray process has the further advantage of imparting some property to the water treated that keeps on acting on the bacterial life even after the water has passed through the sterilizer. This has been called "residual action," and tests and studies have shown that a reduction of 85 per cent may be accomplished in bacteria added to water which has previously been treated by the ultra violet ray process. This opens up an extensive field for study and is very important when swimming pools are considered.

The Ultra Violet Ray Sterilizer is in use on many pools in prominent athletic clubs, schools, colleges and universities the country over and many municipal pools and public pools such as the mammoth pool at Madison Square Garden, New York City, with excellent results. It has been the uniform experience that the water in the pool proper can be maintained within the bacteriological standard of purity for drinking water even while the pool is in constant use by bathers and though the water has been used for extremely long periods without change. Many pools have used the water for over a year without change and practically all for periods of six months at least. This results in great savings in operating expense as well as insuring a pool of satisfactory purity.

The Ultra Violet Ray Sterilizer is not only used with great success on swimming pools but also for the sterilization of any water supply such as those in municipalities, industrial plants, office buildings, hospitals, homes, as well as for bottling plants for use on the product water and also on the water used for giving the final rinse to the bottles. Practically all of the passenger boats on the Great Lakes are equipped with the Ultra Violet Ray.

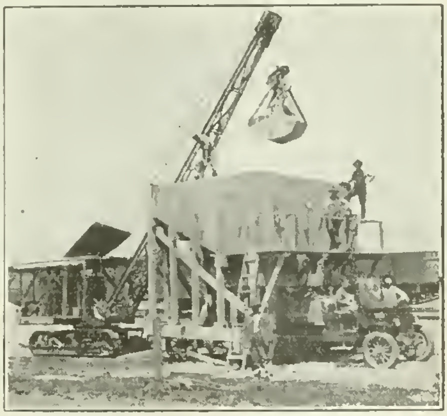
Construction News and Equipment

SUCCESSFUL COORDINATION OF PLANT UNITS ON WISCONSIN ROAD JOB

This story of the relation between materials on hand and successful rapid construction of a highway project is centered about the work of the Wisconsin Construction Company, of Milwaukee, on the Horicon-Beaver Dam Road, on Route 118, in Dodge County, Wisconsin. It is a story of the successful coordination of the integral parts which go to make up a construction plant.

Long before the mixer was on the job, two months nearly, the locomotive crane was unloading all the sand and stone that could be obtained. Ten or twelve cars per day were placed in storage until, when the mixer was ready to start, 10,000 yds. of materials were on hand, or sufficient to complete nearly four miles of 18 ft. roadway. At Rolling Prairie, the shipping point, the contractor found a passing track about 1,000 ft. long. The use of this he obtained for handling his aggregate cars. He also obtained the unused portion of the railroad right of way and leased an additional 50 ft. from the land owner next door.

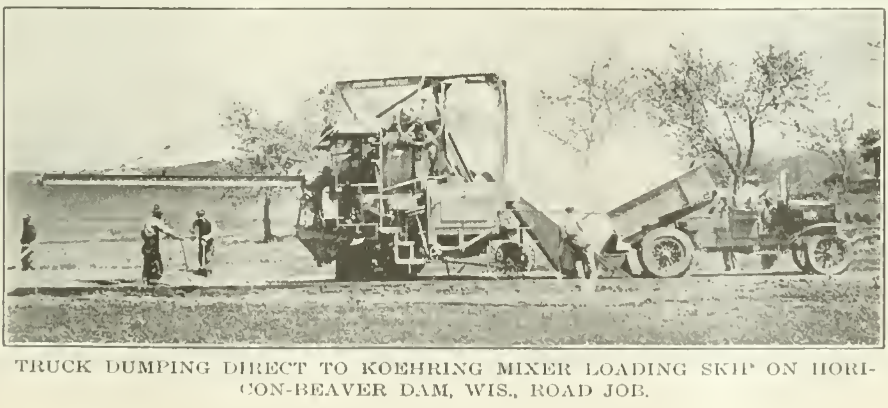
The crane, which has a 40 ft. boom, unloaded the sand into a pile approximately 20 ft. wide at the base. The stone was unloaded in a parallel pile approximately 50 ft. wide at the base. In laying out the plant it was planned to store more than one-half as much sand per foot of pile as of stone, the reason being that the crane must move longitudinally and must at all times be back of the stone pile. In case an insufficient amount of sand is delivered the excess allows leeway before the stone pile is in the way of the crane. In case stone is not delivered



A MATERIAL HANDLING PLANT USED ON THE HORICON-BEAVER DAM, WIS., ROAD CONSTRUCTION JOB.

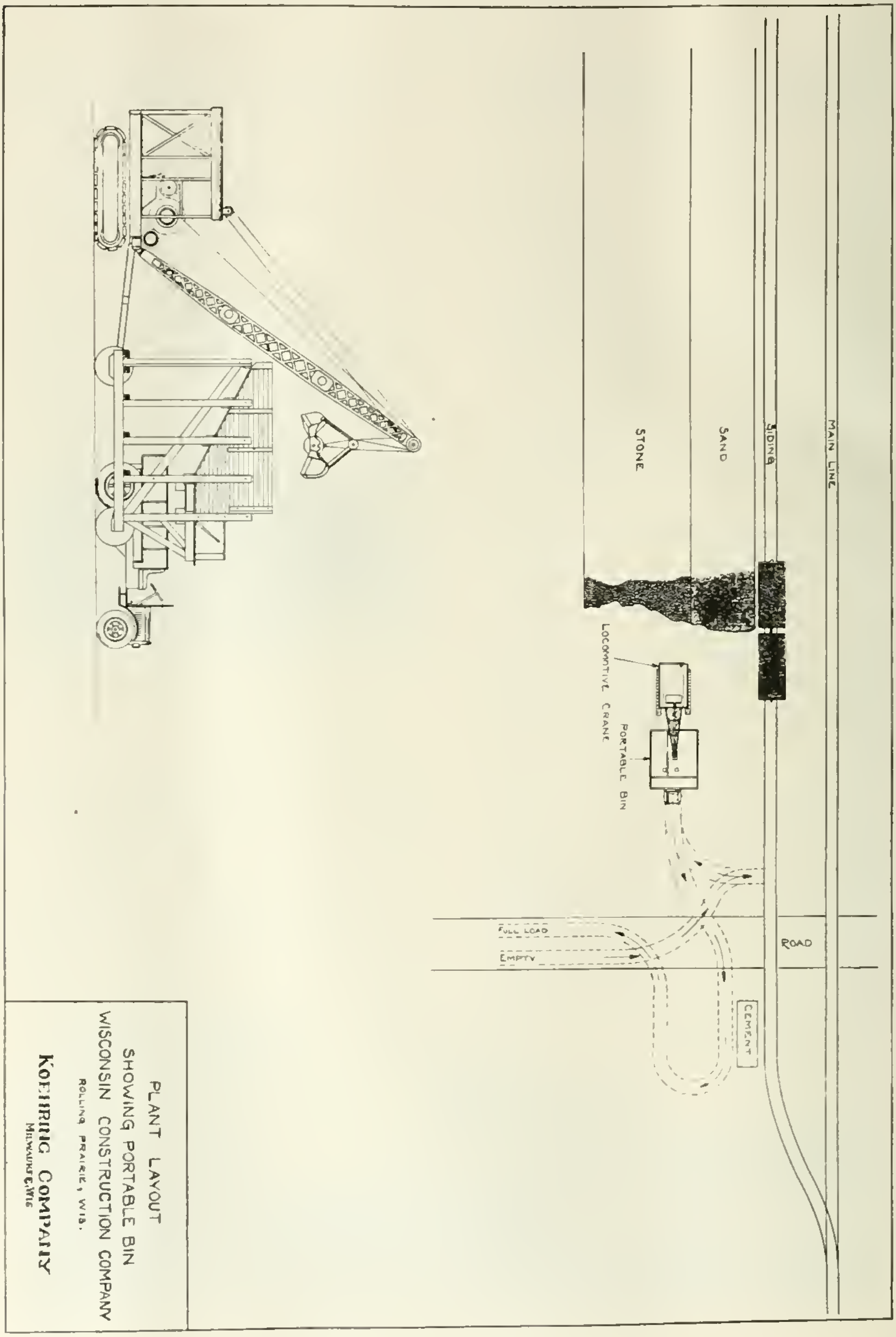
and sand is delivered the crane can operate from the sand pile with ease, handling the sand directly from cars to bin and stone from the storage pile to the bin. The sketch and photographs show the layout.

To make this operation complete a portable bin was necessary. The bin is approximately 14 ft. square and 18 ft. high,



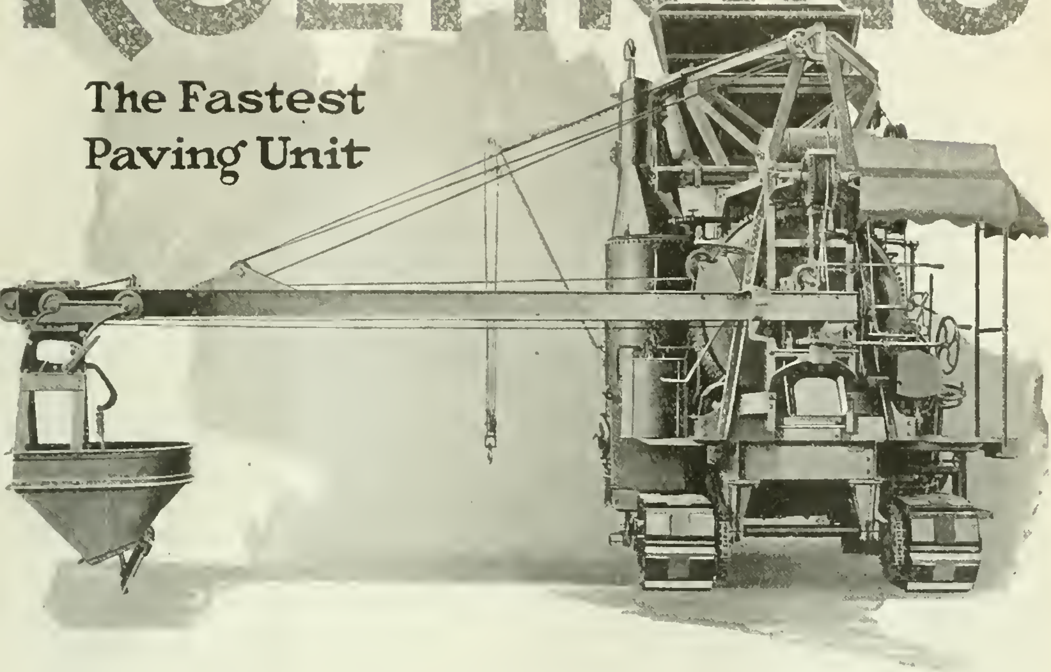
TRUCK DUMPING DIRECT TO KOEHRING MIXER LOADING SKIP ON HORICON-BEAVER DAM, WIS., ROAD JOB.

made of white oak throughout. It is mounted on road wheels, 40 ins. in diameter and with a 12 ft. base. Attached by the rigid 10 ft. pole to the crane mounted on multiplanes, it moves forward as the crane moves, thus making unnecessary the peaking of the boom at any time. The bin is supported at three points, the two rear wheels and on the fifth wheel of the front axle. In this way strains due to



KOEHRING

The Fastest Paving Unit



Heavy Duty Construction is Still the Greatest Profit Factor

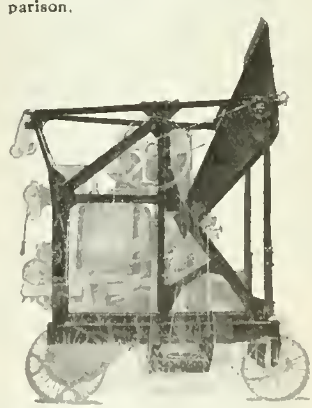
IT'S true absolutely! There's a quick *halt* all along the line when the mixer balks! *It's the mixer that is still the narrow neck of the job.*

Your greatest *profit insurance* is mixer *dependability* —which is just another term for Koehring Heavy Duty Construction.

That's why Koehring would no more build to meet price competition than he would cut down on the safety margin of cables for a passenger elevator.

Koehring *on-the-job dependability,* together with Koehring high speed operation, liberal drum dimensions, automatic actions in charging, discharging and distributing, mean a real profit *insurance* —a liberal extra yardage every day, a *big extra yardage every season.* Write for catalog.

The high angle charging positioo of the Koehring charging skip shoots materials into the drum in a swift, clean slide—and the Koebring frame is built to stand high speed operation of a loaded skip—without chance of frame twists throwing moving parts out of alignment. Next time you see a Koehring, see how that frame is put together—and remember it as a point for comparison.



KOEHRING COMPANY, MILWAUKEE WISCONSIN

MADE RIGHT MILWAUKEE PRODUCT

uneven bearing are reduced to a minimum. Forty yds. of aggregate, 15 yds. of sand and 25 yds. of stone are carried at all times in the bin. Two measuring hoppers are mounted below the bin floor, so designed that they can be adjusted to fit any proportion. Levers controlled from the platform operate the upper and lower cut-off gates.

The two compartment trucks back under the bin receive 27½ cu. ft. of aggregate in each compartment and drive to the cement shed where they are loaded with 2½ barrels of cement, the bags being emptied directly on top of the aggregate. The truck hauls the material to the site of the work. Here it turns and baeks into the skip of the 21E Koehring paver, discharges the load and moves forward about 2 ft. The skip is tnen raised, the material charged into the drum of the mixer, the skip lowered and the truck again backs into the skip, discharges the second batch and leaves for another load.

When mixed, the concrete is discharged into the boom bucket. This bucket is of the spreading type. In other words, the door opens crosswise instead of longitudinally. It consists of a single leaf, hinged at the back of the bucket which is released by the operator from his platform. The concrete is spread in an even layer as the bucket is drawn back. In case it is desired to push the concrete into a corner of the form, this can readily be done by reversing the motion of the bucket. The door is then used as a plow to spread the concrete into place.

The organization of the crew is as follows:

- 1 Crane operator.
- 10 Cleaning up cars and assisting around plant.
- 7 Handling cement at cars and warehouse.
- 1 Bin operator.
- 1 Loading foreman.
- 11 Trucks with drivers.
- 2 Dumping trucks.
- 1 Mixer operator.
- 6 Finishers.
- 2 Form setters.
- 4 Extra men sprinkling and covering pavement.
- 7 or 8 men on grade ahead of mixer.

The finishing is done by hand by the use of a strike-off board followed by the roller and belt.

The day following the placing of the concrete it is protected by covering with earth. The success of this operation is shown by the fact that the first mile of highway was built, even with an average round trip haul of between 7 and 8 miles, in 9 working days. This does not mean 9 calendar days, for due to rainy weather it was possible to work only 9 days out of 20.

This quantity was placed with a green crew and green truck drivers.

The work is in charge of Mr. P. C. Kwerk, sole owner of the Wisconsin Construction Company, who is being assisted by A. G. Brown and Geo. H. Kies.

THE VALUE OF STANDARDIZED CONSTRUCTION EQUIPMENT

By H. A. Hooker, Austin Machinery Corporation, Railway Exchange Bldg., Chicago, Ill.

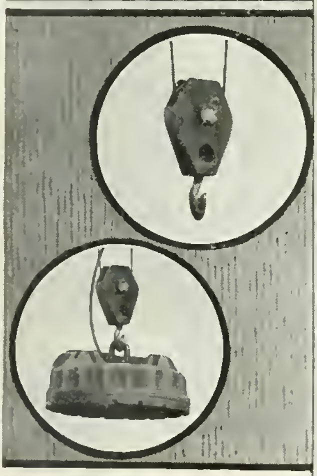
For years the value of standardizing on machinery has been recognized by manufacturers of many classes. Contractors on the other hand, have been very slow to see the advantage.

A contractor depends much upon his superintendent when the purchase of a machine is taken up. Often the contractor overrules the superintendent, whose inclination is naturally toward standardization when possible. Contractors seldom admit losses and therefore a contractor often thinks his competitors are more successful than himself, and must have better machinery, especially if he remembers how the purchase was influenced by price.

Today, however, some of the large contractors are becoming alive to the value of standardization of equipment. They have their engineering department keep cost records and make comparisons of operating costs versus depreciation and upkeep. These records are not simple to keep as to be accurate and useful they must take into consideration many conditions of material, labor and climatic interruptions. The same crew and equipment may lay ten or a thousand lineal feet of concrete pavement, depending upon one or all of a half dozen contingencies.

The money that a contractor makes is the difference between his costs and his contract price. His contract price should be based upon the average cost plus depreciation of equipment, and profit, and, naturally, the more accurate his costs the more certain his profits. At this very point, standardization means much to him in real money, as it gives him a more accurate average cost, and this in turn makes his chances of obtaining a profitable contract that much better. His foremen are interchangeable, as well as

Where There is Construction Work



WHEREVER there is sand, gravel, coal, or other materials to be unloaded or handled the P & H Excavator-Crane goes right to the work and does it.

Structural steel or timber may be unloaded and carried to the job, scrap iron or other steel or iron may be cleared away with a lifting magnet.

Digging is quickly done with excavator bucket, and a scraper bucket may be attached to the crane for grading or filling-in.

If in the round of work some pile-driving must be done—this, too, can be accomplished.

In fact, "Old Bess," as this general utility crane has been called, pokes her nose all over looking for work to do. And she'll do it for you, if you'll let her.

Our nearest distributor or office will be pleased to give you all the details.

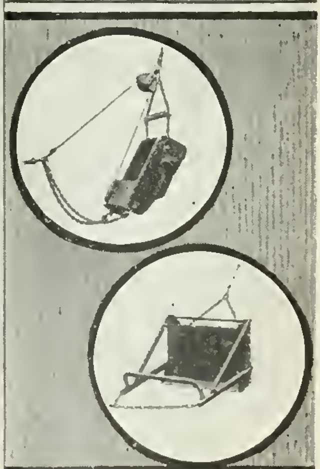
Excavating Machinery Division

Pawling & Harnischfeger Co.

In Milwaukee, Wisconsin, since 1884

New York,	50 Church Street
New Orleans,	Whitney Central Building
San Francisco,	32 Beale Street
Los Angeles,	Central Building
Seattle,	L. C. Smith Building
Portland,	Yeon Building

Selling Agents in 16 other cities



P&H EXCAVATOR-CRANE

the parts of his machines; his operators, assistants from water-boy up become schooled so that the loss of an operator is not a calamity, and the men do not feel so independent and therefore more liable to make an extra effort to please. Every contractor tries to keep some repair parts on hand and standardization simplifies the effort and enlarges the variety at a less outlay. It also simplifies the ordering of same.

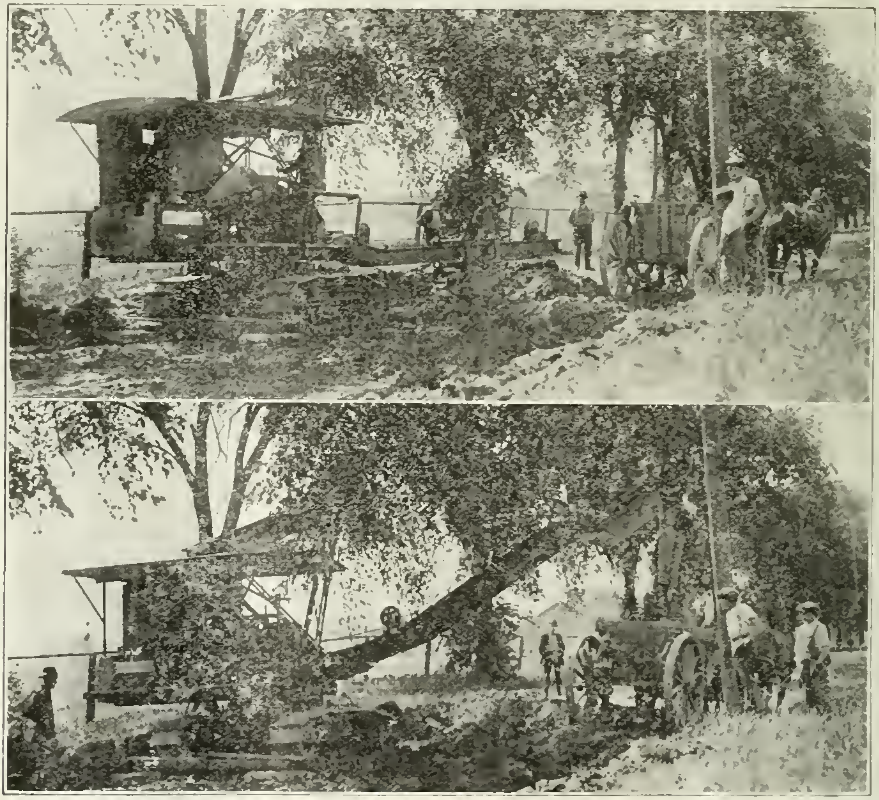
The greatest effort at standardization that has come to my attention was that of Bates & Rogers of Chicago. For one and one-half years they tested and kept cost records on six different makes of paving machines after which they standardized on one make, contracting for eight pavers and selling the others.

Standardization of equipment allows little chance for the passing of responsibility, as one superintendent has an equal chance with another and it creates a contest of superintendents in appearance of machines, upkeep expense and work produced. This spells profit for the contractor.

When possible to purchase full equipment from one company, and time payment is desired, financing is much simplified.

NEW P & H SKIMMER SCOOP MAKES BIG SAVING ON ROAD GRADING JOB

A new Skimmer Scoop has been put on the market by the Pawling & Harnischfeger Co. of Milwaukee, to be used with either the No. 205 or No. 206 P. & H. Excavator-Crane. This may be attached in place of the standard boom in a manner similar to the shovel attachment which was brought out early this spring. The development of this skimmer scoop broadens the field of application of P. & H. excavator-cranes, allowing the contractor



P. & H. CORDUROY TRACTION EXCAVATOR-CRANE EQUIPPED WITH NEW SKIMMER SCOOP.

All Operations Controlled by One Man on Machine. After Scraper Bucket Travels from Near End of Boom to Opposite End, Boom Is Raised, Swung Over Wagon and Load Released. Then It Is Returned to Starting Position, Boom Lowered to Position Desired and Another Load Scraped Up.

to keep down his investment in machinery. The upper illustration shows the skimmer scoop on the full-corduroy No. 206 machine working on a road grading job, Hawley Road, Milwaukee County, Wisconsin. Here the bucket is shown at the end of the travel along the boom, while lower view shows the boom elevated and the load being dumped into a wagon.

That this type of road making machine is of real value is shown by the accompanying record. The contractor (William Datka of Milwaukee) on the Hawley Road grading job kept an accurate record, and a saving of $83.44 per day was made, and the work done in shorter time. The data are as follows:

Number of days on job	8
Total cu. yds. excavated	2,578 cu. yds.
Total hrs. worked	79
Excavated per hr.	32.6 cu. yds.
Number of days saved in using machine in place of wheelers and ploughs	2 days

The operating costs were:

Total cost per day operating with skimmer scoop, including interest and depreciation (assuming 5 yr. life of machine)	$ 91.25
Number of days operating	8
Total cost	730.00
Total cost per day with wheelers, scoops and ploughs	130.00
No. of days (estimated)	10¾
Total cost	1,397.50
Total cost with skimmer scoop	730.00
Difference	667.50

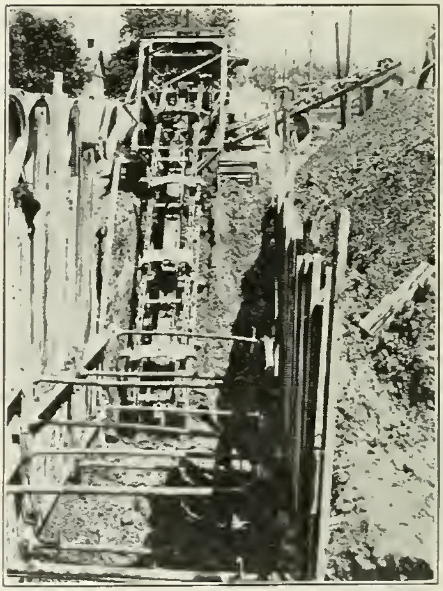
CONTRACTORS URGED TO EMPLOY LOCAL LABOR

A statement, urging contractors to employ local labor, was recently issued by Lewis S. Sadler, State Highway Commissioner of Pennsylvania, as follows: "A survey of the state discloses the fact that in almost every community there are large numbers of unemployed men and that this number is increasing weekly. The Highway Department is anxious to relieve this situation insofar as the contracts under its direction will afford employment. In view of the fact that practically all communities are affected alike and that there is available a local supply of labor for all our existing contracts, our contractors are being urged to seek the services of men living in the community in which they are operating rather than to import labor from a distance; and especially are they being urged not to interfere with such labor as is, or will be, employed on the farms of the commonwealth."

TRENCHING MACHINE PERFORMANCE DATA

At Muncie, Indiana, contractors, Harris-Andrews-Henderson Co., of Youngstown, Ohio, have been excavating a ditch 20 ft. deep and 108 ins. wide at the rate of 266 lin. ft. per day of 10 hours. They use a 54-in. Austin Machinery Corporation trenching machine, with which they work two cuts. Due to the readiness with which the boom can be raised, the time consumed to raise the boom, move the machine forward, and then backward ready to take the other half of the cut, is approximately only two minutes.

The distance between the center of the multipedals and the breast of the bank is 8 ft. 6 ins., so that the length of each cut must necessarily be just a little less,



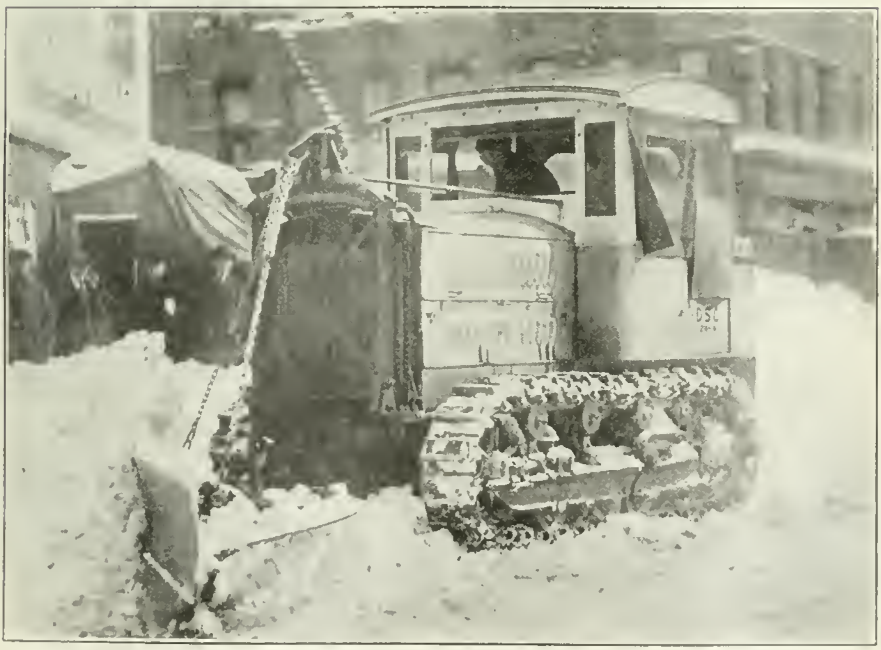
EXCAVATING 47,880 FT. OF DIRT PER DAY WITH A 54 IN. AUSTIN TRENCHING MACHINE DIGGING A DITCH 108 INS. WIDE.

or 8 ft. 3 ins. The speed of the machine is about 1 lin. ft. per minute, making the operation of digging 8 lin. ft. the full 104-in. width in 18 minutes, or at the rate of 80 cu. ft. of dirt a minute.

The Austin trenching machine is equipped with a 100 H.P. gasoline engine and will dig from 27 to 54 ins. wide, and any depth up to a little better than 20 ft. Cost of operation never exceeds $25 per day of 10 hours—a very low cost for excavating 47,880 cu. ft. of dirt a day.

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



CHAMPION SNOW PLOW ATTACHED TO A HOLT TRACTOR CLEARING SNOW FROM STREETS OF NEW YORK CITY.

Motor Truck Operation and Accounting—73

IT PAYS TO KEEP THE HIGHWAYS FREE FROM SNOW

By William E. Voorhees, Kennett Square, Pa.

The winter of 1919-20 was one of unprecedented severity. Snow storm followed snow storm with distressing frequency. City street departments and country highway officials were utterly unable to devise plans for keeping the traveled thoroughfares free from snow. The following winter, that of 1920-21, was quite mild. There was but one snow storm of any size and that came along late in the winter. In January, 1921, it was possible to travel from Boston, Mass., to Bangor, Maine, without seeing a speck of snow—something unparalleled in the history of that section.

We Are Due for a Snowy Winter

No one can tell whether we will have light or heavy falls of snow during the coming winter. The law of averages would indicate that there will be plenty of snow. But whether the snow comes or does not come it will certainly be the part of wisdom to prepare for it. No sane person permits his insurance to lapse simply because there has been a scarcity of fires. In like manner sensible city and country highway officials will endeavor to be prepared for the snow if it does come, and, should the winter prove to be mild, they will have the satisfaction of knowing that they were in a position to cope with the snow storms had they appeared.

A Foot of Snow More Expensive, If Left on Street, Than a Great Fire

Few people realize the colossal losses that annually occur in this country through the interruption of traffic by reason of snow storms. A foot of snow on a city street is a greater menace, if permitted to lay for any length of time, than a disastrous fire. The City of New York was unable to cope with the heavy snow storms that prevailed during the month of February, 1920. The sum of $5,500,000 was expended for hand labor snow removal alone, and the results were far from being satisfactory. The Merchants' Association estimated that the actual money loss to the city in the twelve days that it was in the grip of the storm amounted to $60,000,000, or $1,000 per day for every man, woman and child in the municipality. This, be it remembered, was in one city alone. Add to this amount the loss sustained in all of the large cities, as well as in the rural districts, in the section of this country north of Washington, D. C., and east of the Rocky Mountains, and the result is a staggering total.

Counties Have Their Snow Removal Problems

Losses due to the interruption of traffic by snow storms are not by any means confined to the large cities. In a Philadelphia morning paper of February 21, 1921, the following headlines appeared: "Eighteen inches of snow in Dauphin County." "Lancaster County is covered beneath eleven inches of snow." Reference is made to these two counties merely to show the conditions that prevailed in every county all over the northern part of the country at that time.

CHAMPION SNOW PLOW ATTACHED TO A G M C TRUCK CLEARING SNOW FROM BROAD STREET, KENNETT SQUARE, PA.

The farmers of Dauphin County sell their produce in the city of Harrisburg and buy their supplies in the same city. The farmers of Lancaster County do their trading in the city of Lancaster. The country roads in both counties were blocked with snow for several days after the storm of February 20, 1921. Farmers could not deliver goods to the cities, except in limited quantities and at large expense. The merchants of the cities could not do business with the people in the country. Had it been possible to remove the snow promptly from all of the main roads of the two counties thou-

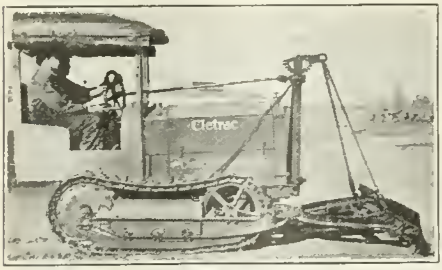
sands of dollars and no end of discomfort would have been saved.

Cost of Snow Removal No Longer Great

Until quite recently the idea was quite generally prevalent among city and country highway officials that, while snow storms undoubtedly caused large losses through the interruption of traffic, yet there was no remedy in sight, as the cost of freeing highways from snow was practically prohibitive. In the old days when snow could only be removed by the hand labor and shovel method this was measurably true. Today it is no longer true. It still costs money to remove snow; but it costs far more not to remove it.

New York City Learned from Costly Experience That it Pays to Remove Snow by Modern Methods

Reference has been made to the fact that the City of New York spent over $5,000,000 for snow removal in February, 1920. One year later the streets of the city were practically cleared of snow over night at a very insignificant cost. The difference is seen in the fact that in 1920 the hand labor and shovel method were very largely used, while in 1921 the city employed a large number of motor trucks and tractors equipped with Champion Snow Plows in moving snow from the middle to the sides of the streets.



CLETRAC "TANK TYPE" TRACTOR AND CHAMPION SNOW PLOW. NEW YORK CITY PURCHASED 100 OF THESE OUTFITS FOR SNOW REMOVAL WORK.

Removing Snow on Connecticut Highways

The Connecticut Highway Department reports that during the heavy snow fall, winter of 1917, the cost of snow removal on a total of 970 miles was $40,000, or a trifle more than $40 per mile. It is true that the State of Connecticut used advanced methods of snow removal, but these methods are by no means a secret and are available to every Highway Department in the country. The method employed by this state was simply to utilize a considerable number of motor trucks and equip them with push plows of the Champion type. Just as soon as the snow began to fall these plow-equipped trucks were sent out over the main highways and were kept working, pushing the snow to each side of the roadway, until the snow ceased falling and the highways were cleared for traffic. The advantages of this method of snow removal are readily apparent. Motor trucks move rapidly, to and from the job, and on it. They are never in the way of traffic, because they move fast enough to keep away from it. They have sufficient power to push a full blade load of loose snow, even when running at a fair rate of speed.

The Modern Method

This is the modern and the only practical method of economical snow removal. It means that states, counties and cities must spend money in the purchase and hire of trucks and tractors, as well as in the purchase of snow plows. On the other hand, it means that the main travelled thoroughfares can be kept open for traffic, at reasonable cost, in the winter as well as at other seasons of the year.

Now is the Time to Prepare

It is the method employed in Massachusetts, Connecticut, New Jersey, Pennsylvania, and, to some extent, in other states. There is hardly a state where snow falls are to be expected, however, that has anywhere near the equipment it should have for snow removal. Measures should be taken immediately by these states, as well as by the counties, and, wherever possible by the towns, to secure trucks and plows in quantities so that when the snow falls it can be pushed out of the main travelled thoroughfares promptly to the end that the annoyance and losses of the past may be eliminated.

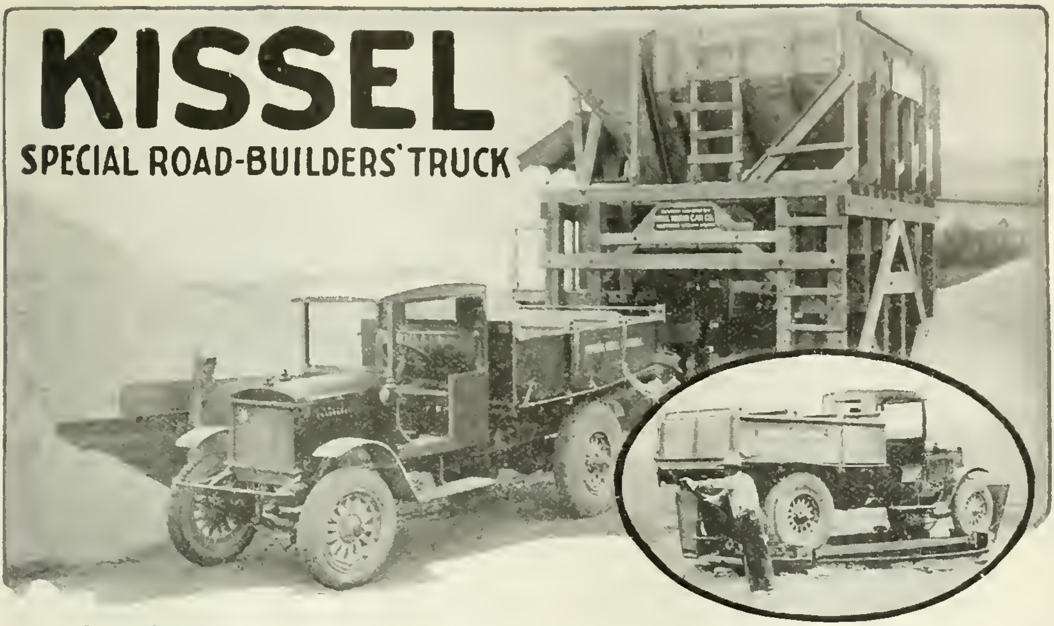
Utilizing Motor Fire Apparatus in Snow Removal

In these days practically all towns, villages and boroughs of any size own motor fire apparatus. When the highways are filled with snow this apparatus is of little value, as it is impossible to move it to the scene of a fire. Such apparatus can very readily be equipped with push plows, thus making the machine of value not only for its primary purpose of extinguishing fires but also to keep the streets open for regular traffic.

This is an age of gasoline power. Large numbers of trucks are being used in every section of the country to transport mail, freight and supplies. Many of these trucks have regular runs between important cities. It has been

KISSEL

SPECIAL ROAD-BUILDERS' TRUCK



Special Kissel Road-builder's truck ready to back under Kissel Combination Hopper that dumps three batches of correctly measured sand and gravel by one trip of lever in less than three seconds

Kissel Road-builder's truck on specially designed turntable, turning loaded truck around in less than ten seconds—saving time, labor and depreciation on truck.

Kissel Engineering Service Helped Establish this Road-building Efficiency Record

The real saving to Peppard, Burrill & Connell, prominent Minneapolis contractors, by using efficiency methods was in actually finishing this 4.7 miles *in less than two months,* while most contractors would have taken three months or more.

JOHNSON CREEK FOOTAGE TABLE

Work Started . . . . July 6, 1921.
Finished . . . . September 6, 1921.

Total actual number of working days, 40
(No deductions for any delays except rain.)

FOOTAGE TABLE

Daily Average Footage . 736 feet
Highest Daily Footage . 903 feet—Aug. 24.

Aug. 1—rain	Aug. 14—Sunday	Aug. 28—Sunday
2—rain	15—827 ft.	29—855 ft.
3—570 ft.	16—498 ft.*	30—318 ft.†
4—742 ft.	17—rain	31—rain
5—711 ft.	18—352 ft.‡	Sept. 1—wet road
6—723 ft.	19—615 ft.	2—520 ft.
7—Sunday	20—rain	3—645 ft.
8—845 ft.	21—Sunday	4—Sunday
9—813 ft.	22—681 ft.	5—Lab'r Dy.
10—rain	23—711 ft.	6—520 ft. (End—6 hrs. work.)
11—wet road	24—903 ft.	
12—620 ft.	25—794 ft.	
13—618 ft.	26—700 ft.	*Rain, 6 hrs. work.
	27—866 ft.	†‡Rain, 4 hrs. work.

Total Footage, **15,447** Total Working Days, **21**

(Note—August 16th and 18th counted as one day: also August 30th and September 6th, as delay on these days due to rain.)

Johnson Creek Road Computations

THE ENTIRE JOB

Average Daily Footage, 620.4 feet.

Length of Road, 4 7 miles, or 24,816 feet. Total number of days on which any work whatsoever was done, 40.

ONE WEEK'S WORK

Daily Average Footage, 766 feet.

In completing this job of 4.7 miles of concrete road there was only one week in which the work was not delayed by rains and wet roads—the week of August 21 to 27. The footage this week, by days, was—

Monday	681 feet	Thursday	794 feet
Tuesday	711 feet	Friday	700 feet
Wednesday	903 feet	Saturday	866 feet

Total Footage for the week, 4,655 feet
Number of days worked, 6

Progress from August 1st to End of Job
Average Daily Footage, 736 feet.

During period from August 1st to September 6th, when the job was completed, rain and wet roads prevented any work on eight working days. On two days, namely, August 16th and 18th, only one-half day's work was possible, due to rain. Despite this handicap, the total footage for this period was 15,447. The number of days worked was 21.

Send for special Illustrated folder showing, step by step, how the Johnson Creek Road contract was Kissel Engineered and systematized. Address

KISSEL MOTOR CAR CO., Hartford, Wis., U. S. A.

estimated that during the year 1920 at least 15% of the freight transported in this country was handled by motor trucks. This does not take into account the large amount of produce hauled from farms to local markets. There is nothing that paralyzes truck traffic like a snow storm. If the country is to have the full benefit of this new and valuable method of transportation, effective measures must be taken to keep the main traveled highways open for travel in winter as well as at other seasons of the year.

Much has been spoken and written during recent years regarding the evil results that inevitably follow a policy of unpreparedness. With the experience of the Great War just behind them the American people should realize that it is at all times immensely profitable to spend reasonable sums for equipment when such expenditure will assuredly be saved many times over when the snows of winter descend upon us.

TRUCKS PROVE THEIR WORTH ON COUNTY ROAD BUILDING

By William Tonkel, Road Superintendent of Allen County, Court House, Ft. Wayne, Ind.

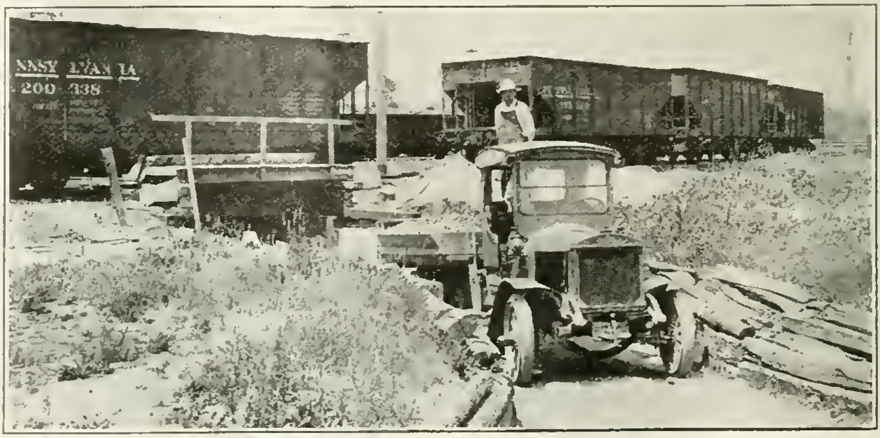
(Editor's Note:—The following article is based on the experience of Allen County, Ind., in the operation of a fleet of 3½-ton Acme trucks on county road work. This county has saved $28.80 per day by using trucks.)

Our original Acme truck is approximately 3 years old, and the other two are nearly as old. All three are 3½-tonners. Besides our Acmes we are working 4 trucks of other makes ranging from ¾ to 3½ tons. In a recent gasoline consuming test the Acmes got 80 miles on 17 gals., while other 3½-tonners needed 21½ gals.

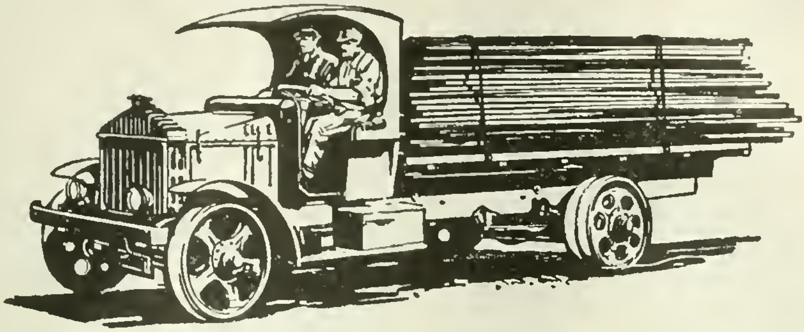
The thing that first made me believe that the Acme was the truck for our work happened some four years ago. There were 8 trucks of several different makes building a road at the end of a 7-mile haul, and each truck was handling 3 yds. of gravel to a load. The road was slightly hilly, and in some parts not very good. The Acme was the only truck that could take its load over certain places without shifting gears, and the one truck that performed its work in good shape. This performance, I have since learned, is not unusual with Acme trucks.

Allen County uses its trucks entirely for maintenance and repair work. When new roads are to be constructed, the work is let out under contract. For this maintenance and repair work we decided that a 3½-ton truck would be best, for a 5-ton truck is too heavy. Our trucks have a 3½-yd. body, which is always heaped up, so we carry approximately 4 yds. of stone, weighing approximately 5 tons. This is something of an overload, but our trucks stand up very well under it. The northern part of Allen County is rather hilly; the rest is fairly flat. Our roads are made of crushed stone, macadam and gravel.

At present we are repairing a piece of road 10 miles from Ft. Wayne, making a 20-mile round trip. The material is crushed stone, which is delivered at Ft. Wayne in freight cars. The truck is loaded by hand or by a chute, and run out to the point where the road is being repaired. The driver opens the rear gate 3 or 4 ins., by loosening a chain. Then



ONE IN A FLEET OF THREE ACME 3½-TON TRUCKS AS OPERATED BY ALLEN COUNTY, IND., ON ROAD WORK.



he gets into his cab, raises the dump body and starts the truck, so that a stream of crushed stone flows out of the rear end of the body and is distributed evenly along the road. After discharging his load he returns to town for another.

It is very easy to make 4 such trips in a day, and if forced a little we could make 5. However, making 4 a day, we can haul 16 yds. of stone per truck to the point. The cost per day on this haul is $19.26, or $1.20 per yard and $1.24 cts. per yard mile. If a team were to do this work it could make only one trip a day hauling 2 yds. .of material. A team costs $6 a day, so it would cost us $3 per yard to haul stone to this point, against a cost of $1.20 by truck. Besides, a team could not spread the stone as the truck does.

Suppose that, instead of repairing this road, we were building it. It takes 1,166 yds. of gravel to build a mile of road. Hauling by team and handling 2 yds. of gravel per day, it would take us 583 days to perform the work. A truck handling 4 yds. of gravel to the load, or 16 yds. a day, could do it in 67 days. At the very low cost of $6 a day for a team, it would cost us $2,208 to haul the material; hauling by truck, at a cost of $19.26 a day, it would cost us $1,290.37, giving us a saving of $917.63.

Building a mile of road that distance from town would cost us by truck $1.11 per yard, and by team $1.89 per yard, a saving of 78.7 cts. per yard, or 41.6% in favor of the truck. But even though the truck did cost more, it would still pay a road superintendent to use a truck because of the greater amount of material that he could handle in a given time. As in all outside work, it is necessary to make the most of good weather.

The trucks employed in this service make a very high mileage, averaging from 75 to 90 miles a day. The average for an Acme truck last year was approximately 74.5 miles. The very low fixed expense of 93.3 cts. a day is due to the fact that these trucks have no taxes, license or administrative overhead, and only a low garage and insurance charge. Last winter was very open and we were able to work 285 out of 305 working days. The average cost for the time worked was $18.37 per day. All our repair charges are lumped, but the $600 per year allowed is ample.

Our trucks are run at an average speed of 14 to 15 miles per hour, and the Acmes are the only trucks we have that can travel 18 miles an hour without injuring themselves.

A summary of the cost data follows:

COST DATA ON OPERATION OF 3½-TON ACME TRUCK, AS OPERATED BY ROAD SUPERINTENDENT, ALLEN COUNTY, FT. WAYNE, IND.

AVERAGE COST	
Cost per day (including driver)...$	18.3671
Cost per mile	.2465
Total cost for period (one year)	$5,235.28
OPERATION	
Days operated	285.
Miles traveled	21,235
Miles per day	74.5
Miles per gallon of gas	4.7
Miles per gallon of oil	160.
ITEMIZED COST	
Driver cost per day (included above) $	5.35
Depreciation per mile $	.0428
Maintenance & repair, estimated, per mile $	.0283
Tire cost, actual, per mile $	.0335

INDIANAPOLIS BUSINESS MEN RESIST ADVERSE TRUCK LEGISLATION

The city of Indianapolis, by ordinance passed in the city council in 1919, declares that as the city streets are maintained from city funds, motor trucks shall be taxed $4 per ton truck capacity by the city for street maintenance.

The state requires by an act passed in the 1921 session of the legislature that motor trucks shall be taxed at about $15 per ton truck capacity for highway maintenance, and the attorney general of the state declares that the city streets of Indianapolis are a part of the state highways.

But as 85 per cent of all trucks owned and operated in Indianapolis do not use the state highways they should not be required to pay a direct tax for their maintenance, in the opinion of their owners, as agricultural implements are not required to pay a direct tax for the maintenance of the streets of Indianapolis.

The 85 per cent of all trucks owned and operated only on the streets of Indianapolis are required by law to pay to the state for the upkeep of the highways which they do not use and they are required by ordinance to pay again to the city of Indianapolis for the same purpose.

It has been learned that 10 or 15 Indianapolis firms would be required under the present law to pay from $500 to $1,000 in direct taxation for highway maintenance while they have no occasion for using the highways, and that over $100,000 is taxed annually against Indianapolis business men for state highway maintenance, who use only Indianapolis streets and pay a street maintenance tax.

Farmers who use the state highways and the Indianapolis public streets with horse-drawn vehicles do not pay a penny of direct taxation for the maintenance of either state highways or city streets.

Heavy tractors and other wheel cleeted agricultural implements, very destructive to highways, are also operated over state highways by farmers without the payment of one penny as a direct maintenance tax.

In view of the foregoing circumstances truck owners in Indianapolis, in conferences called to consider these matters, decided to employ legal counsel to prepare a defense and to resist this legislation, which they regard as unfair and discriminatory. Appeal bonds were held in readiness to take care of all arrests. Motor truck owners have taxed themselves $7 per ton of truck capacity, with a minimum of $1 for the purpose of meeting the contest.

Among the trade associations represented were: Coal Dealers, Sand and Gravel, Retail Grocers, Auto Trade, Transfer, Master Plumbers, Indiana Automotive, Wholesale Grocers, Indiana Transfer and Warehousemen's Association, Association of Electrical Contractors, Commercial Warehousemen, Bakers, Portland Cement, Indiana Highway Transport and Terminal Association, Ice Dealers and Merchants' Association.

The validity of the law, to which the truck owners object, will be determined by the courts. Meanwhile further arrests are enjoined.

PAVING STREET CAR TRACKS IN CALIFORNIA

To the Editor:

I note on page 15 of the August, 1921, issue of Municipal and County Engineering, an article relative to the paving over street railway tracks in California cities, which is rather misleading. The law enacted by the recent Legislature only provided for the paving over street car tracks by the municipalities when a municipality so desired.

It does not relieve the street car companies of their responsibilities unless the city officials determine that public necessity requires the municipality or property to assume this burden.

Yours very truly,

GEORGE MATTIS,
City Engineer.
Oakland, Calif.

Aug. 23, 1921.

USE OF TRUCKS AND TRACTORS ON MISSOURI ROAD WORK

Perhaps one of the greatest incentives to road building in Missouri has been the trucks and tractors furnished by the Federal government, says the "Missouri Road Bulletin," the official publication of the State Highway Department.

There are at the present time 650 trucks and tractors furnished in that way working on the roads of the state. Their value, estimating the trucks at $2,000, which is conservative, and the tractors at $4,000 each, means a total valuation of almost $2,000,000. Every one of these 650 machines is constructing roads, either under local supervision or on some state and Federal aid project.

It is hard to estimate the work toward lifting the state out of the mud that these machines are doing, but it is no doubt the greatest single method that is being concentrated on that work so far as its value in dollars is concerned.

Trucks are every day hauling drags, depositing gravel and other building material along the highways in the 114 counties of the state. They have been at the work in some counties for months and a careful engineer would no doubt say they have already contributed their value to the roads of the state.

The trucks and tractors come from the War Department and are furnished through the U. S. Department of Agriculture to the states in proportion to their road activity. It is estimated that Missouri is getting a thirtieth of the entire supply of surplus road building equipment. It is still coming and is being sent out through the State Highway Department as fast as it is received.

The equipment is put out to the counties at minimum cost to cover freight expense from Washington to Missouri and delivery to the county of each piece of automotive equipment in good condition for immediate use. After being received at the State Highway garage in Jefferson City it is carefully overhauled and such repairs as are needed are given each machine. A large amount of repairs are kept on hand for most of the cars in use and these are supplied to the counties at cost.

As a result of this nearly all of these trucks and tractors are today performing a full day's service for bettering road conditions.

EDITORIALS

BUILD TO PREVENT FIRE

We Americans are tolerating an annual fire loss of over $300,000,000 in physical property alone. Each year over 60,000 people are injured and over 18,000 lives are lost by fire. What a sensation it would create if all these injuries and deaths occurred in one great fire, or even in a dozen great fires. But they occur, usually, a few at a time, but time after time, so the result in the end is the same. The bare figures should be impressive enough to the dullest, without considering the sensational aspects of the case. Each injury, or each death, has a personal significance to some individual or family which dwarfs the economic loss, great as that is. But the economic loss represented by these injuries and deaths is at least as great as that due to the destruction of property.

These losses fix fire insurance rates and in paying our insurance premiums we all pay tribute to uncontrolled fire. Those who do not have fires must still help to pay for the fires of others, while those who have fires do well indeed if they are able to make good their losses by insurance. Of course there can be no adequate compensation to the man who suffers the experience of a fire in his home or place of business. Even if he is compensated for the property loss he never can be compensated for the trouble and anxiety experienced.

The enormity of the figures given may be sensed when one reflects that the great public debt could be paid off in a few years if we could apply to it each year the money we are now burning up. Think how this would simplify the problem of taxation which is now so difficult for us all!

Viewed from any angle the fire loss is a total loss and is as ruinous as it is inexcusable. Everything that can be done to lessen this loss must be done. We must have the best of fire-fighting facilities and we must also fight fire when we build—as well as afterwards. Here. as always, prevention is much better and cheaper than cure.

So far as possible we must build structures of the type which are either fireproof or of the highest type of fire resisting construction, and this applies to both public and private buildings, whether in city or country.

The week commencing October 9 is to be observed throughout the country as Fire Prevention Week. This is very good, as far as it goes, as it will serve to direct public attention to what preventable fires are now costing. But we should have 52 fire prevention weeks each year.

Engineers, architects and contractors know how to build structures that will not burn. Since their professional knowledge enables them to build against fire is it not their duty to act in the public interest and to recommend and insist on fireproof construction whenever and wherever possible? We believe it is.

Finally, our fire loss has reached the proportions of a national scandal and disgrace. Instead of feeling sorry for ourselves about it we should be ashamed of it.

BUILDING OR BREADLINES?

A certain amount of amiable optimism makes life pleasant at times, but it does not, of itself, sustain life. Just now a little wholesome and frank pessimism is in order. Two hard facts are staring us in the face: the unemployed now number fully 6,000,000 men and winter is coming on.

It is all very commendable and very agreeable, up to a certain point (and also very easy) to rely on a favorable turn which will ease the hard circumstances of creature existence, but times come when it is well to realize that few good things just happen or are vouchsafed to humanity by a beneficent providence. The thoughtful are in agreement, now, that work must be found for the idle or we are in for a winter of deprivation and suffering.

Fortunately, by taking thought and acting promptly, work can be provided for those now idle and the many others who may be released from industry with the coming on of the cold season. Public works offer the way out.

As everybody knows, many construction projects have been postponed from year to year for just seven years. Much public improvement work, long held up, should now move rapidly forward. A very great deal of this work can be done during the winter season. The directing minds in the construction industry long ago learned how to cope successfully with cold weather.

This is not only a way out of a bad situation but in the opinion of many it is the only way out. The choice rests between action or inaction, between building or breadlines, between public works or public charity. Only a flabby and unjustifiable optimism will prevent public officials making the proper choice. Now is the time for some robust and rational realism; if we don't take control of the situation in the only way available the coming winter will be one of suffering for the millions of unemployed and their dependents, the women and the children, the aged and the infirm.

While it is unpleasant to direct thought to what will surely happen if we go on waiting for providential, or congressional, relief, it is pleasant indeed to point out that if public works projects be driven forward, now, useful work will be provided for those released from industry and great sums of money will be placed in general circulation, to the immediate and substantial benefit of all lines of business.

EFFECT OF DIAGONAL PARKING ON STREET PAVEMENTS

The effect of diagonal parking on pavements is very bad in some cases. The tendency of such parking is to restrict the traffic to very narrow lanes, and this naturally causes the pavement to wear unequally throughout its width; near the curb it may be as good as new, while near the center of the street it may be badly worn.

The extreme case is reached where diagonal parking is required on car track streets. Nowadays the paving on car tracks is not especially inviting, in many cases, to say nothing of the difficulty and danger of driving on car tracks or of the destructive effect of rails on rubber tires. The tendency is, therefore, for the motorist to keep off the track and, as he cannot drive near the curb because of the parked cars extending far out into the street, he is virtually compelled to drive between the car track and the row of parked automobiles. Frequently this restricts the range available for anything like satisfactory wheeling to a few inches, for each set of wheels, and rutting or other rapid deterioration of the pavement rapidly ensues.

Diagonal parking has its advantages, of course, as it increases the number of machines that can be parked in a block, and it also aids in putting a parked car quickly in motion at the will of its driver without reference to the position or movement of adjacent machines. But whatever the advantages of this type of parking to motorists its destructive effect on pavements is so great and so rapid under certain circumstances that it should not be tolerated, much less required by ordinance.

THE ENGINEER AND TAXATION

There has been more intelligent discussion of taxation during the present year than in an ordinary decade. The reasons for this are well understood. We hope engineers are following the discussion closely and are taking part in it, for the engineer has qualities of mind which should enable him to exert a powerful influence on tax legislation, in the public interest.

We often wonder what engineers think of the various methods of raising revenue by taxation, past, present and proposed. We surmise that the engineer of mature years is inclined to the belief that the whole subject of taxation has been rather badly handled from earliest times down to this hour, with, perhaps, indications of rationality appearing now and then in very recent years.

The engineer is a man of forthrightness who thinks in straight lines and he probably finds abhorrent the devious methods commonly employed in beating the tax devil around the bush. Probably he favors an income tax and some sort of sales, or turnover, tax for if taxes must be levied on a man why not catch him coming and going, earning and spending, to make sure that no one escapes his just burden of taxation?

Not long ago Mr. Lloyd George spoke of "finding money." He was referring to the problem of raising enough revenue to meet expenditures. In other words, the problem is usually to find something that can and will stand a heavy tax, as the politician sees it. The big tax bills usually land where wealth and good nature dwell together.

We urge engineers to turn their attention to the making of equitable tax laws as a high public service. They will find their mental powers equal to the task, we are confident.

RAPID RECONSTRUCTION OF THE BURNED SAUGUS RIVER BRIDGE BETWEEN LYNN AND REVERE, MASS.

Co-operation, plus electricity, recently accomplished an engineering feat of the first order when a 400 ft. section of the burned trestle bridge across the Saugus River connecting Lynn and Revere, Mass., was rebuilt in the record time of 10 days.

Henry S. Baldwin, department engineer of the Lynn plant of the General Electric Company, is credited, both with the inception of the plan and its subsequent execution, although due recognition is accorded both to the support furnished by R. H. Rice, plant manager, and capable technical assistance rendered by other engineers.

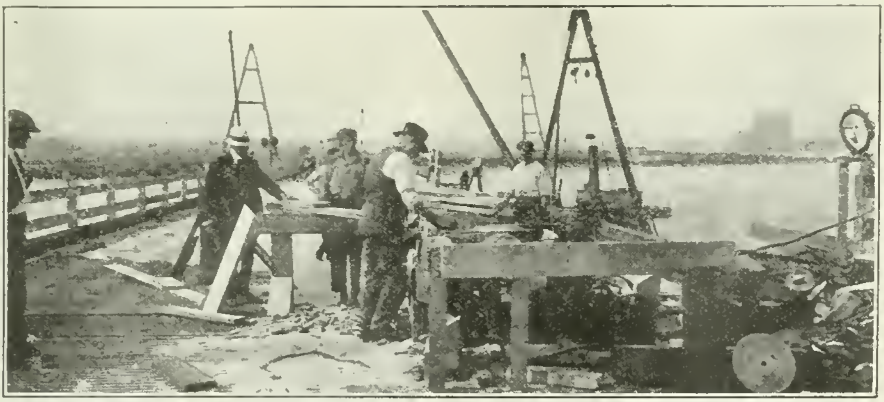
mission's engineers started specifications anyway. On the 21st Lynn, Revere and the town of Swampscott asked the Commission for a temporary bridge.

A hearing was announced on the 23rd and held on the 30th. In the interim the Commission's engineer had reported that to build a bridge costing $150,000 would mean shutting off travel for six months.

This suggestion of delay, with the summer heavy automobile travel just starting, worried Lynn and Revere not a little.

G. E. Company Offers to Do Work at Cost in 15 Days

On the 29th, the day before the Commission's hearing, the General Electric Company, whose River Works are near the Lynn end of the bridge, offered to rebuild the bridge in temporary form at cost within 15 days. Engineers scoffed



SOME OF THE EQUIPMENT WHICH MADE POSSIBLE THE VERY RAPID RECONSTRUCTION OF THE SAUGUS RIVER TRESTLE BETWEEN LYNN AND REVERE, MASS.

Shows Motor-Driven Saw for Cutting Flooring. Floodlights Made Night Work Feasible. Telephones Installed at Each End of the Work. Motor-Driven Augurs, Motor Trucks and Cars, With the Usual Derricks and Pile Drivers Made Up the Modern Equipment Employed for Speeding Up the Work.

The undertaking is probably one of the most unique of its kind and shows how cities, officials and industrial works pooled interests, cut red tape and met a real emergency.

Fire on June 17

The train of events leading up to it started with a fire on June 17th, partly destroying the original structure across the Saugus River, known as the Point of Pines bridge. That fire broke a vital traffic artery.

On the following day the Metropolitan District Commission announced that a new bridge would cost between $60,000 and $150,000, and no funds were available. But in view of the fact that a $50,000 state emergency fund existed the Com-

but Mr. Baldwin, who took charge of the entire job, was sure it could be done. That afternoon he and John Trudinger, an assistant, went out in a rowboat and inspected the ruins. That night complete tentative plans and cost estimates were made.

The next day after the hearing the Commission decided to let the General Electric Company go ahead. The city of Lynn appropriated $40,000 to finance the work and Governor Cox gave assurance that the state would reimburse the city next winter, when the Legislature meets.

Plans Drawn July 2

Detail plans were drawn July 2, the engineers finishing them in the small hours of the next morning, so that they could be given to contractors for bids.

The W. S. Rendle Company of East Boston took the labor contract at $14,200 and the General Electric Company agreed to furnish the materials and supervision for $20,000.

On the morning of July 4 steam derricks appeared at the bridge and work started tearing off the damaged deck and weakened piles. Three days later new construction began.

Storms and heart-breaking obstacles interfered from the start. At first it looked like a month's job. Floodlights were put up and the work drove ahead night and day. As days passed the outlook grew brighter.

By July 12 all the caps except on six spliced joints at the Lynn end of the bridge were in position. On the 14th it was possible to cross the bridge on the loose planking while the cross bracing went ahead swiftly.

When the job of laying the wearing surface of 2-in. spruce planks began the workmen were sure that sawing would take ten days to two weeks. The General Electric Company rushed out an individually motor driven circular saw table with mitering arrangements operated by two experts from the Lynn Works. The planks were cut at the proper angle as fast as they could be fed. The laying of the planks was so swift that Mayor Creamer of Lynn was able to drive the last spike—without missing a stroke—on the 18th, and the bridge was done.

Only the best materials have been put into the structure. The new piles are of oak; the stringers, caps, deck, fence, post and hand rails are of long leaf hard pine and the wearing surface of spruce; 270,000 board feet of lumber have been used and thousands of bolts, made upon order at the General Electric plant, thereby saving time and money, will hold the whole together for years to come. The caps are 8x14 ins. and the stringers 10x16, spanning joints. Instead of a temporary bridge, it is made as well if not better than the original structure, and is guaranteed for ten years.

The Governor Congratulates the Engineer

Following completion of the bridge Mr. Rice received this letter from Governor Cox of Massachusetts:

"I desire to add my expression of appreciation to those which have been so properly extended to the General Electric Company for the splendid public service rendered in replacing the Point of Pines Bridge so rapidly.

"It was a difficult situation, and the prompt and efficient way in which the General Electric Company met the public needs was most commendable.

"May I in turn, through you, congratulate the engineers and workmen for their fine co-operation which has brought such credit to your organization?"

NEBRASKA USES INDUSTRIAL RAILWAY IN CONSTRUCTION OF GRAVEL ROADS

By George E. Johnson, Secretary, Nebraska State Department of Public Works, State House, Lincoln, Neb.

The Nebraska Federal Aid Project No. 135-A, consisting of the Central City-Chapman road is 9.9 miles long and is located parallel with and adjacent to the Union Pacific Railroad in the east central part of the state known as the Platte River Valley. This piece of road, which is part of the Lincoln Highway, has very flat grades. The grading was done by Merrick County in which the road is located. This work was carried on with tractors and blade graders, followed by teams and fresnoes which were used to correct any slight imperfections that

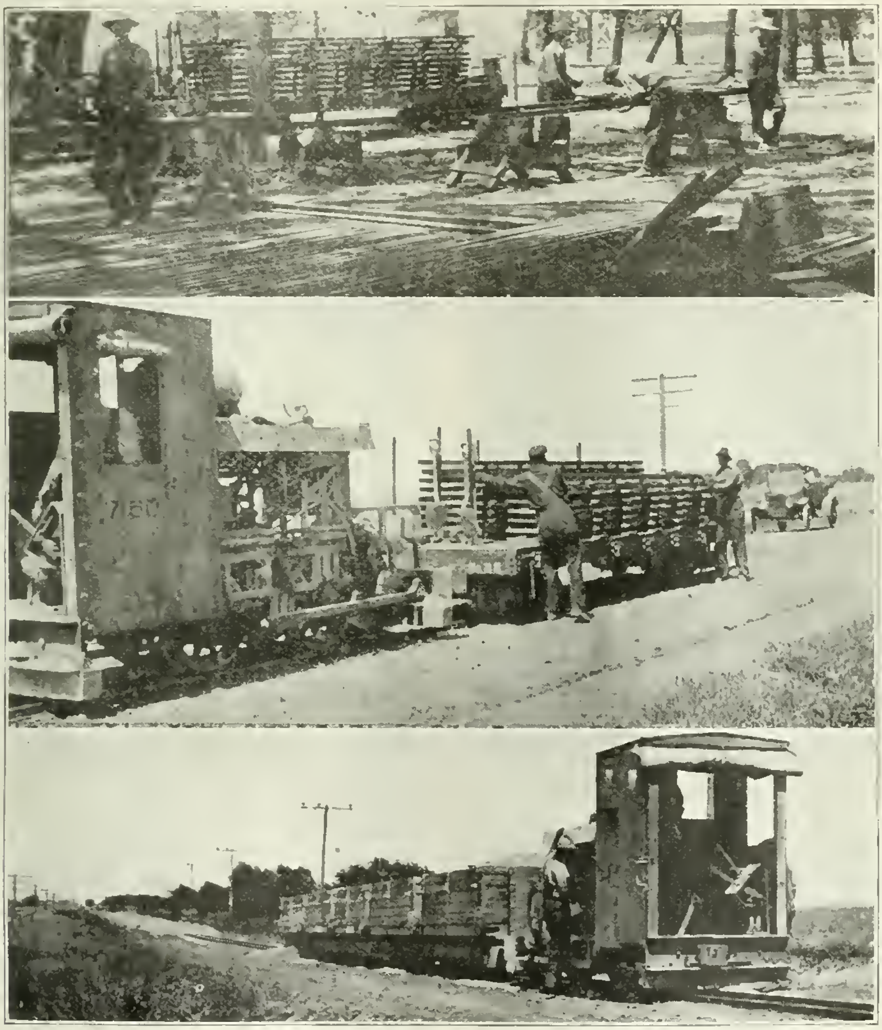
BUCKET LOADER LOADING INDUSTRIAL CARS FROM STORAGE BIN ON GRAVEL ROAD CONSTRUCTION IN NEBRASKA.

might be left in the profile of the road. The cross-section of the graded road is 24 ft. wide with a 6-in. crown at the center and sloping ditches 2 ft. deep on either side.

The part of the improvement in which Federal and State aid (equally divided) was used, consists of the necessary drainage structures and a gravel wearing surface 18 ft. wide. This wearing surface is composed of 4 ins. of screened gravel with a sufficient amount of clay added to make a firm, compact surface. The soil ranges from a black gumbo, which carries a small amount of gravel, to a rather loose sand. In some places the soil contains the binder, while in other places clay must be added to hold the gravel together.

The contract for the construction of the drainage structure, which consists of sectional concrete pipes, culverts, headwalls, and one concrete bridge, was let to the Central Bridge and Construction Company. The Nebraska Department of Public Works under the writer as secretary is laying the wearing surface of this project. They are using state owned labor and equipment, most of the latter being allotted to the state as surplus war equipment.

The clay binder used was located at distances not more than 1¼ miles off of the road. The excavating was carried on with an Austin drag line excavator. The short distance hauls were made with a 20-ton Holt Caterpillar tractor and Eagle reversible trailers, while the longer distances were covered with Packard army trucks equipped with hydraulic hoists and end dump bodies. The gravel was obtained from a pit located in an old channel of the Platte River, only 1,500 ft. from



USING INDUSTRIAL RAILWAY ON GRAVEL ROAD CONSTRUCTION IN NEBRASKA.

Top: Stock Pile of Rails, Horses on Which Sections of Track Are Assembled, and Car of Assembled Sections Ready to Go Out on Road. Center: Car of Assembled Sections of Track at End of Line Ready to Be Laid. Bottom: Gravel Dumped on Road and Train Used for Hauling It.

the project. The pit was covered with a sandy loam soil which was easily removed with the drag line. The farthest distance the gravel had to be hauled was 6¾ miles.

The gravel is pumped with a 6-in. Centrifugal pump, driven by a 12-in. belt from a 45 h. p. Van Blerk 4-cylinder gasoline motor. The plant is mounted on a raft made up of 5 vertical side pontoons held close together by timbers clamped across the pontoon ends at both the top and bottom. The gravel then runs across a nest of slotted sheet screens assembled with a ¼-in. screen on top, a 1/6-in. screen in the center, and a ⅛-in. screen on the bottom. The screens are mounted above a storage bin of 125 cu. yds. capacity in such a manner that practically all the water is carried off over the side of the bin and returns to the pit. It has been necessary to pump from the pit about 2 or 2½ yds. of material to obtain 1 yd. of gravel suitable for surfacing.

The gravel is loaded from the storage bin to the cars with a bucket loader driven by a gasoline motor, and hauled over a 24-in. gauge industrial railway. Whitcomb 7-ton gasoline locomotives are used with V-shaped gondola cars, equipped with side doors hinged at the top and latched at each lower corner. Two men dump the cars, one working on each side. The fenders have been raised so that they are a continuation of the slope of the car bottom, thus making the delivery of the gravel a short distance from the track. The cars carry 4½ cu. yds. each. One locomotive draws four cars on a 1 per cent grade. The highest weekly record made to date is 1,075 cu. yds. of gravel hauled an average distance of 2.14 miles, using one locomotive for empties at the storage and one for hauling on the road.

The rail and steel ties, used on the job were received, part from the War Department and part from the factory. These were piled at the camp and assembled into sections in the shade before being taken out on the road. This was found to be more economical than scattering the material along the road and assembling it in the hot sun. Six men with one locomotive and operator and one 20-ft. flat car, have picked up, hauled a distance of about 3½ miles, and laid ready for use, ½ mile of this track in one 10-hour day. This type of hauling apparatus is far superior to the use of trucks, or tractors and trailers for hauling wearing surface materials over roads composed of light soils as the roads in the Platte Valley of Nebraska are. It is especially advantageous in that it does not tear up the freshly graded road bed or mire down around the low, wet gravel pits, as the trucks and tractors do.

After the gravel is applied and the track taken up, the roadway is scarified and the gravel worked down. On this project the binder was applied and spread first and the gravel worked in afterwards. This is done to hold the gravel nearer the surface and prevent the sandy subsoil from coming to the top in excess quantities. This method has worked out quite successfully throughout the entire state of Nebraska.

SPECIAL METHOD OF HANDLING "SECOND STORY" CONSTRUCTION WORK ON STATE HIGHWAY IN LOS ANGELES COUNTY, CALIFORNIA

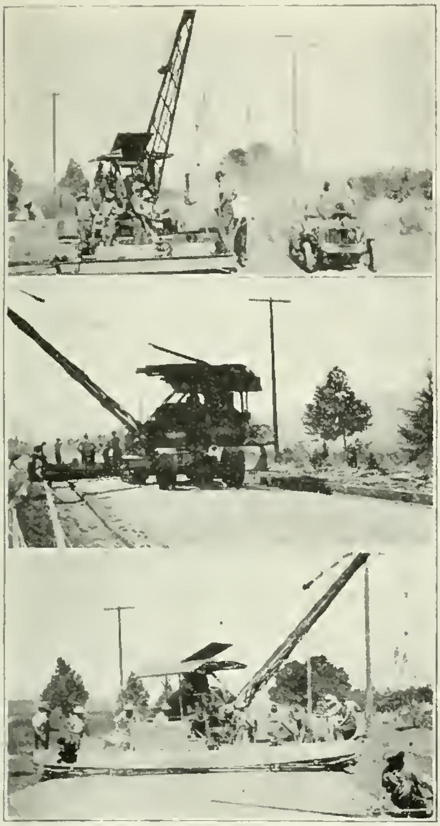
By W. W. Patch, Division Engineer, California Highway Commission, Los Angeles, Calif.

Due to the unprecedented increase in vehicular traffic during the past five or six years, certain of the state highway sections near the larger centers of population have been found too narrow properly to accommodate the travel, and in certain cases have also shown that thicker pavement is necessary to withstand the very heavy truck loads which are becoming a very large part of the total tonnage carried by a number of these sections.

The earlier concrete pavement built by the state averaged about 4⅜-ins. in thickness and 15 ft. in width, and it always has been the avowed intention of the commission to add to this base course an additional top wearing coat of substantial thickness which would result in giving much greater stability and longer life to the pavement.

During the season of 1919 and 1920 a number of miles of the pavement originally laid on Route 2 in Los Angeles County were widened and thickened to a total width of 20 ft. and a total thickness of from 6 to 8 ins. according to the local conditions. The pavement which was made 6 ins. in thickness comprises the adding of an asphaltic wearing surface from 1½ in. to 2 ins. in thickness over the original concrete base where the foundation course still remained in fairly good condition. In other places where the foundation was not in such good condition, the pavement was thickened by adding a reinforced concrete slab 4 ins. in thickness on top of the old pavement, plus shoulders of concrete on each side

2½ ft. wide and 6 ins. in thickness. The reinforcement comprised ⅜-in. square steel bars spaced transversely in the pavement 18 ins. on centers, together with a



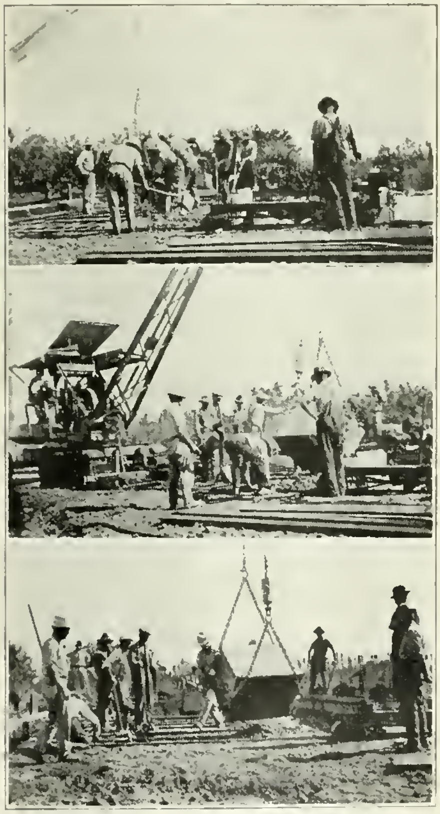
CONSTRUCTING "SECOND STORY" WORK ON STATE HIGHWAY IN LOS ANGELES COUNTY, CALIF.

Top: P & H Crane Handling 2-Ton Box of Mixed Concrete. Center: Excavating for Widening by Addition of Shoulder 8 in. by 2½ ft. Integral with Reinforced Top Slab 4 ins. Thick. Bottom: Austin Tamper with Crane in Background.

longitudinal ½-in. square steel rod spaced 3 ins. from each header and parallel thereto over which the transverse rods were hooked at each end. Between each transverse rod, a short steel rod of the same diameter and about 4 ft. long was placed to give additional reinforcement to the outer edge of the pavement on each side. The concrete in all cases has been mixed in the proportion of one part of cement, two parts of sand and four parts of screened gravel or broken stone.

Where the old base was badly shattered it was entirely removed and the new "second story" was extended through to the subgrade under the old pavement, making the repair of the old pavement integral with the new work.

Similar work is now being done connecting up a stretch about 9.7 miles long between two of the sections which were improved as hereinbefore described last year. The method of working is similar except that the 2½-ft. shoulder strip is now being made 8 ins. in thickness and the concrete is being mixed at a central mixing plant and is being transported in steel buckets holding each a four-sack batch. Upon arrival at their destination the batches are handled from the truck to the subgrade by a traveling crane. It requires about 20 minutes to make the



CONSTRUCTING "SECOND STORY" WORK ON STATE HIGHWAY IN LOS ANGELES, CALIF.

Top: Transverse Reinforcement Supported on three 2-in. Pipes. Center: Crane and Reinforcing Used. Bottom: Austin tamping Machine at Work.

maximum haul from the plant (5 miles) so that the time between mixing and placing under the conditions of longest haul is only about 25 minutes. In order to use this method successfully, the concrete has to be mixed very dry, and in the longer hauls hydrated lime is added during the mixing at the rate of from 1½ to 2 per cent of the weight of the cement. After dumping on the subgrade the concrete is tamped by a mechanical tamper, and the result is exceptionally dense and smooth concrete.

The accompanying photographs show the method of handling this mixed concrete by means of a crane from the truck to its final position in the pavement.

The writer, as Division Engineer, had direct supervision of the work. Mr. Austin B. Fletcher is State Highway Engineer and Mr. T. E. Stanten is Assistant State Highway Engineer.

MODIFICATIONS OF IMHOFF TANKS

By E. A. Stewart, Associate Professor of Agricultural Physics, The University of Minnesota, University Farm, St. Paul, Minn.

I have read with a great deal of interest and pleasure the discussions for the past two years in Municipal and County Engineering, on Sewage Disposal Tanks. I would like to offer an explanation of the operation of the "Kirdorthoff" tank.

The difficulty with the Imhoff tank seems to be that the sludge becomes gas filled and rises in the gas well. This well is usually of so small a surface area that the gas cannot escape, and consequently the sludge does not sink again. The longer the scum is left the more leathery it becomes and the more efficient it becomes as a cover to hold in the gas. If a hole is punched through the thick leathery scum a considerable quantity of gas is always liberated. This scum will not putrify readily unless left where it can ripen.

The number of bacteria in this scum is considerably less than in the solution below. This would naturally be expected as the enclosed gases and other waste products would tend to sterilize the mass. In other words the gas cannot get out of the sludge; the sludge cannot sink; it becomes partially sterile; and the tank fails to function. Scum gathers to a thickness of 10 or 12 ft. in the gas well and perhaps 2 or 3 ft. in the sediment chamber. According to information available, this scum will not collect if grease, soap waste, or the like are not present. The large amount of undigested sludge present, however, is probably partially due to the fault of Imhoff tanks, mentioned by G. Everett Hill in the February, 1921, issue of Municipal and County Engineering. The bacteria may be decreased in number and vitality by not having the decomposition products removed from their workshop.

In the Kirdorthoff tanks these two defects are somewhat remedied. Bringing the fresh sewage in at the bottom evidently helps to carry out the waste products from the digestion chamber. At the same time the sludge is activated sufficiently so that, the particles of sludge come to the top when containing a small amount of gas only.

The ability of sludge to give up small amounts of gas when disturbed and also its ability to hold gas for 8 or 10 hours, and then rise and form a scum was noted in the Grand Rapids Experimental Plant. (See Municipal and County Engineering, issue of Feb. 1921.) This small amount is easily liberated and the sludge sinks again to the bottom. The action of the Imhoff tank at Ripon after turning the fresh sewage into the gas well exemplifies the above statement.

The main principle underlying the construction of the Imhoff tank is to separate the settleable solids from the raw sewage as soon as possible so as to get rid of the large amount of finely divided, somewhat colloidal material found in sewage when it stands for considerable time. Most of the solids in fresh sewage will separate, either float or sink, in one or two hours (creamery waste excepted). The liquid remaining between is quite free from suspended material, its turbidity being less than half the turbidity of the average tank effluent. The fresh sewage should then deposit its suspended solids and pass on out of the tank. This is accomplished in the properly constructed Imhoff tank but it is not accomplished in the Kirdorthoff or single chamber tanks. There are a number of Imhoff tanks, however, in which this is not so. The liquid stays in the tank so long that eddy currents through the long large slots intimately mix, the sewage in upper and lower story. Invariably the Imhoff tank operating on our greasy sewage, that does not give sludge troubles, that is, much sludge and thick scum in the gas well, has a very poor effluent. The analysis of the tank effluent of such a tank is given below. The tank effluent was very black and contained finely divided suspended matter that required 40 to 50 hours to settle out very much of it. The aanlysis is as follows in parts per million:

	Tank Effluent
Total Solids	1566
Solids in Solution...........	1450
Solids in Suspension........	116

What can be done then to secure the

benefits of the Imhoff principle and yet get around the difficulties? It appears from our experience that a large surface in the gas well will help out. This is what is obtained in such tanks as the ordinary single story tank. It seems that we have been giving the sedimentation chamber the large surface area, and the gas well the small surface area, when this should be reversed. Many of the modified Imhoff tanks have been built with a larger surface area for the digestion chamber and these tanks give very little trouble with thick scum or sludge. The large area gives more opportunity for the escape of gases. This does not vary only directly as the area. For instance, with five times the area the same volume of scum will be only one-fifth as thick. The gas then has five times the surface to escape from and has only one-fifth as much scum to work up through. In addition, the gas does not have as much drying effect, and the scum is not so leathery and impenetrable.

We are installing a tank using this principle. This is a small private house tank but we may be able to secure some information on its operation.

Can the other trouble in the Imhoff tanks be remedied? That is can we supply liquor to the digestion chamber without losing the benefit of quick separation of sludge and effluent? I believe that this can be done by carrying one-sixth, or one-tenth of the incoming sewage which is fresh into the digestion chamber direct. The correct proportionate part must be determined by experience. We have no data on this at present but we would like to hear from anyone that has.

There is also a point in the method of operating that I would like to see discussed in Municipal and County Engineering. Should the tanks be operated open or closed in the summer? The only report I have available is the one by Rideal on the tanks at Exeter and Davyhulme. Along with this we probably will have to consider whether the closed tank has any ventilation. Dr. W. Ramsay Smith, of Sidney, South Australia, states that ventilation in the last stages of tank action is beneficial because of some oxidation and nitrification that is being brought about.

BRITISH VIEW ON ADVANTAGES OF BITUMINOUS MACADAM

By Alfred Dryland, County Surveyor of Middlesex, England.

(Editor's Note: This interesting summary of the advantages of bituminous, as compared with waterbound macadam, was presented by Mr. Dryland at the conference of the Institution of Civil Engineers held in London, England, on July 1, 1921.)

For the purpose of this paper the author includes all bituminous matrices used in modern forms of road construction, whether the product of destructive distillation of bituminous coal, such as tar and pitch, the residuals from oils with a bituminous base, or natural bitumens.

The chief advantages of bituminous macadam over waterbound macadam arise from:—(1) Superior cementitious qualities, (2) exclusion of water, (3) resiliency, (4) facility for repairs, (5) economy.

Cementitious Qualities

Waterbound macadam is only held comparatively firmly in place under conditions when moisture is just sufficient to fill the voids in the sand or detritus between the macadam. An excess, or lack of moisture, over or under this standard, results in movement of the aggregate, causing internal attrition, tending to round the arrises, and eventually leading to loss of cohesive stability. With horse-drawn vehicles, mainly iron-tired, the traffic had considerable consolidating powers, and waterbound macadam, except in extremely dry or excessively wet conditions, served satisfactorily on the whole to carry traffic up to a very appreciable tonnage, rendering paving only necessary under the heaviest conditions, mainly in town streets. The advent of the self-propelled vehicle, with its generally higher unit weight, greater speed, and more concentrated propulsive adhesion, caused greater disturbance of the aggregate. The weak concretive effect of the void filling was altogether inadequate to prevent movement, and rubber tires tended to remove the filling between the aggregate.

The first effective step in the process of bituminous binding was the adoption of a dressing of coal-tar, which percolated into the filling material between the stone and had considerable effect, from the action of the pitch contents of the tar, in holding the aggregate firm. It was largely assisted in this process by its power of preventing the infiltration of moisture which had previously acted as a force tending to assist movement and also to increase attrition. The tendency of tar, owing probably to its specific gravity, is to percolate downwards, and repeated coats of this simple and comparatively inexpensive dressing, under limited conditions of traffic, produces a bituminously bound and waterproof macadam road, which, in favorable situations, serves to carry satisfactorily at the present time a traffic up to some 300 tons per yard width per day, even when the traffic has become mainly self-propelled, so long as it does not consist of an undue proportion of rubber-tired heavy vehicles, such as buses. When the surface coating remains complete and waterproof through the winter, nothing better can be desired; but in damp situations the tarred surface is destroyed in the winter time, and both surface attrition and disturbance of aggregate come into play.

Exclusion of Water

To avoid these troubles and effect further adhesion and more complete waterproofing, the expedient of forming a tar-concrete has been adopted, and this, when a suitable aggregate is used, has become a common form of road coating, capable in favorable situations of carrying for several years a main road traffic, including motor buses and other heavy cars, aggregating 500 tons per yard width per day. On the question of aggregate for this purpose the author unhesitatingly puts forward the view that blast furnace slag is far and away the best material for the purpose. He further asserts that a good quality limestone or calcareous sandstone takes second place, and the hardest and best granites form the least satisfactory aggregates. A tar-macadam which compacts, as slag does, into a concrete mass becomes completely waterproof.

Other bituminous methods, such as pitch grouting and so-called "asphalt macadam," which usually consists of a bituminously bound coarse aggregate base covered with a carpet of extremely fine aggregate, generally termed sheet asphalt, is completely waterproof, and although liable to shallow surface distortion, due partially to traffic displacement, but partly also to temperature changes, affords a smooth and substantially non-"attritive" surface of great durability. Granited mastic asphalt and natural rock, the latter laid in powder form, are other well-established methods of providing waterproof and durable carriageway pavings.

Resiliency

All bituminous concrete aggregates undoubtedly have a considerable measure of resiliency which enables them to endure without material damage the shocks and stresses imposed by the impact of wheels of heavy vehicles. They suffer a large amount of distortion without breaking. They have considerable powers of recovery. An interesting subject for discussion is the question of resiliency. It is often claimed these pavements are most durable when voidless. The author would suggest the contrary—namely, that while they are compressible the wear from attrition is small, but when the faculty of compressibility is lost "attritive" wear becomes comparatively rapid. A case which would seem to refute this theory is that of rock asphalt, which, being formed of impalpable powder closely compacted and laid on an incompressible concrete base, would closely approach voidlessness. The author can only suggest that there remains a small measure of compressibility in the thickness of the coating, which is generally 2 ins. in depth. When the thickness is materially reduced it tends to crack and eventually break up.

Repairs

All bituminously-bound roads lend themselves to the process of patching repair, inasmuch as it is easy to cut out defective sections and resurface. The author suggests the chief factor in this process is the provision of a sound abutment for the patches, which can be let in and the joint completely sealed. It is very difficult to effect similar repairs to waterbound macadam owing to the instability and easy displacement of the abutments.

Economy

Economy is found in the comparatively long life of bituminous work compared with waterbound macadam. The test of economy of a road coating, from the expenditure point of view, is gauged by the first cost and maintenance charges divided by its effective life. It is difficult to give specific instances of the relative cost of waterbound and bituminously-bound roads bcause the traffic changes are progressive and variable both as regards weight and units and speed. Moreover, in certain cases, waterbound macadam has been found entirely impossible to maintain in a state to carry the traffic satisfactorily. The author has, however, knowledge of specific instances where slag tar-macadam has been maintained for the last 16 years at a less cost per square yard than the previous waterbound macadam surface entailed at that remote period when motor cars were few and the heavy type were unknown. Further instances are within his knowledge where waterbound macadam from 1908 to 1911, although surface-tarred, could not be maintained for more than three years, whereas the tar-macadam, which was substituted, has lasted so far ten years, notwithstanding the great increase in weight and speed of traffic, while the cost, including maintenance, would not exceed that previously incurred in maintenance in waterbound macadam.

The author puts forward as a general proposition that the life of a well-constructed bituminous road surface may be taken to be at least three times that of a waterbound macadam, and that its economy is self-evident, and that it has the additional advantages of cleanliness and lessened tractive resistance.

HUERFANO RIVER CONCRETE HIGHWAY BRIDGE IN COLORADO

By Robert Dubois, Bridge Engineer, Colorado State Highway Department, State House, Denver, Colorado.

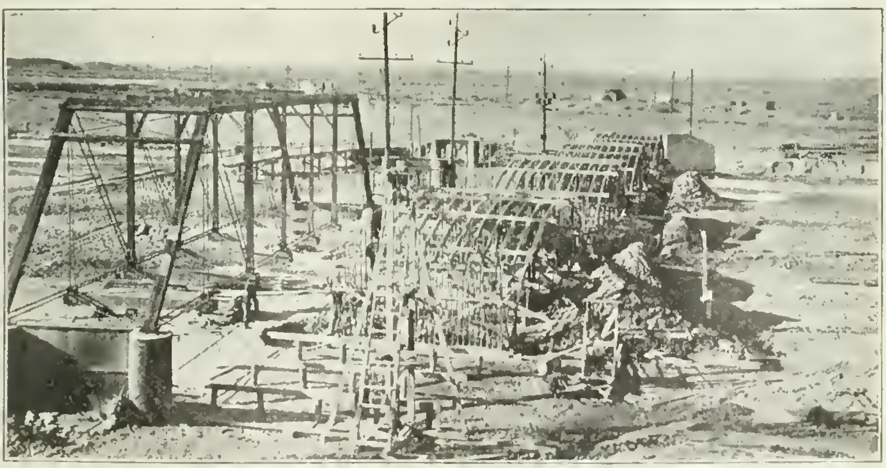
There is just being completed for the Colorado State Highway Department, one of the largest concrete bridges in the state. It is about 20 miles east of Pueblo, across the Huerfano river, on the New Santa Fe Trail, a highway that is not only the main road in the Arkansas valley, but also is the artery for the heavy tourist traffic from Kansas, Oklahoma and Texas to the mountain playgrounds.

The former bridge across the Huerfano was of combination trusses, built almost 30 years ago, two spans of which failed, because weakened by the drillings of woodpeckers at the hip joints. The new bridge is of concrete arches, five 80-ft. spans. The foundations all reach bed rock, though at one end, it was necessary to go down 20 ft. below the stream bed. The cofferdams were sheathed with a single layer of Oregon fir, two by sixes. That the cofferdam for the 20-ft. hole had to withstand considerable pressure is attested by the fact that a piece of fir 2 by 6 incorporated into the waling came out only ¾-in. thick. In spite of this pressure, however, no great difficulty was experienced with the cofferdam, which did not make at any time more water than a single 6-in. pump could handle.

After the normal time for trouble from floods had passed last fall, excavation for the stream piers was begun. When one cofferdam was down about 8 ft., and another all assembled, the river came up and removed them, taking along also some of the equipment. All of the equipment, however, was later recovered, except a small pump. After this, no more trouble was encountered with the weather—the winter being exceptionally open, never interfering with the work.

Piling for the centering was cut locally by the contractor, cottonwood being used. Five-pile bents, on a maximum of 12-ft. centers were used. The segments were made of narrow strips cut to the curve of the arch, nailed onto two by twelves. These were lagged with two by sixes. The centering for all the arches, and the outside forms for the spandrel walls, were finished, and the arch steel all tied in place, before any of the arch concrete was run. Once started, however, one ring 5 ft. wide was poured over one arch each day, giving a high yardage for the contractor's estimate that month.

The spandrel walls required considerable care. Not only was it necessary to pour a vertical lift of 18 ft. in a continuous run, but, there being no overhanging bandrel along the top, especial attention



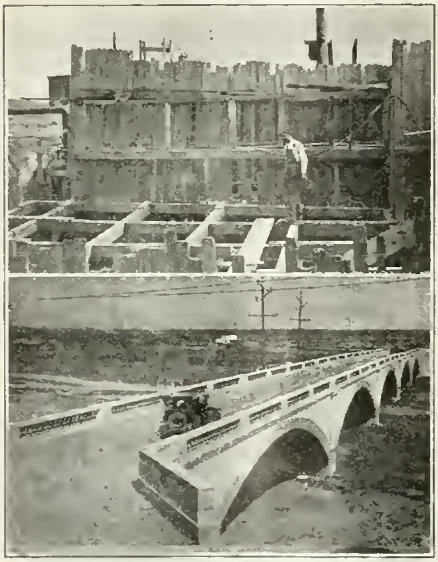
CONSTRUCTION VIEW ON HUERFANO RIVER HIGHWAY BRIDGE IN COLORADO.
From Left to Right: Temporary Bridge; One Span of Old Steel Bridge; Ribs for Centering of New Concrete Bridge.

had to be given the bracing to achieve a true, plumb, wall. Excellent results were attained.

After much of the dirt fill was in place, the centering was struck and the handrail poured. Here again much attention was given to attaining true lines, with the desired results.

The concrete work was almost done, when the flood of June hit the Arkansas Valley, tying up temporarily most of the roads. Part of the old temporary crossing was taken out, and since bridge timbers were badly needed for temporary bridges on other crossings, it was decided to open the new bridge for traffic, incomplete as it was, and not attempt to repair the old bridge, but instead to use that bridge material for a temporary bridge over the St. Charles River, near Pueblo.

As soon as the concreting could be finished, and enough more dirt thrown in to make even a moderate roadway, the contractor's forces were taken off to construct a number of pile trestles at other points where bridges had washed out. These done, the fill was again attacked. A considerable fill is being put in on the Pueblo end, improving greatly both the grade and the alignment. This fill is rapidly nearing completion.



VIEWS OF HUERFANO RIVER CON-
VIEWS OF HUERFANO RIVER CONCRET
CRETE HIGHWAY BRIDGE IN COLORADO.

Upper View: Cofferdam for Abutment Sunk 20 ft. and Cofferdam for Wing Adjoining Down About Half Way. Lower View: A General View of the Bridge.

The Santa Fe Trail will be concreted, from Pueblo east to this bridge, within a few years. When that time comes, it is planned to pave right on across the bridge. Until then, the roadway is being graveled. The new bridge will remove the danger from a bad section of road, there having been a sharp, blind turn down a steep hill to the valley. The new bridge will have straight approaches on easy grades.

The bridge was designed for the State Highway Department by the writer, who also did the resident engineering work during construction. It was built by the Pueblo Bridge and Construction Company, under contract. Their foreman was Thomas Gross, who produced a bridge of unusually good appearance.

SUGGESTIONS ON THE DESIGN OF TILE DRAINAGE SYSTEMS

By J. W. Dappert, Consulting Engineer, Taylorville, Ill.

Without attempting to go far into the past, and without digging up some of the tile-drainage systems put in by Nimrod along the Tigrus River Valley, 1300 B. C., by Vitruvius, and other engineers in Rome from 753 B. C., to the present date, or without examining the terra-cotta pipes laid by Sir James Graham at Northumberland, England, in 1810, and those installed by the venerable drainage engineer, John Johnson, at Geneva, New York, from 1835 to 1858, we come, by easy stages, to present day practices and methods of tile drainage in the Mississippi Valley, and especially in Illinois, said Mr. Dappert, in addressing the Illinois Society of Engineers at its 1921 meeting.

The earlier work of tile-drainage in Illinois was not done in accordance with well established rules or reasons, but was rather by a haphazard "hit or miss" method. Also, I fear that the practice has not yet reached the stage where it is a purely scientific operation based upon rational and wholly deducible formula and rules. In the very nature of the work, being carried along mostly by individual enterprise and with little supervision or aid from any governmental agency, there has been no time or funds for going deeply into the rather intricate scientific problems which confront the average user of tile drains, whether land owner or engineer.

Testing Tile

The Iowa State College at Ames, Iowa, has gone rather fully into the subject of bearing strength of drain tiles, and the American Society of Testing Materials has adopted a tentative method of testing drain tiles and a set of uniform specifications for materials and manner of installing them; but the equipment required to carry out the tests, and possibly the time and expense of both money and brain power necessary to execute them has been a deterring factor against their universal use. When facilities have been provided by the state enabling tests to be made of each carload of drain tile before it leaves the factory, and without direct expense to the purchaser or user, I apprehend that the standard specifications will become almost universal, but at present they are not generally used, and cannot thus be used. A few farmers or land owners frequently have a small joint drain to install, requiring the use of from one to ten cars of drain tile. It is manifest that they cannot afford to pay from $10 to $40 per car for the tests to be made in standard manner, so most of the engineers of this state are going to continue to inspect and reject tiles upon their general appearance as to color, soundness, freedom from cracks, checks, blisters, or other defects, and upon the general reputation of the manufacturers, as we have had to do in the past. Now this should not be so, but until some practical method of application of standard tests and specifications can be put into effect, it cannot be otherwise.

An Experience With Poor Tile

Some of the difficulties which I have found and partly solved in the most practical way at hand may be of some interest. In one instance, about 12,000 ft. of 30-in. vitrified salt-glazed drain tile were being installed, with flat gradient 0.03 ft. per 100 ft., through city streets under pavements, incidentally crossing 5 main lines of railroad tracks and about 20 side tracks. My specifications, made before standard specifications had been worked out, required cast iron pipe 30 ins. in diameter, to be installed under the tracks, and also required drain tile to be of first class quality in all respects, with the usual "terms of endearment." Other portions of the specifications required the contractor to complete the drain and accessories and put them in good working order throughout. He was required to furnish all materials and prices were by the lineal foot. This drain was so situated as to have but 9.6 ft. fall in a distance of about 10,000 ft. This fall could not be increased without dredging work, which would involve perhaps a million dollars and affect the riparian rights of landowners in two different states. Added to the difficulty of gradient and that of railroad track crossings was the natural difficulty of much fine sand in the soil. Fortunately the grade had to be placed so low down as to be wholly under all the former works of man. The borings taken showed that we had a stiff yellowish blue clay at grade of drain. The contract for construction was let about March 6, 1913, at a time of slightly ascending prices, but four or five bids were had at or near the engineer's estimate, and all went well until about 1,000 ft. of the drain tile had been delivered upon the line of work. The first impression upon seeing the tiles was that they were rejects, as some of them had yellow clay adhering to them, although the top soil for several feet in depth of the contiguous land was all quite black. I see now that I should have rejected the entire lot bodily as not being of standard thickness under the specifications, but my idea was that it would cause considerable loss to some one, and delay to do so.

The contractor said he had purchased them under a guarantee that they would meet the specifications, and, if they did not, neither he nor we had to pay for them. Under this arrangement about 40% of the tiles were culled out and the construction began. After many changes in alignment and some changes in the contract, which changes were constantly being sought by the contractor, the work progressed about 800 ft., where depth of backfill upon the tiles reached 7 ft.; practically all the tiles were ruptured by the dead weight of earth in the trench. The final outcome of the trouble was a rejection of all the pipe, a new contract let at 20% advance in price, and two years' delay in completion, with a lengthy trial in the District Court, and a "hung jury," so that not any of the pointed questions raised were ever really determined, and I do not know whether the provisions of my specifications were good or bad. The work was finally completed by the third contractor, and 800 acres of marsh, always heretofore a stagnant pond, full of mosquitos and miasma, converted into small truck farms and gardens which produced bounteous yields throughout the world war.

Some Lessons Learned

The lessons learned from this experience are: First, make your specifications and contracts very explicit and definite, and as brief as possible under the circumstances. The Court loves a brief contract, if it ever reaches court. Second, if it is evident that the contractor is seeking to make his profits by evading the plain terms of the agreement rather than trying to perform them in a practical way, and hopes to profit by trial in court rather than by miles of work performed, then get rid of that contractor by all means and re-let the work. Third, do not presume that all kinds of difficulties have been met, overcome, and reported at length in the society proceedings or journals of various associations, because there is a crooked contractor coming who will readily devise some new difficulty that you have not encountered. Hence, the lesson to be learned here is to look well into the character and ability of the contractor to whom you award important works.

Topographic Surveys

The drainage engineer is frequently presumed to be able, at a glance, to determine the topography of the land sought to be drained, its fall to the outlet, surface slopes, soil characteristics, and all other physical aspects, but usually he cannot do so. Hence, to determine the plan of drainage so that it can be most economically installed, a topographical survey is a necessary part of the expense of construction, and a plan should be evolved which can be, at once or at a later date, put into execution. This topographic survey should include the determination of elevations, sufficient in quantity to make a close topographic map. Do this by stadia readings, if you like, but I find that I can cover more ground per day with a Wye level, using a small pocket compass and level combined, to fill in the more minute details, and in this way cover an area of from 100 to 300 acres per day. The more flat and level the tract, the longer I make the station intervals, and the more rolling the tract, the more carefully should the elevations be taken, that is, within reasonable limits, upon such lands as ordinarily require tile-drainage. Usually the elevations are taken at intervals of 100 ft., while for very flat lands they may well be taken at intervals of 300 ft., but in either case the location and elevation of all depressions, ridges, extremely wet spots, ponds, streams, fences, buildings, and trees should be taken, and their location and elevations determined sufficiently close for platting. While this is going on, test pits should be dug, the soil investigated, elevation of any hard or soft strata determined, samples of any unusual varieties of soils taken for future test and study, and all this data be finally platted upon the map of the area.

During this preliminary survey and investigation it may also be necessary to make a survey for some distance away from the tract in question, to secure a proper outlet, and a close sketch of the creek, branch, or other water course and its surrounding objects should be made, with measurements sufficient to design a proper bulkhead or retaining wall at outlet of tile drain. This survey should also be made with a view to the possible construction of catch basins, inlets, or wells, at the points where they will best serve their functions. These should be placed at fence lines where possible, or at the margins of fields, where they will be least in the way of cultivation or use of the land. It is better to take all possible data of this kind while making the topographic survey, rather than to have to make another long trip later on to secure one or two of the most important facts found to be needed. A day's time extra on the preliminary survey may easily save several hundred dollars in the final determination of the most feasible plan of drainage, and I think it best to get all the data rather more minutely than necessary, as being an error in the right direction.

Utilizing Old Tile Drains.

Frequently, in a topographic survey of this kind, it is found that some sort of a haphazard system of tile drainage has been heretofore laid upon the land, with tiles generally too shallow properly to drain the land. Indeed, it would be difficult to find many tracts of land in the corn belt of Illinois that have not one or two tile drains laid. These should be followed out and their locations determined as much as possible, and that is done by digging holes or trenches where the tiles are suspected, until a mixed soil is found, indicating that the soil has once been dug, and by perseverance and a little experimenting, these old drains can generally (but not always) be traced. Some of the older tiling contractors whom I have known are quite frequently adept at this kind of work. Having found these tiles, they should also be platted from measurements, and have their grade lines marked at intervals upon the map. If such old tiles are found to be filled with a deposit of mud, or are 4 ins. or smaller in size, and are so situated as not to be of much utility in the plan of drainage, they ought not stand in the way of designing a proper system of drainage, and should be ignored. Where it is found that such old tiles are helpful in draining the lands, are in good general condition, and are laid in the natural course of drainage, they may be utilized in the new plan, and the new drains so designed as to conform with them, or very nearly so. Each tract of land should form a separate study, a separate problem, and be worked out to effect the final drainage in the most economical manner. It is the function of the engineer to provide the drainage in the most feasible way, at the least expense, and with the best possible results. Some determination of soil conditions can be had while the holes are dug for purposes of finding the old tiles.

Where, as frequently happens, some of these old drains are missed in the preliminary survey, but are found in the actual construction of the new drains, and are frequently found in good condition and performing their work, it may be desirable to maintain them. This is easily done where new grades are shallower than the old, but most frequently they are the reverse. Where new drain goes under the old, if found in good condition, the latter may be connected by means of a Y junction to the new drain, stopping up the dead end of the old drain by means of bricks and cement. Again, it may be desirable to pass the old drain over the new, in its original course. This is done by building up a mass of concrete, using pieces of broken tile where space is large enough, in such manner that the water will not pass from the old to the new drain, causing wash and displacement of the drain. Where grade of old drain is slightly higher or lower than that of the new drain, and not large enough to admit of junction with each other, a small sub-surface well of brick, laid in cement, can be built with 50 bricks, a bucket of cement and two buckets of sand, which will enclose both drains and allow the water to go to either the old or the new drain, whichever has the least resistance. I have employed all these methods at various times. The passing of one drain over the other must be well done, using cement and tile bats, as suggested, to prevent damage to one or the other of the drains. The little detail of stopping up all dead ends of tile drains by some permanent kind of plugs is of as much importance as the laying of the drain in the first place.

Design of Tile Drainage Systems

With a close topographic map before him, the engineer begins a study of his problem, be it intricate or simple. All time spent in study upon it is justified, for upon the proper design largely depends the success of the enterprise. The old tiles found upon the tract may easily be a deciding factor in determining which one of two possible plans is best. Where areas are flat and the contours rather far apart, the plan should be to cut the contours at right angles, as nearly as possible, with the drains. When you design a system with the laterals spaced parallel to each other at regular intervals, it will often be found that you cannot locate all of them at right angles to the contours. I would allow considerable leeway to this rule, so long as the laterals in regular spacing will cut the contours at an angle up to 45 deg. from perpendicular, after which a new main or sub-main should be installed, in some "thalweg" or depression, which will admit of a considerable area being reached with a parallel system of drains.

Where flat areas are found covering considerable territory, it will be found necessary to insert some sub-mains at intervals, rather than to carry the lateral drains for long distances upon too flat a grade. Also, this method saves going very deep at lower end and very shallow at upper end of lateral, the sub-mains being held down to flatter gradients and made sufficiently large to carry the water from the laterals. Upon lands which are rather rolling, it is found that no regular rectangular or gridiron system of lateral drains is applicable, and in my opinion this kind of land is the most difficult upon which to plan an elaborate system of drainage. The low swails rapidly catch the waters from the more rolling lands and become supersaturated, hence the lateral drains should be provided with more capacity than for flat lands where the accumulation of water is more gradual. In other words, the portions of a hilly farm that require tile drainage at all require tiles of larger calibre than those upon more level land, if you wish to get the water into the drains rather than to have it run away upon the surface, and thus prevent soil erosion.

Where flat areas join precipitous areas, the laterals will generally need to extend well up the slopes, to cut the seepy spots, and should extend to the summit, or very nearly so, and the drain which goes far enough above the point of seepage so that its grade line is about level with the place where seepage discharges will be of more value for drainage than the lateral which goes directly through the seepy spot itself. The reason for this is that the seep itself is caused by a stratum of soft, water-bearing soil overlying a hard, impervious stratum which holds the water and carries it out to the end of the stratum. Often these hard strata dip away from the draw or natural depression rather than toward it, as might be presumed, so that considerable exploration by boring or test pits is desirable upon such rolling lands. This inversion of dip, and many other intricate details of soil formation, are due to the pressure of the ice sheet during the glacial epoch, and to subsequent erosion.

The several different glacial invasions coming from different sources, or from different directions and at different times at least, have also complicated our soil conditions, and are a great study in themselves, not to be treated at great length in a paper of this kind. Suffice it to say that the drainage engineer should inform himself as much as possible about soil formations, soil characteristics, and when he becomes familiar with the various features of soil in a given locality he will be able to forecast, from surface appearances, some of the peculiar and well defined characteristics of soil strata wherever he sees them. This statement is especially true of soils in the upper Mississippi Valley, with now and then such a notable exception that a special study should be made of such exceptional features.

Depth of Drains

The depth at which tile drains are laid or should be laid is dependent largely upon the character of the soil. Usually the tiles work best when laid just a few inches below the base of the soft, water-bearing stratum, and within the hard bottom below it; but it is evident that with a drain laid to a regular gradient this is rather difficult always to accomplish and keep upon straight lines, hence the more need for the test pits and a study both of topography and soil strata. Where the topography is rather precipitous, contour lines close together upon the plat, the cutting of the contours at right angles may not be the most desirable method of location of the drains. It frequently happens that a direction oblique to that of the contours may give the best results, and if a single drain does not cut off all the seepy places the next parallel drain will do so. If I have made it plain that considerable study of soil conditions and topography are worth while in a tile-drainage project, I have accomplished my purpose, and leave it to the ingenuity of each individual drainage engineer to work out for himself the methods of determination.

As to the depths at which tiles should be laid, I find that I cannot always secure as great depth as is desirable, in flat areas and can secure too great depth in more rolling areas of land. In other words, where the tiles could properly be laid to a good depth the topography is such as not to admit of it, and where the topography will admit of deep drains, as on rolling lands, the soil conditions are such that the shallower drains will better serve the purpose. I think most drainage engineers have found this true. Now, as to what depth and space intervals are best—each drainage area is a separate study by itself, and no one can say, except by a study of all the conditions, or by experiment. I have laid tile drainage systems with laterals spaced 200 ft. apart and secured fairly complete drainage upon rather flat land with very friable soils. Again, I have laid the tiles 132 ft. to 140 ft. apart upon rather rolling lands and afterwards found it necessary to double up by laying one new drain between each of the two older drains, to accomplish the same result. Upon the rolling lands the soil is, most generally, not so friable as upon the flatter lands. Also, a drain laid upon a hill slope does not reach out far to draw the water upon the down-hill side, hence the spacing must be close enough so that the contiguous drain will draw the water from the soil upon its up-hill side, from near the locality of the next drain. Again, a study of each area is a necessity to be able to properly design the system and to determine the distance apart of the drains.

Inlets and Catch Basins

In many localities where surface run-off is great, it will be found necessary to install inlets and catch basins. This is especially true of the more rolling lands, where small branch drains, ditches, and water-ways have been made or washed out by erosion. Upon such lands the soil and sub-soil are frequently impervious, or partly so. The water cannot percolate down to the tiles as rapidly as it falls during heavy rains or in melting snows. It forms rivulets and washes away the top soils, and impoverishes the land. A catch basin, usually dug circular like a well, lined with brick or concrete, with its base also lined, and made from 2 to 8 ft. deeper than the outgoing tile drain to form a silt basin, should be installed at fence lines where possible, so as to be least subject to injury by stock and from farming operations. Where necessary a small pen can be built to protect it. These catch basins should have a grated iron frame and cover similar to city catch basins, and, if necessary to install in a field under cultivation, may be left several feet below the general surface, at top of grate, and have a load of broken stone or gravel thrown over the top through which the surface water readily percolates.

Where drainage areas are small a T junction can be placed vertically in the tile drain and a run of pipe carried up to the surface, with a grated iron cap and cover. If in the fields where they would be subject to being damaged or broken they can be covered with brick bats, tile bats, gravel or a mixture of any of these, and will admit surface water and prevent erosion. It is needless to say that all such devices for surface water admission offer a variety of forms of construction, depending as to economical qualities upon the conditions in the locality. But it is more economical in the end to provide some durable design which will not readily decay, such as concrete, iron, stone, or vitrified clay pipe.

Where a system of water inlets or catch basins is designed as a part of the system of drainage, it is evident that greater run-off must be provided for than if merely drainage by percolation, and the tile laterals and mains must be increased in size to allow for this, or otherwise the basins and inlets will not accomplish their purpose, to prevent soil erosion.

Rainfall and Run-off. Sizes of Tile Drains

Just how large a drain should be to serve a certain area is quite a nice little problem in itself. It has often been solved by guess, by engineers and others. The land owners who pay the expenses often determine upon the sizes to be installed, but the engineer is usually called upon to use his skill and judgment in deciding the kind, sizes, and character of drains needed. I note with gratification that those engineers who depend largely upon guess work are dropping by the wayside, and the engineers who determine facts by reasoning and by scientific investigation are coming into favor, for the employing public is learning to appreciate experience, education, and scientific design, in all fields of endeavor.

The study of rainfall is a great topic. In the state of Illinois the variations of annual precipitation are as great as 14 ins., which is 33% of normal precipitation in this state. The rainfall records of the U. S. Weather Bureau show as much as 11 or 12 ins. rainfall in 24 hours in restricted areas, and in unusual floods. The run-off records in the state vary from practically zero to as great as 5 ins. in 24 hours. By taking the extremes in any case we can arrive at no safe and sane conclusion as to how much run-off to provide against in designing a system of tile drainage. We depend largely upon experiment and former experiences as to what is feasible and proper to provide for.

(To be Concluded in October Issue.)

ENGINEERING FEATURES OF STATE PARK AT GRAND HAVEN, MICHIGAN

By William M. Conley, County Road Commissioner, Ottawa County, Grand Haven, Mich.

By the action of the City of Grand Haven in presenting a valuable 10-acre park site along the shore of Lake Michigan to the Michigan State Park Commission motorists have been given direct access to the beach over paved roads, parking space has been provided close to the shore line for hundreds of cars and a delightful playground has been opened to the thousands of tourists who flock to Michigan every summer. The Grand Haven park consists of 10 acres of broad, clean sand beach, located at the terminus of Trunk Line Highway No. 16 and along Trunk Line Highway No. 11, the latter being known as West Michigan Pike, both highways being paved down to the entrance to the park.

At most points nature has barred access to the beaches through the great bluffs and huge sand dunes. The Grand Haven State Park is one of the few points where public improvements have been carried on to an extent that has overcome these barriers and the tourist easily reaches the lake over a fine pavement. Private interests heretofore have monopolized the more accessible points on the lake front and the movement of the State Park Commission is regaining the privileges which never should have been denied the public.

The paving at the State Park for the accommodation of the many visitors consists of a great concrete oval 2,100 ft. in length with a paved width of 25 ft. to be ultimately widened to 50 ft. Parking space for automobiles is provided around the entire oval and 2,500 cars were parked there the first Sunday following the opening day. The park was opened June 26, 1921.

The ultimate plans of the local park commission include the erection of bath houses, comfort stations, playground equipment and a commodious shelter house. A life-saving patrol of some kind will be established for the protection of the thousands of bathers. A landscape architect has in charge the beautification der the efficient management of Paul R. Taylor, City Manager. A program of paving has been laid out two years ahead and the City Plan Commission has tentative plans considerably beyond that period.

The construction of the State Park at Grand Haven is only a part of a large plan laid out by the Michigan State Park Commission of which Mr. Fred Pantlind, of Grand Rapids, is an aggressive mem-

DRAWING OF THE STATE PARK AT GRAND HAVEN, MICHIGAN.

of the park by planting ornamental shrubbery and such trees as can be induced to grow in the clean, smooth sands common to the Lake Michigan beaches. The present city-county highway connecting with this park will ultimately be projected as a boulevard northerly and easterly to form a concrete loop about the city and will provide a choice of routes to the park.

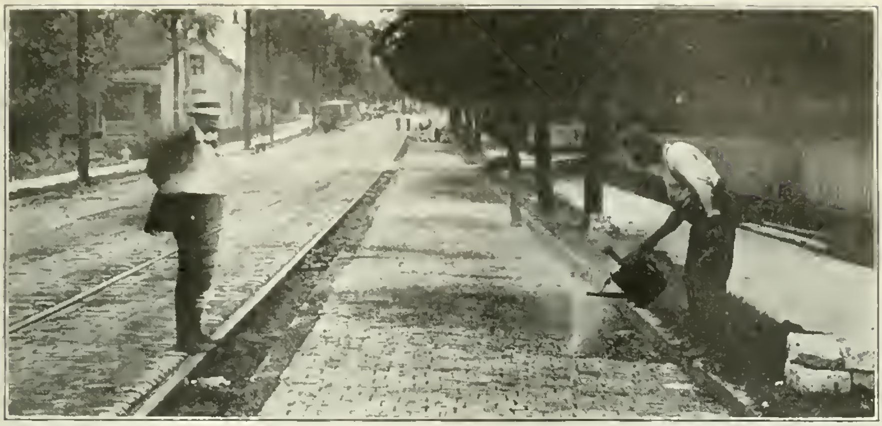
Ottawa County has a great building program of concrete roads under way. This season will see the completion of the concrete paving from Grand Haven to Holland, a distance of 22 miles. From Grand Haven to Grand Rapids, a large part of the distance will be paved during the season, the distance being 32 miles. Muskegon lies 12 miles north of Grand Haven and a fine highway connects the two cities. The City of Grand Haven is now paving its streets with concrete exclusively and the paving laid more than seven years ago is still in excellent condition. The paving is done by force account un-

ber. The Ottawa County Road Commission encourages and lends its aid to all public improvements that in any way benefit the motoring public and it has been an important factor in this particular instance.

PROTECTING PAVEMENTS ON CAR TRACK STREETS

By H. A. Nunlist, Consulting Engineer, 1309 *Traction Bldg., Cincinnati, Ohio*

When a city is ready to proceed with the improvement of its street car streets, the car company frequently is not financially able to carry on the improvement of its right-of-way. The result is to delay the improvement until such time as the company feels it can conveniently stand this added expense. In many cases the tendency to delay reconstruction is augmented by the fact that the rails are in daily use, no consideration being given to the public using the pavement outside of the rails.



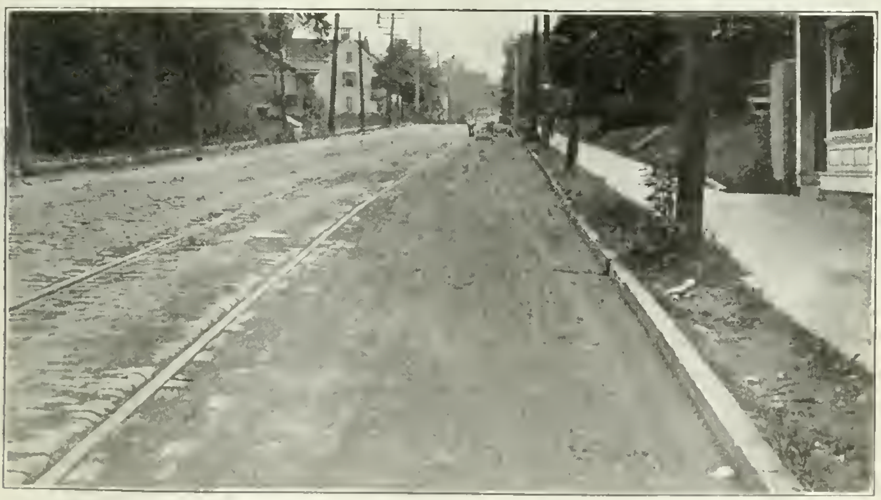
SHOWING GRANITE HEADER IN PLACE—CAR TRACK PAVING NOT DISTURBED —AND POURING TEXACO NO. 39 ASPHALT FILLER ON CARTHAGE PIKE, ST. BERNARD, OHIO.

Work at Norwood, Ohio

For a number of years the principal street in the city of Norwood, Ohio, was badly in need of improvement. It was very difficult to get the city and street railway officials together. In 1915 plans and specifications were prepared by the city engineer for permanent improvement of the city's section of the street, and his solution of the problem has proved so satisfactory that many engineers elsewhere are employing the same method.

A granite header was placed at the end of the ties on a concrete bed 6 ins. deep. The header was placed to act as a curb to hold the street pavement in place, and work progressed in the same manner as paving a narrow street. Later the street car section of waterbound macadam was easily improved.

The granite header, 4 by 10 ins., and in sections of from 3 to 5 ft. long, not only solved the engineer's problem of satisfactorily improving this section of the street, but it also demonstrated conclusively that the street car company could carry on the improvement of its right-of-way without disturbing the adjacent pavement in any way. Not only was the pavement left intact after the street car section repairs had been made, but the header effectively served to limit the shock due to the impact of the moving street cars because of uneven rail joints, flat wheels, etc.



CARTHAGE PIKE, ST. BERNARD, OHIO, SHOWING NEW GRANITE PAVEMENT WITH GRANITE HEADER AND TEXACO ASPHALT FILLER, WITH OLD CAR TRACK PAVING LEFT UNDISTURBED.

At Chicago, Ill., and St. Bernard, Ohio

The city of Chicago employed the granite header in 1919 with such success that the Board of Local Improvements now requires a header on all street paving improvements carrying street car rails.

The city of St. Bernard, Ohio, is well pleased with the repaving of Carthage Pike, the main thoroughfare of the city, which work is being carried on without the street car company repaving its section of the street. The joints of the pavement are being filled with Texaco No. 39 asphalt filler to insure a water tight joint and also to allow for expansion and contraction of the header due to temperature changes.

What the Granite Header Provides

The granite header provides for the following:

First. The reconstruction of the city section of a street independent of street railway company and permits either interested party to repair its pavement area without interfering with the other.

PAVEMENT RECONSTRUCTION ON WABASH AVE., CHICAGO, SHOWING GRANITE HEADER AND NEW PORTLAND CEMENT CONCRETE BASE IN PLACE, STREET CAR RAILS AND PAVING NOT DISTURBED.

Second. An insurance on the life of the city's section, as the header serves to limit the effect of the street car traffic shock, which has been found very damaging to pavements where a division of sections is not made.

Third. City can construct its section without awaiting time for street railway company to finance its section.

Fourth. The top of the header is flush with the pavement, and furnishes a uniform surface.

This method of construction has proven its worth, and can be recommended highly.

HOW HALIFAX WAS REBUILT

By Jacob L. Crane, Jr., Charlevoix, Mich.

(Editor's Note—Mr. Crane collected the material for this article while on his town planning trip through Canada and Western Europe, editorial reference to which was made in the March, 1921, number of this magazine. While Mr. Crane is still abroad, correspondence to the address above given will be brought to his attention).

Under the administration of the Halifax Relief Commission nearly thirty million dollars have been expended in temporary and permanent relief; in re-planning the 325-acre devastated area; rebuilding nearly 600 destroyed houses; completing about 15,000 repair jobs; and adjusting over 16,000 personal claims. In addition to its magnitude, the reconstruction work is notable because it has greatly improved the character of the ruined area by the scientific re-planning of the streets and by the construction of better-situated and better-designed houses in place of the destroyed ones.

In the explosion which occurred December, 1917, in the Halifax harbor, 1,600 people were killed, 6,000 injured, 1,600 buildings were destroyed, and upwards of 12,000, within a radius of 16 miles, were damaged. An entire section of the town was utterly wiped out. The British Government, the Canadian Government, and private subscription (including large sums from the United States) made up a relief fund of $29,000,000. A special Act of the Canadian Federal Government incorporated the Halifax Relief Commission to administer this fund, and endowed it with unusual powers for expropriating and re-planning land.

Under this Commission the usual procedure following disasters, in which the opportunity to rebuild well has not been utilized, was abandoned. Instead of paying damages to owners of ruined property, the Commission bought or expropriated enough of the ruined area to control its new development, and re-planned and re-built it according to a thorough and comprehensive plan. The old streets had been wastefully and inconveniently laid out according to the usual rectangular plan; some wide avenues ran straight

against grades as high as 20 per cent, and the maximum grades of the nine principal east and west streets were 8, 10, 11, 12, 13, 14, 15, 18 and 20 per cent; the approach to the center of the district was roundabout and over an alternation of flat steep grades; advantage had not been taken of the splendid site overlooking the harbor; and lot subdivisions were standardized without regard to use or the character of the site.

Re-planning is always expensive and wasteful in its re-distribution of values, the price which must be paid for lack of planning in the first place; but on the whole there could scarcely have been a more economical plan for Halifax than the one proposed. Of 508,370 sq. ft. of land included in the new diagonals, central square, etc., 433,140 sq. ft. can be saved in streets, waste land, etc., which may be converted into building land. The balance is but 75,230 sq. ft. No radical change could be made in the old rectangular plan without scrapping expensive local improvements, but with as little violence as possible to the old system, the new system is planned to secure easy circulation of traffic and proper distribution of the density of building; the overwide streets are narrowed and the houses set back; two new diagonals at grades under 5 per cent lead to adjoining regions from the center of the development and converge in a central square around which the principal public buildings are to be erected, and which is an important distribution center for traffic from all directions; a convenient location is made for trolley service; excellent sites are provided for stores and for school houses and other public buildings; the advantages of the town's site are better used by studied situation and orientation of buildings; a fine hill site is reserved for a park; and one district which had been mostly occupied by "shambles" was re-planned for multiple-type workmen's houses.

The design and construction of the buildings was taken up in the same way. Ross and McDonald, of Montreal, architects, devised plans which meet the financial requirements of the development and at the same time afford greater variety, interest, and attractiveness to the district than it formerly possessed. Houses better situated and more attractive than those renting at from $20 to $40 a month in other parts of the city can be had here for from $18 to $25. Part, but by no means all, of this difference has been written off the books of the Relief Commission as excess charges due to the maximum prices at which the work was done. All of the houses will eventually be sold, first choice being given to former residents of the district. Many are built of a not un-attractive compressed concrete block with granite facing and with stucco or frame second stories, as shown in the accompaning view.

The 325 acres along the harbor, being re-built under the direction of the Halifax Relief Commission, are incorporated as part of the city plan now being completed for the remaining 3,960 acres of Halifax, by the Town Planning Board, assisted by Mr. Thomas Adams, Town Planning Advisor of the Dominion Bureau of Conservation. The planning of the region surrounding the city is under direction of the Halifax County Council, which has prepared four schemes to take care of an area totalling 18,138 acres. The rebuilding of Halifax is giving most effective practical demonstration of town planning values. Instead of the uneconomical and commonplace type of development found in most of Halifax, and in most areas rebuilt after catastrophes, the development of this area possesses decided advantages in economy, appearance, and convenience of use. Mr. Wm. E. Tibbs is manager for the Halifax Relief Commission, and Pickens and Roland, of Halifax, are supervising engineers.

A REBUILT AREA IN HALIFAX, NOVA SCOTIA, SHOWING HOUSES OF CONCRETE BLOCK, STUCCO AND FRAME CONSTRUCTION. THIS IS THE NEW COLONY OF WORKMEN'S HOMES.

WATER WORKS SECTION

USING ELECTRICALLY OPERATED VALVES AT BUFFALO, N. Y., AND CAMBRIDGE, MASS.

At Buffalo

In 1917, the Bureau of Water, City of Buffalo, under the able superintendence of Mr. George C. Andrews, the present Water Commissioner, started a campaign to reduce water waste consumption with three objects in view:

First. Reduction in operating cost due to decreased pumpage.

Second. Eliminating the necessity of laying new feeder mains, on account of the reduction in consumption.

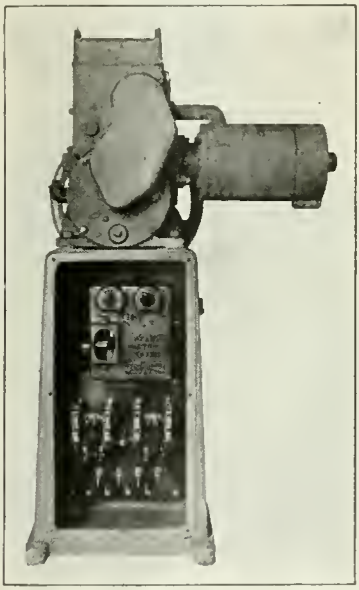
Third. To reduce the total pumpage to a figure more in keeping with that of other cities, so that a filtration plant could be built at a much less expense than would be necessary if no control were exercised over the waste of water.

DEAN VALVE GATE POSITION INDICATOR USED FOR INDICATING POSITIONS AT ANY DISTANCE FROM VALVE.

Water is supplied to Buffalo at two pressures, the low, or reservoir service, and high, or direct pumping service.

The low service is connected with the Prospect Reservoir with a capacity of 116 million gals. and supplies approximately one-quarter of the daily consumption.

The five pumps at the Col. Francis G. Ward Station are connected by hydraulically operated valves with two 60-in. discharge mains, one on the low service, and the other on the high service. These discharge mains are in turn connected with 36-in. and 48-in. mains in Front Ave., Seventh St., and Prospect Ave., so that discharge from either 60-in. main can be put on high or low service by operating the necessary valves.



DEAN VALVE CONTROL FLOOR STAND SHOWING CONTROL SWITCHES IN WATERTIGHT COMPARTMENT.

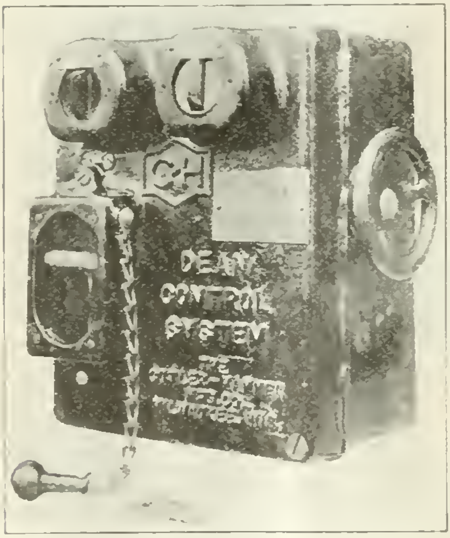
Under ordinary daily operation at the present time it is necessary to operate one of the pumps on the high service in the Massachusetts Ave. Station in order not to overload the 60-in. discharge high service main at the Ward Station. Besides this, ample boiler reserve at the Massachusetts Ave. Station is provided for in order to handle the entire high pumping service in case of emergency. This is done on account of the fact that the Ward Station is dependent upon a single 60-in. main for its high service discharge, and any failure in this line would leave three-fourths of the city of Buffalo gasping for water.

By closing three 48-in. valves, and opening two 36-in. valves it is possible to change the 60-in. discharge main in Jersey Street from low to high service, and utilize it as an auxiliary high pressure discharge main.

By daily operation of these valves it is possible to utilize the Jersey Street main for high pressure service during the hours of peak load, and reduce the discharge materially through the 60-in. discharge main on Porter Ave. In addition, it will allow of the maximum output of 150 million gallons per day being obtained from the Ward Station entirely on the high pressure system.

All peak loads during 80 per cent of the year can be met by the Ward Station alone.

The Massachusetts Ave. Station fires may be banked for 80 per cent of the



DEAN CONTROL STATION INCORPORATING EMERGENCY FEATURE LOCK.

year, and the coal consumption may be reduced from 10 to 15 tons per day, resulting in a reduction of the operating cost in fuel alone of some $12,000 per year.

In order to provide these conditions, it would be necessary to either install a new 60-in. main, or operate three 48-in., and two 36-in. valves twice a day, which would require the services of a large number of men, and consume considerable time.

It was finally decided that an attempt would be made to provide some mechanical operating device, so that these valves may be operated by one man, without loss of time, and the Dean Control System, as manufactured by Payne Dean Limited was adopted for the 5 valves in question, and also for 10 similar valves in the Massachusetts Ave. section.

The electrical control system is unique, inasmuch as there are two centralized points of control, one at the Lakeview Ave. Storehouse, completely controlling five valves on Jersey Street and the other control station at the Massachusetts Ave. Gate Keeper's House, controlling the 10 valves in that section.

The problem of adapting a modern control system to old valves also had to be considered, as many of these valves bore no name and no identification mark as to number of turns required to operate.

The application of the Dean System is being made to each valve without in any way shutting down the supply, and during the time of construction the valves may be operated by hand in case of emergency.

The location in which the electrical operating device has to work is anything but desirable, since many of the vaults containing the valves are filled, or partially filled with water, and further, the Dean control units have to withstand the rubbish and water that escape into the vault through the manhole covers. For this reason special attention is given to the design of the units to make them positively waterproof.

On Jersey Street the valves will be operated from a pillar in the street, and adjacent to the valve, and also from the Lakeview Storehouse, each valve then being operated from two points of control. The Massachusetts Ave. valves are all operated from one point.

The cable conveying the current from the switchboard to the valve is all of the highly insulated lead covered steel taped type, buried about 24 ins. below the ground level, and provided with waterproof joints wherever it is connected into the controlling apparatus.

The control units are to operate on current provided by the new turbine units being installed at the Francis G. Ward Station. When this system is in operation it will enable each valve to be closed within ten minutes, by merely touching a lever, providing at the same time indication by means of lights showing whether the valves are open or closed, and on one valve that is used for throttling purposes, an improved Dean Position Indicator is being installed, showing exact position of gate during its full length of travel.

The installation is such that the whole series of valves may be operated within a minute or so of each other, and electrical closing is accomplished by one man in a few minutes, whereas hand operation would require the best part of a day.

Also, in case of leaks or breaks, the system will be utilized.

At Cambridge

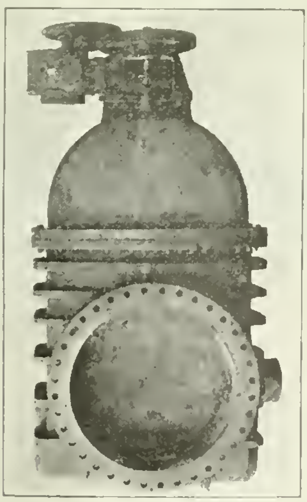
Payne Dean Limited recently completed a rather unique installation for the city of Cambridge, consisting of electrically operating, by means of the Dean System, two 48-in., and one 36-in. distributing valves, controlling the entire system of supply.

If any trouble occurs between this point and the reservoir, or the reservoir should start leaking, the operation of these valves within five minutes would enable water to be pumped directly into the system, instead of to the reservoir.

These valves are underground, in extremely wet pits, and are operated from floor stands placed on concrete foundations.

The system was not the slightest bit disturbed during the installation, and operation was available while the work was being done.

The Control System consists of standard alternating current Dean Units, mounted on floor stands, and provided with vertical shaft, which engages the operating nut of the valve. These stands are provided with mechanical indicators showing the position of the gate, and the control of the valves is at present obtained from the adjacent Weir House. Later, it is proposed to effect control of these valves



DEAN E 2 CONTROL UNIT ATTACHED TO RENSSELAER 48-IN. WATER VALVE, LOUISVILLE, KY., PUMPING STATION.

from the Fresh Pond Pumping Station.

Mr. Timothy W. Good, the general superintendent, states that this is only the beginning of the electrification of all their large gates, which they consider one of the most important features of the distributing system, not only for the operation of the valves in case of emergency, but to keep the valves in operating condition by periodically opening and closing them.

STREET PILLER BOX STAND FOR DEAN CONTROL STATION.

He also states that they are at present equipping four additional gates at the Payson Park Reservoir with Dean Control, contract for which has been let, and that they hope to have most of their large valves so equipped within the near future.

An inspection system has been arranged whereby their engineer and foreman close these gate valves at least once a week.

HOW ST. PAUL WATER DEPARTMENT SAVES $65 PER DAY ON ROUTINE CONSTRUCTION

By J. W. Kelsey, General Superintendent of Water Works, St. Paul, Minn.

We are using 5 Novo engines for various purposes in the St. Paul dater department. One 15 hp. Novo engine is operating an air compressor; another 15 hp. engine is operating a trench backfiller, and a third 15 hp. engine is operating a concrete mixer. The other two are 2 hp.

Novos on pump rigs, used to pump water from trenches when we are laying water mains. The two small ones have been in service 7 years, and it was on the basis of their good performance that we purchased the larger outfits. These have been in use from one to two years.

Drills Through Rock at Rate of 1 Foot Per Minute

We are using the air compressor rig on jobs where we are required to lay water mains and pipes through rock. In many parts of St. Paul the rock lies very close to the surface, so that it is necessary to dig trenches through solid rock, some of which is limestone and some sandstone. In such cases, of course, it is necessary to resort to blasting; and it was to drill the holes for blasting that we purchased the 15 hp. Novo engine operating an air compressor.

This equipment will produce 80 cu. ft. of air at 100 lbs. pressure per minute. Working at capacity, the unit will operate a standard rock drill very easily, with power to spare. In the hardest lime rock the average rate of drilling is about 1 ft. per minute.

2 Men and Outfit Replace 18 Men

Formerly we did this work by hand; but with the air compressor and jack hammer the two men operating this rig replace 18 men doing the work by hand. Such labor is paid for at the rate of $4 to $5 per day. The average is $4.50 per day, making our saving with the outfit $72 per day in labor alone.

The Novo engine is mounted on wheels, making it easy to transport to any part of the city. This is very essential, as our work takes us to different districts. An electric driven compressor would be out of the question, because it is often impossible to plug in on current. In the same way a steam compressor could not be practical because its excessive weight would make it too hard to carry around.

Pipe Laid Through Rock in Winter

A great deal of our pipe laying work in rock is done in the winter time, because it is just as difficult to cut through rocks in the summer as it is in winter. The Novo engine has proved absolutely frostproof; but the compressor rig being water cooled, requires special care in cold weather.

The trench backfiller is used to fill in the trench after the pipes are laid. The outfit consists of the 15 hp. Novo equipped with a double drum, drag line and scraper with a 30-ft. boom. The capacity of the scraper is about 1 yard. On this work the Novo outfit is set up on one side of the trench and the scraper on the other.

Replaces 6 Men and 3 Teams

It is a one-man operated machine, and very flexible in its manipulation, as it is mounted on multipedal tread. As the men say, "It can be turned on a nickel." It is capable of doing the work of about 3 teams with drivers, and 3 additional men necessary to hold the scraper when horses are used. This outfit is capable of backfilling a trench 8 ft. deep and an average of 3 ft. wide at the rate of about 110 ft. per hour. This makes its capacity 2,640 cu. ft. per hour.

When using horses this is very tedious work, and in hot weather both drivers and horses suffer considerably. The Novo makes this work easier for everybody, besides saving us considerable in wages and the hiring of teams. By the use of this equipment we have displaced 3 men and three 2-horse teams with drivers.

Our machines do not work every day, but the compressor averages about 7 full months a year, and the backfiller about 6 full months. The cost of repairs on either outfit does not average over $50 a year. The average life of either machine should be at least 4 years. At the end of that period it will be traded in toward a new one.

Saves $65 Per Day

Figuring wages at $4.50 a day for the operator and $4.50 for the helper, the cost of operating the Novo compressor outfit is $15.29 a day, including $9 a day for wages of the two men required. The engine averages 1¼ gals. of gasoline per hour of operation. As the two men with the compressor outfit do the work of 9 times as many men working by hand, it effects a saving of $65 daily on this kind of work.

The cost of operating the trench backfiller is $14.86 per day, including the wages of the one man required to operate it. As this outfit is replacing 6 men and 3 teams, it is easily saving the department $30 a day over the use of teams. As it handles 2,640 cu. ft. per hour, the operating cost is .07 cents per cu. ft.

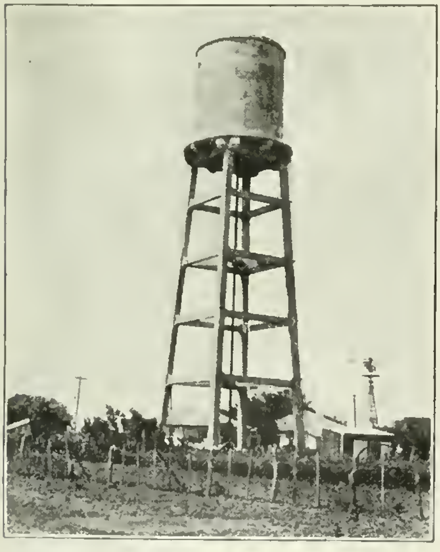
Novo engines are very simple of construction, so that a man with any knowledge of gasoline engines can operate them efficiently. We have had very few repairs to make; but when the engine does need attention it is easy to handle. As there are only two castings to a Novo, we can get any part off and on again in a short time. The valves are easily accessible, and the ignition system is so simple that timing it causes little trouble.

ELEVATED REINFORCED CONCRETE WATER TANK REDUCES INSURANCE RATE IN YORKTOWN, TEXAS

By W. L. Simpson, Consulting Engineer, 414 National Bank of Commerce Bldg., San Antonio, Texas

An elevated reinforced concrete water tank with a capacity of 66,000 gals., recently completed in Yorktown, Texas, has reduced the insurance key rate for the town, resulting in reduced insurance rates for every building in that city. This is due to the increased water pressure made possible by the tank.

At the same time that the tank was under construction an extension was made to the 8-in. water supply main and other improvements were made to the water supply system. The entire project, including the elevated tank, cost less than $15,-



REINFORCED CONCRETE 66,000 GAL. TANK AND TOWER AT YORKTOWN, TEXAS.

000. This is a small price to pay for a first-class water supply, better fire protection and lower insurance rates. The accompanying illustration is from a photograph taken just after the tank was completed.

The foundation for the tower was carried 7 ft. below the ground line. The height of the tower from ground to platform is 79 ft. The tank itself is 21 ft. in diameter and 28 ft. deep, making a total height of 107 ft. The columns are 25 ft. apart at the base and 15½ ft. at the top. The tank platform is 27 ft. in diameter.

The water supply for this system is obtained by pumping from deep wells driven to sand, in which the water rises to within a few feet of the surface. This elevated tank is a new departure in this section of the country. It seems to be an ideal arrangement for a small city and will no doubt lead to similar projects in other communities, as the people of Yorktown consider it a good investment.

The tank and water supply extensions were designed by the writer's firm. The contractor was Henry Schoenfeld, of San Antonio, Texas.

THE USES OF LIME IN WATER PURIFICATION

By C. Arthur Brown, Chief Engineer, Engineering Bureau—Water Purification, American Steel & Wire Co., New York, N. Y.

Approximately, there are 1,015 filter plants in the United States and 114 in Canada, purifying municipal water supplies. There are about 40 plants in the U. S. using chemical coagulation without filtration, the number in Canada being unknown.

Approximately, the tonnage of caustic lime used for this purpose in the U. S. is 55,000 tons per annum. This is absorbed by about 120 plants.

Using the same ratio and assuming 30 per cent of our municipal systems might be induced to use this material, the tonnage of caustic lime would be 185,000 tons per annum.

Assuming 40 per cent of these plants using lime, the consumption would amount to 247,000 tons per annum.

A rather careful survey of the possibilities would seem to indicate that between 30 and 40 per cent of the water purification systems in this country might use lime advantageously.

If we assume the growth in the building of water purification plants to follow the curve of the last ten years, the consumption in 1931 might reach a total of 346,000 tons per annum, which is the maximum which we reasonably could hope to attain.

It should be remembered that the use of lime for this purpose does not date back many years. The first complete softening plant for municipal use was designed by the speaker in 1902 for Oberlin, Ohio.

Advantages and Disadvantages of Iron and Lime Process

In this connection, the advantages and disadvantages to be expected from the use of the iron and lime process of water purification play a very important part. That advantages and disadvantages do exist cannot be disputed but, with the proper use of the process, the advantages are greater than the disadvantages, even to a greater extent than is believed generally.

There are some waters with which this process is not well adapted to produce the most satisfactory results, but this holds true of all other processes of water purification. Where the process can be used to advantage, the type of water being adapted to its use, the benefits to be derived are as follows:

Advantages

Any chemical method using two chemicals will be more flexible and will meet more different conditions than a similar process using only one chemical. Thus, in the use of this process, it is feasible to meet more varying conditions and produce a result in the purified water which will vary within wider limits than if we were trying to use a coagulant alone.

If it be desirable to soften the water, this can be done, while if it be desired to leave the water with the same degree of hardness as it naturally carried, this likewise can be done, or if it be thought advisable partially to soften, this procedure can be made effective. If the raw water be very turbid, it is usually possible to use a larger amount of lime and save on the more expensive coagulant, sulphate of iron. If the conditions are such that considerable quantities of lime cannot be used without other difficulties, it is feasible to use more iron sulphate and secure proper results in this manner.

A soft water is more desirable than a hard water for most commercial and all domestic uses. The ability to soften or partially soften a water by the use of this process is very desirable. Some of the advantages of soft water may be mentioned:

Advantages of Soft Water

In many chemical processes, a soft water is very advantageous. For steam generation it is much to be preferred. For laundry purposes a soft water is very economical, saving much soap. It is much more economical to use for tea and coffee. Vegetables, cereals, and meats cooked in soft water are more nutritious and of better taste than those cooked in hard water.

The life of linen, cotton, silk, and woolen goods is largely prolonged by washing them in a soft water, rather than in hard water.

Where two materials of different vibratory rate are brought into close contact, the difference in the vibratory rate of the two tend towards the fatigue of both. Thus, if a mineral matter having a low vibratory rate is brought into intimate contact with a vegetable fiber possessing a higher rate of vibration, the conflict in the vibratory rates of the two has a tendency to fatigue and wear out both of the materials.

If a vegetable fiber is brought into intimate contact with an animal fiber, the lower rate of vibration of the vegetable fiber reacts unfavorably on both, tending to fatigue both.

Where a hard water is used to cleanse these fibers, mineral matter is deposited on and in the fibers, the result being that the lower rate of vibration of the mineral matter tends to fatigue and destroy the fibers. This matter might be gone into at greater length but space will not permit.

The effects of very hard water upon the human economy, when used as a beverage, is less satisfactory than where a reasonably soft water is used for drinking. Many of the so-called chronic ailments of the human system, such as gall stones, rheumatism, kidney troubles, stiffness of joints or muscles and some forms of auto-intoxication are benefited by the use of a soft water, particularly if it be used freely.

When the Public Demands Soft Water

A proper presentation of these facts would have a tendency to cause the public to demand the softening of hard waters. Public officials in charge of water plants are as amenable to public demand as other public officials, but the demand must be made before they can be expected to act.

It costs more to build a plant that will soften a water supply than it does to built a plant that will filter the water without softening it. It costs more to operate the softening plant than it does to operate the plant which filters but does not soften. The public should expect and can well afford to pay a cent or two more per thousand gallons for a soft water than for a hard water, and they must be educated to this point before we can expect our public officials who are entrusted with the construction and operation of these plants to become enthusiastic over water-softening.

It is well to remember that experience is the best teacher. In cities where softening plants have been built and the citizens have become accustomed to the use of the softened water, the public official who attempted to abandon softening would find himself out of a job in a remarkably short period of time and his successor would be very loth to attempt the same thing, regardless of the expense of operation and maintenance.

The reaction of lime with the hardening compounds in the natural water is rather slow. It can be materially hastened by providing the plant with a properly designed mixing chamber. Some of the trouble can be avoided by building the settling basins with a larger capacity than where softening is not attempted but even after all these things, we must still expect some after effects to be found.

Objctions Hampering Softening Process Extension

These objections may be sufficient to prevent many cities from building softening plants or plants to use lime without material softening, but they have not proved of sufficient force to stop softening in plants where the citizens have become familiar with the advantages of the softened water and until such time, we must regard them as being more largely theoretical than practical.

One of the greatest, if not the greatest difficulty we have encountered in inducing cities to adopt the use of lime for these purposes is to be found in the design of plants to use the process. Usually, the engineer having charge of design must take into consideration the amount of money available to build the plant.

Generally speaking, the money provided is not adequate to permit the engineer to do all the things he deems necessary or advisable. As it costs more to build a plant to use lime properly than one not intending to use lime at all, his natural tendency is to build the cheaper plant and use the money he saves in this way to do some of the other things he wants to do.

Ordinarily, the engineer is the court of last resort and the city is guided entirely by his judgment. If he is opposed to the use of lime, it is rather difficult to induce him to change his mind and practically impossible to have the plans provide for the use of this material unless he can be shown the advisability of so doing, and this is not always the easiest thing imaginable.

Engineers are not very prone to listen to laymen who attempt to discuss engineering problems any more than a doctor is likely to give assiduous attention to a layman attempting to tell him how to care for a patient.

A Bureau Rendering Valuable Free Service to Engineers and Cities

Realizing this fact, our company established its Engineering Bureau—Water Purification, about 18 years ago. The function of this bureau is to keep a little ahead of the times, if possible, particularly in lines relating to the use of sulphate of iron and caustic lime in water purification work, and to be in a position to advise and consult with interested parties in the use of the process.

The services of this bureau are free to any engineer, city, or corporation having any water purification problems, regardless of the nature of such problems. Our instructions are to tell the truth, no matter whom it hurts or benefits. Where iron and lime can be used to better advantage than anything else, we are instructed to say so and prove it if given a chance but where we think some other material will do better work or give more satisfaction, we are instructed to say so quite as frankly.

The speaker has been the chief engineer of this bureau since its inception and has repeatedly advised against using sulphate of iron in cases where he deemed it less suited for the needs of particular cases than other competing material.

Even in cases where we are entirely satisfied that our process is the best for a particular case, we cannot always convince the engineer in charge of design of this fact, but we can frequently show him savings, short cuts, new methods, and in various other ways be of service to him. Sometimes these bring results later on at some other point.

Furthermore, in investigating plant conditions and operation, the faults of design become more or less apparent, and sometimes we are enabled to find solutions for difficulties that have proven beneficial in the design of later plants. Some of the advances in the art of water purification, in the betterment of equipment, and in the avoiding of troubles are traceable directly to this bureau.

The foregoing matter is from a paper presented by Mr. Brown before the annual convention of the National Lime Association, held in New York City, on June 15, 1921.

PREPARED JOINT 2 IN. CAST IRON PIPE

The development of Prepared Joint by the Research Department of the American Cast Iron Pipe Co., Birmingham, Ala., has enabled that company to put on the market a 2-in. cast iron pipe. Thus the more durable cast iron can now be used in many cases where black and galvanized pipe have been used in the past.

Prepared Joint

"Prepared Joint" is factory-made. To complete a joint in the trench it is necessary only to insert a plain-end into a hub and calk the lead. In the trench there is no yarning or pouring of lead. The joint materials are placed in the hub under such conditions at the factory that they are uniform. It does away with lead melting apparatus along the trench and eliminates the trouble incident to pouring hot lead joints in wet ground. The speed with which it is calked in a trench reduces cost of labor.

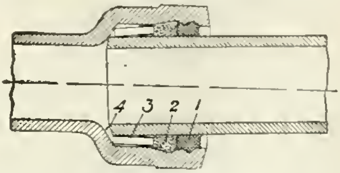


FIG. 1—DIAGRAM SHOWING ELEMENTS OF PREPARED JOINT FOR 2-IN. CAST IRON PIPE.

1, Lead; 2, Hemp; 3, Wedges; 4, Inclined Shoulder.

This joint has been supplied in sizes up to 12-in. for several years. It is made at the factory by standing the hub in a vertical position and inserting the joint materials, which includes a band of iron wedges and proper amounts of hemp and molten lead. The joint materials are left uncalked and are protected in shipment by a wooden plug so constructed that it can be removed easily in the field by a bar or piece of wrought pipe inserted through the spigot end. Because the mandrel over which the joint was made at the factory is slightly larger in diameter, the spigot end of a pipe is easily inserted into the Prepared Joint, which then is calked in the same way as the old-fashioned trench-poured lead joint. This joint automatically tightens under deflection. Ability to deflect without leaking or breaking is especially important in smaller sized pipe. In this pipe the inside shoulder of the bell is beveled as shown at 4, Fig. 1. When the joint is first calked the iron wedges slide down this beveled shoulder, or incline, until they engage the spigot end of the next pipe all around. Then each wedge is a small anvil against which the calking is perfected. In case of deflection after being laid, as so often is the case under street traffic and in made earth, the extreme end of the pipe goes down and carries with it at the bottom the wedges (3), which are brought forward as they move along the inclined shoulder (4), forcing the hemp (2) and lead (1) into further compression and thus automatically tightening the joint as deflection takes place.

The Two Inch Pipe

This pipe is 5 ft. in laying length, weighs 5 lbs. per lin. ft., and is tested to 300 lbs. hydrostatic pressure. It is guaranteed to withstand 150 lbs. working pressure. The short length of this pipe is a decided advantage in handling, in adaptability to the contour of the ground, and flexibility with consequent proof against breakage.

With this pipe, standard 2-in. screwed fittings are used and it will connect up with standard threaded 2-in. pipe. Moreover, it can be tapped for standard ½-in. service connections; for larger connections a standard saddle or fitting should be used. Four kinds of this pipe are furnished as wanted:

1. Hub and spigot.
2. Double-hub.
3. Double thread.
4. Repair hub.

A leaking section of 2-in. black or galvanized pipe is replaced with 2-in. cast iron pipe in the following manner:

First—Cut a short piece of thread and spigot pipe 6 to 12 ins. in length from a double threaded pipe. Screw this short piece into a coupling to make the connection.

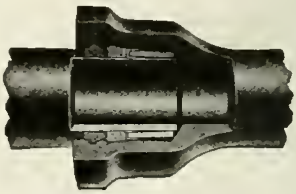


FIG. 2—PREPARED JOINT 2-IN. CAST IRON PIPE CUT OPEN TO SHOW POSITION OF JOINT MATERIALS.

Second—Calk a double-hub pipe on to this, which gives the line a hub leading.

Third—Calk hub and spigot lengths on to this continuously until a fitting is wanted.

Fourth—If a fitting is desired, connect

to it with all or a part of the thread and spigot piece left from the first cutting. Get away from the fitting with a piece of spigot and thread and a double-hub.

Fifth—To connect with threaded pipe again, use a piece of spigot and threaded pipe of the proper length.

If this pipe is laid on 4-in. blocks no bell holes are necessary. After a section is completed start at the beginning, taking the blocks out consecutively and letting the pipe down with as little disturbance of joints as possible. Or it is entirely feasible to put together three to five lengths at a time on top of the ditch, calking one side and then rolling them over and calking the other side, then lowering the section into the ditch, calking in the ditch every third to fifth joint. It is preferable to dig a bell-hole with this method of laying instead of using blocks in the ditch as before mentioned.

Each pipe is octagon shaped at the base of the bell. This enables the pipe to be twisted either with a wrench or chain-tongs when it is taken up.

The repair hub makes repairs and cutting-in possible with a minimum of labor, because it has a telescoping effect. The section of pipe to be removed is broken out. The repair hub is telescoped over the spigot end in the ditch until its spigot will enter the other hub. Both hubs are then calked in the usual way.

THE TREND OF READJUSTMENT IN THE WATER WORKS FIELD

By Robert E. McDonnell, Consulting Engineer, Interstate Bldg., Kansas City, Mo.

A good water works official doesn't put off his purification improvements until an epidemic is on, and the rehabilitation of his pumping equipment should not follow a fire, but should be a preventive of the fire and take the lead. Too many water works improvements follow instead of lead. So many follow the growth of towns when they should really precede the growth and anticipate the requirements. A city is no bigger than its water works plant.

Water plants all over the United States have suffered a severe set-back owing to the war; the failure of the water plant to improve has retarded other improvements. Several cities, to my own personal knowledge, now have immense paving and building programs that must await the laying of new water mains and larger feeders.

Things Learned During the War

A famous surgeon recently remarked that the medical and surgical discoveries developed by the war would later save more lives than were lost in the war. The higher standards and improved efficiency in water works installations and operation since the war have been remarkable. We learned the value of co-operation and the value and use of propaganda before the public to call attention to our water works needs. We learned the use of emergency treatment and sterilization plants and found that for temporary use a very bad water can be freed from bacteria. The scarcity of help in war times turned our attention to the use of all kinds of labor and office saving appliances. The handling of accounts in water offices has changed from a bookkeeping job to a job for a mechanical operator who now turns out water bills for ten customers in the time required for one by the old methods. The placing of the water departments on a cash basis for purchasing supplies has become almost universal. The high cost of fuels brought engineers and operators to using equipment with the least consumption of fuel. The economy of operation in pumping equipment has more weight with eight and ten dollar coal than in pre-war days with two and three dollar coal.

Eliminating Waste

The Government preached economy and elimination of waste until water waste surveys are being made with excellent results. A smaller water consumption per capita is the goal of many superintendents. The installation of meters to measure water used and check the needless waste has saved many a water department from ruin. Pure water is too precious a commodity to deliver to a customer without some check on how much he gets. The city with a universal meter system and a station meter for checking water pumped with water sold was a few years ago a rarity, and is now quite common. We have also found that service to the public is the only kind of politics necessary to play in order to hold the job.

Pure Water

Regardless of whose fault it is, the water official who permits impure water to get to the customers, whether by accident or otherwise, is going to have rough going. He will have customers telephoning, State Boards of Health telegraphing, American Public Health Service visiting

him, and life will have all the joy taken out of it. Therefore, let nothing but pure water enter the mains. No water plant can ever be called a success without absolutely pure water for its customers.

Figures Look Smaller Now

So many big things were done in a big way during war times that we have raised our ideas as to capacities, sizes and costs. A bond issue that formerly staggered a community is put through now without hesitation. These bond issues are now needed in hundreds of towns. Water improvements were so long deferred that water plants are underbuilt and behind in their building programs.

Burden of High Freight Rates

In the twenty-five years' experience of the writer in the water works business he has never seen such an urgent need of water improvements; yet there is a hesitation and a marking of time, due largely to the desire for lower prices, a better bond market and a decline in freight rates. When the freight on a ton of water works materials almost equals the cost of the materials themselves it is becoming a burden that hampers progress.

A short time ago implement dealers were selling farm implements at high prices and farmers bought them when reminded that very few bushels of wheat or corn were needed to pay the price, but now the farmers come back with their own argument, offering the same number of bushels for the implements. The farmer's argument hits machinery dealers with the same argument used by the dealer a year ago. In the water works materials the prices have not all declined to a level with the prices charged for water. Water departments everywhere are in need of better prices for their water, for the present prices are out of line when compared to the cost of materials and labor needed to rehabilitate the plants.

Water Rates Too Low

Pure water and higher standards of service are being demanded constantly and yet water rates have remained almost stationary. Many officials fool themselves into believing their cost of pumping and delivering water is lower than it really is. Recent investigations by the writer for a city showed water being delivered to large users at less than its cost and one railroad official boasted of the fact that his company had, in many cities, been getting water at less than its cost. This causes trouble when the time comes to replace pumps and to rehabilitate the plant. It behooves every water official to take stock within himself, analyze his operating costs, interest on his bonds, sinking fund depreciation and see what rates should be applied, especially to large users, who too often enjoy water rates ruinously low.

The foregoing discussion is from the presidential address delivered by Mr. McDonnell at the recent annual convention of the Southwest Water Works Association.

A STRAIGHT DYNAMITE PROOF AGAINST FREEZING IN ZERO TEMPERATURES

The Du Pont Company has developed and perfected a formula for the manufacture of straight dynamite which results in that explosive being proof against freezing even in zero temperatures. As a consequence of this development the company has determined to discontinue the manufacture of its former straight dynamite and hereafter all this kind of explosive will be made by the new low-freezing method. The perfection of the formula is the result of years of experimentation in the laboratory and in the field and marks one of the greatest advances in the art of explosives manufacture. Straight dynamite has for years been the standard of the world in nearly every kind of open work, but a disadvantage has been its liability to freeze at temperatures below 50 deg. Fahr. As any dynamite loses some part, if not all, of its efficiency when chilled or frozen, many attempts have been made to make it low-freezing. The perfection of the new "powder" by the Du Pont Company makes it possible to use straight dynamite the year round in industrial operations. Thawing, with its loss of time and attendant dangers, has practically been eliminated. The new explosive has been fully tested and proved and the formula for making it has been made standard in all the plants of the company producing dynamite.

MUNICIPAL BOND MARKET

Following an active demand and a sharp rise in market values in July and the early part of August, bond business was very dull in the latter part of August. There was no indication of any weakness, however, and the month closed with prices firm and the floating supply of bonds notably small, says *The Bond Buyer*.

11-21-31

Construction News and Equipment

ADVANTAGES OF PORTABLE EQUIPMENT FOR GRAVEL PIT WORK

By H. P. Sigwalt of the T. L. Smith Co., Milwaukee, Wis.

In many states there are small and medium sized deposits of sand and gravel which have not been worked by producers because it does not pay to install an expensive stationary plant for the amount of aggregate available.

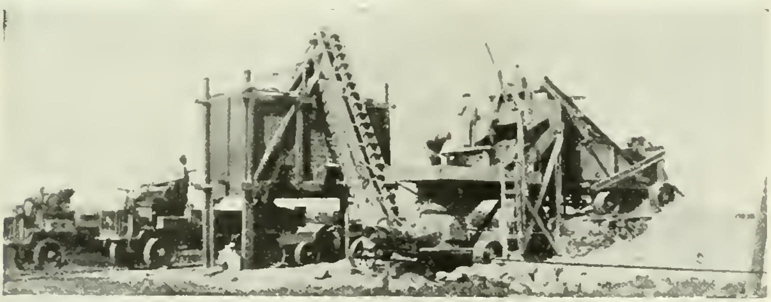
Contractors sometimes find small deposits of excellent aggregate in the immediate vicinity of construction work they have in hand, but because of the expense connected with producing sand and gravel, these contractors feel that they cannot afford to work out these deposits, so they purchase their materials from some distant producer who operates a big pit—usually so far from the job that rail transportation is necessary.

Work in Green Lake County, Wis.

These methods are adding to the cost of construction in general. Contractors who are trying to get down to "bed rock" costs will undoubtedly find some interesting suggestions in the following description of the portable gravel pit plants developed by the Bridge and Highway Commission of Green Lake County, Wis.

The problem in Green Lake County was to utilize the gravel deposits in the county without investing a great deal of money for equipment. The deposits ran small and occurred at several points along a stretch of 26 miles of road which is part of the county's new road program. By utilizing several of these deposits as the road work progressed, it was apparent that a lot of hauling expense could be avoided.

In his investigations of suitable equipment, Commissioner D. C. Williams saw the possibilities of combining a portable rock crusher with the portable Smith Excavator and Loader. Plans were drawn up which suited the county's requirements perfectly and it was found that a complete plant of this type could be installed at very little expense. The whole plant was comprised of one Minneapolis Steam Tractor, 20 H. P., one Allis-Chalmers Portable Gyratory Crusher, one bucket elevator, one Smith Excavator and Loader, two small material bins (total capacity 20 yds.), and screens.



ARRANGEMENT OF EXCAVATOR AND PORTABLE ROCK CRUSHER AT GREEN LAKE COUNTY GRAVEL PLANT AT MANCHESTER, WIS.

The first plant was installed near Manchester, Wis., at an excellent deposit of gravel that needed no screening. Three to five trucks—quads and four wheel drives, army issue—were available. This was not sufficient to handle the capacity of the plant but average daily production ran between 125 and 137 cu. yds.

A Second Plant Installed

The first plant proved so satisfactory that another plant was installed, practically a duplicate of the first, at Dalton, Wis., about 7 miles from Manchester. With these two plants a long stretch of road was handled and the truck-haul was cut down very materially.

About 10,000 yds. of sand and gravel were taken out at Manchester and then the complete plant was moved to another pit closer to the work in hand. At Dalton the first pit yielded about 4,000 yds.; then the whole plant was easily moved about 100 yds to another excellent deposit containing approximately 10,000 yds. Moves of this sort would have been prohibitively expensive, if possible at all, with any equipment less portable than that employed.

Plant Layouts

The pictures show plainly how the plants are set up. The excavator and loader is placed at the edge of the gravel deposit, mounted about 4 ft. off the ground. It digs within a 150-ft. radius. The rock crusher is placed so that the excavator loads directly into it. A bucket-conveyor elevator carries the crushed stone and sand as it is discharged from the crusher, up into the material bins. From the bins the trucks are loaded.

ARRANGEMENT OF GRAVEL PLANT AT DALTON, WIS.

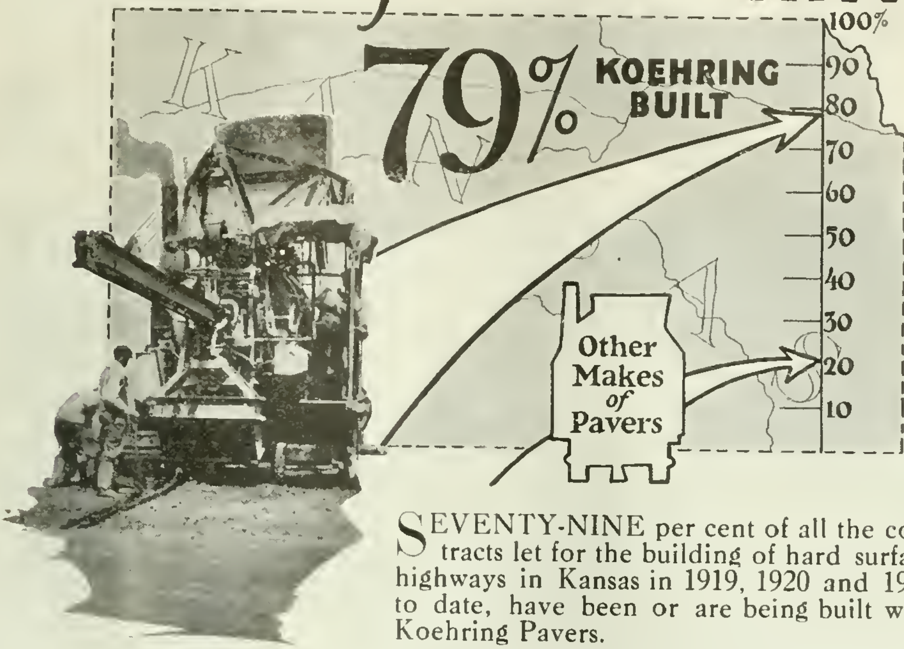
The Smith Excavator and Loader is operated under its own power—18 H. P. gasoline engine. The rock crusher and bucket-conveyor are operated by the steam tractor.

All the labor required on a plant of this type is one foreman, one excavator operator, one crusher man, one tractor operator, one man at the loading bins, two or three men in the pit—7 or 8 men with a plant capacity of about 200 yds. per day.

ABOUT 10,000 CU. YDS. OF GRAVEL HAVE BEEN REMOVED FROM THIS MANCHESTER, WIS., PIT WITHOUT MOVING THE EXCAVATOR.

Several other Wisconsin and Minnesota counties, doing their own road mainte-

Kansas *for* KOEHRING



SEVENTY-NINE per cent of all the contracts let for the building of hard surface highways in Kansas in 1919, 1920 and 1921 to date, have been or are being built with Koehring Pavers.

Such an almost universal choice by Kansas contractors speaks more eloquently of the value and worthiness of Koehring Pavers than pages of advertising could possibly do. Here are the statistics:

Total number miles concrete road let to date in Kansas	181.349
Total number miles of brick road let to date in Kansas	60.043
Total mileage of hard surfaced roads let	241.392
Mileage paved or being paved with Koehring machines	191.309
Mileage paved or being paved with all other machines	50.083
Percentage of Koehring Paved roads .	79.249
Percentage of roads paved with all other machines	20.752

Of the 181.349 miles of concrete roads let, 137.224 miles, or 75.668% are Koehring built roads. And of the 60043 miles of brick roads let, 54.085 miles, or 90.077% are constructed with Koehring pavers.

The customer is the final judge of worth. And 79% of the state hard road builders of Kansas back their judgment that the Koehring Heavy Duty paver is the paver of absolute dependability.

Koehring re-mixed concrete is **DOMINANT** strength concrete.

KOEHRING COMPANY
MILWAUKEE, WISCONSIN

KOEHRING

nance work, have employed the Smith Excavator and Loader to excellent advantage in gravel pits.

Advantages of Portable Equipment

Producers who have adopted the Smith Excavator and Loader on gravel pit work find its advantages sum up as follows:

It requires only a small investment.

The operating cost is low, because of minimum labor expense.

The equipment is out of the pit at all times.

The wagons or trucks are loaded at the surface, not down in the pit.

The plant is portable; when the pit is abandoned, the equipment can be moved easily to another deposit.

Because of portability, plants can be located close to work in hand, thus cutting down the distance of haul.

Small deposits, which it would not pay to work in any other manner, can be profitably excavated by this method.

The excavator does its own stripping. It is equipped to plow, dig, haul and load any type of soil. With other gravel plants, a steam shovel or some other equipment must be used first to strip the overburden.

If conditions demand big production, two or more excavators can be set up so as to load into the same crusher.

Under existing conditions, with freight rates so high on sand, gravel and stone, it is particularly advisable to utilize those deposits closest to each job and the above method suggests an economical and practical method, with trucking haul reduced to a minimum.

CHANGING STONE QUARRY FROM HAND TO STEAM SHOVEL METHODS

By Irving Warner, General Plant Manager, Charles Warner Co., Wilmington, Del.

During the extremely difficult operating period of the war and immediately thereafter many a quarry operator turned his attention to the question of eliminating hand work and substituting the steam shovel. Now that the pressure of labor shortage is removed, many operators are no longer considering this expense, although others realize that sooner or later the laborious work of sledging and loading stone must give way to machine methods.

The purpose of this paper is to discuss the various local conditions and their effect upon the choice of proper equipment.

The particular problems may be summarized as follows:

1. The Quarry.
   a. Nature of the stone.
   b. Height of the quarry face.
2. Size and type of shovel.
3. Transportation system.
4. Crusher.

Each of these items must be taken in its relationship to the others and, at best, any solution is a compromise.

The Quarry

The nature of the stone has a most important effect upon the size of the crusher. A strong-bodied stone of high crushing strength and few cross fractures requires a crusher with a larger opening than a softer, more friable rock, irrespective of the size of shovel and cars. In fact, this question of the strength of the rock may be the determining factor in the selection of a crusher of sufficient size.

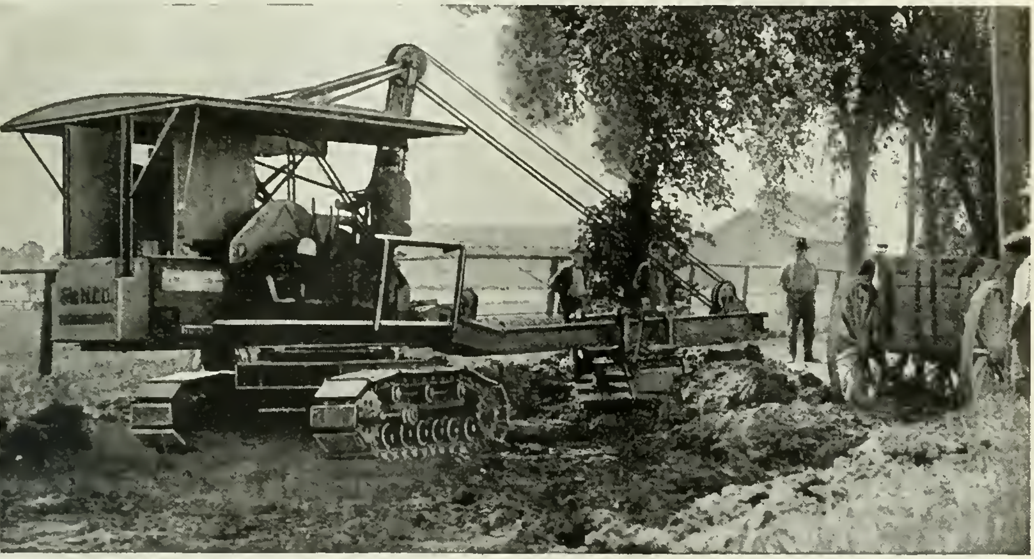
Near Bellevue, Ohio, the France Stone Company has a deposit of stone which is quite filled with cross fractures. This stone blasts down easily and is handled by a railway type steam shovel with a dipper of about 2½ or 3 yd. size. This material is dumped into a No. 9 gyratory crusher and requires very little hand feeding. This plant affords an extreme example of the satisfactory combination of a large shovel and small crusher which is possible through the nature of the rock. A No. 9 crusher has an opening between the head and the concaves of 18 ins.

At the plant of the Charles Warner Company at Cedar Hollow, Pennsylvania, a reverse condition has been experienced. Some of this rock has very high crushing strength and blasts out in large diamond shape pieces. At this plant ¾ yd. traction shovels are used, yet it was quite easy to handle pieces which will arch and choke in a jaw crusher having a 48x60 in. opening.

No one should consider changing over his quarry from hand methods to steam shovel without making a thorough examination of the practice and equipment at various plants. And when such a survey is made it is necessary to give most careful attention to the character of the rock in the quarry where the changes are contemplated. It is one of the most important phases of successful installations, and is the one most likely to be overlooked.

The height of the quarry face has a bearing more on the methods of quarrying employed than on the equipment of shovels and crushers. It does have an effect upon the proper drilling equipment. A face of less than 40 ft. is preferable

THIS NEW P & H SKIMMER SCOOP
Saved $83.44 Per Day on a Road Grading Job



This Rapid Road-Grading Boom and Scoop may be Attached to Any P & H 205 or 206 Excavator-Crane

Here is a way to speed up your road-grading work and save money. The Skimmer Scoop may be used in place of the Standard Boom furnished with P & H Excavator-Cranes.

We have a supply of the new Bulletin TX which gives detailed data on a road-grading job, showing remarkable savings in time and money. We are ready to send you a copy on request.

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for any size of shovel. A certain standard practice has been developed in the large fluxing stone quarries between New Castle, Pennsylvania, and Youngstown, Ohio. These quarries are all operating on horizontal strata. In some cases the height of the face will be 15 ft., in a few cases as low as 7, and sometimes as high as 22 ft. The shovels used are the railway type handling dippers from 2½ to 4 yds. Drilling is done on the top and at such distance back from the face that these large shovels can clean up the entire shot on one passage. Since the quarry face is of a uniform curvature the development of the quarry consists of a gradual spiraling out which brings a very high efficiency of operation.

In higher faces, or with the use of smaller shovels, it becomes necessary to make two or more trips past the front of the blast in order to make a complete clean-up of the loose rock. There are some objections to this system, as it is likely to make the production of the shovel inconsistent. In some cases the shovel will produce more on the first trip when working on loose stone and in other cases it will make better time on the latter trips, when it has a greater body of stone to work against. Difficulties in this connection can often be overcome by proper quarry management. By blasting against a shot that is already out, it is often possible to maintain a loose condition of rock which facilitates the work of the shovel and at the same time maintain a considerable depth of broken rock so that the shovel always has plenty of material to work upon.

The higher the face the greater is the tendency for the stone to come out insufficiently shattered. This becomes a very serious problem with stone which has a natural tendency to come out in large pieces. Therefore it is not desirable to drill the holes back at a considerable distance from the front, as this condition would thereby be aggravated.

This problem has been appreciated at one of the quarrying operations near Youngstown, Ohio, where the churn drill has been abandoned and rows of tripod drill holes are put down from on top. More frequent spacing of these smaller holes results in a more thorough breaking up in the primary blast, largely obviating delays for block holing.

Steam Shovel

Undoubtedly the best size and type of steam shovel for quarrying purposes is the railway shovel running on a track and mounted on eight wheels, with a dipper capacity of about 3 yds. These shovels are rugged, of a standard type and should be used if other conditions around the plant permit.

Such a shovel with good quarry management can deliver from 1200 to 1500 tons of stone a day. Accordingly, it would scarcely be wise to use a shovel of this size unless at least 800 tons daily were desired. It might also be undesirable to have a plant entirely dependent upon one shovel for its supply of stone provided there were no facilities for storage. This would be a question that every operator would have to settle for himself, namely, whether he would be willing to take the chances of being tied up through the breaking down of a single shovel or whether he would take the increased operating costs of having an extra shovel or by using smaller equipment.

It scarcely pays to use a railroad shovel of less than 2½ yds. capacity. With the smaller sizes, the shovel becomes slow in moving heavy stuff and it is not flexible enough to get out of the way for heavy shooting. In addition the cost of laying the tracks for the shovel and for the paralleling line of industrial track would be no greater for the big shovel than it would be for a smaller one.

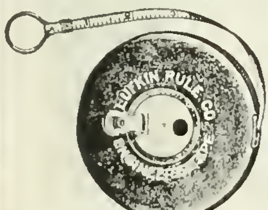
Smaller shovels have been used only to a comparatively limited extent in quarries. Yet in the few installations there seems to be a concensus of opinion to step down to shovels of the traction type of 1 yd. capacity or less.

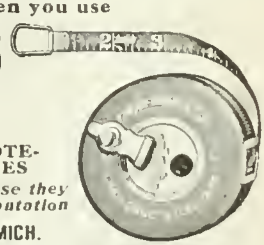
It is not usually feasible to use a shovel on traction wheels of a size greater than 1 yd. In some quarries this has been done where there is very little dirt in the stone, so that the quarry floor offers a very good roadway for a heavier shovel. The ¾ yd. shovel on traction wheels will weigh approximately 20 tons, and in general this is heavy enough load on any ordinary quarry floor.

Under good local conditions a ¾ yd. shovel can do about 300 tons daily. A crew of two men is sufficient unless the quarry floor is allowed to become irregular.

Well built small shovels can handle stone larger than a 48x60 in. jaw crusher can receive, so that in general no problem of additional block holing is introduced through the use of these smaller machines. The objection to their use lies in the fact that in heavy work they become quite slow, comparatively more so than a heavier shovel.

Small shovels on traction wheels offer attractive possibilities to a quarry opera-





tor under the following local conditions:

1. A small tonnage say, less than 800 tons per day.

2. Where it is desired to split up the tonnage into smaller units either for reliability of stone supply or because of the nature of the rock that must be taken out from the different points in the quarry.

3. When an industrial system is of light weight which would prohibit the use of a heavy shovel.

4. When the conformation of the quarry prohibits the rounding out of the quarry in a uniform curve so that the railway shovel cannot be advantageously employed.

5. Where the floor is firm so as to give good roadway for a shovel on traction wheels.

From the present outlook there would appear to be no field between the small traction shovels and the large railway shovels. Therefore the investigator is practically limited to these two extremes of installation. With the perfecting and cheapening of the caterpillar tread, there may be a future for the full revolving shovel of about 1½-yard capacity. It is to be noted, however, that a full revolving shovel of large size must necessarily be sluggish as compared with the railway type shovel which moves only its boom.

Transportation System

The following points regarding a transportation system must be taken into consideration.

1. Relative size of car and shovel.
2. Size of the unit of train movement.
3. Relative size of car and crusher.

When using heavy railway type shovels, the gauge of the industrial track should not be less than 42 ins. and standard gauge of 4 ft. 8¼ ins. is preferable. With standard gauge, it is possible to use a heavy, well-designed car that will hold as much as 15 tons which is very instrumental in rapid operation.

A point not usually considered is that a high car is cheaper to load than a low car and that high cars may more safely be used on a wide gauge track than upon a narrow gauge. The economy in loading high cars is due to the fact that when it completes its working stroke, the shovel usually has its dipper well in the air. This allows the runner to drop his load without the necessity of lowering the dipper down to the car.

By the use of as large a car as possible, much time is saved on the shovel in the actual spotting of the dipper and through rapid dumping from a greater height. The large, heavy car on standard gauge can stand punishment of this kind which would be impossible with lighter cars. Also the spill will be much less.

The size of the unit of train movement is not always given the consideration which it deserves. For good practice the train load of stone handled on one movement should equal at least 20 minutes of the nominal capacity of the shovel. As for example a railway shovel with a nominal daily capacity of 1,200 tons equals 120 tons per hour, equals 2 tons per minute, should be served by a train carrying 40 tons of stone. In practice, with a daily average of 1,200 tons, this 40 ton train should be filled in from 10 to 15 minutes time and the balance is lost time in moving the shovel, shifting trains, hard digging, etc.

Corresponding figures with a small traction shovel would be 300 tons per day, equals ½ ton per minute, which would require a train of at least 10 tons capacity.

In these figures may be noted one of the fundamental reasons why the small shovel can compete with the large one. Very few operators of railway shovels will serve them with a 40 ton train. The operator of a small shovel has no difficulty in serving it with trains of 10 to 15 tons each. In fact, with a specially designed car, the Cedar Hollow Plant of the Charles Warner Company has succeeded in making train units of 21 tons. This was accomplished on a track of 24-in. gauge, which is altogether too narrow even for shovels as small as ¾ yd.

Even a ¾-yd. shovel is preferably served by a track of 36-in. gauge in order to get sufficiently large train units and a high car that can be loaded more economically. The new type of car at the Cedar Hollow Plant, above mentioned, operates satisfactorily on 24-in. gauge and averages a 3½-ton load. But to secure stability on 24-in. gauge, it is of necessity quite low, which slows up the shovel slightly. Aside from this it is a very satisfactory car.

The relative size of the car and the crusher is of utmost importance and most frequently overlooked. A large car demands a large crusher, all other conditions being equal. If the car is of such small size that its load will not fill and cover over the top of the crusher, then obviously there is much less opportunity of jamming and arching.

This condition is much helped by having a considerable length of chute between the point of dumping the car and the mouth of the crusher. This thins out the load and causes the large stone to go in endwise, thereby permitting the use of a larger car than would otherwise be possible. An apron feeder or similar device will accomplish the same purpose .

It would be well to reiterate here the important factors that have bearing upon the proper size of the crusher. We constantly hear discussed the relative size of shovel and crusher as if this relationship were the only or the most important point. But the most important considerations of determining the size of the crusher are the nature of the rock itself and the size of the car. The size of the shovel also has an important bearing but certainly less than the others.

Steam shovel service is exceedingly hard on cars. Any car of the "contractor type" or the rocker dump type will not be durable when used with steam shovels. It is necessary to have a type of car in which a considerable portion of the bottom is flat and resting directly upon a heavy decking on the truck. Otherwise the dropping of stone will be constantly knocking the body out of shape. This type of car requires a power dumping device at the crusher. Spring journal boxes are very helpful in saving a car from rough treatment.

It might be well to say one word regarding the use of the motor truck for transportation from shovel to crusher. At least one company is trying this out with reputed success but no cost figures available. Undoubtedly under conditions of a short haul and good roadbed, the motor truck may become popular when used with smaller shovels. But it would appear safer for the average operator to stick to well tried and economical industrial railways rather than experiment with thet high-priced and rapidly depreciating motor truck. The time will come when 3-ton dump trucks can be purchased for $1,800 or less and then a new era will be opened for the quarry operator. In the meantime, he will do well to adhere to accepted practice.

The Crusher.

In most installations the crusher is selected for the size of its opening rather than for its capacity. Since the jaw crusher has a large mouth opening for its cost and output, it is usually selected for all installations of lime plants. The order of importance of different items which go to determine the size of the crusher is approximately as follows:

1. Nature of the stone.
2. Size of the car.
3. Size of the shovel.

The effect of all of these has been elaborated but it would be well to inject a word of caution at this point. Experience has shown that most installations have crushers which are too small for their purpose. Quarry operators install large shovels to secure economy at the quarry face, probably skimp a little bit on the size and type of car and end up with a crusher which is very much too small. The easiest thing to change in a quarry is the size or type of the shovel. Usually the most difficult thing to change is the crusher itself on account of lack of head room, necessity of additional foundations and larger conveying and elevating machinery. Therefore it would appear to be better to put the money into the crusher and if skimping must be done, skimp on the shovel and the rolling stock. Many good installations have been seriously hampered by delays at the crusher itself.

The largest size jaw crusher that can be shipped and erected with a one-piece frame is the 48x60-in. Any size larger than this must be shipped knock-down on account of railroad limitations. As a result this size crusher is now being frequently installed. It is being successfully fed by shovels of various sizes running from a ¾-yd traction shovel at Cedar Hollow Plant of the Charles Warner Company up to 3-yd railway shovels at the plant of the Security Cement & Lime Company and at some of the Ohio lime manufacturing plants. This crusher is not quite large enough for this work. But it has been the economic limit for these plants on account of the excessive cost involved in the purchase and installation of the larger sectional frame crusher. There is occasional difficulty at all the plants using this crusher which is usually due to the nature of the rock or failure to supply a sufficiently long chute from the car dumping point to the crusher mouth.

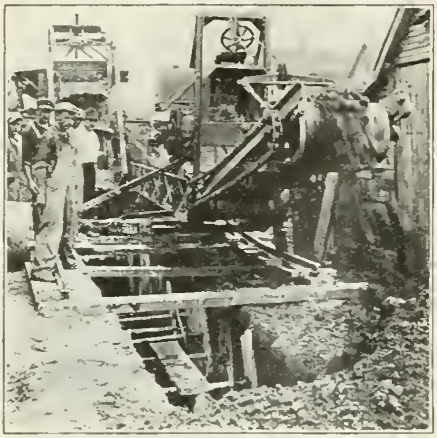
Other plants have installed crushers of size 42x48-ins. and 40x42-ins. This has been an unfortunate economy since almost any shovel or any naturally hard-bodied rock will cause considerable jamming and arching with these smaller size crushers.

The gyratory crusher should only be considered where enormous capacity is desired, say 4,000 tons per day or more, such as is required in large fluxing stone operations.

The foregoing matter is from a paper by Mr. Warner before the recent annual meeting of the National Lime Association.

SEWER TRENCH BACKFILLER WORKS IN 11 FT. ALLEY.

There is an ever increasing demand for sewer construction in alleys, rather than in the streets. Without a continuous backfiller any trenching machine is practically useless, due to insufficient space in a 16-ft. alley to deposit the dirt, especially if the trenches happen to be deep. Depositing the excavated dirt on one side only is the logical method, the other side being used on which to string out the pipe. Depositing the dirt on both sides is a nuisance and even then, there is insufficient space to permit economical handling of the job. Then comes the backfilling to be done by hand or by teams in congested space. Thus the ordinary traction backfiller is at a big disadvantage for obvious reasons.



AUSTIN CONTINUOUS BACKFILLER FOR SEWER TRENCHES WORKS IN 10 FT. 6 IN. ALLEY.

The Austin Machinery Corporation's continuous backfiller, shown in the illustration, while adapted for alley work, is also ideal for work in the open.

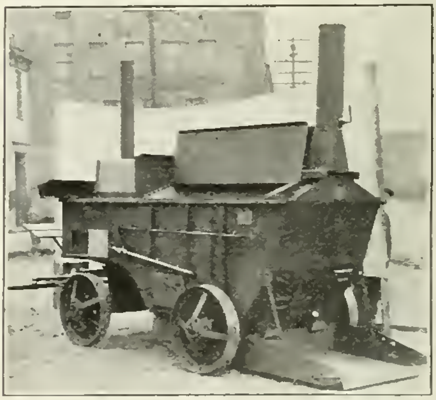
A short conveyor takes the excavated material from the standard cross conveyor belt and delivers it to the main belt, which, driven by gasoline engine, and therefore independent of the power on the trenching machine, carries the dirt back and into the trench. The device moves on short light rail sections, and is attached to the trenching machine for traction purposes. The rear end is supplied with a winch for raising and lowering, so that wagons can be loaded without any difficulty. The backfiller is built in sections of 4 ft. 6 ins., so that any reasonable length can be used, the conveyor belt being lengthened or shortened up accordingly.

The especially important part of this device is that it operates within the outside measurement of the trencher, so that in an alley 10 ft. 6 ins. wide this trenching machine can be used.

THE ANDRESEN ROAD REPAIR OUTFIT

Until quite recently there has been no single piece of apparatus on the market with which all types of pavements could be properly maintained. For instance, to repair asphalt streets has necessitated the use of expensive asphalt plant, wagons or motor trucks, road rollers, toolheater wagons, etc. The result has been that many cities and counties, due to the large expense involved in equipment, could not afford or were not justified in purchasing machinery with which to make necessary repairs. The natural result has been that many roads and pavements have rapidly gone to pieces due to want of proper maintenance.

A machine to fill the need so described was patented and placed on the market about a year and a half ago by H. P. Andresen & Co., 1261 N. Clark St., Chicago. This machine, which is built by Littleford Bros., 460 East Pearl St., Cincinnati, Ohio, has been perfected under service conditions. It is well suited to the road patrol or gang system of maintenance, for with this machine no other equipment is necessary for patching any type of road, whether asphalt, bituminous concrete, cement concrete, brick, water bound and asphalt macadam. It is primarily intended to make small repairs



THE ANDRESEN ROAD REPAIR OUTFIT.

before larger, more expensive ones become necessary.

The machine is drawn by a truck, or team of horses, and carries all necessary materials, tools, heating appliances and the 3 or 4 men required to operate it. With this plant it is not necessary to use rollers, tool heaters, tar kettles or wagons and an asphalt plant is not required. Large cities can use this output to advantage in conjunction with their asphalt plants for the patrol system of repairs.

The outfit is well suited for emergency Portland cement concrete work in the winter; hot water, hot stone, hot sand and mixing device all in one apparatus. With this outfit road and street maintenance work can be done throughout the year, thus making use of men necessarily carried on the payroll through the winter months to keep an organization intact.

There is but one fire. Temperature control, so necessary when working with bituminous materials, is obtained by the use of two stacks, each provided with a self-locking damper. If the asphalt in the removable kettle in the forward end of the wagon becomes too hot, by closing the damper in front stack all the heat necessarily goes under and through the sand and stone bin to the rear stack, and vice versa.

There is no waste of coal or of paving materials, for the asphalt (water or tar), sand and stone are all discharged direct by gravity into the combination mixing pan at the rear. There is no necessity for rehandling material ordinarily left along the roadside, as a consequence no unsightly mess remains. The mixing pan when raised becomes the tool carrier.

The Andresen Road Repair Outfit combines in a single device a heating or melting kettle, two bins for heating sand and stone, a combination mixing pan and tool carrier, a heater for tampers and smoothers, a coal burning furnace, a coal bin, a cement bin, space on top of bins for carrying materials and tools, a hot shelf for keeping pouring pots warm, and a driver's seat large enough for four men. These parts are compactly mounted on a single set of four wheels and are arranged so that the material charged into the wagon at the top is heated and delivered simply by force of gravity to the mixing pan at the rear. It is constructed entirely of steel excepting the driver's seat, foot board, wagon pole and trees.

Contracts Awarded

ROADS AND STREETS

Ark., Arkadelphia—East Brothers, Arkadelphia, awarded contr. for surfacing with gravel certain street and Federal roads in Clarl Co. Rd. Improvement Dist. No. 1, at $89,653.

Ala., Jasper—Jerry Gwin, Birmingham, Ala., awarded contract to construct Bankhead hwy. thru Walker Co.; 30 ft. wide, with 16-ft. hard surface gravel, at $135,000.

Ala., Livingston—W. K. Saulsbury & Co., Birmingham, awarded contr. for 9 miles bitum. macadam paving, penetration method, at $177,000; 9 mi. clay and grav. constr. to Finnel Co., Tuscaloosa, at $123,000. Both contracts awarded by Board of Revenue, Sumter Co., Ala., State and county will each contribute $75,000 and Federal government $150,000.

Ala., Tuscaloosa—Thompson & Donoho, Birmingham, Ala., awarded contr. to construct 25.2 miles Byler rd., at $223,000.

Cal., Sacramento—Henry J. Kaiser, Oakland, awarded contract for paving and grading bet. Upton and southerly boundary of Siskiyou Co., at $18,515, and bet. Healdsburg and Cloverdale at $350,000.

Cal., Santa Barbara—Samuel Hunter and Chas. T. Richardson, 525 E. Haley St., Santa Barbara, awarded contract for paving 23 miles of highway in the Lompoc permanent road div., with 3½-in. asph. conc. base, and 1½-in. surface, at $485,535.

Colo., Trinidad—Strange & McGuire, Boulder, awarded contract for paving here at $178,381.

Ill., Waukegan—F. C. Nelson, Racine, Wis., awarded contract for paving 4.5 miles Wauconda-Volo rd., 18 ft. wide, concrete, at $137,995.

Ia., Audubon—Geo. Condon Co., 415 Farnam Bldg., Omaha, Neb., awarded contract for excavating 17 miles, at $116,500.

Ia., Iowa City—Wm. Horrabin, Iowa City, awarded contract for paving various streets, $8,000 brick paving; $57,000 bitulithic.

Ky., Frankfort—State Hwy. Dept. let contract for shaping and draining 6.2 mi. Somerset-Stanford rd., Pulaski and Lincoln Cos., to W. Lutes & Co., Lexington, at $105,834; shaping, draining and surfacing with rock asph. 1.4 mi. rd. from east to southwest corp. limits of Scottsville, Allen Co., to Speed Parker, Inc., Speed bldg., Louisville, at $57,560; surf.-treating roads in Nelson, Rockcastle, Warren, Bourbon and Woodford Cos., to R. B. Tyler, 114 S. Fourth St., Louisville, at $29,071; Anderson and Garrard Cos. to Eaton Oil Works, Covington, at $7,482; Madison Co. to Southern Oil & Tar Co., Louisville, at $10,252.

Ky., Frankfort—Wm. Lutes & Co., Lexington, awarded contracts for 6 2-10 miles waterbound macadam, Lincoln Co., at $105,000; Speed-Parker Co., Louisville, awarded contract for 1⅓ mi. city impvts. in Scottsville, Allen Co., at $55,000.

Ky., Louisville—Louisville Asph. Co. awarded contract to constr. 4.5 miles rein. conc. on Bardstown rd., St. Proj. 3, Sec. A, F. A. P. 50, at $161,582.

Ky., Richmond—Geo. T. Miller, Lebanon, Ind., awarded contract to construct 7 miles rein. conc. on Dixie Hwy., Madison Co., at $243,287.

Ky., Sanford—Wm. Lutes & Co., Lexington, Ky., awarded contract to constr 6.2 miles waterbound macadam road, at $105,000.

Ky., Winchester—State Hwy. Comm., Frankfort, let contr. to S. M. Billiter, Covington, Ky., for constructing 9.5 miles Ky. rock asph. on Midland Trail in Clark Co.; State Proj. 47, Sec. A, F. A. P. 63, at $352,889.

La., Abbeville—W. E. Goron, New Orleans, awarded contract in Rd. Dist. 1, in 8th Ward of Vermillion Parish at $350,000.

La., Gretna—T. W. Johnson, 2323 Chestnut St., Iew Orleans, awarded contract for curbing and ıldg. 82,000 sq. yds. conc. walks, at $304,555.

Me., Augusta—Frissell Eng. Co., Gardner, Mass., ıwarded contract for paving 3.59 miles State hwy. n Bangor and Veazie, 18 ft. wide, concrete, at 64,483; 3.1 mi. in Turner and Livermore, 18 ft. vide, gravel, to J. H. Kerr, Rumford, at $55,876.

Mich., Lansing—St. Hwy. Dept. let contr. to Remus Constr. Co., Remus, for grading, draining nd surfacing State trunk line rd. 13-20, at $71,673; I. J. Bacco, Iron Mountain, contr. for grading, raining and surfacing 3.883 mi. State trunk line d. 90-1, Sec. A, Dickinson Co., at $36,618.

Minn., Grand Rapids—Following awarded contrs. or 27 miles conc. paving bet. Grand Rapids and Keewatin, 2 mi. paving in Grand Rapids, 1 mi. in Coleraine, to be laid this season, 13½ mi. bet. Grand Rapids and Marble, to Johnson, Drake & Piper, 912 Plymouth Bldg., Minneapolis, at $417,958; 3½ mi. bet. Marble & Keewatin to Winston Bros., 01 Globe Bldg., Minneapolis, and E. W. Coons Co., Hibbing, at $411,929, both sects. conc. paving with 0-lb. mesh reinf. and crushed rock aggregate.

Mo., Kansas City—G. G. Roudebush, awarded ontract for paving Quindaro blvd., from 5th St. o 17th St., at $168,878; C. C. Clark, Topeka, warded contr. for grading, paving and bldg. culverts along Southwest blvd., from city limits of Rosedale to Johnson Co. line, at $79,164.

Mo., Kansas City—W. G. Mullins Constr. Co. ontr. to pave 31st St., Troost Ave to Woodland Ave., at $26,661; Gray Paving and Material Co., t $15,147, to pave 9th St., Campbell to Troost; Fred Lorrimer contr. to pave Oak St., 63rd to Meyer blvd.; W. D. Doyle Constr. Co., to pave Walrond Ave., Benton blvd to Benton Ave., at about $100,000.

Mont., Butte—Heislet Constr. Co., Salt Lake City, Utah, awarded contr. for constr. of Pipestone Pass rd., south of here, at $73,000; 18 miles long.

Neb., Omaha—Peterson, Shirley & Gunther, Omaha, awarded contr. by Bremer Co., Iowa, F. A. P. 88, for grading 10.7 miles west and east of Waverly, estimate quantities, 86,955 cu. yds. earth excav. and 1,007 cu. yds. solid rock excav. at 42c per cu. yd. and $3 per cu. yd. respectively.

Neb., Omaha—American Paving Co., 411 Finance Bldg., Omaha, awarded contr. for repaving Dodge St., at total of $100,000.

N. J., Mt. Holly—Union Paving Co., 30th & Locust Sts., Phila., awarded contr. for paving Mt. Holly-Burlington rd., sheet asph., at $323,992.

N. J., Salem—M. Staub, Sweedsboro, awarded contr. for rein. conc. paving; 47,146 sq. yds., Woodstown-Salem rd., Route 6, Sec. 7, at $166,637.

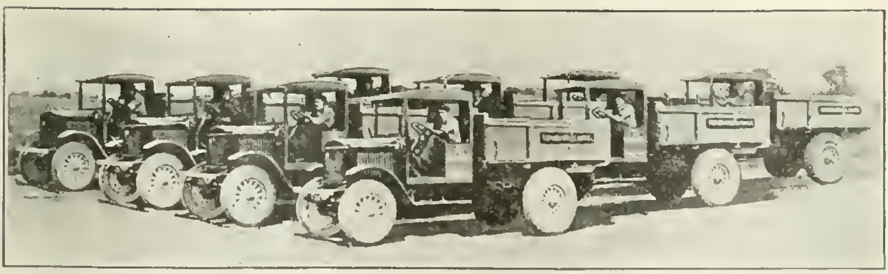
N. C., Tarboro—Cheatwood & Driscoll, 511 W. 12th St., Richmond, Va., awarded contr. by State Hwy. Dept., at Div. Office here, for grading and paving 9.57 mile road bet. Greenville and Ayden, Pitt Co., at about $237,000.

N. J., Trenton—J. J. Barrett, 147 Lafayette St., awarded contract for paving 2 miles Carter rd., from Lawrenceville to point near Rosedale, waterbound macadam, at $158,072; J. J. Barrett, 147 Lafayette Ave., awarded contract for impvt. of Chambers St. and Princeton Ave., $4,500 ft. long, 20 ft. wide, at $39,521.

N. C., Charlotte—Blythe & Blythe, awarded

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



FLEET OF 9 SPECIAL KISSEL ROAD-BUILDERS' TRUCKS EMPLOYED BY PEPPARD, BURRILL & CONNELL, ON JOHNSON CREEK, WIS., ROAD CONTRACT.

Motor Truck Operation and Accounting—74

MOTORIZED REFUSE COLLECTION AT PEORIA, ILL.

By E. E. Pierson, Bloomington, Ill.

By the utilization of a system of motor trucks and trailers the operating expenses of the Peoria, Illinois, garbage department have been greatly reduced, while efficiency has been promoted.

Perhaps the most perplexing problem that confronts the American city of any size is the disposition of the municipal waste. Refuse from the kitchen, ashes from the stove and furnace, paper, etc., accumulate and must be disposed of. Each city, in most instances, experiments in a number of varying directions and widely divergent methods in the hope of keeping the expense to the lowest possible point and, at the same time, safeguarding the public health and eliminating complaints from householders, business institutions, etc.

The Peoria system saves much lost motion by the use of heavy trucks and a long string of trailers coupled together. Smaller trucks bring in one trailer to the headquarters of the garbage department, one truck and trailer being assigned to each district. Heavier trucks then haul four to six of the loaded trailers to the city dump, low places which are to be filled with the refuse, or to the yards of stockmen who feed the edible portion of the garbage to hogs.

The expenses of the garbage department have been vastly curtailed since trucks and trailers were adopted, while complaints from the public have been greatly reduced. The present method of garbage disposal is the most satisfactory and most efficient in the history of the city.

TRUCK AND TRAILER TRAIN HAULING MUNICIPAL REFUSE IN PEORIA, ILL.

TWO TON TRUCK SAVES $4,000 PER YEAR ON ASH COLLECTION WORK

By Charles E. Firth, Box 27, Crum Lynne, Pa.

The dependability of my 2-ton Acme truck is shown by the fact that it has never been laid up for a day. Since October, 1920, it has been operating chiefly on ash collection work for the city of Chester, Pa. This work is done under contracts secured in competitive bidding. As the bids must be figured on a very close margin of profit, a dependable truck is essential.

The truck has been running on this work 5 days a week. In the morning it makes a 2-mile run to Chester, starting in on its ash collection work as soon as it reaches the city. The truck operates with 2 helpers, who go along beside it, picking up the boxes and baskets of ashes and dumping them into the truck. We always try to get the main streets cleaned before the big business rush commences, in order to avoid congestion caused by park-

ing passenger cars in the downtown district.

As a rule the truck covers 3 or 4 blocks to get a load. As soon as it has about 4 cu. yds. of ashes it starts on its trip to the dump. This trip may vary in length from 3 blocks to 2 miles each way. Since the truck has a dump body, it takes only a moment to unload, when it starts back for the next load.

The truck has been averaging between 12 and 15 trips to the dump a day. Then at the end of the day it has the run back to Crum Lynne. On some days the truck ends up about 4 miles from the garage. It averages 40 miles a day; and in spite of a great deal of running at low speed, and the power required to operate the dump, it gets 5.7 miles to a gallon of gasoline.

Once a month the truck makes a trip to Philadelphia to bring back a load of feed. Occasionally it is hired out to do general hauling for other people. There are usually odd jobs to be had for a dump truck.

So far repairs have cost only $50.10 for a frozen radiator and a snapped spring, so $150 a year will be ample to cover this item. My time is occupied in handling the Acme truck, another 2-tonner and 16 horses, so $500 a year of my salary must be charged against the Acme. There is no charge for garage, because I keep the truck in a building of my own that would not be used for any other purpose. The cost also includes the wages of a driver at $5 a day and 2 helpers at $4 a day.

Figuring these costs on the National Standard Truck Cost System, the 2-ton Acme costs $22.17 a day, 55.42 cts. per mile, 41.07 cts. per cu. yd. and 27.71 cts. per cu. yd. mile.

I have operated horses for 25 years, and motor trucks for 3 years, and I know how they compare on every kind of work I do. On ash collection work it would take 3 teams to do the work of the 2-ton Acme. Each team would need one helper and would cost about $13 a day. The 3 teams would, therefore, cost $39 a day, or $16.83 more than the truck. Figuring that the truck operates 5 days a week, this means a saving of $4,375.80 a year.

Then, too, the horses would not be as dependable, because in hot weather they are often overcome by the heat, while in cold weather they slip and slide and often injure themselves. I have always found it hard to get their shoes sharpened in winter, because the minute there is ice on the ground there is a long line of horses waiting at the blacksmith shop.

The excellent care given the truck has been repaid by a low repair cost, and the fact that it has never been laid up for a day. This is remarkable, because the roads near the dumps are extremely rough, and the truck has to back over glass, tin cans, etc., whenever it dumps a load. In the winter the motor never stops running.

So far I have been able to keep the same driver on the Acme all the time. He is a good man, who looks over the truck regularly, and takes excellent care of it. When anything does go wrong, requiring expert attention, we get very prompt service from the Philadelphia dealer.

I have found that it pays to treat my drivers well and keep them interested in their job. If they work hard and get through early in the afternoon I always let them off for the day. This helps to keep them feeling more willing to work overtime when necessary.

The cost data follow:

COST DATA ON PERFORMANCE OF 2-TON ACME TRUCK IN ASH COLLECTION WORK

AVERAGE COST	
Cost per Day (Including Driver and Helper)	$ 22.1682
Cost per Mile	$ .5542
Total Cost for Period	$2593.68
OPERATION	
Days Operated	117
Miles Traveled	4680
Miles per Day	40
Miles per Gallon of Gas	5.7
Miles per Gallon of Oil	160
ITEMIZED COST	
Driver and Helper Cost per Day (Included Above)	$ 13.00
Depreciation per Mile	$ .0547
Maintenance and Repair, Actual, Total	$ 50.10
Maintenance and Repair, Actual, per Mile	$ .0107
Maintenance and Repair, Estimated, per Mile	$ .0144
Tire Cost, Estimated, per Mile	$ .0236

TRANSPORTATION EQUALITY AS VIEWED BY RAIL AND TRUCK MEN

To the Editor:

In the June, 1921, issue of Municipal and County Engineering I noticed an article written on Transportation Equality by Mr. M. L. Pulcher, Vice President and General Manager, Federal Motor Truck Co., Detroit, Michigan, in which he refers to the following:

"Many states are proposing legislation to limit the load that can be carried by a motor truck, to such a degree that thousands of firms, now owning heavy duty equipment, will be forced out of business

and the capital invested in their trucks will be almost a total loss; also State and National taxation of motor trucks and passenger cars is being carried to an unreasonable point." He further speaks of "the old fable of killing the goose that laid the golden eggs, as being forgotten, for the motor trucks are one of the greatest aids to commerce that we have today."

Mr. Pulcher has not considered the initial form of transportation which built up our country by spending enormous sums of money—coming direct out of the pockets of the men who had faith in developing the resources of our Western country. Those men did not have federal aid, state, county or private subscriptions to assist them in building up their roadbed to do business on. I wonder if he has ever thought for one minute what would be the condition of rail transportation if the right-of-way, roadbed and track were furnished our steam and electric roads free of charge, so all that would be necessary for them to buy would be the rolling stock?

It makes no difference how the money is acquired to build the hard surface roads, it is invested capital and is entitled to earn at least a reasonable return on the money, together with a certain sum set aside for depreciation. These items of expense should be borne by the men or firms that use the roads in a commercial way. The farmer is entitled to a good road free from any other expense except taxes, to deliver his product to the market; the same should apply to the pleasure rider or the business man. When roads are used by taxies, jitneys or commercial trucks, in competition with the pioneer builder of transportation facilities, is when the old fable of killing the goose that laid the golden egg comes in. Right wrongs no man, we need every means of transportation, there is room for them all. Every line of business should stand on its own merits, furnish its own capital to do business on, or at least be willing to pay a reasonable amount for the use of the money and bear their portion toward the upkeep.

Today the automobile and truck hold a free hand. The enormous amount of capital and material used in automobile manufacturing has been a very attractive business, both to the commercial interest and the producer of raw material. The automobile craze has been the means of many a man mortgaging his home, eventually losing all of his savings for years, to buy an automobile, for pleasure, having no other use for a machine. It has been only a few years since capital had labor down to a place where they merely existed, but today labor has capital in a much worse position. Every laboring man is entitled to his hire, but the employer is entitled to an honest day's work. Production is what this country needs more than anything else. A laborer that is interested in his home is invariably a good employee, but one not interested in his home usually does just as little as he can to get by on. When good sound business judgment governs this country again there will be plenty of work and business for everyone. An equitable basis is sure to bring quicker and better results.

Very truly yours,

E. J. PRATT, General Manager,
The Southwest Missouri Railroad Co.,
Webb City, Mo., July 5, 1921.

(The foregoing discussion by Mr. Pratt was brought to the attention of Mr. Pulcher, who has written the following reply.—Editor.)

To the Editor:

"Transportation Equality" evidently does not mean the same to all of your readers. It is, perhaps, only natural that our conclusions in this regard should be somewhat colored by our viewpoint.

Mr. E. J. Pratt, General Manager of the Missouri & Southeastern Railway, makes several statements in his letter in reply to our first "Transportation Equality" plea, which indicates that he believes motor trucks have a pretty easy time of it against the tribulations and vicissitudes of the railroad.

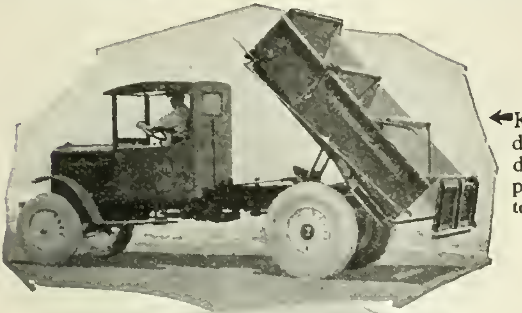
Well, as a truck manufacturer, we seek no quarrel with any railway or railway official. We acknowledge the great work of development accomplished by the railroads in the past 60 years. We deplore the period of stifling of, and legislating against, the railroads merely because they were public service corporations and seemingly legitimate prey of lawmakers.

In our article we were merely entering a plea for equality and fairness for all forms of transportation, and emphasizing the reasons why the motor truck should not be discriminated against in unreasonable laws or unjust taxes. You will doubtless remember we said:

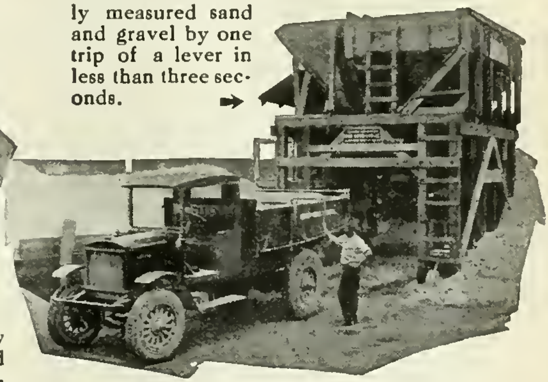
"There are five main means of transportation today—steam, electric railways, inland waterways, motor vehicles and horses.

"Each one is particularly suited to certain kinds of transportation, and should be allowed to do that haulage for which

KISSEL Road Engineering Service



Kissel Special Road-builder's truck. Hydraulic dump body of three batches of one yard each—designed, geared and powered for the flexibility, proper speed and dependable service necessary to meet contractors' requirements.



Kissel Special Road-builder's truck ready to back into Kissel combination hopper that dumps three batches of correctly measured sand and gravel by one trip of a lever in less than three seconds.

Kissel Special Road-builder's truck on specially designed turntable—being completely turned around by one man in less than ten econds, preparatory to backing up to mixer.

The Kissel Road-Division Engineers and Systematizes Road Building along Proven Increased Efficiency Lines

KISSEL Engineers have proven that the motor truck is the most efficient way to transport material if properly designed and equipped. In addition, the proper facilities for loading trucks must be provided as well as for measuring material and handling the truck before it reaches the mixer.

We have gone into this work extensively and have proven that merely designing the proper trucks to haul material is only part of this work—and that it is just as important to figure out what is needed to make the trucks efficient to do hauling at the lowest possible cost.

To that end our engineers have perfected these methods and equipment and are handling the work in the most efficient manner, *second to none,* as leading road-builders and contractors in different states will testify.

We have in preparation engineering data from different Kissel equipped road-building jobs showing actual cost per batch on various length and graded hauls. Also letters from prominent contractors stating how Kissel trucks and equipment have increased their road-building efficiency. To reputable contractors and road-builders we will be glad to forward this material. Ask for illustrated story of the Johnson Creek road contract.

KISSEL MOTOR CAR CO., Hartford, Wis., U. S. A.

it is fitted, with the least hindrance. They all serve the public, which in the end is the Government. There should be no discrimination against any one of them as opposed to the other."

That is our stand in this matter. We firmly believe there is room and need for all the forms of transportation, and we believe each one should help to pay its just cost of Government expense.

Railway Subsidies

We do not exactly agree with Mr. Pratt regarding the lack of assistance given to the railways in the pioneer days. It is a well known fact the Union Pacific and other great systems in this country received bonuses in lands, and even money, for the laying of their rail lines across the country. The above mentioned road received every other quarter section of land along miles and miles of its right of way. In Canada, the Canadian Pacific Railroad stock has long sold around $200 per share, not entirely because of the value of the road, but also on account of the rich land grants made them in the early days by the Canadian Government. Many smaller roads have had direct assistance, one case in mind being one railroad in Michigan. The builders were given a bonus by nearly every city through which they planned their road. The company, or its promotors, then turned around and sold bonds for the construction of the road and pocketed the bonuses, which act we are not condemning or praising.

Further, hundreds of electric roads, the country over, have been given right of way and bonuses by city, town and county without end to place their lines as feeders to the cities and haulers for the country. The line from South Bend, Indiana, to Benton Harbor, Michigan, through the fruit belt, was built out of donations of right of way and property and tax adjustments.

So it is an established fact that the rail lines have had much Federal, state, city, town and county aid, and private subscriptions as well, to help them in their early days, and to tide them over the promotional periods.

We have recalled these facts, not to disparage or detract from anything the railway men, pioneer or modern, have done. We would but laud their success in the development of the natural resources of the United States. However, Mr. Pratt has drawn so fine a picture of the railroad beginnings that he has left out a considerable part of the background. The railways were an economic blessing to the public, and that public gave liberally from its money and resources to help the railroads, which was eminently fitting and fair.

Prohibitive Taxes

Now Mr. Pratt seems to think that railways (as he believes) have always paid all of their own way—every vehicle traveling on the highways should likewise entirely pay for and maintain the routes they use—the highways. If this is done, which is extremely unlikely, then the farm wagons, traction engines, motor vehicles and other forms of highway transporting units would immediately decrease in numbers and be operated only under stern necessity, and the whole economic fabric and marketing business of the country would suffer.

But Mr. Pratt would exempt the farmer by entitling him to a good road to deliver his products over, also the pleasure rider and business man, at no cost but ordinary property taxes. He would levy against jitneys, taxis, or commercial vehicles, in other words all competitors of rail lines, for the whole cost of the highways. He forgets that the business man, whom he exempts with the farmer from paying the cost, is the very man who operates the trucks to furnish the railway haul, or to bring raw material and products to the rail shipping point.

Many Rail Men Appreciate Motor Transport

That all railroad men do not agree with Mr. Pratt is evidenced by the statements of some of the biggest railway men in the country on the motor truck for L. C. L. shipments.

Daniel Williard, President of the Baltimore & Ohio Railroad Co., says:

"I think I realize properly the importance of motor truck transportation, and I believe it is to the best interests of the country as a whole that such transportation be developed along economic lines.

"I think there is a proper economic field for all agencies of transportation so far developed, and wherever it can be clearly shown that the motor truck can perform the transportation service required at a total economic cost lower than the cost where the railroad is used, then in the public interest the motor transport system should be used. The railroads and the motor truck each have their own sphere of economic usefulness, and, in my opinion, it would be a mistake for either one to extend its influence and activities beyond the economic limits thus clearly established."

C. A. Phelan, General Manager of the Missouri-North Arkansas Railroad Company, says:

"There is no question but what the motor truck is a great asset in the handling of freight to and from the railroads to the interior country, and there is an opportunity for considerable development along such lines in this country."

J. F. Gorman, President of the Chicago, Rock Island & Pacific Railroad Company, says:

"There is no question of the value of motor trucks in serving rural communities, and I think equally they can be used to advantage in the transfer of freight in the large shipping centers, replacing trap cars now used for that particular purpose, which experiment has been tried in at least one important city.

"Good roads are necessary for the development of the motor truck transportation, and the large sums now being applied to this particular purpose in almost all parts of the United States, if expended at proper locations, will enable the motor truck to serve well many localities not now adequately served by the railroads."

Not only does the attitude of these railroad men toward the truck reflect the true status of the two forms of transportation, but it conveys the thought that it is the wise thing to do to contemporize the two greatest transportation methods in the world today.

The Trucks Are Paying, Yes Indeed

As far as paying a share of this cost and maintenance of the highways, the trucks certainly are doing that. Last year the combined automotive industry paid $316,720,878 in taxes—and so many kinds of taxes, too—Federal, excise, registration, license, motor fuel, motor transportation franchise tax, mileage tax, business taxes on manufacturer and dealer, horse power taxes, weight taxes, personal property, chauffeur, driver—almost no end of taxes. Much of the moneys thus received are spent for cost and maintenance of the roads, which, as we have said before, is proper and fitting. But our protest, feeble that it is, is towards the $500 to $2,000 per vehicle which is being levied against some capacities of trucks in some states; not just heavy duty trucks either. In one state it will cost over $1,000 taxes to operate a 2-ton truck if the law is enforced. In many others no 5-ton truck, even adequately tired for road conservation, can operate without paying more tax to the state than the gross haulage receipts would amount to.

This legislation and taxation, we maintain, is not helping solve the country's transportation problem, nor settling the question of who should build and keep up the highways, nor which is the best way to ship goods for short or long haul, but the attitude of lawmakers is directly in opposition to the settlement of these matters. We do not believe that the great American public, which was so long denying to the railroads a proper freight rate, will permit the crippling of another form of transportation through excessive taxes. We believe that fairness and common sense will prevail in the end—but truck operators are suffering now. Why not relieve this situation now?

Natural Economic Selection

And so we could go on expressing our own and others' opinions regarding the functioning of the railway and motor vehicle and of the right and wrong of the distribution of cost and maintenance of highways, adequate to the demand of the country upon them—but it would avail us nothing. The economic necessity will in the end govern the situation. If the nation needs more motor truck transportation than it has ever had, then the trucks and the roads will be built to haul the goods, and if the trucks can most economically haul those things which are best suited to that form of transportation, or which must be transported where the rails don't reach, then where is the argument—why the discussion? As always, the old law of average takes its stand where none can move it. Business will go on and the world will raise, sell, trade and barter, and the result is transportation—more and faster transportation. Let's not have words about the means. Let's only have to do with the most available and economical means at hand and use that as often as the need arises. Very truly yours,

M. L. Pulcher,
Vice-President and General Manager,
Federal Motor Truck Co.
Detroit, Mich., Aug. 11, 1921.

MOTOR BUS SERVICE FOR CONSOLIDATED RURAL SCHOOLS

(Editor's Note: Following is the full text of the report of the Committee of the National Highway Traffic Association appointed to study this subject. Ernest Farr, chief of the Firestone Ship by Truck Bureau, Akron, O., is chairman of the committee. Other members are: L. L. Driver, Director Bureau of Rural Education, State Dept. of Public Instruction, Harrisburg, Pa.; R. P. Crawford, Assoc. Editor, Nebraska Farmer; and Macy Campbell, Head of Dept. of Rural Education, Iowa State Teachers' College.)

This report will be confined to brief discussions of recent progress in rural school consolidation, the use of the motor bus for the transportation of pupils and the development in equipment, and a somewhat more elaborate discussion of the relation between school consolidation and motor transportation of pupils. Subjects of local importance or which must be worked out as individual problems for each installation, such as operation details, will not be touched on. Also the relation between consolidation and transportation will be developed to apply only to those districts in which conditions are unfavorable to consolidation.

Number of Consolidated Schools

At the beginning of 1920 there were about 13,000 consolidated schools in the country and 212,000 one-room schools, which should provide a field for about 40,000 more consolidations. Exact figures are not available, but it is believed that 14,000 is a conservative estimate of the consolidated schools now in operation and that there are 3,000 to 4,000 more in prospect. Pennsylvania alone is working on 200 consolidation projects.

Educators are becoming more intensely interested in consolidation. It means a raise in the standard of teacher, personnel and pay, a subject that is being agitated throughout the country. Many institutions of higher education, such as Kentucky State University and Kansas State Agricultural College, are including the subject of consolidated schools in their extension courses. Women's clubs are interesting themselves in consolidation campaigns. The United States Department of the Interior is assisting in the consolidation movement and has the cooperation of the Department of Agriculture through its county agricultural agents.

Progress of Motorization

So much for the progress of consolidation. What is of more interest at this time is the question of transportation. The following quotation is from a letter received from Mr. Lee L. Driver, Director, Bureau of Rural Education, Pennsylvania Department of Public Instruction: "Hundreds and thousands of places are finding that the motor can be run where it used to be thought impossible. They are also finding that it is cheaper when service is considered. Many communities have not purchased horse-drawn vehicles for two or three years and are relying wholly upon the motor. In Pennsylvania more motors are being used than horse-drawn vehicles."

One county superintendent in Ohio reports that last year they had 20 automobile buses and this year they have 60, and probably will be completely motorized within a short time. Cuyahoga County, Ohio, reports that no more horse-drawn vehicles will be purchased. Montezuma County, Kansas, expects to be completely consolidated this year, with six schools, using 50 buses, serving the whole county. The State of Washington, in the northwest, reports that motor buses are the principal transportation medium and the State of North Carolina, in the southeast, reports that motor buses are displacing horse-drawn vehicles.

It will be seen that the motor bus is rapidly becoming the recognized transportation medium where consolidation is in effect. Transportation is the most vital factor in rural school consolidation and, where consolidation is not in effect, the principal stumbling block in the path of its attainment is the question of transportation. It is for this reason that this report is largely devoted to a discussion of the importance of transportation to consolidation.

Consolidation Depended on Transportation

As a foundation for a case for the motor bus it may be well to show just how dependent consolidation is on transportation. The two are so closely allied it is impossible to discuss them separately. To support a consolidated school, the district must be large enough to furnish an adequate tax duplicate. When an area of that extent is included transportation must be provided or a large percentage of the children in the district cannot attend, and it is not to be expected that a parent will vote to tax himself to maintain a school not available to his children. Without going into details, a compilation of several recent articles on consolidation gives 56 different advantages the consolidated school has over the old rural school. Of these 56 advantages 14 are the direct result of furnishing transportation. The balance are dependent on transportation, at least to the same extent as is consolidation, which is close to 100 per cent.

The transportation of school children should be measured by time rather than distance. If a pupil be required to ride over one hour each way the undue fatigue probably will reduce his general efficiency, not to mention the fact that he may not have sufficient time left for necessary duties on the farm. A comparison of horse and motor bus transportation on this time basis is interesting. It may be estimated conservatively that six miles, including necessary stops, is the maximum distance for a horse-drawn vehicle in one hour, and that under similar conditions the motor bus will make 12 miles. In other words, the use of motor buses will quadruple the size of a district which may be served by a consolidated school, at the same time transporting the pupils in an equal length of time as well as in equal or greater comfort than if they rode in horse-drawn vehicles.

Returning briefly to the 56 advantages previously mentioned, 21 are directly dependent on the increased size and equipment of the school and 12 on the increase in number of pupils. Therefore, by multiplying the possible area by four the motor bus not only enhances the efficiency of the majority of consolidated schools but enables their establishment in districts where the area practical for horse-drawn vehicles can not produce the necessary taxes to support the school and pupils to patronize it.

As an example, take the State of North Dakota. It may be assumed that a maximum travel distance of six miles is a maximum air line distance of three miles from the school, since as a rule the roads follow section lines and more or less doubling along the routes is necessary. This makes the maximum area of a consolidated district a circle of three miles radius, or about 28¼ square miles. Now the average assessed value of land in North Dakota is $3,750 per square mile or $106,000 in a district of 28¼ square miles. This means one of two things if horse-drawn vehicles must be relied on: an open country consolidation which does not have the tax duplicate of a town or city to support it cannot exist, except as an incompletely equipped plant, little superior to the one-room school, or the district must be extended so that many of the pupils spend three to five hours a day traveling to and from school.

Other considerations are density of population and topography. On the average, in North Dakota, there would be only about 62 school children in a district of 28¼ square miles of area. In the valleys of the eastern mountains and the canyons of the western, topography frequently makes consolidation impossible unless motor buses are used. Consequently it would seem that consolidation is absolutely dependent on motor bus transportation where average land value is low, where population is scattered or where topography necessitates a long, narrow district.

Cost of Motor and Horse Transportation

Enlarging a district increases the average transportation distance per child per day, so it may be well to compare in a general way the cost of motor bus and horse transportation. A compilation of the records of various schools representing all sections of the country shows an average transportation cost of 1.8 cts. per child mile by motor bus and 3.0 cts. by horse hack. Still assuming that the bus is capable of double the time mileage possible by horse, and assuming districts of a maximum size of one transportation hour, the cost of transporting the average pupil will be 20 per cent greater by bus than by horse hack. Transportation cost amounts to about 10 to 15 per cent of the total cost of tuition. Therefore, under the most unfavorable circumstances the use of motor buses will increase the unit cost of tuition about 3 per cent, but at the same time it offers the compensating advantage of a district of quadrupled area, greatly increasing the possibilities of economies in other directions. For instance, doubling the investment in the school plant should be more than sufficient to give equal advantages to four times the pupils, thus reducing the amount of taxes necessary to retire bonds by 50 per cent.

Improvements in Buses

Taking up the subject of bus equipment, many improvements have been made recently. Several manufacturers of trucks and bodies have given the school bus special attention, with the result that there are now on the market several standardized buses providing maximum value, seating capacity and comfort at minimum cost. While it is important that each installation be studied as a separate problem, the general tendencies in chassis and body construction should be noted.

Where replacement equipment is being purchased the tendency is to get away from the light chassis and use those of larger capacity, the 1-1½ ton being the most popular. This is an important and an apparently well-founded development from the standpoint of safety as well as economy.

Bodies may be divided roughly into two classes—the side-seater and the cross-seater. The side-seater gives a minimum of comfort and seating capacity. A recent development of the side-seater has an extra seat down the center, accommodating three rows of pupils lengthwise in the bus. This gives added seating capacity, but is not all that could be desired so far as comfort is concerned, and is rather unsafe unless a rear door is provided, which, in turn, reduces the capacity. The cross-seater is of two general types, one having individual side entrances and the other having an aisle down the center and rear and front doors. Considering seating capacity, comfort and safety in their relative importance, it is believed that the last mentioned type is the best for the average installation.

Motor Bus Dependent on Good Roads

The dependence of consolidated schools on motor transportation has been emphasized. In conclusion, it should be stated that the motor bus is also dependent on, and greatly limited by, a very important factor. From all over the country come reports substantially the same as that contained in a recent communication from J. C. Nuerman, Specialist in Rural Education, Department of the Interior. Mr. Nuerman says: "Until we have a better system of roads and more money for roads I do not look to see the consolidated schools advance as rapidly as they will when the good roads problem is settled."

DETROIT MUNICIPAL STREET RAILWAYS OPERATE NEW TROLLEY TOWER TRUCK

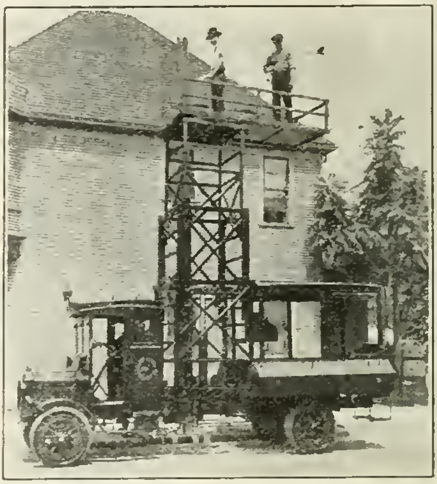
The accompanying illustration of the "Standard" hydraulic elevated trolley tower truck, now being used by the Municipal Street Railways Department of the city of Detroit, shows an unusual installation of the tower and body arrangement. The tower can be elevated or lowered in less than a minute by moving a lever which is within reach of the driver's seat. It is the first tower of its type built.

A three section Trenton tower is located between the cab and body. The tower is operated by a Wood Hydraulic Hoist, located on two cross members in the center of the tower. The hydraulic hoist is hooked up with the hand hoist arrangement so that in case of emergency, or when the motor is not running, the tower can be raised easily by one man turning a crank. The tower lowers by gravity and the hand arrangement is fitted with a brake to control the downward speed of the tower.

The enclosed cab has sliding doors and is fitted with an auxiliary roof to allow the workmen to walk on it. A ladder shaped to the contour of the cab side is attached to provide means of getting on the tower platform.

The body is equipped with four longitudinal tool boxes. The two inside tool boxes are full length of the body and the two outside ones, which are longer, straddle the tower frame.

There are six double 8-in. hooks attached to the body posts for hanging on coils of rope and wire, etc. The inside



"STANDARD" 2½-TON HYDRAULIC ELEVATED TROLLEY TOWER TRUCK.

tool boxes will be used as seats for the workmen. The passageway between them has provisions for removable partitions to make four extra large compartments. The covers of the outside tool boxes are on an angle so arranged as to keep the contents dry in wet weather. A step and a hand rail at the rear end of the body make it easy for workmen to get tools and material from the inside tool boxes and compartments. The body can be completely enclosed in inclement weather with curtains that are rolled up and attached to the top of the body. The chassis is equipped with a pintle hook and both front and rear tow hooks.

The electric lighting equipment consists of two head lights, one tail light, two dash lights, one spot light and searchlight. The searchlight is mounted on the top of the cab and is so arranged that it can be swung in any direction to illuminate the work while repairs are being made.

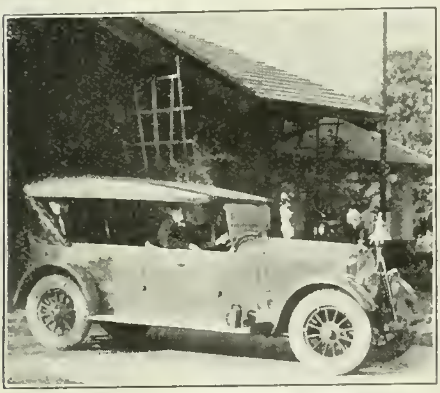
The total height from the ground to the tower platform when elevated is 19 ft.

6 ins.; when lowered it is 10 ft. 4 ins. This truck is manufactured by the Standard Motor Truck Co., Detroit, Mich.

NEW CAR FOR THE FIRE CHIEF

Because of the ease of control, coupled with high speed when required, much interest attaches to the National Chief—a new fire chief's car built around the standard National Chassis by the National Motor Car & Vehicle Corporation, Indianapolis, and sold through the representatives of the Stutz Fire Engine Company. The first of this series has been delivered to Mr. Matheny, who represents the Stutz Company in Kansas City territory.

The car is finished in brilliant vermilion with bright nickel fittings. A special fire bell is mounted at the front with pull cord leading through the dash. An attention getting electric siren is also provided. A removable high power electric lamp is mounted on the running board so as not to interfere with speedy entrance and exit from the car. A Pyrene is fitted under the front seat on a special clip floor board mounting.



THE NEW "NATIONAL CHIEF" FIRE CHIEF'S CAR.

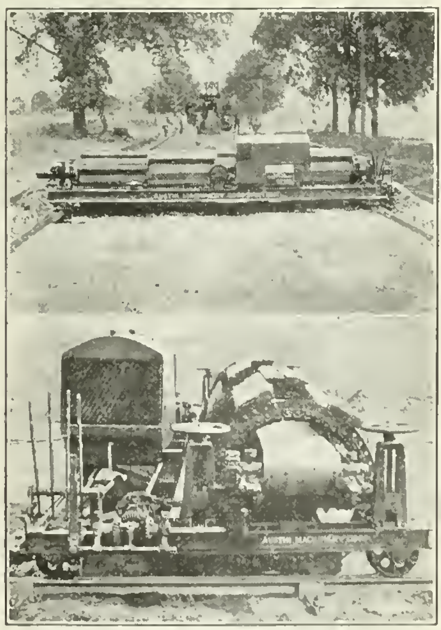
The National Chief is furnished in either roadster or seven passenger types. The roadster follows the general lines of the standard National Sport model with an extra disappearing seat in the rear. The lines are so distinctive that it is recognized at once as an afficial car.

The National Chief, with seating capacity for seven, is very appropriate for municapal turnouts and parades, as well as regular fire duties. Speed has not been sacrificed in furnishing the extra seating capacity. Another attractive feature is that aside from fittings and finish both models have a regular stock National chassis, thus in case of accident repairs and replacements can be made very easily and quickly.

THE AUSTIN SUB-GRADER

With five billion dollars already appropriated for highway construction in the United States during the next ten years, road engineers and contractors are looking into every means which will assist in the efficient building of enduring concrete highways. As an additional step in meeting this demand, a new Sub-Grader has been put on the market, designed primarily to effect a labor saving in finishing the road after it is rolled prior to putting on the concrete. In addition to the lessened number of men on the job, the mechanically true grade means a substantial saving on concrete.

This Austin Sub-Grader, one-man, gasoline operated, is drawn along on the Road Forms by means of cables. The 4-ft. digging buckets, equipped with removable steel plow lips, are set to drive in five distinct places to depths varying from 2 to 4 ins. In trimming the road, two plows shave off the sides between the forms and the buckets. The buckets then trim the road, depositing the excavated material on the 15-in. conveyor belt, which discharges the surplus material outside the forms. One passage over the road leaves the sub-grade perfect for the laying of the concrete.



VIEWS OF THE AUSTIN SUB-GRADER.

EDITORIALS

PERMANENT RESULTS FROM EMERGENCY PUBLIC WORKS.

President Harding's Conference on Unemployment, through a committee, has urged upon municipalities, counties and states the extreme desirability of getting new public improvements under way at once as a means of providing employment for those who are idle. The recommendations of the committee are published in this issue and will naturally receive the attention of every reader.

The point is being raised in some quarters that if the federal government looked with disfavor on a grant from the federal treasury to the unemployed it is not fair to expect local authorities to "make work" just to help the idle at public expense. This view merits attention, although it is not widely entertained, because it misses the point entirely. It has not been the thought, at any time, of those who have urged the undertaking of improvement projects as a means of providing employment that such a course should have merely temporary benefits to an unfortunate minority.

These emergency measures are not disguised charity but are calculated to make charity unnecessary. Only useful work of permanent value should be undertaken. Fortunately there is plenty of useful work to be done in every locality where there is a real unemployment problem present or in prospect.

Sound procedure is illustrated in the case of the city of Boston, where a special effort has been made to get started all the public work which has been determined upon as a matter of policy. City contracts have been placed for new buildings amounting to $2,746,200. Repairs and renewals, subway work and Public Works Department requirements, etc., bring the total up to a little over $4,000,000.

In August $106,000,000 worth of municipal bonds were sold by 333 municipalities, and to the end of September such bond sales are $700,000,000 in excess of the total for the entire year 1920. Thus there is much money available for public improvement work on projects which have been carefully considered and fully planned. Construction work should go forward at once on all such projects, in the opinion of the President, Secretary Hoover and scores of others of the highest authority who have carefully considered all phases of this subject.

RATING CITIES ON THEIR PUBLIC IMPROVEMENTS

Many readers undoubtedly are familiar with the procedure of the National Board of Fire Underwriters in rating the water supply and distribution works of a city with respect to the adequacy of fire protection they furnish. The rating is based on a clearly defined and easily understood set of standards for the various features of a water system, and the city is rated as a fire risk in accordance with the deviations of local facilities from the established standards, and thus the fire insurance rates are fixed to a large degree. Water works that look complete to the layman, and even to the local water superintendent, are shown to be incomplete and inadequate by comparison with the established standards.

It would be of great interest and value to have standards with which cities could readily compare the completeness and adequacy of all forms of improvements. When is a city adequately paved? When is a city adequately lighted, sewered, etc.? These questions cannot be answered at this time for lack of recognized standards.

It would seem to be as feasible to prepare standards for comparison of other public improvements as it is for water systems, and the need is just as great although of a somewhat different character. The reader will appreciate the many advantages to a city in having recognized standards with which to compare its public works of all kinds. We should like to see this matter taken up and made the subject of an investigation and report by a committee of some national engineering society.

WEALTH, HEALTH AND THE MUNICIPAL ENGINEER

A distinguished British municipal engineer, who has published a 120 page volume of his professional reminiscences to give the general public a better conception than it now has of the work which devolves on a municipal engineer, in a recent letter to the editor of The Surveyor and Municipal and County Engineer, of London, inquires why it is that municipal engineering receives so little encouragement from local authorities and the general public. He quotes the following passage from "The Life of Lord Warwick": "While the soldier, sailor, diplomat and politician reap their substantial rewards, none is ever offered to those who carry the heavy burden of municipal responsibility and work." He asks what is to alter this apathy towards men who are giving the best of their lives and ability to the work of improving the surroundings and amenities of their fellow citizens, and who are responsible for so much that make life worth living. He feels that their labors should command some "substantial rewards" instead of the present meagre salaries which are so often grudgingly bestowed on them.

While these points were made with respect to the employment conditions of municipal engineers in England they apply equally well to conditions in America. Therefore his answers to his questions have an interest to American municipal engineers.

His explanation of the conditions described lies in the fact that the labors of the municipal engineer bring in no direct monetary return, and consequently his work is not valued in the same manner as that of the employees of a commercial enterprise. He concludes: "The majority of mankind is apt to place a higher value on wealth than on health, whereas a wise man knows that the latter is of infinitely greater importance. Until this is more fully realized I fear that the chances of a better recognition of the services of the municipal engineer are somewhat remote."

The editor of The Surveyor makes interesting comments on the observations of his correspondent. He says: "Long experience has shown that to secure an improved status for the municipal engineering profession it is not sufficient merely to reiterate the fact that the present position is neither satisfactory to the public nor just to the municipal engineer. The careful inquirer will go a step further and ask what are the reasons which lead to an attitude of mind on the part of local authorities and the general public that results in a common failure to appraise efficient civic engineering service at anything like its proper value, whether this be measured in the benefits conferred on the community or in the remuneration which the engineer receives for his work." He agrees with his correspondent that "all save the wise are apt to place a higher value on wealth than on health, and even when health is considered at all, it is surprising how little attention is bestowed on preventive as compared with curative processes. The work of the municipal engineer does not bring in an immediate cash return, but is concerned with the health of the community, which he preserves by preventive measures. It would appear, then, that municipal engineers will not receive full recognition until the advent of a saner general outlook on life. Meanwhile the only hope of improvement seems to lie in a missionary campaign among members of local authorities."

Probably our readers will agree with this diagnosis of the case and also that the remedy proposed is good. We maintain that through proper publicity the general public, as well as the higher officials, can be made to appreciate the service of the municipal engineer and its money value to the community. Recently it has been demonstrated that the public can be interested in the fair treatment and adequate compensation of its servants, as in the cases of public school teachers and postal employees.

Municipal engineers can secure better compensation and longer and more secure tenure of office whenever they make up their minds to go about it. They must tell the public, and public officials, of the money saving possibilities of good engineering and of the money wasting possibilities of poor engineering, and of the value of good engineering as health insurance as contrasted with the menace to the health of the community inherent in poor engineering. This is not a visionary proposal but is intensely practical. It will not be necessary to go to the public with generalities, but any number of deeply impressive facts and figures are available for immediate use; facts and figures which will convince the people and elected officials that competent municipal engineers should be well paid and protected against the machinations of the machine politicians.

BITUMINOUS PAVEMENT DESIGN —AGGREGATE SURVEY

By F. S. Besson, Major, Corps of Engineers, U. S. Army, Assistant to the Engineer Commissioner, D. C., District Bldg., Washington, D. C.

Certain investigations recently made in the District of Columbia have shown clearly that defects of bituminous pavements can not be charged entirely to deficient compaction, nor to the presence of smooth grains in the aggregate, nor to the existence of rigid bases. Poor pavements result from various causes. Failure may be due to poor design; to the bitumen content, or to the aggregate employed. As an aid to proper design a diagram was developed which is reproduced herewith. See Fig. I. By the aid of this diagram the bitumen requirements for what may be called a "normal mix" may be readily determined. It was fully realized that the proper bitumen content would not always assure a satisfactory pavement, and therefore further investigations have been made in an attempt to discover other causes of failure and to place the theory of bituminous paving design upon a practical basis.

Most pavement and floor mixtures used throughout the United States are prepared according to one or another of several well-known or patented formulae which call for combinations of aggregates in accordance with specified sieve analyses. Artificial mixtures are usually expensive. In some parts of the country the cost of the generally advocated mixtures is absolutely prohibitive. If it can be shown that natural aggregates found locally will give equally good results, the economy which will follow is quite apparent.

Two Outstanding Features in Design of Bituminous Mixtures

There are two outstanding features in the design of bituminous mixtures:

a. Each combination of sand, stone or gravel requires a different amount of bitumen, for what may be called a "normal mix," see Fig. I.

b. Some aggregates, no matter what the bitumen content, fail to be of value as paving mixtures. By varying the bitumen content with other aggregates, mixtures applicable to widely different uses may be obtained.

As already stated, the proper bitumen content for the "normal mix" for any aggregate may be determined by using the diagram shown in Fig. I. The specific gravity and voidage of the aggregate are obtained by placing a 1000 gram dry loose sample in a graduated cylinder, 62 mm. in diameter, using gasoline for submergence. For general street and road purposes, mixtures falling on the curve when

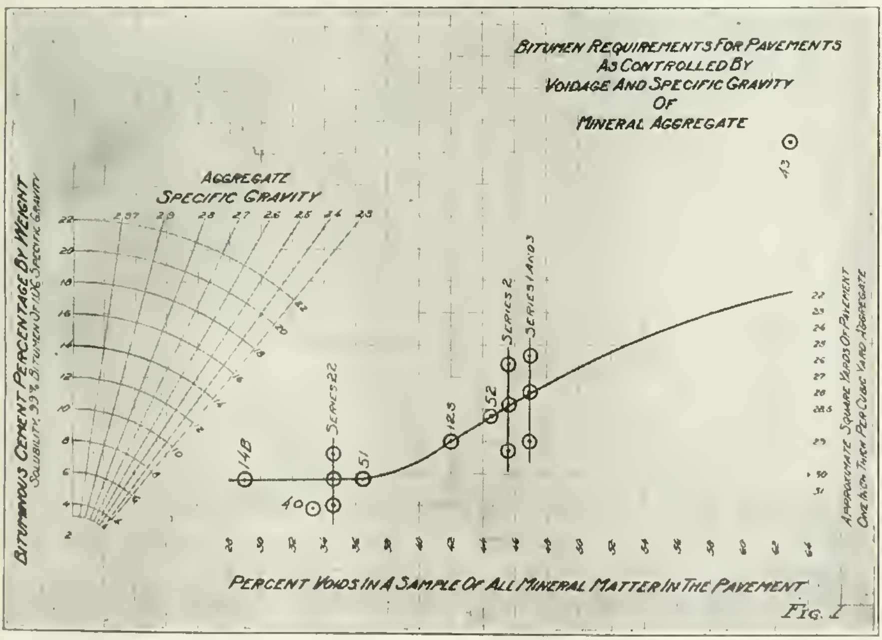


FIG. 1—BITUMEN REQUIREMENTS FOR PAVEMENTS AS CONTROLLED BY VOIDAGE AND SPECIFIC GRAVITY OF MINERAL AGGREGATE.

plotted on the diagram will be correctly designed, so far as the bitumen content is concerned. If a mixture is desired for other purposes the diagram supplies a definite basis for investigation.

Plotted on Fig. 1 are some specimens to which further reference will be made in the present discussion. No. 40 is a sample from a recent paving job, illustrating what is generally known as a "lean asphaltic concrete." A seal coat is just as essential with this mixture as with a penetration macadam pavement, and such a coat in this particular case costs approximately 8 cts. per sq. yd. It may be questioned whether better service

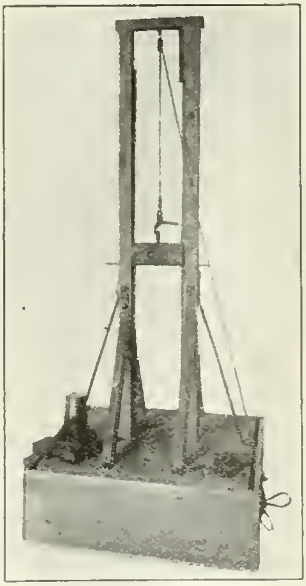


FIG. 2—APPARATUS FOR MAKING AND TESTING BLOCKS.

could not be obtained by improving the primary mixture 8 cts. worth, making it denser and richer, thereby doing away with the necessity for the seal coat. It is plainly evident that some means must be devised to test the relative worth of bituminous mixtures as affected by the aggregates employed, and this comes under the second of the two outstanding features in pavement design.

Specimen "12S" represents a sample taken from a pavement, probably one of the oldest serviceable sheet asphalts in this country. The fact that the mixture is most excellent is proven by its life of 42 years and by the further fact that the service it is rendering today is more economical, the maintenance cost much less, than that given by other surfaces but half its age. This pavement was laid without a binder course. In developing a standard practice in the District of Columbia by the "mix and try" method extending over practically half a century, a great number of experimental pavements have been laid. The worth of each has been tested under service conditions. Many early proved of no account while others, though differing greatly among themselves as to structure, have given good results. It happens, however, in considering certain pavements to determine final design this "12S" type was not chosen and a standard was finally adopted calling for a topping mixture of about 11 per cent bitumen underlaid by a 1½-in. binder course.

Three Elements in Bituminous Pavements Which May Cause Failure

In any bituminous pavement composed of binder and topping there are three elements to which failure may be attributed: the binder, the bitumen in the topping and the mineral aggregate. Which of these three should be blamed in case the pavement fails has many times been a matter of mere conjecture. Carrying out investigations along lines suggested by the old pavement, specimen "12S", other examples have been found which indicate clearly that the binder course is unnecessary. Its complete elimination is advocated and this will do away with one of the three elements to which failure has been charged. Furthermore, based upon 100 as the cost of a 3-in. surface comprising 1½-in. binder and 1½-in. topping, the former has generally cost 43 per cent and the latter 57 per cent. But entirely omitting the binder course the cost may be proportionately reduced. Since the surface without the binder course is but one-half the usual thickness, in repair work less material is needed for patching and the maintenance cost is likewise reduced. The base underlying an asphaltic pavement should be considered as permanent construction with an indefinite life whereas the surface must be replaced periodically. If only a topping mixture covers this base, when re-surfacing is necessary but one-half the usual thickness has to be stripped and replaced; again the material salvaged has more value than if half of it consisted of binder. To offset these economies no good reason whatever for placing a binder course between the base and the topping has been found.

Years ago many bituminous cements were of an unstable nature. Even when they were made with a good native asphalt as a base unsatisfactory results were often obtained because of the many poor fluxes then on the market. Today bituminous materials are controlled by accurate specifications guaranteeing uniform products. Having at hand what is known to be a good cement, the diagram, Fig. I, determines the quantity to use for a "normal mix." Though thus working from a known basis as regards the bitumen requirement of any aggregate, the worth of the resulting mixture in its application to specific purposes is still undetermined. Heretofore, experience under service conditions has been the sole criterion with a marked hesitancy in departing from known standards. In the paving industry nothing can ever entirely supplant practical experience. However, it is essential to have a method of testing bituminous mixtures in order reasonably to forecast what may be expected under actual service.

Investigation of Different Mixtures

In order to carry further the investigation of different mixtures, the apparatus shown in Fig. 2 has been designed. Cylindrical compressed blocks, 10 c. m. in diameter, are made of the mixture to be tested. Each block contains 1,000 grams of mineral aggregate and as many grams of cement as may be necessary to give the desired percentage of bitumen. The block is placed in the apparatus and over it is centered a steel pin 19 m.m. in diameter, which is subjected to blows from a 20 kilogram weight falling through a distance of 0.8 meter. After a number of blows it is found that the pin either fractures the block or penetrates it to the full length of the pin, 60 m.m., accompanied by more or less cracking. A record of the number of blows and of their general effect, together with a close study of the tested blocks, supply sufficient data for satisfactory conclusions concerning the different mixtures.

Study of Cracked Pavements

The deductions from such tests must necessarily be based upon the behavior of sample blocks taken from pavements which have been subjected to service tests and whose behavior has been noted carefully. By testing such blocks from existing pavements it is possible to form accurate conclusions concerning the behavior of experimental mixtures. The material in block "48S", Fig. 3, was taken from one of the most conspicuously cracked pavements in the District. This was laid in 1903 and the defects appeared shortly thereafter. The "2" in the upper right hand corner records the number of blows delivered in breaking the block. The next specimen "15S" shows a friable mixture which broke down under but one blow.

The many cracks in some Washington streets are quite apparent and it is obvious that there is something wrong with pavements which behave in this manner. Samples taken from these cracked pavements habitually give block tests similar to "48S" and to "15S." Therefore, like results in the case of new mixtures would caution against their use in actual practice. As a contrast to these two samples, specimen "2S" was obtained from a street laid in 1905. Under heavy traffic it has given uniform, economical and satisfactory service. An experimental mixture giving a block test similar to "2S" might be looked upon with tentative favor.

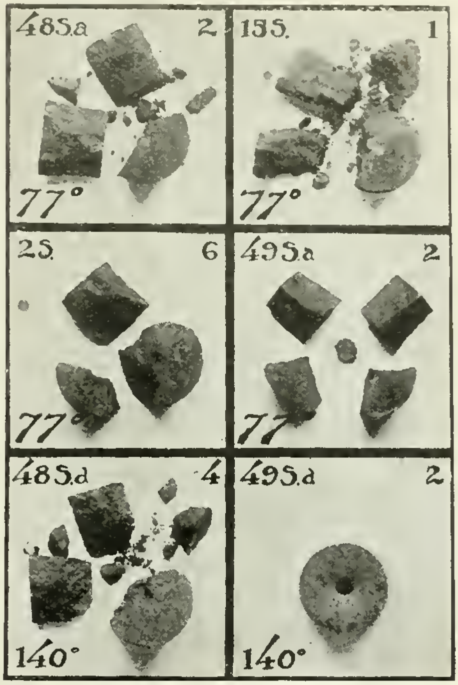


FIG. 3.

The upper left hand figures are specimen numbers. Those in the upper right corners the number of blows delivered and those in the lower left, Farenheit temperatures. These specimens represent good and bad streets. No. "48S" a much cracked pavement and "49S" a waved one. No. "15S" a worn out surface, and "2S" a good one in its prime. The "d" blocks show the relative influence of high summer temperature. These six photographs serve as standards. If an aggregate gives similar specimens to one of these a primary assumption is that it will render analogous service in a street. Such a comparison is the first step in the complete survey of an aggregate.

A Study of Waved Bituminous Pavements

Cracked and good pavements are illustrated by the specimen blocks already mentioned. Waved pavements call for special study. In an endeavor to investigate such pavements by the block test trouble was had at first in determining the cause of this most objectionable defect of bituminous mixtures. Though many blocks were broken it was found that those from waved pavements gave about the same results as those from cracked surfaces. For example, "49S" represents a much waved pavement and yet it closely resembles "48S" from a badly cracked pavement. It is apparent that each of these two is poor, but a correct determination of the causes of failure can not be drawn from the photographs showing the behavior of these two specimens.

A study of the waved streets in the city showed that maintenance is heavier during the hot summer months than during the winter. Furtherfore, it has been found that waved pavements can be ridden over with more comfort in winter than in summer. In cold weather the bumps iron out, but they re-appear again when warmer weather comes. This suggested making the block tests at higher than usual room temperature. A thermometer buried in a street on a summer day registered as high as 140° F. Accordingly a series of tests was made as represented by samples "48S.d" and "49-S.d" marked 140° in the lower left hand corner of the photographs. It is easy to determine which of these two pavements cracked and which waved. A specimen from the former breaks somewhat similarly to a good specimen at average temperatures. The one from the waved pavement is so soft that the pin readily penetrates. Just the opposite to waved pavements, observation has shown that streets which crack badly generally show greater deterioration in winter weather, while they render fair service in the warmer summer time.

Usefulness of Block Tests

The actual usefulness of these block tests depends upon our ability to draw proper conclusions therefrom, based upon the behavior of similiar blocks than from pavements tested under service conditions. In order to determine the value of any particular aggregate, all of the elements of bituminous design must be known. The diagram, Fig. 1, will give the amount of bitumen for the "normal mix" and thus fixes that element which has heretofore been one of the greatest uncertainties in paving practice. Care must be taken that the results of the block test are not affected by temperature changes or by variations in the consistency of the bituminous cement. The blocks must be made and tested under constant conditions. In all the investigations described herein successful results are largely due to the painstaking assistance rendered by Mr. Vernon Cleaver of the Engineer Department of the District.

While the block test alone can not determine all of the causes of defects in old pavements, it can aid in preventing their occurrence in new ones. The succeeding photographs illustrate how, with this aim in view, a sample aggregate may be investigated. In order that the results might be strictly comparable the same bituminous cement was used in all of these blocks.

As a preliminary study, this cement was mixed in varying amounts and of different consistencies with proven aggregates. For instance, a tested block containing aggregate extracted from the street previously referred to by the symbol "12S" is shown in Fig. 4. The cement tested 45 units penetration at 77 deg. F. By this means it is possible to establish models that may be used as standards in investigations of unknown aggregates.

Discussion of Tests

The previously mentioned specimen "40" is shown in Fig. 4. The material for this block was taken at the asphalt plant from a truck just loaded for delivery to the street. This mixture contains but 4.5 per cent bitumen soluble in C. S. 2, insufficient properly to bind the aggregate. Particularly it should be noted that though the larger stones are rough and angular, being a crushed trap rock, they do not form a properly consolidated conglomerate. Under but two blows the block is torn apart rather than broken, there being no planes of cleavage through the stones themselves.

No. "14b" is shown as a contrast. The coarse aggregate is smooth quarter and half inch gravel. The 6.1 bitumen percentage is normal for the 29 per cent aggregate voidage. In the plane of fracture it is seen that the larger material is not torn from the surrounding binding matrix. Not only do the half inch pebbles break cleanly but also the quarter inch ones. The bitumen and fine grain material form a binding agent that develops the full strength of the particles of stone aggregate.

Specimen "43" plotted on the diagram Fig. 1, and shown by photographs in Fig. 4, is an extreme mixture. The mineral aggregate is very fine, all passing the 200 mesh. One thousand grams placed in the graduated cylinder measure just 1000 c.c. In this loose condition the material has a voidage of 63 per cent, and thus, though of higher specific gravity than the aggregate used in specimen "14b", its weight per cubic yard is but half that of the latter. Between the two extremes located at the ends of the curve, Fig. 1, lie a great field of mixtures with aggregates of different voidages and corresponding weights per cubic yard. Notwithstanding such wide variance in aggregate weights it is remarkable that when mixed with normal percentages of bitumen and compressed, the resulting surfaces weigh close to 100 lbs. per sq. yd. per inch of thickness. It is seldom that the difference is much in excess of 10 per cent above or below the weight. Some mixtures containing large stones or material of unusual specific gravity are exceptions.

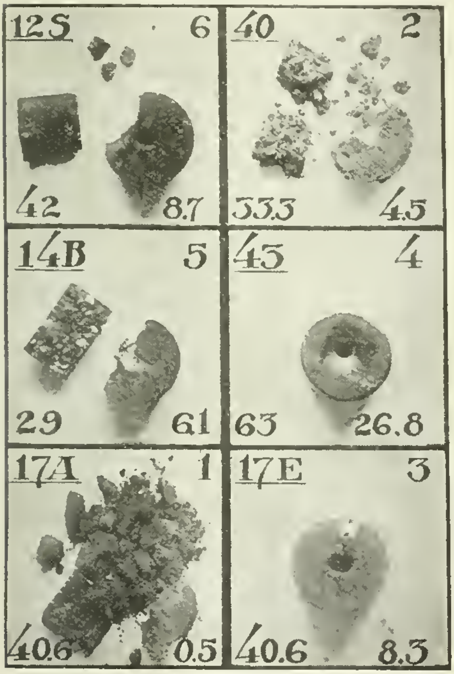


FIG. 4.
Test of blocks in order to show the influence of variations from "Normal Mix" as indicated by the Diagram, Fig. 1. The symbols in the upper left hand corners designate the specimen; those in the upper right, the number of blows; those in the lower left, the voidage of the aggregate; those in the lower right, the percentage of bitumen.

While the weights per sq. yd. may differ but little, the amount of bitumen depending upon the aggregate used, may vary within wide limits. With low voidage aggregates the bitumen by weight may be but one-fifteenth of the mixture, while with fine dust one-fifth of the mixture may be bitumen. When a finely divided sand or dust is mixed with a bituminous cement the material's bulk shrinks to a great extent so that as little as 22 sq. yds. of paving 1 in. thick may result from a cubic yard of aggregate. For coarser materials the shrinkage is less and, with very low voidage aggregates, as much as 31 sq. yds. 1 in. thick may be obtained per cubic yard of mineral aggregate. The right hand ordinates of the drawing, Fig. 1, furnishes a means of approximately estimating the amount of aggregate required to lay a given area of pavement. Specimen "43" has a surplus of bitumen, purposely so, in order to make a mastic that might be floated into place for special purposes. The extra bitumen increases the bulk of the resulting mixture over that of a "normal mix" so that instead of 22 sq. yds. per cu. yd. as shown by Fig. 1, 27 sq. yds. 1 in. thick may be covered, a square yard 1 in. thick weighing 89 lbs. containing 65 lbs. of mineral matter and 24 lbs. of bitumen.

Fallacy of Certain Theories Demonstrated

Specimens "17a" and "17e", Fig. 4, considered in conjunction with "43", illustrate the inapplicability of the "surface area of aggregate" and similar theories in determining the amount of bitumen that should be used. The material in "43", all passing the 200 mesh, is an impalpable powder. Its character is distinctly unlike that of material retained on the 200, the granular nature of the latter being plainly evident. Some theories assign huge and, in fact, indeterminate values to dust in bituminous mixtures because of the great area presented by the total of the tiny surfaces of the particles. On the other hand, the voidage diagram, Fig. 1, shows that 19 per cent, that is 235 grams of bitumen with 1000 grams of this fine mineral matter constitutes a normal mixture and thus affords a definite base from which to work.

The aggregate used in the blocks of series "17" is standard Ottawa sand, all passing the No. 20 sieve and retained on the No. 30. The grains are round and polished smooth. For most aggregates the minimum amount of bitumen that can be mixed therewith is not much below the normal quantity. Ottawa sand, because of the absence of dust and the smooth surface of its grains, can be mixed with a very small quantity of bitumen. The surface area of aggregate theory applied to this sand indicates for its use in comparison with other known mixtures hardly more than a trace of bitumen. Accordingly, block "17a" was made with but 5 grams to 1000 grams of sand. Its disintegration under one blow proves

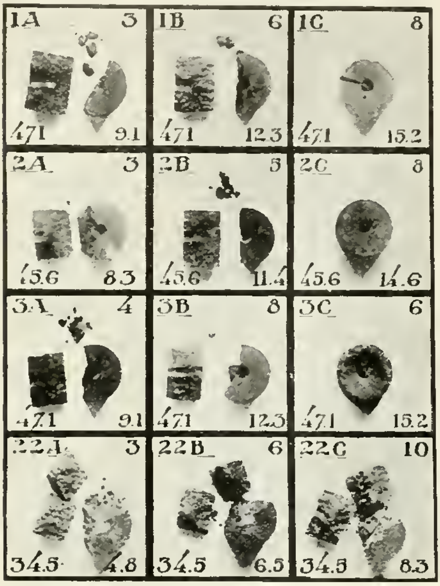


FIG. 5.
This group shows the comparative behavior of different aggregates with percentages of bitumen below normal and above. The aggregate in Series "1" is a sand, 100% passing a No. 10 sieve; for Series "2," 85% of this No. 10 sand is combined with 15% limestone dust and for Series "3," 70% with 30% dust. These three sets show that a "normal mix" is independent of the amount of fine material but is determined by the aggregate voidage. Series "22" aggregate is a combination of 15% Limestone dust and 85% quarter inch sand, about one-third of the latter being retained on the No. 10 mesh. It should be particularly noted that for this aggregate a surplus of bitumen does not make a soft mixture; that is, one which may be perforated by the pin.

the failure of the theory especially in comparison with block "17e" containing 90 grams of bitumen in accordance with the voidage diagram, Fig. 1.

It has long been assumed that the addition of dust to aggregates calls for an increase in bitumen. From tests one, two and three, Fig. 5, it is apparent that bitumen requirements depend upon voidage; and upon the presence or absence of certain sizes in the mineral matter, only as the voidage is affected thereby. A combination of 70 per cent sand with 30 per cent limestone dust may have the same percentage of voids as straight sand, and, therefore, the two aggregates may require the same amount of bitumen. Blocks are shown containing less than a normal amount and also a surplus of bitumen, the penetration being 50 units in each case. While voidage regulates bitumen requirements the character of the resulting mixture is seen to depend upon the quality of the aggregate itself. For instance, compare "1 b" and "3 b", "1 c" and "3 c", at the same time noting the number of blows. For comparison blocks of Series "22" are shown in order to illustrate an aggregate that resists the softening influence of an excess of bitumen. These blocks contain 85 per cent quarter inch sand mixed with 15 per cent limestone dust. This sand contains a large proportion of quarter inch pebbles, and it is interesting to note that in breaking the blocks, the pebbles are sheared apart showing that the full strength of the aggregate is developed by the mixture.

Determining Adaptability of Aggregates

The tests that have been described help to determine the adaptability of aggregates heretofore not used for bituminous purposes. Many natural sands are deficient in very fine particles which deficiency may be supplied by the addition of what is ordinarily known as filler. Portland cement may be used, but is expensive and not entirely satisfactory. Limestone dust is extensively used for the purpose. In exploring the possibilities of an aggregate the addition of dust must be considered both from the standpoint of cost and durability. In doing so it is well to make comparisons with some well known mixture. The standard aggregate in Washington costs approximately $2.65 per cu. yd. and is used with an average of 11.3 per cent bitumen. A cubic yard of aggregate lays about 28.5 sq. yds. of pavement 1 in. thick at a cost for the mixture of 20.6 cts. per sq. yd. per inch, weighing 100 lbs.

The specimens shown in Fig. 6 constitute a study of Potomac River sand, passing a ¼-in. mesh, combined with limestone dust, the quantity of the latter ranging from zero to 40 per cent. One idea being to develop an aggregate of little cost, it is necessary to use a practicable minimum of dust which costs $4.50 a cu. yd. while sand costs but 80 cts. per cu. yd. The photographs show an almost uniform increase in strength as limestone is increased up to and including 25 per cent. Above 40 per cent the combined aggregate loses its sand character and assumes more that of a dust, the voidage of the combination increasing rapidly.

Potomac River quarter inch sand is not as constant a mixture as might be desired but the choice of a combination with approximately 20 per cent limestone dust has been found to be a conservative mean that allows for a good deal of variation in both the sand and dust under working conditions without materially affecting results. Comparing specimen "36" with others that have been shown, it is seen that a 20 per cent limestone dust combination promises exceptional durability, and with this percentage, a mixture is obtained at reasonable cost. The quarter inch sand is worth 80 cts. per cu. yd. weighing 2,800 lbs. Limestone dust, $4.50 per cu. yd. weighing 2,060 lbs. An 80% sand, 20% dust combination costs 1.94 per cu. yd. weighing 2,950 lbs. Seven per cent bitumen is used. A cubic yd. of aggregate lays 30 sq. yds. of pavement 1 in. thick. The cost for aggregate is 6.6 cts. and for 7.4 lbs. of bitumen, 7.4 cts.; a total of 14 cts. per sq. yd. 1 in. thick. If a surface on a street is to be laid to a depth of 1½ ins. this mixture affords a saving in materials of approximately 10 cts. per sq. yd. as compared to the cost of the topping now in use.

During the construction of pavements it is usual practice to take samples of mixtures from streets for the purpose of check analysis. In sifting the aggregates obtained from such samples cases have been found with but a trace of the dust originally used. Usually, more than 65% of limestone dust passes the 200 mesh. If a specified proportion is added to a known sand the percentage of the combination passing the 200 sieve may readily be computed, and any difference therefrom should be accounted for. Some mixing machines of the revolving drum type attached to direct heat dryers permit much of the dust to be blown out and lost. Even after the elimination of loss it has been found that sifting does not invariably discover all dust present. Microscopic examination shows that much dust may adhere to the larger particles of aggregate, thus causing a false granulometric determination.

The necessity of subjecting bituminous cements to rigid tests has long been recognized, but no tests have heretofore been commonly applied to determine the relative stability of mixtures as affected by the mineral matter employed. The variation in behavior of different aggregates when mixed with percentages of bitumen other than normal has been explained. It remains to illustrate the action of aggregates as influenced by the consistency of bitumen predetermined by the penertation test. Also the susceptibility to temperature changes of aggregates when mixed with normal amounts of bituminous cement.

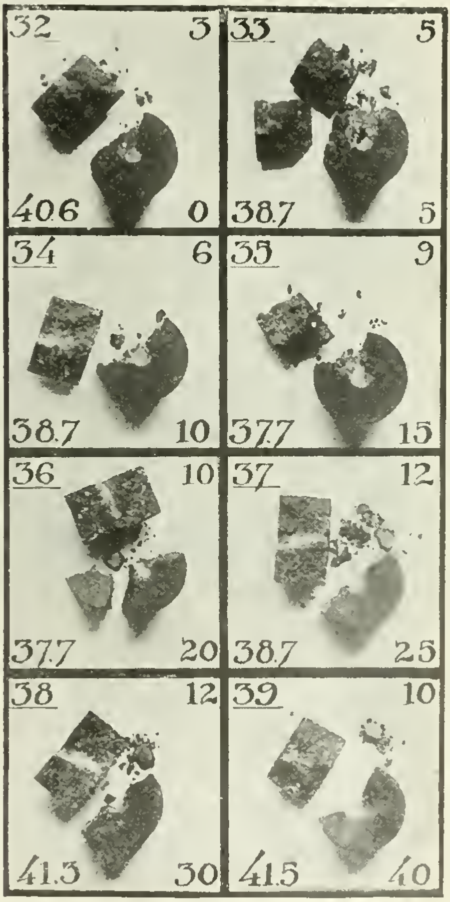


FIG. 6.
In these blocks the amount of limestone dust is varied from 0 to 40%, as shown by the figures in the lower right hand corners. Mixed with the limestone dust is quarter inch sand, the amount varying from 100% sand in specimen No. "32" to 60% in No. "39." The bitumen content is the same for all blocks, 7.4%. The figures in the lower left corners represent aggregate voidages. Those in the upper right the number of blows.

Three aggregates are shown in Fig. 7, each mixed with a normal amount of bitumen, the penetration varying from 15 units for the "A" Blocks to 90 for those marked "P." Series "23" blocks contain 85% quarter inch sand with 15% limestone dust. Series "25" are 100% No. 10

sand and those labeled "26" are 70% No. 10 sand, with 30% dust. Bituminous pavement mixtures have been variously classi-

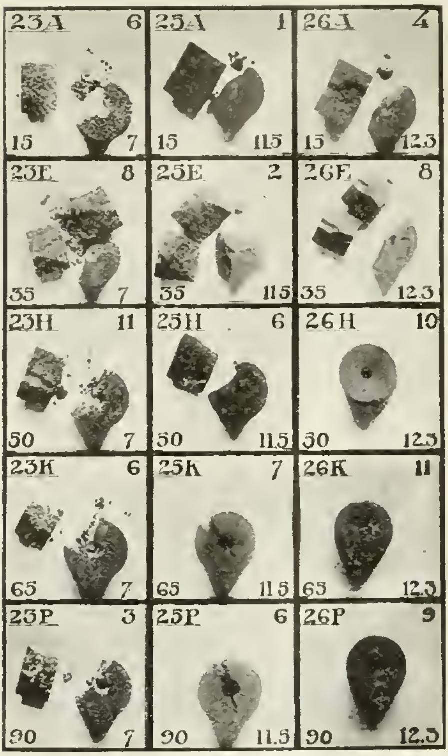


FIG. 7.

These photographs illustrate the relative effect of penetration on mixtures made from different aggregates. Upper left hand figures are specimen numbers; upper right, number of blows; lower left, penetrations; lower right, bitumen percentages. The aggregate for Series "23," voidage 35.6%, is a combination of 15% limestone dust and 85% quarter inch sand, about one-third of this sand being retained on the No. 10 sieve. Series "25," voidage 45.7%, is a sand, 100% passing the No. 10 mesh. Series "26," voidage 47.1%, is 70% No. 10 sand combined with 30% limestone dust.

fied in accordance with certain specified aggregate sieve analyses into four or five groups. Usually, and often without justification, a cement of higher penetration is called for with coarse materials than with fine ones. In view of the bitumen requirement diagram, Fig. 1, it is seen that division into three classes is logical; those mixtures having aggregate voidages of less than 40%, those with voidages between 40 and 50, and those above 50%. Particular penetrations should not be assigned for use with any one class, but should be determined experimentally to fit the needs of each case. For instance, with mixtures that call for small bitumen percentages usually high penetrations are specified, but from the photographs in Fig. 5 it may be seen that Series "23" aggregate with but 7% bitumen gives better results with a cement of less than 50 units penetration than above.

Temperature Effects

Since the temperature of the material in a street may vary from well below freezing to above 150° F., the less sensitive a paving mixture the better. It is well known that some pavements give good service in the winter but wave and push into bumps in the summer. The susceptibility as developed by the Block Test, comparing two aggregates, is shown in Fig. 8. Series "51" is 82% quarter inch sand with 18% limestone dust. The aggregate voidage is 36.5% and the bitumen percentage 6.7. Series "52" is a No. 10 sand and dust mixture similar to that used as a standard in Washington for a number of years past. The aggregate voidage is 44.6% and the bitumen percentage 11. As in other comparisons, so in the present one, it is seen that the quarter inch sand and dust combination stands out favorably. The strength of the mixture at low temperature is most remarkable. When heated to more than 130° F., the matrix loses some of its bind-

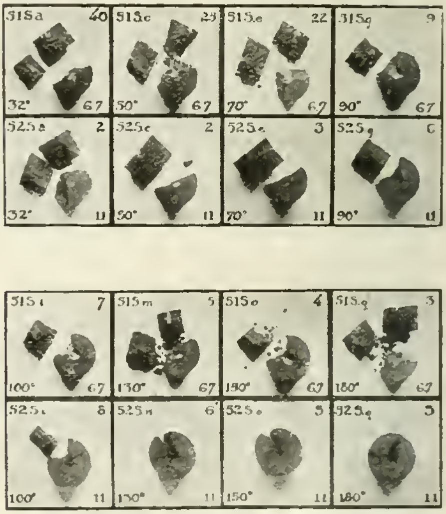


FIG. 8.

These specimens show the susceptibility of two aggregates to temperature changes. The Series "51S" blocks contain 82% quarter inch sand with 18% limestone dust, giving a voidage of 36.5%. Series "52S" contain the No. 10 sand and dust mixture that has been used as a standard in Washington for a number of years past, the aggregate voidage being 44.6%. The upper right hand figures record the number of blows; the lower left the temperature and the lower right the percentage of bitumen.

ing ability and the quarter inch pebbles in the plane of cleavage are not sheared apart. It would appear that this Series "51" mixture would serve better in a cold climate than in a warm one. However, reference should be made to the penetration test as illustrated by the blocks shown in Fig. 7, in which group appears an aggregate similar to No. "51." The temperature run was made with an asphalt cement testing 51 units penetration at 77° F., whereas Fig. 7 shows that the penetration might with good reason be reduced to as low as 35 units. Furthermore, it has been shown that variations in bitumen percentages greatly alter results obtained with aggregates. Thus there are in fact four elements; original aggregate, dust or filler, quantity of bitumen, and penetration of bitumen, an understanding of the significance of each of which is essential for the satisfactory control of bituminous design.

Practical Trials

After making aggregate surveys with block tests, as thus far described, it is essential to carry out practical trials. A territory such as the District of Columbia, making four or five hundred patches daily in its sheet asphalt streets, is in a particularly favorable position for the practical part of experimental work. Patching is of sufficient scope to afford a good service trial, and yet is of such a nature that if a particular mixture fails no great harm is done. In this manner information may be obtained as to the workability of a mixture both at the plant and on the street. A good idea may also be obtained as to the surface appearance; smooth, slippery, rough, or porous.

In Washington, after observing for some time the success in repair work of combinations of quarter inch sand and 15 to 20% dust, a street was recently surfaced with such a mixture. A location was chosen fronting a cement and steel warehouse, so that the pavement might be subjected to heavy traffic and afford a good test of the material. No binder course was used, the concrete base being laid 7½ ins. thick instead of the usual 6 ins. in order to provide for 1½ ins. of surface only. This experimental pavement was utilized for but a portion of the square, the remainder for comparison being the pavement which has long been a standard in Washington with 1½ ins. of binder and 1½ ins. of topping. The new mixture handled readily at the plant and on the street. It rolled nicely, giving a surface comparing well with that of the standard pavement. This construction and other sample surfaces to be laid are to be closely observed in order that their behavior may furnish a guide for future work. The proportions per batch were:

8	cu. ft. Sand	820 lbs.	76 %
2½	cu. ft. Dust	190 lbs.	17.5%
70	lbs. Bitumen	70 lbs.	6.5%
		1080 lbs.	100 %

In comparison with usual stipulations restricting aggregates for bituminous mixtures it is well to note the specifications governing the mineral matter in this experimental pavement, which were as follows:

SAND: The sand shall be equal to what is known as well graded quarter inch Potomac River concrete sand, clean and free from injurious soft particles or organic matter.

ITEMS	REINFORCED CONCRETE 3 inch Per Sq. Yd.			BITUMINOUS SURFACE 2 inch Per Sq. Yd.		
Sand	.041 cu. yd.	$.033		.059 cu. yd.	$ .047	
Gravel	.062 cu. yd.	.074				
Portland Cement	.145 bbl.	.375				
Tar Coat (in place)		.035				
Reinforcing @ .022 per sq. ft.	9 sq. ft.	.198				
Limestone Dust				38 lbs.	.085	
Asphalt Cement				14 lbs.	.140	
Material Total			$ .715			$ .272
Operations on street		.10			.08	
Plant charges and operation		.12			.27	
Hauling @ 70c per ton	390 lbs.	.136		215 lbs.	.077	
Total Operating			.356			.427
Operating and Material, Total			$1.061			$ .699
10% Overhead—10% Contingencies			.212			.140
Contractor's Profit			.197			.136
Total per sq. yd.			$1.470			$ .975

DUST: Limestone dust shall be used, 85 per cent passing a 100 mesh screen.

Proper Exploitation of Local Cheap Materials

The proper exploitation of local cheap materials has a value not generally realized. During late years gravel and sand have been developed to some extent for bituminous mixtures. Usually, however, so many restrictions are placed on the aggregate grading that much screening and blending of sizes are made necessary. The mental attitude of a contractor is affected by the involved specifications, which is reflected in the bidding. In a recent competition for a topping to be placed on a concrete road in a western state, a 2 in. bituminous surface lost in favor of a 3 in. hydraulic cement concrete of 1-2-3 mix. The losing bid per sq. yd. was 60% higher than that for the 3-in. concrete, the latter including a tar paint coat for the old road and 28 lbs. of reinforcing per 100 sq. ft.

Based on Washington conditions and the use of a quarter inch sand asphaltic mixture, it is of interest to analyze this situation comparing data relative to the two constructions as tabulated on the bottom of page 131.

This tabulation shows that a 2-in. bituminous surface may be constructed for 33% less than a 3-in. reinforced concrete one. This result is markedly different from the indication in the actual bids mentioned above, that the latter surface would cost 60% more than the former. In the account as recently published of the first series of investigations carried out in the District the conclusion was reached that a concrete base is well justified for a new bituminous pavement. To complement this conclusion it may be stated that when a top is required a bituminous surface is equally warranted for an old concrete pavement.

Utilizing Old Waterbound Macadam

In the District of Columbia there are 150 miles of original waterbound macadam roads. While probably no more pavement of this type will be constructed, the proper conservation of that now in place has become much of a problem. About 10 cts. per sq. yd. is being spent in treating most of these macadam roads with oil or tar and screenings which is exclusive of expenditures for general repairs necessary to bring the macadam to first class shape prior to the surface treatment. A road thus renewed and oiled and similarly treated periodically gives fair service, its yearly maintenance depending greatly upon the traffic to which it is subjected. In any event, annual expenditures are several times as much as for asphalt streets and, under heavy traffic, these roads cost many times as much as asphalt under like conditions.

In order to utilize old macadam under exceptionally severe traffic, various bituminous surfaces have been constructed thereon, and in a few cases our standard sheet asphalt. The application of this latter is unsatisfactory. Being 3 ins. thick, it necessitates some dressing down of the old road in order to give a practicable grade and cross section, and, even then, results in an abnormal crown and little or no curb display. The original cost of sheet asphalt, consisting of a binder course and topping, is large, and such an outlay generally proves improvident when used to cover the uncertainties and hazards existing in old macadam streets.

The use of the quarter inch sand mixture previously discussed herein, together with the elimination of the binder course, presents a proposition unusually attractive. It has been shown that this surface can be laid for approximately 50 cts. per sq. yd. per inch of thickness. An inch and a half covering should give economical and satisfactory results. This depth may be thinned to 1 in. on the sides of the road along the curb. In order to give construction of this nature a service test a section of waterbound macadam was chosen several squares in length. So that a positive determination could be made, a portion of the street, for comparison, was surfaced with a bituminous macadam.

The old road, repaired and brought to a good shape with new stone and screenings, was opened to traffic for three weeks prior to construction of the new surfaces. During this period it was sprinkled twice daily. The portion to be topped with the quarter inch sand mixture was divided into two sections, one simply being well broomed just prior to receiving the surface, the other being sprayed with a light tar, about ¼ gal. per sq. yd. This treatment was given the day before laying the hot mixture in order that the tar might have time to soak into the street. The portion covered with bituminous macadam was thoroughly swept prior to being surfaced. Thus there are three sections available for comparisons; a 1½ in. sheet asphalt laid on a macadam road, a similar construction, the macadam having just been dressed with a light tar, and third, a 3-in. bituminous surface on the existing road laid in accordance with usual specifications for penetration macadam.

For this latter construction the stone used averaged 2,500 lbs. per cu. yd. and cost, delivered at the city's railroad yard, \$2.88 per ton. Fine material for the seal coat cost \$1.08 per ton. It might be noted that the freight on a cubic yard of stone is 45 cts. more than the entire cost of a cubic yard of quarter inch sand F. O. B. the city's wharf. Tar used for binding the stone cost approximately 16 cts. per gallon in place. The cost of the penetration macadam may be itemized as follows:

unsatisfactory mixture. Due to the uncertainties in such work, it has been common practice to require contractors to guarantee their construction for periods of from one to five years. Why should the responsibility be placed on the contractor when the engineer specified the work and design down to the minutest detail? It is unnecessary to blend materials so as to conform to certain well known or patented formulae. An aggregate that is used with success in Portland cement concrete may be handled with assurance in bituminous mixtures.

3-in. Penetration Macadam—Cost Per Sq. Yd.

ITEM	AMOUNT per Sq. Yd.	COST per Sq. Yd.	
2½-inch stone @ \$2.88 per ton	230 lbs.	\$0.33	
1 -inch stone @ 2.88 per ton	40 lbs.	.057	
Screenings @ 1.08 per ton	30 lbs.	.043	
Hauling @ 70c per ton (300 lbs. of stone)		.105	
Spreading stone and screenings		.045	
Rolling		.030	
2¼ gals. tar @ 16c in place		.360	
Total operating and material			\$0.97
5% contingencies—10% overhead			.15
Contractor's profit			.15
Total per sq. yd.			\$1.27

A one and a half inch surface using a hot mixture with quarter inch Potomac sand can be laid for 75 cts. as compared to \$1.27 for a 3 in. penetration construction. The thinner surface, not execessively raising grades, is, of the two, better adapted for topping existing old roads. Not only is there advantage from the standpoint of primary engineering and economy but also the inch and a half sheet asphalt renders better service and costs less for maintenance.

Conclusions Independent of Location

While the comparisons that have been made herein of different surfaces are upon conditions existing in the city of Washington, the conclusions reached are to a great extent independent of locality since the economy shown is largely one of material quantities. The saving that appears in favor of a premixed surface can be realized only when the work is not enveloped by such a haze of specification requirements as to confuse the contractor. With the design of bituminous pavements on a workable basis, it is not necessary to place dependence upon misleading granulometric formulae. Certain mesh combinations of aggregates in one locality mixed with a definite amount of bitumen may give a satisfactory pavement. The same combinations made up in a different locality may give a most

Procedure in Selecting Proper Aggregate

It is thus apparent that there are a number of variables to be properly controlled if successful bituminous design is to be achieved. The cost is, of course, a vital consideration and any good pavement must not only render efficient service, but its cost must be within reason. With the understanding that due weight is given to the cost factor, the following would be the procedure in selecting the proper aggregate: The "normal mix," diagram, Fig. 1, enables the quantity of bitumen to be determined for any aggregate. The block test then shows the probable behavior of the mixture made with this aggregate and determines whether or not it will be satisfactory for use as paving material. This simple block test enables us to vary the composition of the aggregate by the addition of filler or dust and shows to what extent the mixture may be affected by changes in the penetration of the asphalt cement. It further shows the behavior of the mixture under temperature changes. The object of all of these tests is to obtain a paving mixture, economical in first cost, economical as to annual maintenance, and one that will render satisfactory service under the actual traffic to which it will be subjected.

REPORT OF PRESIDENT HARDING'S CONFERENCE COMMITTEE ON MUNICIPAL ORGANIZATION TO HANDLE UNEMPLOYMENT EMERGENCY

(Editor's Note: Every responsible public official should read and act on the recommendations contained in this committee report to the extent of his resources and abilities. He is relieved of the responsibility of making the decision to act [that decision has been made at Washington for the nation], but it is his responsibility to act on the decision so made. Briefly stated, this report points the way to a nation-wide municipal drive against unemployment. It will solve the local employment problem wherever acted upon and, if followed throughout the country, will solve the national unemployment problem. It will be noted from the committee roster, given below, that men on the committee are familiar with state, municipal and county public improvement work and know what they are talking about.)

It is Up to Local Communities

Cities and towns must be relied upon for immediate attack upon the emergency created by unemployment. Whatever is done must take place in local communities and the citizens of such communities are the ones responsible and capable of seeing that the necessary measures are carried out. This but repeats the first principle of American public life, reliance upon local initiative and obligation.

The mayors of cities are the natural and authorized leaders and directors of their communities for all emergencies affecting the public welfare. In the present crisis the mayor should head the effort of each locality and organize the most influential and representative citizens and agencies to handle the local situation.

Mayors and Governors Should Lead

In the interest of speed, order and effectiveness the chief official of each community should immediately marshal all its resources. The mayor and his organization should furnish such leadership as will enlist the support and utilize the services of all.

The governor of each state as the superior officer of all local officials is urged to call emphatically to the attention of communities and mayors their peculiar responsibility and fitness for handling this unemployment situation.

The methods of accomplishing results must vary with each locality, and no methods capable of universal adoption can with safety be recommended. Therefore specific recommendations to communities are confined to the very urgent one that following the leadership of their mayors with united local committees they accept this primary obligation to the full.

General Guiding Principles Based on Past Experience

However, the following suggestions or general principles based on past experience are respectfully offered to such communities:

1. The Mayor's Committee should try to harmonize the operation of all the different agencies which are trying to relieve the situation, so as to avoid clashing and wasted effort.

2. The facts of the extent and distribution of unemployment should be in the possession of the committee and should be made available to the public.

3. Each locality should have a public employment bureau.

4. The Mayor's Committee should try to get the whole community behind the effort to speed up the construction of public improvements. In a period like this there should be the greatest activity in putting up new schools and other needed public buildings, and in necessary repairs and improvements in streets, bridges, sewerage, public utilities, parks and other municipal works.

5. Every effort should be made to provide real work by stimulating industry. Meanwhile each industry should be urged as far as possible to keep together its own force by giving at least part time employment.

6. In some cities "Spruce-Up" campaigns have proved good. In these every one is urged to do at once whatever is needed in the line of sprucing up his property. This applies both to public and private owners of property, to small householders and flat renters as well as to large companies, hotels, theaters, etc. It should be made clear to all that money spent in this way, stimulating the regular activities of industry, will help to reduce unemployment far more than any other aid.

7. It is important to strengthen and increase the resources of the local family welfare agencies which are best prepared for effective service, and to give them vigorous support in order that they may deal promptly and adequately with the needs of families and individuals. The burden of meeting these needs should be borne, not by a selected few, but by many.

Provision should be made for maintaining the usual facilities for the homeless, and for the relief of poverty arising from sickness, from widowhood, from mental or physical handicaps, in order that these may not be a complicating factor in the problem of unemployment. Cities that have municipal lodging houses or other adequate provision for the homeless man find that this makes possible differentiating the two problems of the resident and floating unemployed, and enforcing regulation against vagrancy and begging.

8. Consideration should be given to the practicability of keeping children in school as long as possible in order that they may not compete for the insufficient number of jobs and also that they may profit by additional schooling and the postponement of the beginning of wage-earning. It may be found desirable to give scholarships to minors beyond the compulsory school age, and the public schools have provided special vocational training for them so that the period of unemployment may be used to equip them for better positions.

9. It must always be remembered that an unemployed person needs work, first and last, and that the community should relax no effort to find work for him, regarding other aid only as a temporary measure to be superseded at the earliest possible moment by work. The community should be able to handle the situation in such a way as to make bread lines unnecessary. Each community should remember that hunger and want must be relieved, and it should always be prepared to take whatever measures may be needed to prevent human suffering.

10. We suggest that each city avail itself of the experience of others. The methods of Detroit, Boston, Philadelphia, Milwaukee and New York have been brought to the attention of the conference, and we are certain that the mayors of these and other cities will be glad to answer inquiries.

The report is unanimous. Col. Arthur Woods of New York is chairman of the committee and the following are the other members: Charles M. Babcock, St. Paul, Minn.; Bird S. Coler, New York City; James Couzens, Detroit, Mich.; Bascom Little, Cleveland, Ohio; Andrew J. Peters, Boston, Mass.; Ida M. Tarbell, New York City; Ernest T. Trigg, Philadelphia, Pa.; Matthew Woll, Washington, D. C.; G. E. Haynes, Washington, D. C.

A FRIEND OF THE FARMER TAKES US TO TASK

To the Editor:

I am in receipt of your circular letter enclosing clipping from Municipal and County Engineering. (Reference is made to a reprint of the editorial entitled: Building or Breadlines, published in the September, 1921, issue.—Editor.)

Referring thereto, let me call your attention to farming, the industry, the largest buying power in the world, which you and those you represent, helped down and are now keeping down in the interest of economy.

How do you expect any money in circulation in the corn belt, which embraces five states, with the price of corn at 35c and oats at 15c? You can "Legislate" and "Resolve" and send out propaganda for the next ten years and the situation will not improve. You asked the farmer to set the example, but you did not keep your promise and follow. Now, instead of keeping him down, help pull him out of the mire and you will see work and business start immediately. He is the biggest buyer of labor, for he buys every material and product of labor. The farmer, nor anyone else, for that matter, that knows anything about progressive economy, will demand a cheap or low priced industrial system. It is better for the welfare of the country that prices maintain a fairly increased level. It stimulates business and industry and is an incentive to labor to earn and each individual's prosperity is then wholly dependent upon his ability to save.

Very truly yours,

JOHN A. GOODWIN,
Investments, Real Estate, Law, Insurance, Loans, Etc.,
203 North Street,
Normal, Illinois.

Sept. 28, 1921.

(Editor's Note: Mr.Goodwin's letter is most welcome because it states a view widely entertained in the agricultural districts and because it illustrates the fact that we are living in "an era of mutual suspicion and distrust," so we gladly embrace the opportunity to make a few observations on the points raised, in our own behalf and that of "those we represent."

Now what are the facts? In the first place let it be said that the farmer's notion that every city man's hand is set against him is a nightmare and nothing more. Agriculture is the mother of us all and every city man who is worth two pins not only recognizes this fact but finds much pleasure in admitting it. We are not thankless children and have no thought of denying our mother agriculture. The Construction Industry is very proud of its position as the second among American industries, second only to Agriculture. To be second only to Agriculture, is, of course, to lead all the rest and that is quite enough. We doubt if any American wants any industry to take the leadership from Agriculture. At any rate this is an impertinence of which the Construction Industry is incapable.

We see no justification for the statement that "we" and "those we represent," helped farming down and are now keeping it down in the interest of economy.

Let us take the "we" part first. (It should really be spelled "wee" because it is so small.) Would it surprise you greatly, Mr. Goodwin, to learn that the editor of this magazine was born and reared on an Illinois farm, that his furrow often broke the "stubborn glebe," that he knows what it means "to meet the sun upon the upland lawn," and that his father, and only brother still live on the old homestead? Such is the case, unimportant in itself, you will say, and right you are, but important as an illustration of the fact that the majority of city dwellers either came direct from the farm or are but one or two generations removed from it. The cities are not peopled with one race of men and the farms with another; the city man and the farmer are blood brothers and when the farmer is not prosperous the city man is unhappy and, moreover, is usually anything but prosperous. No, the assumption that the city man "helped the farmer down" will not hold, not in this day and generation.

Not long ago we were talking with an elderly gentleman who has been a leader in the Construction Industry for many years and he deplored the farmer's present position, saying the rest of us could not hope to profit greatly while the farmer is not prosperous. This is generally understood and is a basic economic truth. The Construction Industry, and every other industry, would be very happy to see the farmers again prosperous, for selfish as well as sentimental reasons.

Our editorial, which prompted our correspondent's letter, had nothing to do with the imaginary case of the farmer against his relative in the city. We were not dealing with theories, economic or otherwise, but with two facts recognized by everybody from the President of the United States down to the editor of this modest professional journal, namely: the unemployed now number fully 6,000,000 men and winter is coming on. We advocated, and still advocate, and shall keep on advocating the launching of long delayed public improvement projects as a means of providing useful work for those who are now idle. This is an old, old method of coping with unemployment. It has been used many times during past depressions. Obviously, it will not help the farmer to have men idle, in the cities, who must subsist on public charity before another spring unless work is found for them to do. We advocate a time-tried procedure which our position has naturally brought to our attention and understanding.

In this issue we publish a letter from a correspondent in Decatur, Ill., who tells us that his city is now doing the various things we propose. If we remember the geography of our native state, and we think we do, Decatur is not for from Normal and both are in the corn belt, which region, we stoutly maintain, is the present day Garden of Eden. What is good for Decatur is good for Normal, too.

The editor is not an economist, either of the long or short-haired variety. But one or two things seem so plain we should all agree on them. First, the present depression is world wide. It is worse in every other country than it is in ours. The export trade is "flat" and the farmer can't sell his surplus over domestic requirements. This is merely the cold, grey morning after the debauch of the greatest war in history. Second, it is certainly better for the farmer to have city people busy and able to buy than to have millions of them idle and subsisting only by grace of breadlines and soup kitchens administered by the tight hand of charity.)

WILKINSBURG, PA., MODERNIZES 29-YEAR-OLD BRICK PAVEMENT

By Charles F. Sperling, Borough Engineer, Wilkinsburg, Pa.

What is perhaps one of the most economically constructed stretches of street improvement on the entire Lincoln Highway, particularly when considered from the standpoint of durability and the service it will render traffic in years to come, has just been completed on Penn Avenue in the Borough of Wilkinsburg, Pennsylvania. It is of vitrified brick and cost only $1.93 per sq. yd.

The story, to be rightly told, must start back in 1892, when the original pavement was laid. At that time there was no knowledge of swiftly moving automobiles and heavily laden motor trucks which later were to grow to such numbers as to create our modern traffic and attendant paving problems.

There were a few requirements, however, which determined the type of paving to be placed on Penn Avenue 29 years ago which hold equal importance today. In the first place the street is abutted on one side by a railroad siding. This meant that heavy wagons transferring freight would use the thoroughfare. A durable pavement was therefore essential.

The Original Pavement

The following construction was adopted: An 8-in. two-course rolled stone and gravel base, 2-in. sand cushion and a 4-in. vitrified brick wearing surface.

For 25 years this pavement stood up without a sign of impairment. Then during the war, when an added burden was thrown on the highways, this particular street got more than its share. Army trucks and commercial trucks, heavily laden, used it summer and winter.

Despite this increased traffic, both in number and in weight of vehicles, a condition which the designers of the road never expected it would have to undergo, the principal apparent effects were slight local base settlements. This resulted from the heavy traffic further compacting the base. It settled in spots where the base had not been as thoroughly compacted as it might have been at the time of construction.

Because of the fact that the heavy traffic caused the old base to settle, and because we realized that in years to come this main thoroughfare would be called upon to carry increasingly heavy traffic, it was decided to strengthen it this summer, still adhering to the original type of construction as to base and wearing surface, because both had justified themselves in the 29 years of service.

When the old brick were taken up we found in several places, to the length of 100 ft. and about 4 ft. wide, several stretches of no other foundation than river sand. In my opinion this was placed there originally contrary to specifications, and I speak of it because the sand seemed to support the surface equally well with the old stone and gravel base which was supposed to underlie the entire surface.

The Reconstructed Pavement

In the reconstructon we made good use of the old foundation. After rolling it several times thoroughly to compact it, we spread over it about 6 ins. of granulated slag, of which a cheap supply was available locally. This we rolled down to a thickness of about 3 ins. The slag was then thoroughly sprinkled with water and rolled again, shaped to grade, and rerolled until it presented a perfect base. We used a 5-ton gasoline tandem roller.

On this newly strengthened base we laid, directly upon the granulated slag as consolidated, a 3-in. vitrified brick wearing surface. We then rolled the brick surface with the 5-ton roller and lastly applied a filler of asphalt according to the specifications of the .National Paving Brick Manufacturers' Association.

In conclusion I want to say that the cost of $1.93 per square yard does not include any salvage on the old brick. These we are going to use in paving the bottom of our culverts, of which we have a mile or two in the borough.

SEWER CONSTRUCTION IN DETROIT, MICHIGAN

By F. F. Griswold, Pressed Steel Dept., Truscon Steel Co., Youngstown, Ohio

Several years ago the City of Detroit annexed a great deal of property lying north of Highland Park and Hamtramck. Drainage of this property was necessary, and considering the rapid growth of Detroit in the past few years it seemed quite likely that these sections would soon be built up. For that reason the Department of Public Works has been putting in the storm water sewers.

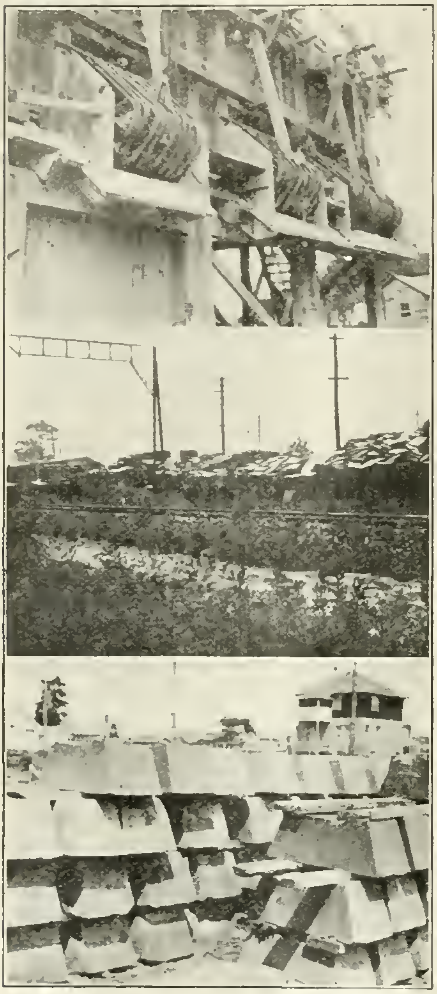
The total Detroit sewer projects as originally drawn up totaled some thirty-three million dollars, and of this amount contracts have been let for approximately twenty million, leaving thirteen million dollars of contracts yet to be let. These are being let at the rate of about 1¼ million per month.

The type of soil through which sewers are being constructed is ideal. It is practically all high grade blue clay. This clay starts, in most instances, about 10 to 15 ft. below the surface, and tests which have been made have found it to extend down 250 ft. to 300 ft. and further.

The Bates Street Sewer

One section of the Bates Street sewer is being constructed by Booth & Flynn, General Contractors, Pittsburgh and New York. It is some 3,000 ft. long and is 13 ft. 6 ins. inside diameter. The walls are concrete and are 16 ins. thick. This is one of the three new relief sewers in the center of the city.

In the south end of this sewer the ground is quite sandy and wet in places, and it is necessary to construct the sewer under air. In some places the roof of the sewer is only about 11 ft. from the street surface, and for that reason a heavy air pressure cannot be maintained, as there would be a possibility of blowing up the street. The pressure is maintained at about 6 pounds per square inch, which is sufficient to keep back the water.



VIEWS OF SEWER CONSTRUCTION

View of Muck Handling Hoppers Used on Large Jobs—Truscon Tunnel Liner Plates for Use in Gratiot Ave. Sewer—Concrete Blocks Used in Connection with Truscon Form on Livernois Road Sewer.

Working Under Air Pressure

In order to work the sewer under air it is necessary to build two bulk heads in the sewer near the shaft. These bulk heads are about 30 ft. apart and are made of concrete poured integral with the walls of the sewer. A square hole is left at the bottom just large enough for a loaded car to pass through. Heavy steel doors are swung on hinges on each bulk head. These bulk heads form a chamher in which the air can be equalized, thus allowing cars to pass through the tunnel while maintaining air pressure. For example, when a car comes down the shaft to go to the head of the tunnel it is necessary to open a valve in the outside bulk head, which allows the air in the chamber to equalize with atmospheric pressure. When the pressure has been equalized the door is opened and the car pushed into the chamber. The door is closed and also the outside valve. Now the inside valve is opened and the pressure in the chamber is equalized to that within the sewer, thus allowing the inside steel door to open and the car to go on through.

The Mining

On the night gang there is a "Miner" who digs a hole just large enough to work in and to the depth required in the next day's digging. This makes a place for the men on the day gang to work in when they start to work. One or two men will go into the hole and dig it out until it is large enough for several men. They dig on the sides and roof first so that the roof is finished ahead of the rest of the sewer. At the same time the floor of the sewer will be dug out to a little below the spring line. When the digging has progressed to this point the Needle Beam is put in place and lined up. The Needle Beam is a heavy I-beam about 4 ft. longer than the length of sewer to be dug each day. It is used to line up grade and center line. One end of the Needle Beam rests on a ledge in the far end of the tunnel and the other end is blocked up and wedged with a hearing on the concrete which was poured the night before. With the Needle Beam in place and the roof held firmly by jacks, one end of which is braced against the Needle Beam and the other against tunnel liner plates, the digging continues until the necessary amount of dirt has been removed, and the outside diameter is correct. The section of the sewer is then ready for setting forms.

Two Ways of Setting Forms for Concreting

The forms for concreting are lined up in two ways. The first of these, and the way which is generally used in the large diameter sewers, is by means of the Needle Beam. The cross-bracing of the ribs of the form is so spaced that when resting on the top of the Needle Beam the ribs will be in correct alignment as regards grade. The spacers between the ribs of the forms will keep them in line and as the Needle Beam has already been set up as to grade, the setting up of the form is very simple.

The Needle Beam is already under pressure on top, due to the fact that jacks are working from it against the tunnel liner plates used in the roof, therefore it is possible to put one or two jacks in position against the under side of the Needle Beam and against the ribs of the steel form to hold it in place and keep it from floating when the concrete is being poured.

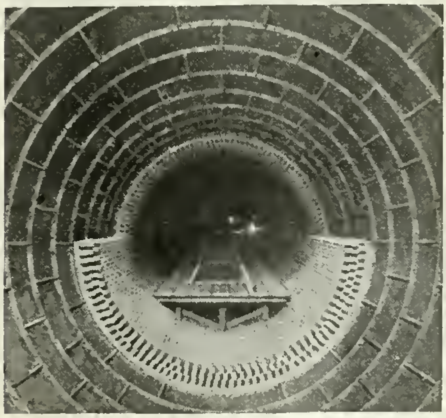
The second way of setting up forms is by means of concrete blocks. These blocks are pre-cast and have set before being used. When the forms are ready to be placed several of these blocks are put in position and lined up as to grade and center line. The ribs of the forms are then built up on these concrete blocks. Bracing is accomplished by means of jacks, which hold the ribs against the concrete blocks, and also by means of blocking from the top of the rib to the roof of the tunnel.

As soon as the ribs are in place the plates are put on up to the spring line. The row of plates nearest the concrete which was poured the day before, or, in other words, the row of plates which would be handiest to the car of concrete as it comes to the head of the sewer, are not put in until the concrete is up to the edge of them. The plate is then put in and the concrete shovelled up over the plates. They begin to pour the concrete just as soon as the lower plates are in place, and as the concrete fills up the side more plates are put on. By this method it is not necessary to lift the concrete as high as it would be were the plates put on up to the top at one time. When the top of the sewer is reached key plates are slipped into place and the concrete shovelled up onto them a little bit at a time and pushed back into place with a hoe. This is probably the slowest and hardest part of the job.

Placing the Forms

In placing these forms the ribs are first put in position, lined up and spaced. These ribs are formed of heavy channel of sufficient strength to withstand whatever pressure is required of them. The ribs are made up in two, three or four sections to a circle, depending upon the style, construction and the size of the sewer. Gusset plates are fitted to the ends of the channel, one on each opposite leg of the channel; in other words, one separate plate is riveted solid to one leg of channel A, while another gusset plate is fastened solid to the opposite leg of Channel B, thus when they come together they can be slid into place by one another and then bolted securely. Where conditions make it necessary there is also special reinforcing from the gusset plate fastener to the center beam and from there to the gusset plate on the lower side.

The plates used for covering the ribs are of various sizes, depending upon the diameter of the sewer. They are generally 3 ft. in length and 18 ins. to 36 ins.



TRUSCON TUNNEL LINER PLATES, SEVEN-MILE ROAD AND GRATIOT AVE. SEWERS, DETROIT, MICH.
Outside Diameter of Sewers—12 Ft. to 13 Ft. 8 Ins.

in circumferential width. At the top of the forms there are plates which are called "Key" plates, which are small and easy to handle. These are placed in one at a time as the concrete is filled in between the form and the roof.

It takes about 5 hours to pour 12 ft. to 15 ft. each night, and this concrete has set sufficient by the next night to make possible moving the forms up to the next position.

All Detroit sewer work is under direction of Mr. C. W. Hubbel, Chief Engineer, and Mr. Sears, Superintendent. Fred Legg is chief inspector, having assistants on each separate job.

NEW COMPLETE STREET LIGHTING SYSTEM FOR KANSAS CITY, MO.

Kansas City, Mo., will be one of the first cities in the country to adopt a uniform system of modern ornamental street lighting illumination on a large scale; and incidentally this improvement will mean displacing 2,000 gas posts with which the residential section of the city is now lighted, as well as a number of electric lights of the cluster and overhead pendent type.

The city has just contracted with the Kansas City Light and Power Company for the installation of approximately 7,000 lamps in Novalux units, and it is expected that by the time they are installed the number will be doubled in order to keep step with the progress of the city, the residential districts of which are rapidly expanding. An initial order for 2,000 Novalux units has already been placed with the General Electric Company, and additional ones will follow as the work progresses.

TYPICAL STREET LIGHTING FIXTURES FOR KANSAS CITY, MO.

Left: Form 8, General Electric Novalux Fixture with Alabaster Rippled Glass Globe—Right: Form 16, G. E. Novalux, Equipped with No. 97 Diffusion Globe and Metal Canopy.

Some years ago there arose in Kansas City a demand for ornamental street lighting. The business district is pretty well covered by street car lines, and therefore it was decided to utilize the trolley wire standards for holding the lamps. A cluster of four globes, each containing a 100-watt multiple lamp, was placed on each standard. Approximately 1,200 trolley poles were equipped in this way, the whole constituting what was called the Bright Way Lighting System.

Outside the business district, and between it and the residential sections, there is a small zone which for a number of years has been lighted by four-ampere magnetite arc lamps of the pendent type and G-E Form 6 Novalux fixtures equipped with 600 candle power lamps and hand refractors. The residential section has for years been lighted entirely by gas posts, using several thousands of gas lamps.

The recognized inefficiency of the cluster lighting, together with the poor results obtained from the gas lamps, resulted in a popular demand for better street lighting.

The Chamber of Commerce took up the matter and started an agitation for correcting this condition. A "Get it Done" committee was appointed, and after various reports on the subject had been made, the city, the Chamber of Commerce and the Kansas City Light and Power Company united their forces to give the city a modern street lighting system. The result is the new installation authorized and just announced.

The cluster lamps now in use on the trolley poles will be replaced by an ornamental bracket supporting a Form 8 Novalux unit with alabaster rippled globe and metal canopy.

The gas posts will be supplanted by iron standards of Flemish pattern which were designed by the Illuminating Laboratory of the General Electric Company and will be manufactured by the King Manufacturing Company of St. Joseph, Mo. These will be equipped with G-E Form 16 Novalux units, some of which will be furnished with No. 107 alabaster rippled globes and metal canopies, and others with the No. 97 diffusing globe and metal canopy. The alabaster rippled globes are of clear glass, rippled, with a flashing of opal. The ripple gives life to the "dead" light—i. e., the light from an incandescent lamp as contrasted with that of a luminous arc—and the opal gives diffusion. All of these fixtures are to be equipped with 400 and 600 c. p. lamps, the majority using the latter size.

All of the units will be of the IL transformer type for safety-first reasons, making it impossible for anyone to be injured in replacing lamps, cleaning glassware, etc. The lighting company plans to maintain the new system in the very best condition and is having constructed a motor truck which will be used exclusively in cleaning the glassware of the lamps.

"Tarvia-KP" and stone are turned over by hand until all stones are coated. Then sand is added.

The hole to be patched is cleaned out and the bottom and sides are painted with "Tarvia-KP."

The mixture of "Tarvia-KP," stone and sand is put in the prepared hole.

A Patch in Time Saves Many a Road—

NOW is the time to fortify your roads against the ravages of winter. Patch the surface breaks, fill the depressions—have your streets and highways in ship-shape condition before the first snowfall.

For winter, with its alternate freezing and thawing will ruin a road, whereas a *little* care *now* may mean a vast saving in actual dollars later on.

"Tarvia-KP" has an astonishing variety of uses. It is employed in patching macadam, asphalt, bituminous-concrete and cement-concrete roads.

"Tarvia-KP" is a material that can be used for patching at any time of the year—it is as serviceable in winter as in summer, for freezing does not injure it. A batch of the mix can be made today and used weeks hence—in fact, aging improves it.

"Tarvia-KP" makes a smooth, perfectly bonded patch—a patch that becomes an integral part of the road itself. A patch that is durable.

There is only one "KP" and that is "Tarvia-KP" patching material made by The Barrett Company.

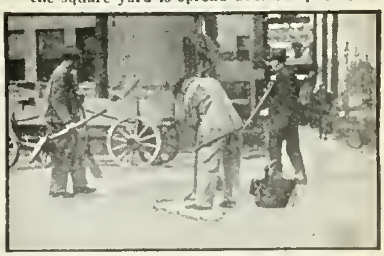
Our nearest office will gladly send you an illustrated manual of instructions showing each step in patching a road with "Tarvia-KP."

The mixture is well tamped and covered with screenings.

A seal-coat of ½ gallon of "Tarvia-KP" to the square yard is spread over the patch.

Tarvia-KP

FOR COLD PATCHING



Screenings are scattered over the seal-coat and the patch is again tamped.

New York, Detroit, Salt Lake City, Johnstown, Elizabeth, Chicago, New Orleans, Seattle, Lebanon, Buffalo, Philadelphia, Birmingham, Peoria, Youngstown, Baltimore, Boston, Kansas City, Atlanta, Toledo, Omaha

The Barrett Company

St. Louis, Minneapolis, Duluth, Columbus, Houston, Cleveland, Dallas, Milwaukee, Richmond, Denver, Cincinnati, Nashville, Bangor, Latrobe, Jacksonville, Pittsburgh, Syracuse, Washington, Bethlehem

THE BARRETT COMPANY, Limited Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

Authority was given the mayor of the city by the City Council to enter into a new contract with the company, and this contract is pronounced one of the best of the kind ever written. Requests for copies of it have been received by the company from all over the country.

The following is a partial description of the number and types of lamps to be used in the new installation according to the terms of the contract.

The present bright way street lights will be replaced by 952,600 c. p. Mazda series lamps with Novalux units in the downtown district and 300, 400 c. p. series lamps in replacing the old bright way system in the outlying business district.

To replace gas lights on streets, boulevards and parks, 1,080 600 c. p. lamps on standards will be used. Twelve of the city's parks will be lighted with 357 units of the same type.

The total number of new street lights covered by the contract is 6,980. These replace 5,421 street lights which were in use April 1, 1921.

CONCRETE TEST HIGHWAY AT PITTSBURG, CALIFORNIA

The need of more information on some phases of highway construction is recognized by engineers and the general public in California as elsewhere. With this in mind, and in the belief that the material they manufacture would prove a valuable aid in securing reliable results under some of the most difficult conditions, the Columbia Steel Company of San Francisco inaugurated the construction of a test highway. In the execution of this work to date they have received the hearty co-operation and assistance of other interests desiring to contribute in this manner toward acquiring more knowledge on the subject of highway building.

The test highway has been built at Pittsburg, Calif., in accordance with the plans published in a preliminary report, dated July, 1921, issued by the Columbia Steel Co. This highway will be tested to destruction by means of motor-truck traffic. The highway was completed on July 11 and the traffic on it has started.

This traffic will be continued until the several types of road are broken. The road is built entirely on adobe, and it is so arranged that water can be turned into the side-ditches and its surface brought to an elevation equal to that of the top of the sub-grade.

There are also four tunnels constructed for the purpose of making a study of the action of the slabs and sub-grade under traffic and variable moisture conditions. Careful observations will be made from time to time to determine the rate and amount of saturation of the sub-grade from the water-filled ditches. Other observations which this limited space prevents describing will be made.

The 13 types selected for investigation are the results of conferences with and suggestions by leading federal, state and county highway engineers, and represent their ideas as nearly as possible within the scope of this test.

As the investigation proceeds the information secured will be given free to the public by means of bulletins, so far as the compilation of results permit. This is a public test for public information, and the interest of those who have the construction of "good roads" at heart is solicited. All are invited to visit this test highway at any and all times they may desire, and these visits will be very welcome to those in charge of the investigation.

Mr. Lloyd Aldrich, consulting highway engineer of San Francisco, is engineer in charge and John B. Leonard, consulting structural engineer of San Francisco, is associate engineer.

FREIGHT RATES ORDERED REDUCED ON ROAD MATERIALS IN OHIO

The State Utilities Commission of Ohio, backed by public sentiment, expressed through the newspapers, by official sentiment through state officers up to the Governor, and the testimony given before it by representative paving brick manufacturers, have ordered substantial reductions in intrastate paving brick freight rates, effective Oct. 20, 1921. Sand and gravel shared also in the ordered reduction, but not to the extent of the consideration given paving brick rates.

The ordered reduction restores rates on the foregoing materials to those in effect prior to August 25, 1920; in other words, removes the last 40 per cent increase. Then, in addition, because, as stated in the order, paving brick had received prior advances disproportionate to those given other competing materials, an additional reduction of 10 cts. a ton is ordered on paving brick alone. For example, a present freight rate in Ohio of \$2.24 becomes under the order \$1.50 per ton; a \$1.84 rate becomes \$1.22, to use two common Ohio rates as illustrations.

Here is a precedent for other states.

WATER WORKS SECTION

WATER RATES FOR INDUSTRIAL CONSUMERS

By E. E. Bankson, of the J. N. Chester Engineers, Union Bank Bldg., Pittsburg, Pa.

A common source of controversy, in water rate cases, is the industrial rate or rate to large consumers, and on inspection of representative rate schedules which have been approved by courts and commissions there is to be found a wide variation in the attitude towards this industrial rate. The purpose of this discussion is to examine the permissible variation, in this respect, within a consistent course.

The generally accepted basis of any rate theory is that "the individual charge for service shall be equal to the cost of the individual service," although there are many cases where the decision, as to rates, has been influenced by the value of the worth of the service as indicated by competition or possible loss of business and an effort will first be made to explain or partially define the useful scope and limitations of these two factors.

The Cost Basis

The cost basis (including depreciation and fair return) may be considered as the ideal condition serving as a guide in fixing the rates, the magnetic pole, so to speak, toward which the rates will be drawn, and they may or may not closely approach the ideal point depending on the relative strength of opposing forces in the form of competition, etc. The embryo advocate of the "cost basis" is usually unable to recognize the justice of the "value basis" under any circumstances, apparently failing to appreciate the fact that, though we are at liberty to fix rates according to any measuring stick which seems good, we have no way of compelling the consumers to purchase at the stated price.

As a general proposition the primary function of a water works plant is that of supplying water to the community both for general purpose and for fire protection, with the industrial supply as incidental to the main issue, although the reverse may be true in extreme cases. Certainly the grid-iron distribution system, which is a large percentage of the total investment, as well as the fire reserve, and filter plant, if any, is created for the community.

The decision, therefore, as to the industrial supply resolves itself into the question as to whether or not this incidental supply can be sold at a profit, and Mr. Chester has very clearly defined a profitable or permissible rate for large consumers as "any rate which produces a result that will add to the net revenue of the plant," but coupled with this definition is also the understanding that such a rate to a large consumer should be the highest rate at which the sale can be effected; a higher rate would defeat the sale. This rate, too, will vary with different localities, for instance the Pennsylvania Railroad takes its entire supply in that district from the Dennison Water Co. at approximately 10c per 1,000 gals., while an average rate of 7½c does not prove attractive to that same company in the Upper Sandusky district.

The foregoing discussion does not imply that an attractive rate should be offered to all possible takers, for there would be no justice or equity in providing this incidental supply at a loss; in fact, the only justice in fixing a rate to a large consumer which would appear lower than the rate indicated by the "cost basis" lies in the fact that the net revenue thereby obtained is to be applied in fixing a lower rate for the major supply than would be possible without the revenue from this large consumer; granting a fair return on plant investment in either case. For instance, if a manufacturing plant can easily obtain and only requires raw water under a low head, and if the city is supplied with filtered water under a high head, the lowest rate should be made unattractive to the manufacturer, for in their case the value of the service to the manufacturing plant is lower than the minimum profitable rate to the water department or company, and to supply this incidental service at an attractive rate would actually increase the burden to the domestic consumers.

Another most vital point in this connection is that the attractive price to this large consumer may prove profitable only because of the "existence" of a surplus plant capacity which can be used in delivering this incidental supply, and that this price might prove unprofitable as soon as additional capacity was made necessary. In a recent case we protected the Water Company's position in this respect by indicating the low rate as applying only "so long as the present facilities of the Water Company are adequate," and in another case where the plant capacity had been reached, and where one industrial plant was taking over half the delivery at a low rate, we doubled the rate to large users so that the rate would be in excess of the value and this large industry be thereby eliminated (or retained only at a rate which would justify an increase in plant capacity).

Example of an Actual Case

An example of an actual case may be cited where an analysis of conditions will serve to support the foregoing statements:

A large industry in the town of "X" is now providing its own raw water supply at a cost, for 1920, of 1.6c per 1,000 gals., and is in a position to supply the necessary filtered water for its own plant at a computed cost of 4.2c per 1,000 gals. Allowing for contingencies, however, and for the advantages of the more reliable and carefully guarded city supply, they paid, in 1920, an average rate of 5¾c to the city plant for their drinking and sanitary requirements.

The rate of 5¾c is admittedly less than the rate which would be indicated as equitable under the "cost basis" by an impartial analysis of the annual burden from the Water Company costs, but it is the highest rate at which the business of this industry can be retained, and because of retaining this business at this rate the fair charge to other consumers is maintained at 12c per 1,000 gals., less than it would be if this industrial business were lost to the Water Company.

On the other hand even the out-of-pocket cost of the Water Company service is 2.1c per 1,000 gals., which would be increased by necessary fixed charges on additional plant capacity if the Water Company should attempt to supply its filtered water to the industrial plant as a substitute for the present raw water private supply. For the Water Company to offer a rate which would attract the entire demand of this industry in competition with its cost of 1.6c would result in an increased burden for domestic consumers, provided a fair return is maintained for the water. The equitable conclusion is evident that the lowest rate offered by the Water Company should be made attractive to the sanitary demands of the industry, but *positively unattractive* to the raw water demands in this particular case.

The foregoing principles applied to the majority of water rates would indicate that the value of the commodity is more compelling than the computed cost of individual service, and it is to be noted that, under a total fair return, if the industrial rate is fixed lower than cost, the domestic rate must be fixed higher than cost, which is still within the value of the product, provided the domestic consumers continue their connections. Commissions have often recognized this feature of value through their approval of rate schedules so designed, and different phases of value have been recognized in many decisions, a few of which we quote at random:

Different Phases of Value Recognized

In the Bar Harbor Power Company's Case, Maine, "Rates should not be higher than the value of the service to the consumer."

In the Greenville Water Co.'s Case, Maine, "If, in a given instance, it becomes a question whether the company shall receive an adequate return or the rates shall be just and reasonable to the customer, the company must yield to the superior rights of its customers."

In the Butte Electric Co.'s Case, Montana, "For whatever force is given to the principle that a just rate must take account of the value of the service to the public, it cannot be said that the latter principle destroys the fair return principle, i. e., while the service may be worth nothing to the man who cannot pay, the utility cannot be compelled to meet his necessities."

In the Illinois Northern Utilities Co.'s Case, "Gas plants, located in small communities, cannot expect rates sufficient to make them paying concerns because such rates would exceed the value of service to the consumer." Which the writer interprets to have the same meaning as expressed in the following case.

In the Lehigh Valley Transit Co.'s Case, Penna., "There are limits of fare beyond which transportation companies cannot go without driving away their business."

The foregoing analysis indicates that "value" is the final controlling element in many cases and that an industrial rate determined by value rather than by cost may be within good legal practice, as well as good business, so long as the existence of that rate will effect a lower rate to other consumers. The "cost" basis is the goal towards which we strive, and which can be attained in some cases.

The Case of Pittsburgh, Pa.

There are instances, such as we found in the case of the City of Pittsburgh, where the most compelling influences guiding the broad and general policies of the water service are in support of, rather than against, the "cost basis" for fixing rates. For the large steel mills and furnaces, located on the river banks and requiring only raw water under a low pressure, it was clearly seen to be poor economy for them to share with the city the cost of purification, pumping over the hilltops, and finally transporting the water long distances, when a satisfactory supply is at their doors at a very much lower cost. It would in the end create a financial loss for the City of Pittsburgh to deliver water for such purposes at a price which would prove attractive to the manufacturer so located; especially so in this case, where we discover one company pumping more water than that handled by the city plant, and years ago the City Council very wisely fixed the lowest rate at a point which is unattractive to the steel mills and insures the city against an uneconomical increase in plant capacity of monstrous proportions.

Every Case Stands on Own Merits

From the foregoing discussion the reader might possibly erroneously infer that we are advocating the "value" basis as a general rule for fixing water rates to industrial consumers, but such an attitude is exactly contrary to our thoughts. We are rather pointing out that every case stands on its own merits, and we do advocate a sane, logical and consistent analysis resulting in the correct policy for each case.

The question of water rates to industrial consumers is nothing more than the question of the amount or extent of the "Slide" in the meter rate schedule and, on the basis of cost alone, you may find conditions supporting rates all the way from an absolute flat rate to all consumers on the one hand increasing to a very decided slide on the other hand.

Practice of the General Water Co.

The General Water Company, a Pennsylvania corporation, operates a water works plant which is owned and used jointly by some half dozen coal and coke companies. The Water Company delivers water to a central point and provides supply lines for a certain distance in any direction at which point a large consumer may join on and complete the line to his plant desiring service. In this case, therefore, remembering that all of the consumers are large industrial, there is no call for any slide in the schedule and no urgent need of any variation due to service charge or minimum charge.

Conditions at Milwaukee

The conditions at Milwaukee, Wis., indicate a basis for rates of only a slight practical difference from the foregoing. In this case the consumer, big or little, pays outright for his gridiron street main, individual service line and meter, thereby eliminating from the rate base the more common causes for slide in the schedule with the exception of the cost of meter reading, billing and collecting, which cost is covered in this case by a uniform service charge, and the remaining cost consists of the uniform or flat price per 1,000 gals. to one and all. If it were practical to cover the service charge in the price per 1,000 gals. there would be created a justification for a small slide in the rate schedule.

At Cleveland, Ohio

It is the understanding of the writer that Cleveland follows practically the same policy as Milwaukee, except that the Cleveland water department furnishes the meter, creating a fair additional cost, which, if thrown entirely into the rate per 1,000 gals., would justify still more slide in the schedule than as mentioned for Milwaukee.

At Erie, Pa.

A practice similar to that followed by the City of Pittsburgh is next in line which differs from Cleveland, with respect to items mentioned, only in that the water department furnishes also the gridiron street main, indicating still more slide in such a schedule, while the practice in the City of Erie, where the Water Department provides all of these things and the individual service line in addition, justifies the greatest slide in the schedule of the entire list so far.

Following the case of Erie, let us look at a private plant, where the Public Service Commission requires, of the Water Company, all of the items of consumer service rendered by the Erie plant, and where we are also confronted with the condition that the industrial rate be fixed on the basis of "value" at a lower rate than pure costs would indicate. We then are justified in a still greater slide in our schedule, or, more properly, a part of this slide in all cases should be covered by a service charge, or a minimum charge.

The maximum slide in a rate schedule

is justified in the case of a private plant operating under the conditions of the case last mentioned, with the addition that there exists an excess in plant capacity which would otherwise remain idle, and where it is permissible temporarily to utilize this surplus capacity at a low rate sufficiently in excess of the cost of fuel and coagulants.

The control in these various cases might be considered as appearing on a curve or diagram, representing slide in schedule, with the General Water Company appearing at the bottom of the curve, while at the top would be found the small private water companies giving, under Commission jurisdiction, all of the mentioned items of consumer service and under the controlling influence of the "value" basis, supported by an otherwise surplus plant capacity. To find the relative position, on this curve, of any plant or water company it is only necessary to examine its characteristics and environment, but in any and all cases the final decision as to rates and slide in schedule should and must be based on sound, logical and controlling reasons.

This paper was presented by Mr. Bankson before the 1921 annual convention of the Central States Section of the American Water Works Association.

SOFTENING WATER FOR BOILER USE BY ZEOLITE METHOD

To the Editor:

Milton F. Stein, C. E., in his article, "The Economy of Feed Water Heating and Purifying in the Water Works Pumping Station," in Municipal and County Engineering, Vol. LX, No. 5, May, 1921, does not appear to recognize the utility of the art of softening water for boiler use by the Zeolite method.

Zeolite water softeners have been on the market in this country for more than eight years, and records touching on their application indicate that the vast majority are used for the production of boiler feed water, both in condensing and non-condensing plants.

The Zeolite water softener should not be compared with "the usual type" of mechanical filter, since its functioning demands a special construction and accessories that make it a unique apparatus. The problem of filtration is to pass water through a layer of material which has openings in it sufficiently large to permit the free passage of the water and small enough to stop the suspended particles that are desired to be removed. The Zeolite water softener problem is one of bringing all particles of the water into contact with the Zeolite material, which at once introduces a vastly different mechanical problem from that of simple filtration. It should further be noted that no Zeolite mineral is on the market in its natural form, for all minerals that originally possess some exchange properties must be artificially prepared or treated before they become valuable for softening water.

Mr. Stein's description of the softening of water is correct, but his comparison with the quality of softened water produced by the lime-soda process is by inference incorrect, for one infers that the lime-soda process invariably removes objectionable salts from the water, and invariably reduces the total dissolved solids to a very low amount, while the Zeolite process "exchanges objectionable salts for others," which action is condemned by inference as a defect of the Zeolite process.

The facts are that the lime-soda process partly precipitates from the water a portion of the temporary hardness, generally known as carbonate hardness, but the lime-soda process cannot precipitate all of it, because the resultant calcium carbonate is soluble in water to the extent of about two grains per gallon. Furthermore, additional carbonates generally exist in the colloidal state, which do not precipitate, and which pass over to the boilers in the treated water.

The lime-soda process cannot precipitate out any chloride or sulphate hardness, generally referred to as permanent hardness, and when operating at highest efficiency only transforms such hardness to equivalent sodium salts. If, therefore, Zeolite softened water is to be condemned by reason of its sodium content, the conclusion follows that lime-soda softened water must likewise be condemned, as it contains the same element.

It is obvious that the greatest possible theoretical reduction of total solids by the lime-soda process is less than the total amount of temporary hardness contained in the water to be treated. Furthermore, an excess of reagents must be used to maintain the chemical reactions, and this excess, existing as soluble salts in the treated water, increases the total solids above the amounts that would theoretically be expected. It is significant that in the actual operation of lime-soda softeners this excess is considerable.

The two items of sludge disposal and after reactions are not mentioned, although operators of lime-soda softeners are keenly aware of the difficulty and expense caused by the cleaning and dispostion of sludge.

It is stated that "sodium salts are known to aggravate foaming," and that "it follows that if a very hard water is softened by the Zeolite process it will indeed be softened, but in its changed condition may cause trouble through priming and foaming." Since permanent hardness (chloride and sulphate hardness) is not precipitated out by the lime-soda process but is transformed into sodium salts, it follows that waters containing a measure of permanent hardness when softened by the lime-soda process will also be high in sodium salts, and there would therefore be no difference in the priming and foaming qualities of such a water were it to be softened by the Zeolite method.

Sodium carbonate is not only contained in lime-soda treated water but is an important constituent of many boiler compounds. In fact the addition of sodium compounds to boiler feed water is an established practice to correct objectionable feed waters, which practice has not given bad results. On the contrary, it is considered highly beneficial to the boiler and has always fulfilled its purpose when correctly used.

Foaming is not a boiler trouble to be feared in well conducted boiler operation, where the boiler saline concentration is regulated by a blow-off schedule that keeps the concentration of boiler salines below the foaming limit. As a matter of fact where boiler feed waters are reasonably free from mud and other suspended matter foaming should be mostly considered as an announcement by the boiler that something is wrong, an automatic alarm in reality, rather than a boiler trouble.

Again, it is contended "that waters high in sodium salts have an embrittling action on steel." It should be carefully noted that this statement has never been proved, but on the contrary has frequently been denied by many prominent engineers and scientists.

Occluded hydrogen is generally considered a measure for the determining of the embrittlement of steel. Fuller* among others proved that the amount of hydrogen occluded by steel in contact with hot tap water or steam is the same, or higher, than the amount occluded when a highly concentrated caustic solution was used, and it may therefore be seen that the contention, "that waters high in sodium salts have an embrittling action on steel" has no sound basis in fact. In general it may be said that embrittlement of boiler materials and the occurrence of cracks is confined to those parts in which internal stress has been introduced during fabrication. The most common kinds of such cracks are the lap-joint cracks. The Hartford Steam Boiler Inspection and Insurance Company† has maintained for many years that the mechanical stresses set up by boiler construction are primarily responsible for the cracking of boiler sheets in or near the seams.

Further consideration demonstrates that the actual amount of sodium salt in the boiler makeup water is of no importance whatever in the above discussion, for be it great or small the evaporation of water in the boiler will bring these salts to a point of concentration where blow-off is required, and from that time on the boiler will always contain this amount of sodium salts.

The use of Zeolite softeners as applied to boiler feed water is not limited to any particular set of conditions, but in fact applies to all ranges of water supplies and operating requirements. Where waters are high in permanent hardness the Zeolite method alone is a satisfactory solution, and in the case of high temporary hardness the problem is advantageously solved by the combination of lime with Zeolite softeners. The lime is used to precipitate out the major portion of the temporary hardness, while the latter finishes off the work of the former and completely removes the permanent hardness, thus delivering a clear neutral water of zero (no) hardness.

Since Zeolite softened water fed to boiler room apparatus is completely free from scale, sludge or mud-forming impurities, which cause great waste of fuel and overheating of metal, and since the absence of scale eliminates internal cleaning of boiler surfaces, it may be seen that singularly attractive advantages are presented by the Zeolite water softener.

Very truly yours,

THE PERMUTIT CO.,

440 Fourth Ave., New York, N .Y.
Sept. 30, 1921.

*Trans. Amer. Elec. Chem. Soc., Vol. XXXVI.

†The Locomotive, Apr. 1905, Repub. The Locomotive, Jan. 1921.

CONTROL OF THE OPERATION OF RAPID SAND FILTER PLANTS

By J. W. Ellms, of The Frazier-Ellms-Sheal Co., Consulting Engineers, Illuminating Bldg., Cleveland, Ohio.

It is now over 30 years since the Massachusetts State Board of Health began its investigation of the water supplies of Massachusetts. At that time the study of the physical and chemical characteristics of natural waters was regarded as of prime importance, comparatively little attention being paid to their bacteriological content. The microscopical examination of waters for algae, diatoms, protozoa and similar organisms had also been shown to throw considerable light on the quality of surface waters for public supplies. As bacteriological technique was perfected, and as the relation between polluted water and certain diseases became more evident, the examination of waters for the number of bacteria which they contained, together with attempts to isolate certain species of bacteria, came more into vogue.

The early experimental work on the merits of rapid sand filters for purifying public water supplies, carried on at Providence, Louisville, Cincinnati, Pittsburgh, New Orleans and Washington required the utilization of all the available methods of examination, and as a result of this work analytical methods were much improved, and their interpretative value much better understood. The various kinds of natural waters experimented with in these investigations impressed upon the workers the need for careful standardization of the methods of analysis. This idea took concrete form in the appointment of a committee on this subject by the American Public Health Association. The original work has been revised from time to time, and is at present in process of further revision in order to keep pace with our advance in knowledge on these subjects. In order that this revision of methods may be adequate, the membership of the committee should be enlarged to include representatives of several of the other national scientific associations, such as the American and New England Water Works Association, the American Chemical Society, the American Society of Bacteriologists and the American Societp of Microscopists. A revision of these methods by such a committee would be authoritative in the broadest sense, and would establish a firm basis for comparison of results and for interpretation of those results.

Laboratory Control

The control of the operation of rapid sand filter plants is based largely upon accurate information obtained in the laboratory. If this information is immediately available, so that processes may be modified during the progress of the water through the plant, or if it can only be obtained many hours after the water has been treated, the data secured should be utilized directly or indirectly by the operator in order to guide him in handling the plant. This is much easier said than done, even if we grant the accuracy of the laboratory methods. Facts are of small value unless they are properly interpreted, and unfortunately there is not the consensus of opinion in regard to interpretation even amongst those presumedly qualified to express an opinion.

Points of Disagreement

To illustrate conditions commonly met with, we do not agree always upon the merits of fine versus coarse flocculation after treatment with chemicals, upon the proper periods of sedimentation, upon the velocities that may safely be used in conduits, upon the means for preventing incrustation upon filter sands when lime is used, upon the completeness of the precipitation of aluminum hydroxide where alum is employed, upon the size of the sand grains that will produce the greatest bacterial removals, upon the extent to which chlorination of filter effluents may be carried to offset lowered filter efficiency, upon the signficance of secondary bacterial growths in settling basins and perhaps filters, upon the weight to be attached to the presence of B. coli, and to numerous other questions constantly arising from the data that the laboratory produces, and from observation of plant conditions. That waters differ widely in character and consequently in their susceptibility to purification processes is axiomatic. Nevertheless, the most experienced operators are inclined to draw conclusions from too little data and from too limited knowledge of the varied waters which are being purified for public consumption.

Caution as to Innovations

It cannot be too strongly stated that many of the fundamentals of rapid sand filter plant control are the result of the accumulated experience of more than 25 years' labor in extensive experimental work, costing many thousands of dollars, as well as the practical operation of numerous plants purifying waters of widely varying character. The utilization of new principles which are the result of scientific research, but which have not been tried out on a practical scale, requires caution and an open mind. What may be true under controlled conditions when demonstrated in a laboratory beaker, may be far from true under the conditions existing in a large filter plant. Unforeseen conditions, and factors that cannot be controlled may so modify the original principle that its value for practical purposes is nil.

In spite of the advances made in the art of water purification during the past quarter of a century no true scientist would claim that the art has been perfected or further progress impossible. The careful scrutiny of all new ideas advanced and their subjection to rigid practical tests are not only scientific but wise. The revolutionizing of an art requires the establishing of new principles, beyond any question of doubt, and not until this is done may past practices be thrown into the discard.

Water purification in its broadest sense may perhaps include the purification of drinking water, the softening of water for industrial purposes, the disposal of sewage, and the adequate treatment of industrial waste liquors of many kinds. The field for research work is enormous, and the problems involved intricate. There is plenty of room for many workers. If each contributes his mite to the problems presented to him he will have done his part.

Conclusions

The points I wish to bring out in this paper may be summarized as follows:

1. We must have a set of standard methods of analysis which will be authoritative and adequate for the problems to be solved.

2. We must formulate our problems in such a manner that it is evident to all what the questions at issue are.

3. We must be receptive to new ideas, examining them with candor, neither accepting nor rejecting them without rigid testing.

4. Finally, we should hold fast to that which has been established by costly experiments and practical operating conditions until new methods have demonstrated beyond doubt that something better is possible.

This paper by Mr. Ellms was presented at the 1921 annual convention of the Central States Section of the American Water Works Association, at Columbus, Ohio.

HUMAN RELATIONS OF PUBLIC UTILITIES

By H. C. Peffer, Head, School of Chemical Engineering, Purdue University, Lafayette, Ind.

(Editor's Note: In introducing the following remarks before the Indiana Municipal League Professor Peffer said: "A college professor is no more fitted by virtue of his position to speak with authority on all subjects than any other man. His opinion, along his special line, is entitled to due respect; outside his specialty, his opinion may be only an impertinence." Unfortunately, in the opinion of many who have not outgrown their schoolboy prejudices, even the existence of a professor is an impertinence. Perhaps that is why the editor gave up teaching in the class-room to take up teaching through a professional journal. However that may be, and the point is of no consequence, better men are remaining on the job in our schools and colleges. Prof. Peffer, who, by the way, did a splendid piece of public service work as representative of the Indiana Municipal League on the Indiana Gas Standards Committee, has here expressed some very true and wholesome views.)

As a result of a number of years of contact with the human family in the various relations of subordinate, employer and teacher, one thing stands out, viz., faith in humanity; most men are essentially honest.

What I meant to say is that most people intend to be honest, believe themselves to be honest, and aim to deal fairly with others; in fact, most of them are honest enough within the limitations of human nature to deal according to facts in an impersonal proposition.

It is, however, a feature of human nature to be suspicious of strangers or those outside of one's immediate circle, and to trust one's friends; probably an inheritance from savage ancestors.

We have here the nub of the utility situation, coupled with the fact that we have during the past 50 years advanced more rapidly in applied science and engineering than in the science of human relations.

Certain of the relations of the utilities to the public are based on facts; others depend on opinion, very often based on prejudice or irritation, without any basis of facts.

It is believed to be a fair statement to assert that the utilities serving the public are in general as efficiently handled from an operating standard as business enterprises in general. They are among the largest employers of high grade technical specialists and among first to utilize modern inventions and improvements.

In their contact with the public, however, they are probably less efficient than other business organizations, to the cost of both the utility and the public.

That the conditions under consideration are not unavoidable and not a part of the industry may be evidenced by instances in other lines. The department stores of John Wanamaker, Marshall Field and others, probably have as many contacts with the public as most of the utilities. Anyone who has travelled in Canada has probably been impressed with the courteous, helpful attitude of railway and street car employees and of the police.

Manufacturing concerns whose contact with the public are small in comparison with the above allow only experienced, high grade men to come into contact with the public and find that it pays.

The Indiana Gas Standards have attracted much attention outside the state because of the method of their formulation and because they embody the results of a comprehensive survey of the gas industry in this state, by competent engineers, and under actual operating conditions.

It will be recalled that the investigating committee appointed by the Public Service Commission comprised representatives of the Public Service Commission (the State), the Indiana Gas Association (the Manufacturers), the Municipal League of Indiana (the Public), and the National Bureau of Standards (an impartial scientific body).

It would scarcely be expected that in a committee representing such apparently diverse and conflicting interests absolute harmony would prevail. As a matter of fact, differences of opinion did arise, and were warmly contested; in the end, however, all disputed points were settled as they should have been, on the basis of the scientific and technical facts elicited during the investigation.

The recommendations of the committee, subsequently promulgated by the Public Service Commission, are believed to render substantial justice to all concerned. Under the regulations, as they now stand, the gas companies are able to operate without hardship, and under definite conditions which they assisted in formulating. The consuming public is assured of gas of uniform quality, of probably higher calorific value than under the old standard.

The foregoing is cited as an example of efficiency where it is most needed, in the relations and dealings between the utilities and the public which they serve.

It is necessary to remember, however, that the public, like the individual, has little regard for facts when exasperated by some real or fancied grievance; on the other hand, it will tolerate much from those who have its friendship.

The railroads are today suffering the vengeance of exasperated public opinion. It is extremely doubtful whether the public would have ever become sufficiently interested as to the amount of water in stock issues and like matters to take any action, if they had not been the victims of discourteous or even outrageous treatment from employees of the railroads. The American public believes in a square deal.

All this is not for the purpose of introducing a new patent medicine which will cure all our ills; we have had too many economic and legislative patent medicines in the past.

What the utilities now need most is a course in the science of human relationships and a liberal supply of the Abe Lincoln brand of human nature. With mutual trust and confidence reestablished, the utility problem will solve itself.

THE "IDEAL" ELEVATED WATER TANK

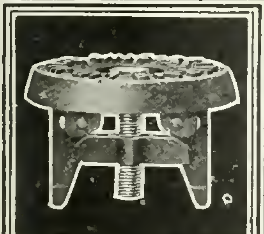
To the Editor:

One point which Mr. W. L. Simpson did not bring out in his article in the September issue regarding an elevated concrete water tank in Yorktown, Texas, is worthy of mention.

Mr. Simpson says in effect that this tank reduced the insurance key rate for the town on account of the increased pressure produced by the tank. He also says that the water works system which he describes seems to be an ideal arrangement for a small city.

This is well and good, but it should be brought out that the insurance rates were not reduced because the tank was built of concrete and that the rates would have been equally reduced had the city constructed the long-standard elevated steel tank.

Mr. Simpson does not make clear whether the water supply system which he describes is "ideal" or whether the tank itself is "ideal," and to make sure that no one assumes the latter to be the case it should be mentioned that if any elevated tank is entitled to be termed



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This *MUELLER* improvement over the old type screw adjustment box, permits the raising or lowering of the upper section without injury to the curb cock or service.

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"ideal" the steel tank is certainly entitled to this distinction.

The elevated steel tank has been the standard in American municipalities for more than 25 years and it has universally rendered a most excellent service—combining such qualities as low cost, long life, freedom from cracking, leaking, rotting and burning, and solidarity on account of its unit construction and self-supporting bottom—which will probably never be equalled by any other type of tank.

I think this explanation is due, at least as a small token of appreciation to Mr. Horace E. Horton who invented the elevated steel tank with a self-supporting bottom, and as a means of informing city officials and others of the fact that concrete as yet has not proved its place as an "ideal" material for the construction of elevated water tanks.

Very truly yours,
CEDRIC B. SMITH,
Chicago Bridge & Iron Works,
37 W. Van Buren St.,
Sept. 28, 1921. Chicago, Ill.

NEW P & H BACKFILLER

The new power backfiller designed by the Pawling & Harnischfeger Co., of Milwaukee, to speed up the work of backfilling trenches and ditches, is designated as P. & H. 203. This machine is mounted on full corduroy tread and is operated entirely by one man, who guides the progress of the machine as well as the scraper bucket and boom. The boom on the 203 is 30 ft. maximum, 20 ft. minimum, and the engine is heavy duty 18 h.p. four-cylinder gasoline unit. The illustration accompanying this description shows the machine at work on a city of Minneapolis job, filling in a water pipe trench.

With the boom extended to its maximum length of 30 ft., four loads may be filled in per minute. With shorter boom length more loads are dumped into the trench per minute. In fact, just the one man, the operator, with this P. & H. backfiller can work steadily without fatigue and do the same work as a crew of 40 to 50 laborers backfilling with shovels. The construction is like P. & H. Excavator-Cranes; the body being made of heavy I-beam, gears cut from solid block, steel plate corduroy treads, gear-driven, and centralized control.

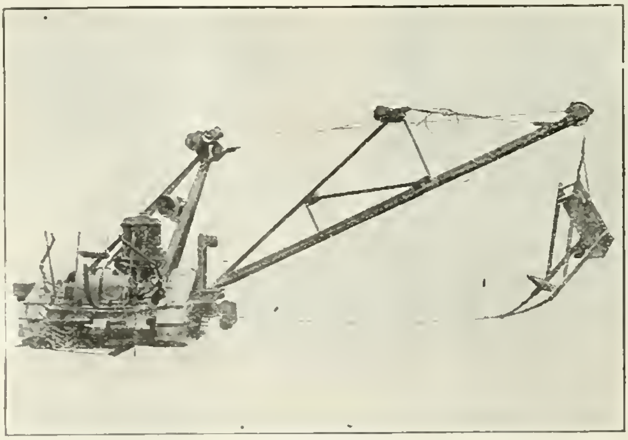
WHAT DECATUR, ILL., IS DOING TO RELIEVE UNEMPLOYMENT

To the Editor:

I have just read your editorial appeal in your September issue, for more municipal work to relieve unemployment.

As I read it I wondered if you were acquainted with what Decatur, Illinois is doing and has been doing for the last 12 months. We think there is not another city in the country that is doing what we are to help the town and that means also to help idle labor. Decatur is a city of 43,818, 1920 census, and here is some of the work that is in progress:

Concrete and earth dam	$800,000
Building of new bridge	230,000
Raising approaches and piers of several other bridges, about	200,000
Clearing land in the impounding reservoir	90,000
Abandonment of one bridge and the construction of a road in place of it—at least	20,000
Rip rapping blocks	20,000
Sewers and water mains in new additions	75,000



P & H BACKFILLER ON WATER PIPE JOB IN MINNEAPOLIS.

Several small paving projects and many more large ones already under way for next year, including several miles of resurfacing.

An intercepting sewer in progress of construction and plans for a sewage disposal plant nearly completed.

Five miles of concrete sidewalks planned, for one new addition, that will go down as soon as sewers and water mains are in.

Then this little town of ours had to buy about 3,800 acres of bottom land, much of it very good farming land, for the impounding reservoir.

The money for a part of the impounding project was provided by a patriotic citizenship. The city needed a million dollars. State laws restricted its bonding power and its taxing power. A voluntary corporation of citizens was formed under the name of the Decatur Water Supply Co. and issued stock paying seven per cent. In a few days this issue was oversubscribed by our people.

I believe that the work Decatur is doing ought to be a good example for other Decaturs and other cities of the country. Do you know of another town that is doing as much as we are?

Very truly yours,
HENRY H. BOLZ, Reporter,
Decatur Herald.

Decatur, Ill., Sept. 28, 1921.

(Editor's Note: Our correspondent is justly proud of what his city is doing. We have always had a good opinion of Decatur and are glad to have our judgment so conclusively confirmed. This is, indeed, a splendid example for other cities. Here is a city living up to the best traditions of an honored name.)

TYPHOID FEVER AND PREJUDICE AGAINST CHLORINATION OF DRINKING WATER

How a community, by too strenuous protest against an unpleasant but transitory condition, can condemn itself for years to an annual recurrence of disease, is strongly brought out in a report by Dr. R. G. Perkins, of the Cleveland Division of Health, recently reprinted by the U. S. Public Health Service.

Cleveland, says the report, obtains its water through two cribs placed 4½ miles out in Lake Erie and delivers it through two pumping stations, at one of which it is filtered and at both of which it is chlorinated.

Chlorination was begun in 1911, when the growth of the city and the increasing pollution of the lake water made treatment essential. After numerous experiments the "dosage" of chlorine necessary to make the water safe was determined. This amount was added and the typhoid curve fell with unusual sharpness. Unfortunately, conditions compelled the delivery of the chlorinated water through the mains in some parts of the city so shortly after it was treated that the taste of chlorine was still apparent.

Much complaint followed, but was dying out when, early in 1912, a flood in the Cuyahoga River, which enters the lake at Cleveland, carried sewage and trade wastes out into the cribs, through which they reached the city mains. The trade wastes gave to the water an unpleasant taste, which everybody promptly blamed on the chlorination.

The mayor bent beneath the storm of protest. By his order the "dosage" of chlorine was reduced and during the ensuing nine years it has never been high enough, the report says, fully to counteract the ever-present pollution in the raw water.

The typhoid bacillus in drinking water is very difficult to find by laboratory methods, but the finding of sewage pollution is always considered as a warning of its possible presence.

In 1918, in the effort to better conditions, a filtration plant was put into service at the larger pumping station, which handles nearly three-fourths of the city consumption. Laboratory tests, however, show that sewage pollution is present in the unfiltered water in the city mains nearly half the time and in the filtered water from 8 to 22 per cent of the time.

In 1918 and in 1920, when these tests showed the water to be badly polluted, the number of cases of typhoid fever in the city that could not be traced to any cause other than the water was double those that occurred in 1919, when the tests showed the water to be much better. From this the report argues that the pollution of the water and the amount of typhoid fever are directly related; and that when the pollution is reduced to a minimum, as the report says that it can be by existing facilities, typhoid fever in the city will be very greatly reduced.

It should be added that the engineer of the water division of the city, a man whose experience the report concedes to be large, finds himself unable to admit that the untraced part of the rise of typhoid in Cleveland in the summer is due to water pollution.

Construction News and Equipment

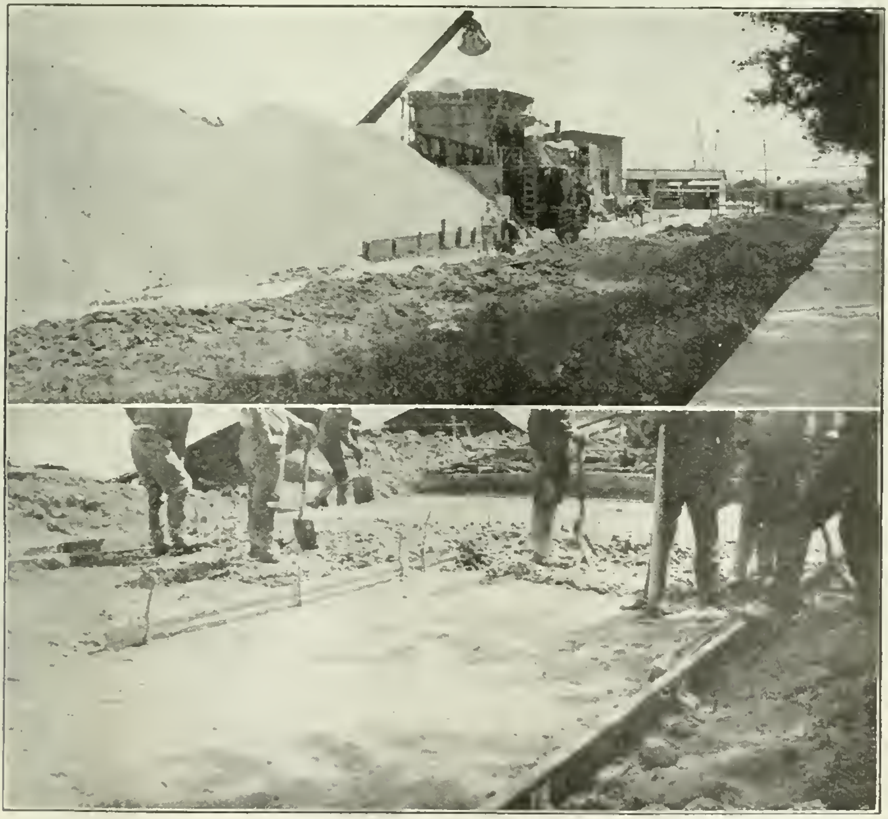
DAY LABOR CONSTRUCTION ON LINCOLN HIGHWAY AT FRANKFORT, ILL.

By B. H. Piepmeier, Engineer of Construction, Illinois Division of Highways, State House, Springfield, Ill.

On account of the high prices prevailing in the spring of 1921, very few highway contracts were awarded in Illinois. The State was very desirous of knowing the exact cost of construction under various conditions and therefore decided to build by day labor two sections of road, one at Frankfort, Illinois, and the other at Dwight, Illinois. The Frankfort section was selected, as it was the only earth gap in the Lincoln Highway between Joliet and the Indiana State line. The section is four miles in length and located through a rolling country. The Department therefore decided to utilize some of the war equipment, which it had received, in connection with the construction of this section of road.

Six Miles from One Set-Up

Six, 1½-ton G. M. C., pneumatic tired trucks with Lee dump bodies; 6 3-ton Velie trucks with Lee dump bodies, and 6 3-ton Velie trucks with standard hydraulic dump bodies, together with a 10-ton Austin gas roller, 5-bag Milwaukee concrete mixer, 15-ton industrial crane of the locomotive type, Lakewood finishing ma-



VIEWS ON DAY LABOR CONSTRUCTION ON LINCOLN HIGHWAY AT FRANKFORT, ILL.

Material Yard at Frankfort—Lower View shows Position of Corrugated Central Joint Before Concrete is Placed. Pins are Removed After Concrete is Spread, Leaving Corrugated Metal in Place.

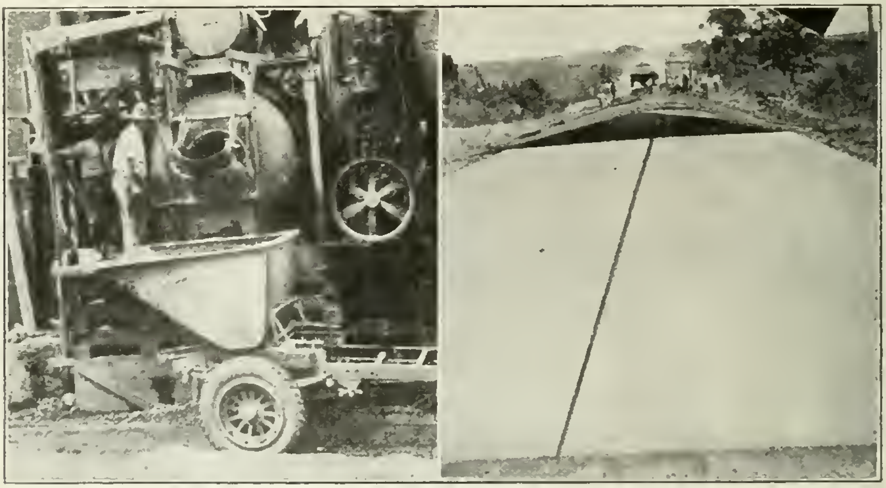
chine, and gasoline pumps were shipped to Frankfort and construction started June 8, 1921. On September 4th the entire four miles which it was originally planned to build were completed. The progress made and the results obtained were so satisfactory that an extension of two miles was authorized, making a total of six miles to be built from the one set-up.

Central Mixing Plant

On account of the conditions existing, it was decided that a central mixing plant at Frankfort would be the most desirable way of building the road. Bins having a capacity of about 25 cu. yds. for stone and 15 cu. yds. for sand were erected so that they could discharge material directly into the hopper of the stationary mixer. An 8-car cement shed was erected near the plant and so arranged that cement could be handled by wheel-barrows directly from the car or shed to the hopper on the mixer. The stationary mixer is so arranged that the batch may be discharged directly on the trucks. The capacity of the plant is approximately 700 ft. of 18-ft. pavement for a 10-hour day. The best day's run has been about 560 ft.

The New Illinois Standard Concrete Pavement

The type of pavement that is being built at this point is recognized as our new standard: namely, 18 ft. in width with a 2-in. crown having a uniform thickness of 7 ins. A 6½-in. strip of corrugated metal was placed lengthwise down the center line of the pavement. Five-eighths inch round deformed bars, 5 ft. long on 10-ft. centers were placed through the corrugated iron stip at right angles to it. Three-fourths inch plain round bars were placed 6 ins. from each edge of the slab. The ¾ in. round bars were first painted with a heavy coat of red lead paint to prevent rust. They were then dipped in hot asphalt having a penetration of about 35. The asphalt coating was for the purpose of breaking the bond so that in case of transverse cracks the longitudinal bar would not be ruptured but remain across the crack and act as a supporting dowel for carrying the concentrated load from one side of the crack to the other, thereby increasing the carrying capacity of the concrete slab. The corrugated metal strip in the center of the pavement was used to eliminate the unsightly longitudinal crack that frequently occurs in concrete pavements and to permit the dividing of the pavement in two parts so as to make the road safer for traffic. Corrugated metal was used, as it serves to make a dove-tail joint, thereby preventing a displacement of one side of the pavement above or below the other. The five-eighths, 5-ft. long, deformed bars that were placed at 10-ft. intervals through the center joint is for the purpose of holding the two slabs together so that the corrugated joints will always be effective. Inasmuch as the corrugated metal joint comes within ½ in. of the surface of the finished pavement, a crack forms as soon as the concrete has taken its final set. This longitudinal crack is exactly in the center



VIEWS ON DAY LABOR CONSTRUCTION ON LINCOLN HIGHWAY AT FRANKFORT, ILL.

Five Bag Concrete Mixer at Central Mixing Plant—Right View Shows Center Joint Filled with Asphalt; Also Arched Covers to Protect Pavement from Wind and Sun.

of the pavement and when filled with a light tar or asphalt, covering a width of about 3 ins. immediately over the crack, serves as a dividing line for traffic going in opposite directions. It has been found that the dividing line adds very materially to the safety of the road, particularly after night. It has been found that the glare from the headlights of automobiles shows up the center dividing line and makes it possible for approaching vehicles to meet with a greater assurance of safety.

To date there have been approximately 40 miles of this new type of cross section of pavement built in Illinois. Thus far, it has been found so satisfactory that the Department will continue to build this type.

MARSHALL COUNTY, IOWA, CRUSHES STONE FOR PRIMARY ROADS

The primary road paving program laid out by the Marshall County, Iowa, Board of Supervisors, which threatened to be handicapped considerably by the lack of quickly available supplies of gravel for concrete aggregate, has opened up an entirely new industry for the county. In the extensive and various operations necessary in getting the rock out from under its heavy clay covering, crushed and delivered to the road builders, has furnished employment for many local men at a time when employment has been badly needed, says the Service Bulletin of the Iowa State Highway Commission.

After the voters of Marshall County had put themselves on record as favoring a hard-surfacing program for the Primary Road System the Board of Supervisors began to investigate the advisability of the installation of a rock crushing plant at Quarry, Ia., as a means of decreasing the cost of the pavement. After careful inspection and exhaustive tests five acres of land, part of what is known as Rock Valley Quarry, and which contains a fairly high grade of limestone deposit, were purchased at a price of $1,000 per acre. Approximately two acres additional were leased as a site for the crushing plant and railroad spurs. Quarry is located about four miles southeast of Marshalltown, at the junction of the Lincoln Highway and M. & St. L. railroad. The quarry had been operated about 20 years ago, furnishing dimension building stone. Work at that time had been carried on some distance below water level. Operations were discontinued at that time on account of the difficulty of getting rid of the water.

The land bought does not include the old workings, but extends back from the face of the ledge. It averages about 20 ft. above water level in the old excavation. Overlaying this ledge is some 15 or 20 ft. of clay, which necessitates extensive stripping.

Two methods of stripping of the clay presented themselves—first, by means of hydraulic pressure; second, by means of steam shovel. On account of several serious difficuities presented by the hydraulic method, and the fact that a cut of several thousand yards of excavation was necessary for the railroad spur entrance, the steam shovel method was adopted and a model "21" Marion Steam Shovel purchased.

The crushing and auxiliary equipment was furnished by the Austin Manufacturing Company. It consists of a No. 7½ and a No. 5 Austin Gyratory Crusher, a bucket conveyor, a revolving screen, a friction hoist, five end dump rock cars, and the necessary shafting and auxiliaries.

Electricity was chosen as the motive power. A transmission line approximately one and a half miles long was erected. The 3,300 volt line from Marshalltown to Le Grand was tapped and the three-phase 60 cycle A. C. current of 2,300 volts was carried to the quarry, for use in the motors. For illumination at night this current was stepped down to 110 volts.

Slip ring induction motors of 150 and 40 h.p. were purchased—the former to drive the crushers, conveyor, screen and hoist, and the latter to drive a 10x10 Sullivan Air Compressor to supply air pressure for jack hammer drilling. The question of individual drive presented itself, but the increase in the number of motors required for this system would have complicated and delayed delivery, and the idea was discarded.

The crushers are located in an open framed structure 34x42 ft. in ground plan, by 35 ft. in height. The motor house, a "lean-to" 18x34 ft., abuts the crusher house. The bins are 18x32 ft. in plan and about 48 ft. in elevation, having a clearance of 21 ft. 6 ins. beneath, to allow engines and cars to pass. The screen house is located over the bins and is approximately 20 ft. high. From the ridge pole to the ground is about 70 ft.

It is interesting to note that practically all the timber for the plant was furnished by a native timber company, operating just across the Lincoln Highway from the quarry.

The large motor drives a jack shaft from which power is transmitted to the various machines through a system of belts, chains and gears.

A spur, 1,200 ft. long, with a passing switch of 500 ft. was run in from the M. & St. L. main line. Trackage to provide for 10 loaded and 10 empty cars is provided.

The stripping was accomplished by the shovel, which was at first served by teams and wagons. This proved so unsatisfactory, however, that Koppel and later, Western side dump cars were employed. These were moved by means of a homemade gasoline dinky constructed by the shovel runner. An old Continental motor furnished the power, which was transmitted through a friction drive. This feature was later changed to a positive gear drive.

While some of the stripping was employed to fill around the crusher plant, by far the greatest part was wasted into the pond formed by the former quarrying operations. A trestle work was built out at one end of the lake and as the fill was widened the track moved over.

Preparatory to shooting, the drilling is accomplished by means of an Armstrong Type 25 blast hole driller, which drills a hole 5 ins. in diameter and 23 ft. in depth. The holes are in rows and staggered so as to be about 10 ft. from center line to center line. Enough holes are shot to provide a quantity of rock that can be handled nicely. Some difficulty was encountered at first in shooting because of the seamy nature of the rock, which allowed the charge to shoot out. This was avoided, however, by heavier loading.

In view of the fact that sufficient stripping is done for this year's operation, the shovel is now being used to load the rock. This operation was at first done by hand. The rocks that are too large to be accommodated by the crushers are pushed to one side by the shovel and are jackhamered for subsequent blasting. The small pieces are loaded into the rock cars, which are towed by a team to the foot of the incline leading over the crushers.

Here the hoist cable is attached to the car and the latter pulled up the incline over the crushers. At the top of the incline the end gate of the car is automatically raised and the load is dumped into the No. 1½ crusher. When empty, the car is run down by gravity and another loaded one secured.

This crusher has an hourly capacity of about 125 tons of rock crushed to pass a 3½ in. ring. It discharges into a bucket conveyor, in which the rock is carried to the top of the screen house, where it is discharged into the 48 in.x 20 ft. revolving screen. This screen has 8 ft. of 1-in. perforation and a 5 ft. 6 in. dust jacket with 5/16 in. perforations. The graded rock passes from the screen into the proper bin, while the rejection, that rock too large to pass a 2¾ in. ring, passes over the end of the screen into the rejection chute and thence to the No. 5 crusher for further crushing. This crusher also discharges into the same conveyor as does the No. 7½, so that the rock is once more discharged into the screen for graduation.

The graded rock is loaded in the cars for shipping by gravity through gates in the bottom of the bins.

The rock, although containing some oolitic formation, is in general of very good quality for road-building purposes, having a French coefficient of 8.

While there may have been some doubt at first as to the ability of the plant to produce rock in sufficient quantities for the needs of the paving contractor, this has been dispelled, as the contractor is in no position to handle the entire output of the quarry.

Up to about April 15, when the actual operation of crushing started, the quarry represented an investment of around $80,000. This, of course, includes much labor and operating cost in connection with stripping and drilling, which should be charged against this year's production. Thus far the cost of production has been at a very satisfactory cost per ton.

The screenings—the by-product of the quarry—have several uses. With a total phosphate content of between 84 and 85 per cent, they will be an excellent medium for neutralizing soil acidity. They also have a possibility of being used for road repair work and perhaps surfacing on minor highways.

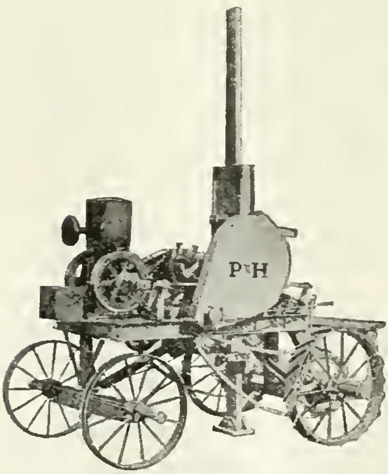
During construction and operation the plant has been under the supervision of George B. Walker of Denver, Colo. The working force, in addition to the superintendent, while it varies with conditions, consists in general of the shovel crew of three men, the well drill operator, the jackhamer man, the track man, the hoist operator, the blacksmith, the oiler, two men handling the rock cars, and the water boy.

Bunkhouses have been erected on the premises, in which the foremen and workmen live. County Engineer Don C. Elder took very great interest in the erection, installation and operation of the plant. Already the rock crushing plant has prov-

en itself a money saver in reducing the cost of paving to the county. It has restored to activity one of the deserted spots of the country and has made use of home materials for a home enterprise and has established a new home industry that should furnish employment to a large number of men for several years to come, as well as give the county engineer and road officials relief from anxiety as to where their road-building materials are to come from for paving their Primary Road System.

NEW P & H POWER TAMPER

The accompanying illustration shows the latest model P & H Power Traction Tamper made by the Pawling & Harnischfeger Co. of Milwaukee, this new type having a number of improvements over the previous model. All chains and gears are supplied with enclosing-guards, the tamper and steering cables used are 3/8 in. in diameter instead of 1/4 in., new type traction wheels are furnished, with



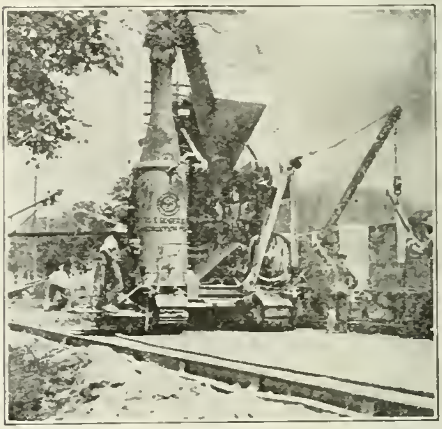
NEW P & H POWER TAMPER.

extension axles to allow for changing the tread from 58 ins. to 76 ins. The standard tamping head is 150 lbs. in weight as before. Other refinements are embodied in the design which makes it an improved machine for speeding up the work of tamping all kinds of ditches and trenches. Only one man is required to operate it—control of the power ram and the forward or backward movement of the tamper being readily accomplished from the operator's seat.

PROPER PLANNING AND COMPETENT SUPERINTENDENCE MEAN GREATER PROFITS ON ROAD CONSTRUCTION

Just how much the production of any equipment can vary, from the handling by one superintendent to that of another, is shown in the following record made by Bates and Rogers, Chicago, on their contract for 17½ miles on the Cleveland-Akron highway.

Work was begun on May 2nd. From that date on for seven weeks the daily



AUSTIN 21-E PAVER AT WORK ON CLEVELAND-AKRON, OHIO, HIGHWAY.

footage increased from low 168 on one day, the first week, to 738 feet in one day of the seventh week; from a daily average the first week, of 295, to daily averages, the following weeks, of 412, 439, 553, 489, 572 and 659. The "low" days were caused by insufficiency of water, as they are dependent upon springs for their supply.

The Austin 21-E Paver had just the same capacity on the first day as it did the succeeding days, but the men were not worked in, the water supply was not dependable, the material was delayed in reaching the paver. But the superintendent on the job is also an engineer, so that all the problems of material, water and coal supply were soon solved, not only for the "next day" with its possible increased production, but for any scale of increased production that they might speed up to. How efficiently he planned his whole schedule from day to day so as to get the maximum out of his equipment is shown in the figures below.

This roadway is reinforced concrete, 18 ft. 4 ins. wide, 8 ins. thick on the sides, and 10 ins. in the center. A thousand feet of ordinary roads could have been run by such a superintendent at the rate he is working this heavy yardage road.

It is encouraging to manufacturers of equipment, knowing the possibilities of their machines, to see them on jobs that are handled so resultfully.

The following are the daily footages accomplished by Bates & Rogers:

May	1	Sun.	"	8	Sun.
"	2	245	"	9	425
"	3	283	"	10	328
"	4	358	"	11	356
"	5	383	"	12	459
"	6	168	"	13	414
"	7	333	"	14	490

"	15	Sun.	June	1	541
"	16	452	"	2	554
"	17	501	"	3	616
"	18	554	"	4	283
"	19	303	"	5	Sun.
"	20	296	"	6	573
"	21	517	"	7	527
"	22	Sun.	"	8	622
"	23	512	"	9	656
"	24	609	"	10	633
"	29	Sun.	"	11	425
"	30	Dec. Day	"	12	Sun.
"	31	453	"	13	582
May	25	532	"	14	648
"	26	673	"	15	738
"	27	555	"	16	670
"	28	440			

Contracts Awarded

ROADS AND STREETS

Guide—Contracts Awarded

Ala., Birmingham—Etowah County awarded contract to build part of Gadsden-Birmingham Hwy. from Gadsden to St. Clair Co. line, County will do the work with convicts and regular rdbldg. equipt. at $277,098.56 for the job. Road will have 6-in. slag base with 2-in. surface of asph. conc.

Ala., Camden—Miller & Miller, awarded contract to constr. road bet. Camden and Monroeville, at $91,000.

Ala., Montgomery—Jerry Gwin, Birmingham, Ala., awarded contract to construct Bankhead Hwy. Walker County, at $135,000.

Ark., Little Rock—P. F. Connelly Paving Co. awarded contract for rebldg. and resurfacing roads at Fort Roots, at approx. $250,000.

Cal., Fresno—Geo. S. Benson & Sons, 247 Douglas Bldg., Los Angeles, awarded contracts for grading and graveling 2 stretches of White's Bridge road, Route 1, Sec. C, county hwy. at $101,960 for part 1, and $80,550 for part 2.

Cal., Fresno—Federal Constr. Co. awarded contract for paving Ventura St. at $73,148; Thompson Bros. contract for paving L St. at $69,654; paving Lucerne Lane at $1,309 and Huntington Blvd. at $14,558.

Cal., Fresno—Contracts for paving county hwys. with asph. conc., Spec. 3, awarded as follows: T. A. Hanrahan, San Francisco, Route 7, Sec. A, Clovis Ave., 4.99 miles, at $102,308; California Constr. Co., San Francisco, Route 11, Sec. B, Elm Ave., 10.13 miles, at $230,658; T. A. Hanrahan, San Francisco, Route 18, Sec. A, Central De Wolf and Wash. Aves., 7.84 miles, at $165,593.

Cal., Los Angeles—Fairchild-Gilmore-Wilton Co., tract for impvt. of Gramercy Pl.—10th St. to Country Club Dr.—at $10,441; Geo. H. Oswald, 366 E. 58th St., award contract for impvt. of Western Ave. —Adams St. to Santa Barbara Ave.—at $93,947.

Cal., Los Angeles—Wm. Liddington, 420 E. 60th St., awarded contr. at $65,857, for paving portion Norton Ave. (concrete).

Cal., Santa Ana—Fairchild-Gilmore-Wilton Co., Los Angeles Ry. Bldg., Los Angeles, awarded contract for improving 3 miles road in Road Imp. Dist. No. 7 near Placentia, at $55,000; Steele Finley, local, awarded contract for asph. conc. surfacing on La Miracad Ave., Brea-Olinda Rd. Orangethorpe Ave., W. Bway., Grand and Euclid Aves., at $58,261, also contr. for grading and paving with 5-in. asph. concrete certain streets in town of Yorba Linda, at $15,742.

Cal., Orland—Warren Constr. Co., Journal Bldg., Portland, Ore., awd. contract for paving 25 blocks at $150,000.

Cal., Yuba City—Galbraith & James, Richmond, awarded contracts for paving Cooper tract and Shasta St. ditsricts in town of Yuba City at $112,825 and $17,557, respectively.

Colo., Denver—C. C. Madsen, Denver, awarded contract for grading and drainage of Broadway at $85,715.

D. C., Washington—Cranford Paving Co. awarded contract for approx. $200,000 worth of asph. paving, including new streets and resurfacing. W. F. Brenizer Co. and Geo. B. Mullin Co. awarded contracts for grading number of streets. Comrs. also ordered that more than 100 streets in all sections of District be treated with oil or tar for protection during winter months.

Fla., So. Jacksonville—J. Y. Wilson Co. awarded contract to pave streets at $129,800.

Ida., Boise—Morrison-Knudson Co., Boise., awarded contrs. for construction of 2 sections of hwy. at $70,000.

Ill., Flora—Lincoln Constr. Co., Chicago, awarded contract for 145 miles hard surfaced road at $165,-728.40. The 7½ miles bet. Louisville and Flora are included.

Ill., Galesburg—Graham-King Constr. Co., Galesburg, awarded contr. for brick paving at $81,000.

Ill., Joliet—J. C. McCarthy Co., Joliet, awarded contract for asph. paving at $66,000.

Ill., Springfield—Frazier-Davis Constr. Co., St. Louis, awarded contract by State Hwy. Dept. to constr. 8.47 miles Route 15, Sec. 2 and 3, St. Clair-Clinton Cos., at $191,776.

Ill., Springfield—Contracts awarded as follows: Powers-Thompson Constr. Co., Joliet, Ill., 6.71 miles com. rd., at $151,704; Wilson A. Jaicks, 232 E. Pearson, Chicago, Ill., .46 miles com. rd., at $9,925; Cameron-Joyce Co., Keokuk, Ia., 8.68 miles at $160,582; H. K. Rhodes, Lincoln, Ill., 7.86 miles at $148,527; Chas. W. Clark Co., Clinton, Ill., 6.78 miles, at $131,990; Keokuk Quarry Constr. Co., Keokuk, Ia., 4.36 miles, at $99,483.

Ill., Springfield—Frazier-Davis Constr. Co., St. Louis, awarded contract for paving Wascoutah-New Memphis Rd. at $191,776. Road is 47 miles long and lies partly in St. Clair and partly in Clinton Co.

Ill., Springfield—Contracts for highway constr. awarded as follows: Jas. A. Sackley, 133 W. Wash. St., Chicago, 1.44 miles, at $44,574; Ernest Berns & Co., Lombard Bldg., Indianapolis, 6.81 miles at $200,333; grading contracts as follows: Ben F. Harrison, 6117 S. Racine Ave., Chicago, 1.52 miles, $5,345 and 3.17 miles, at $47,689, Trnest Berns & Co., Lombard Bldg., Indianapolis, $27,234; Jas. A. Sackley Co., 133 W. Wash. St., Chicago, contract for impvt. of 1.44 miles, at $44,574.

Ind., Petersburg—Contracts for improving roads awarded as follows: Martin & Zinc, Petersburg, 3 sects. of road at $31,631, $30,518 and $49,823; Frank Elkins, Petersburg, Ind., 4 roads, $43,870, $27,840, $23,950 and $18,460.

Ia., Burlington—Pickens Constr. Co., Burlington, awarded contract for paving Main Street at $65,000.

Tenn., Knoxville—Murray Constr. Co. awarded contract for paving E. 5th Avenue and E. Clinch Ave. at $255,417; Mexican oil asph. conc. with 5-in. base and 2-in. surface.

Kans., Ft. Scott—J. T. Dalton & Son, Junction City, awarded contr. for 7 miles bitum. macadam, at $110,000.

La., Amite—Womack, Kent & Blomyer, Inc., Kentwood, La., awarded contr. for constr. of gravel roads and bridges, 16.2 miles, at $154,512; Peterman & Louistalot, Franklin, La., 15.8 miles, at $152,434.

La., New Orleans—L. Biddle and I. W. Ball, McComb, Miss., awarded contract for constructing gravel road (Opelousas-Marksville Hwy.) 22.35 miles, at $93,611. J. C. Wimberly, New Iberia, awarded contr. for 22.35 miles Opelousas—Marksville Hwy., at $95,984; A. D. Lambert Constr. Co., Rapids Hotel, Alexandria, Ala., awarded contr. for grading and draining 25.42 miles Houma-Morgan Hwy., at $34,189; Harvey and Frith, LeCompte, La., contract for bldg. 4 miles Camp Beuregard-Grant Hwy., $15,270.

Me., Augusta—Contract for constr. of highway awarded as follows: J. Arboric, 82 Church St., New

MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation

Motor Truck Operation and Accounting—75

HIGHWAY TRAFFIC AND TRANSPORTATION

(Editor's Note: Following is the 1921 report of the Committee on Traffic and Transportation of the American Society for Municipal Improvements. Prof. A. H. Blanchard, Ann Arbor, Mich., is chairman and Messrs. Robert Hoffman, Cleveland, Ohio, and Charles O. Boyd, Beckley, W. Va., are the other members of the committee.

Investigations conducted during 1921 influence the committee strongly to urge the general adoption, by municipal governments, of the recommendations embodied in its 1920 report relative to the following subjects :

Use of "Dummy Cops" at street intersections.

Installation of "Rotary Traffic" at street intersections wherever practicable.

Design and construction of long radius curb corners.

Economic design of street widths on through thoroughfares in small towns and cities.

Utilization of by-pass highways for towns and cities located on important national, state, and county trunk highways.

Consideration of the installation of motor bus routes in municipalities, when an extension of the public passenger transportation system is required, in view of the resulting advantages of such installations from the standpoints of maintaining the maximum practicable traffic capacity of streets and of avoiding the use of car tracks in roadways.

Wild Cat Jitneys Condemned

Based on a careful analysis of public passenger transportation, the committee considers that it is highly desirable, from the standpoints of economic public service transportation and the efficient use of municipal streets by traffic, that the Society should strongly condemn the development of "wild cat," so-called, "jitney" service. Not only is the installation of such service undesirable from the standpoint of the overcrowding of streets with five-passenger public transportation vehicles, but it is obviously unfair to public service corporations, operating under franchises, to be forced to compete with a "jitney" service which almost universally is operating on an uneconomic basis. The present overcrowding of some of the principal thoroughfares of the City of Detroit with hundreds of five-passenger "jitneys" furnishes a striking example of this type of public service transportation development.

Highway Transport Divisions for Large Cities

Your committee recommends that a Highway Transport Division should be installed in engineering or highway departments of municipalities having a population of over 100,000. The duties of this Division would be to deal with all matters pertaining to traffic and transportation which affect the economic design and maintenance of streets and their efficient use by pedestrians and all classes of vehicles.

One of the important functions of such a Division would be to make highway transport surveys as preliminary to the design and redesign of streets, the determination of efficient methods of maintenance and the formulation of recommendations pertaining to efficient traffic regulations.

A highway transport survey embodies all investigations in the field and office which are necessary to determine the probable amount, character and effects of the future traffic which will use a given highway during the lives of its several component parts. Such a survey for a given street may cover a consideration of all of the following factors: First, all highway elements which affect economic highway transport; second, legislation relative to franchises and rates, weights, dimensions and speeds of passenger cars, trucks, tractors and trailers; third, state and urban traffic regulations; fourth, vehicular and population statistics; fifth, traffic censuses of motor and horsedrawn vehicles and cars operating on tracks; sixth, vehicular operation as affecting roadways and other parts of highways; seventh, present and future traffic and commercial transport developments in such fields as agricultural and dairy farming, mines, quarries, gravel and sandpits, oil fields, lumber tracts, fisheries, plants, factories, wholesale and retail stores, parks and parkways, summer and amusement resorts, and real estate im-

provements, which affect or will affect the traffic on the street under consideration; eighth, common carriers, such as steam and electric railroads and waterway transportation companies and their relationship to street traffic; and ninth, the characteristics of the methods of highway transport such as street car, rural, interurban and urban motor-bus operation, municipal haulage, long and short general rural haulage, rural motor express, intercity haulage, intercity express, and horse transport.

Men assigned to a Highway Transport Division should be experienced highway engineers who have or are rapidly acquiring a knowledge of the following subjects: City planning, highway transport economics, legislation, surveys and methods; highway transport management, including delivery systems, scheduling and routing; traffic regulations; interrelationship of highway, railway and waterway transport; port, terminal and warehouse facilities; and the fundamentals of the mechanism and operation of automobiles, motor trucks, tractors and trailers.

FIVE-TON TRUCK PAYS FOR ITSELF IN 18 MONTHS ON CONSTRUCTION WORK

By G. A. Van Dusen, 685 Greenwood Ave. Detroit, Mich.

I purchased a 5-ton Acme truck in September, 1919, and since then it has not only paid for itself, but has also made me a good living.

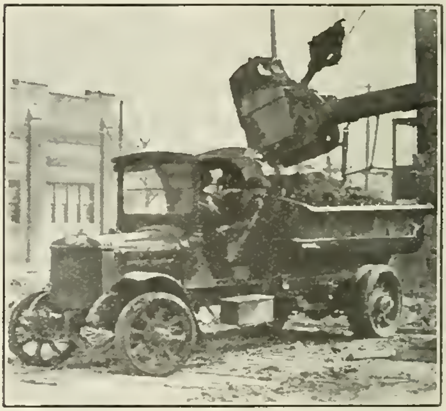
This truck is equipped with a 5yd. dump body and hoist, and was bought especially for road work; but I have been using it on various hauling jobs, such as road building, excavating, hauling building supplies, etc., in Michigan, Indiana and Illinois. During its 18 months of operation the truck has traveled 18.704 miles, and averaged around 35 miles a day.

The mileage per day depends on the job. Some road jobs average around 80 miles a day, while in handling building supplies and ordinary hauling the average is only 20 or 25 miles. The length of time spent on various jobs also varies. Sometimes the job lasts only two or three days, while other jobs may last two or three months.

With my truck I have never hesitated to take on any job which a motor truck had any business to tackle. Excavating work is particularly hard on a truck. It requires going down into an excavation, taking on a load anywhere up to 8 tons, and climbing up a rough, soft incline which would tax any make of truck. And on road building jobs the roads are usually rough, and so hard on a truck.

The truck, I find, will pull through places where other trucks are held up. In fact, some contractors specify their preference for Acme trucks on their jobs, because some other makes are likely to get stuck and hold up the entire job. My truck has pulled many another truck out of a bad place. All the work I go into is hard compared with what a truck on city work runs into.

During the year ending March 1, 1921, the truck traveled 9,456 miles in 270 days. Figured on the National Standard Truck Cost System, it costs $16.05 a day



ACME 5-TON TRUCK AS OPERATED ON CONSTRUCTION WORK BY G. A. VAN DUSEN, DETROIT, MICH.

to operate. This includes $5 a day to me as driver. I am allowing $400 a year for maintenance and repairs. The operating costs, of course, vary according to the work done.

One day I hauled 14 loads of asphalt a distance of 1½ miles, making an average of 7.3 tons per load. The cost of operation was:

Variable expense—42 mi. @ 23.69c..	$ 9.95
Fixed expense—1 day..............	2.76
Driver's wages—1 day.............	5.00
Total operating cost per day.....	$17.71

Hauling 102 tons on this day made the cost of hauling 17.3 cts. per ton, and 11½ cts. per ton-mile. The usual day's work on this job was 11 trips, but on this particular day I got in 14 trips.

On one job I was hauling gravel a distance of 8½ miles, making a round trip of 17 miles. As I hauled 4 loads a day, I covered 68 miles. The roads were paved

all the way, and part of the haul was over city streets. The cost was:

Variable expense—68 mi. @ 23.69c..	$16.10
Fixed expense—1 day	2.76
Driver's wages—1 day	5.00
Total operating cost per day	$23.86

I averaged 6 cu. yds. to the load, or approximately 8 tons. The cost per cubic yard was 99 cts. or 11 cts. per cu. yd.-mile. The cost per ton was 74½ cts., or 8.7 cts. per ton-mile.

On a certain road building job, I usually hauled 10 loads a day a distance of 3½ miles, making 70 miles a day. The roads were good, though slightly hilly. The costs were:

Variable expense—70 mi. @ 23.69c..	$16.58
Fixed expense—1 day	2.76
Driver's wages—1 day	5.00
Total operating cost per day	$24.34

As the truck hauled 6 cu. yds. per trip, the cost was 48.5 cts. per cu. yd. and 11 cts. per cu. yd. mile.

During its first year of operation the truck was a big source of profit to me. I had plenty of work, and was getting $1 a yd. or $4 an hour, according to the nature of the work. In 18 months it paid for itself and earned me a good living besides. The truck has not been operating so steadily lately, but as business is getting better I expect it will soon be busy again.

AVERAGE COST OF OPERATING 5-TON ACME

Owned and operated by G. A. VanDusen, Detroit, Mich.

Cost per day (including driver)	$	16.05
Cost per mile		.4585
Total cost for period		4,335.93
—Operation—		
Days operated		270
Miles traveled		9456
Miles per day		35.02
Miles per gallon of gas		4.5
Miles per gallon of oil		150
—Itemized Cost—		
Driver cost per day (incl. above)	$	5.00
Depreciation per mile	$	.1128
Maint. and repair, actual, total	$	.
Maint. and repair, actual, per mile		.
Maint. and repair, esti., per mile		.0423
Tire cost, actual, per mile	$	.0172

MUSHROOM TRAFFIC LIGHT PREVENTS ACCIDENTS

Ten months ago the first Mushroom Traffic Light was placed in Milwaukee and since then this light has been adopted in many other cities, including Indianapolis, Chicago, Minneapolis, Detroit, St. Louis, Kansas City and many smaller cities. This light, here illustrated, is the latest development in a traffic light or signal that is discernible by day or night, and yet proves harmless if struck by an automobile or other moving vehicle. If one of the wheels of an auto strikes the steel shell it either slides off to one side or may pass over the top without injury either to the light or the automobile. By dividing traffic and keeping motorists where they belong collisions are largely prevented.

The device is an 18 in. hemisphere of brilliant light, rising 8 ins. above the level of the pavement, in the center of street intersections. It is for intersections where the traffic is heavy, but where a crossing policeman is not regularly stationed. The very presence of the signal denotes a busy corner even to the tourist.

VIEW OF THE MUSHROOM TRAFFIC LIGHT.

The National Safety Conference has recommended the Mushroom Light to the Liability Insurance companies as a means of accident prevention, which would lower the cost of insurance and save money to motor vehicle owners.

It is a simple looking thing—a well guarded, brilliantly colored hemisphere—set in the roadway as though one had set a flare in the street, but in reality it is somewhat intricate and is carefully worked out on scientific principles of illumination, and those of psychology, too.

This new light was designed to replace the old iron post or silent policeman that stood majestically in the road, conceived and executed on the lighthouse plan—way up in the air—where a motorist's eye should never be. Let the mariner fix his eyes on the stars, there are no bumps in his road—but the man at the wheel must keep his gaze on the right of way. His line of vision is always down on the

street. There is where the psychology comes in.

The brilliant red, or green, or yellow light, as desired, from this new mushroom light is in line with the eye and is never obstructed by a street car or automobile passing between the driver of the car and the light. It is seen underneath the passing car. It can be put between street car tracks without interfering with the passage of cars or acting as a danger trap for automobiles driving alongside of street cars. Being down in the roadway, the light is always discernible from any angle regardless of approaching or passing cars.

The foundation is set about 4 ins. under the level of the roadway. Above appears the glass hemisphere, made of materials very like that used in kitchen utensils. The design of the grating or covering is where a good part of the science comes in. It is so arranged with reference to lines of illumination and optics that as one approaches the light the angle remains the same; the steel ribs do not appear at all, and the mushroom is always a solid ball of light.

To make the brilliant bit of illumination only two 60 watt lamps are used under the glass. The light of the two bulbs is so multiplied by the refraction of the glass and reflection of the shell that the candle power is seemingly much greater.

Another point to the Mushroom is the way a big truck with an overhang, which was almost bound to hit the silent cop or the iron post, can ride right over the mushroom light and even if it runs over it with a wheel—the heaviest truck made, fully loaded—cannot injure the light.

The first one of these lights to be installed was on an important street corner in the City of Milwaukee, and the city records show that the old iron post (such as is in common use in our cities at the present time) which stood on this corner previous to the time the mushroom was installed, was in an accident on the average of every five days, doing damage to the post to the extent of anything from merely breaking the glass globe on top, which meant an expenditure for the city of ten or twelve dollars, up to the complete demolition of the post, which meant an expenditure of many, many times that amount. This does not take into consideration the damage done to the cars that collided with the post. The amount of that damage is best known to the drivers that hit it. The Mushroom Light that replaced this post has been there nearly a year without one cent of expenditure for upkeep by the city or drivers except painting from time to time.

This traffic light is marketed by the Electrical and Specialty Co., Madison Terminal Bldg., Chicago.

SHORT COURSES IN HIGHWAY ENGINEERING AND HIGHWAY TRANSPORT

The University of Michigan is the only institution which offers courses, of the kind here outlined, for men engaged in the practice of highway engineering and highway transport and which may be taken during leaves of absence of from two weeks to four months. The courses will be offered during the winter period of 1921-1922. These courses will be given in periods of two weeks each. A man may take one course or a group of courses. For further information, write to A. H. Blanchard, University of Michigan, Ann Arbor, Michigan.

December 5 to 16, 1921

C. E. 72. Earth, Sand-Clay, Gravel and Broken Stone Roads. Professor Smith.

C. E. 81. American and English Highway Transport Methods. Professor Blanchard.

December 19 to 31, 1921

C. E. 77. Highway Engineering Financing, Management and Organization. Professor Smith.

C. E. 79. Highway Transport Legislation and Traffic Regulations. Professor Blanchard.

January 2 to 13, 1922

C. E. 78. Grading Machinery and Operations. Professor Bateman.

C. E. 80. Interrelationship of Highway, Railway and Waterway Transport. Professor Riggs.

January 16 to 27, 1922

C. E. 68. Bituminous Surfaces and Bituminous Pavements. Professor Blanchard.

C. E. 82. Highway Transport Costs and Record Systems. Professor Smith.

January 30 to February 10, 1922

M. E. 40. Mechanism, Operation and Maintenance of Motor Trucks, Tractors and Trailers. Professor Lay.

C. E. 69. Highway Laboratory Research. Professor Bateman.

C. E. 70. Highway Structures. Professor Gram.

C. E. 84. Highway Transport Management. Professor Smith.

February 20 to March 3, 1922

C. E. 67. Highway Transport Economics and Surveys. Professor Blanchard.

C. E. 73. Brick, Cement-Concrete, Stone Block and Wood Block Pavements. Professor Bateman.

March 6 to 17, 1922

C. E. 71. Highway Specifications, Contracts and Jurisprudence. Professor Riggs.

C. E. 75. Highway Engineering Seminar. Professor Blanchard.

C. E. 76. Highway Engineering Theory and Design. Professor Smith.

C. E. 83. Highway Transport Seminar. Professor Blanchard.

CONCLUSIONS ON HIGHWAY ENGINEERING COURSE

(Editor's Note: Following are the conclusions relative to highway engineering courses embodied in the 1920 Report of the Committee on "Civil Engineering" of the Society for the Promotion of Engineering Education, as presented at the recent annual meeting of the society by the chairman, Arthur H. Blanchard, Professor of Highway Engineering and Highway Transport, University of Michigan.)

1. In four-year civil engineering curricula without technical electives there should be included a course in the fundamentals of highway engineering aggregating three hours per week throughout one collegiate year.

2. In four-year civil engineering courses with options there should be included a required 2 or 3 hour semester course or a course aggregating 30 to 50 hours in the fundamentals of highway engineering, and optional courses aggregating 6 to 9 hours a week for one semester which would include courses in the theory and economics of highway improvements, highway design and highway laboratory.

3. In not less than ten universities, located in different geographical sections of the United States, there should be offered short period advanced courses covering all phases of highway engineering. These advanced specialized courses should be designed primarily for men who have taken a first degree, who have acquired a knowledge of the fundamental principles upon which such advanced courses are based, and who have had a certain amount of experience in highway engineering. It is evident that such courses should be given under such conditions that it will be practicable for engineers and others engaged in highway engineering to take advantage of the opportunities offered. Such courses, given in a concentrated form in short periods of from two to three weeks during the winter months, constitute the most efficient method of meeting the demand of practicing engineers for advanced technical education in highway engineering. Graduate courses of this type were fully explained in a paper entitled "Graduate Courses for Practicing Engineers," presented before the society in 1916.

4. One engineering institution in each state should conduct, sometime during the winter months, a highway engineering conference, of about one week in length, for the discussion of the highway engineering problems of the state by the engineers and officials of the state, county and municipal highway departments.

VALUABLE TRADE LITERATURE

Skimmer Boom Attachment for Excavator Crane.—The Pawling & Harnischfeger Co., of Milwaukee, Wis., has issued Pamphlet TX, which describes and illustrates the new Skimmer Boom designed for attachment to the standard P. & H. 205 or 206 Excavator-Crane. The point is made that by replacing the standard boom of either of these cranes an efficient road grading machine is provided. In fact, this is similar to the shovel attachment brought out earlier this year and which is designed for use with either of the two types of P. & H. cranes mentioned. Data and operating cost figures on a road grading job done by William Datka, contractor, are included, together with a profile for the road prepared by the county highway department.

How to Build Asphaltic Concrete Pavements.—"Tell me how to do it and make it short." That is the first sentence in the text of the new booklet entitled "Texaco Asphaltic Concrete," recently issued by the Asphalt Sales Department of The Texas Company.

The entire booklet carries out the thought of the first sentence, because it tells in a thorough but brief and interesting manner just how to build an asphaltic concrete pavement. In addition to the literature giving each step in construction, there are excellent illustrations which show how a Texaco Asphaltic Concrete pavement is constructed. Engineers, contractors, or public officials who want a copy of this booklet may get one by addressing the office of this paper or by writing direct to The Texas Company, Asphalt Sales Department, 17 Battery Place, New York City.

Road Maintenance with Tarvia.—The purpose of this new Tarvia booklet is to show the various methods of maintaining pavements of every description. The booklet also describes and illustrates the steps to be taken in patching every type of roadway. These methods are so clearly described and accurately illustrated that by simply following the instructions given any variety of pavement can be easily maintained.

Austin Rollers, Motor and Steam.—This is the title of an exceptionally useful 9x12 in. 64 page catalog recently issued by the Austin Manufacturing Co., Wrigley Bldg., Chicago. Every road roller need is catered to in the Austin line; steam rollers, both coal and liquid fuel burning types; motor driven rollers using gasoline or kerosene are built in three types and a large range of sizes from 5 to 15 tons in weight; Austin tandem rollers are favorites with the paving contractors and city street departments. Country road builders, township, county, state and federal governments have endorsed Austin Steam and Motor Macadam Rollers. The entire line of rollers is fully illustrated and described in this catalog.

Snow Plows.—The Champion and Climax Snow Plows, of the Good Roads Machinery Co., Inc., Kennett Square, Pa., are illustrated and described in this 7x10 in., 32 page catalog, which also contains much valuable information on removing snow from roads and streets.

Steel Pipe.—The manufacture and use of Hammer-weld steel pipe in sizes of 24 to 96 ins. in diameter is described in Bulletin No. 13, issued by the National Tube Co., Frick Bldg., Pittsburgh, Pa.

Asphalt-Block Press.—A bulletin descriptive of their new asphalt block and tile press has been issued by the National Moulding Press Corp. of 262 Fulton St., Brooklyn, N. Y. It is claimed this is the first press of this sort to be placed on the market at a price within the reach of every contractor and plant owner.

Austin Motor Sweepers—This circular illustrates and describes the Austin Motor Sweeper made by the Austin-Western Road Machinery Co., Wrigley Building, Chicago, Illinois. It would be of direct interest to many municipal and county officials. The design of the sweeper is illustrated and described and several views showing it in operation are presented.

BRITON CALLS OUR ROADS NARROW AND DANGEROUS

Alfred Dryland, Chief Engineer for Middlesex County, England, recently came to this country for a six weeks' inspection of highways. His comments are of interest, as for example: "Road-building is making great progress in America, but the great weakness in your system is your partial development of width. Little attention, also, seems to be paid to the edge of the road. There is a large mileage of roads that are not up to date. You have an enormous area to develop. I have traveled more dangerous roads in the vicinity of New York than in my entire 40 years of experience in England. Your roads are dangerous, because the paved widths are too narrow for the amount of traffic they bear. There should be a minimum width of 30 ft. of pavement, affording room for at least three vehicles to pass. The United States, however, is developing excellent pavements. It is only a question of time and money until you will lead the world, both in the quantity and quality of your roads."

THE RESPONSE OF SCRANTON, PA.

To the Editor:

I have read your editorial: "Building or Breadlines," in your September issue, and I take great pleasure in saying that your article hits the nail on the head. Although we are fairly prosperous in the anthracite coal fields, I have called a meeting for the purpose of discussing the question of unemployment and have sent invitations to the following officials and business men to be present: All city officials, county officials and school board officials who have charge of appropriating money for public uses; the president of our Board of Trade, the presidents of the Rotary Club and Kiwanis Club, the presidents of our largest banks, the publishers of our daily papers and other business men whom I know will give their best advice on the question of unemployment.

Very truly yours,

ALEXANDER T. CONNELL, Mayor,
Oct. 10, 1921. Scranton, Pa.

EDITORIAL

ARE WATER DEPARTMENTS AND COMPANIES LIABLE FOR FIRE LOSSES WHEN WORKS DO NOT FUNCTION PROPERLY

Of vital interest to every water utility in Indiana, whether privately or publicly owned, and of great interest and concern to every water works and other public utility man in the entire country is the New Albany (Ind.) water works case which has passed through the Appellate Court with a decision against the utility, and in which the Supreme Court of Indiana has been asked to take jurisdiction.

Very briefly, the New Albany Water Works was sued for $25,000 damages on account of a fire loss which, it is contended, could not have occurred but for the fact that a fire hydrant, immediately across the street from the damaged property was out of order. The lower court was not in sympathy with the claim against the utility and the case was carried to the Appellate Court which held in favor of those who suffered the fire loss. The utility then filed a petition asking the Supreme Court to take jurisdiction and several briefs in support of the petition for transfer to the Supreme Court have been filed, by permission of the Court, of course, by attorneys for both publicly and privately owned water utilities in Indiana.

It seems, therefore, that if the views of the Appellate Court are sustained by the Supreme Court, not only private water companies but municipal water departments as well will be subject to damage suits whenever there is a fire loss and a suggestion is made that some part of the water works system was not functioning properly, thus contributing to the extent of the fire loss. In other words, if this view prevails, all Indiana water utilities will find themselves in the fire insurance business, so far as liabilities are concerned, but without collecting any premiums or fees for assuming such risks. Is it any wonder Indiana water works men are disturbed at the possibilities inherent in such a state of legal opinion?

The utility under discussion formerly operated under a franchise granted by the city, but sometime before the fire in question occurred, surrendered its franchise to the city and received an indeterminate permit to operate under the Indiana State Public Utilities Act and to render the same service as provided for in the original franchise, including fire hydrant service. Now it is conceded by all parties that under the common law as interpreted by the Indiana Supreme Court, as well as by the courts of other jurisdictions, there was no liability to the individual citizen of the municipality for the reason that there was no privity of relation between the citizen and the utility. The question of the common law liability has not, therefore, been involved in this case and the utility's liability, if any, comes under the provisions of the State Public Service Act.

The State Public Service Act provides, among other things, that when a utility surrenders its franchise and receives by operation of law in lieu thereof an indeterminate permit to operate, the permit is held under all the terms, conditions and limitations of the Act. The Act also provides (Sec. 7) that every public utility is required to furnish reasonably adequate service and facilities. Section 116 of the Act provides: "If any public utility shall do or cause to be done, or permit to be done any matter, act or thing in this Act prohibited or declared to be unlawful, or shall omit to do any act, matter or thing to be done by this Act, such public utility shall be liable to the person, firm or corporation injured thereby in the amount of the damage sustained in consequence of such violation."

The utility claims that the Public Service Law does not provide for any liability of a public utility that did not exist prior to its enactment, while it is contended by the other party to the suit that by passage of the Act Indiana has fundamentally changed the law governing Public Service Corporations, and that under the Act the management and control of such corporations has been taken over by the State and by statutory enactment the State has determined the obligations, duties, rights and liabilities of such corporations, not only to the State and the municipality in which they operate, but to the general public and the individual intended to be served by such Public Service Corporation, and that by such enactment a liability has been created where none theretofore existed.

The judge of the Appellate Court who

pronounced the decision against the utility, in the course of his decision, said: "Recognizing as we must, that before the passage of such Public Service Act there was no liability on the part of the public service utility to an inhabitant of a city within which such corporation was operating under a franchise for injuries suffered by such inhabitant because of the negligent acts of such public service utility, we are wholly unable to interpret the sections aforesaid, Nos. 7 and 116, of the Public Service Act, so as to make them simply an enactment of the common law principle theretofore established and by such interpretation thereby make the provisions aforesaid an absolute nullity. By the use of language so plain of understanding and so easy of interpretation, we must hold that the legislature intended thereby to change the law so as to create a liability that did not theretofore exist, and it has created a liability in favor of the individual injured because of the negligence of such public service utility in failing to furnish reasonably adequate service of water for fire protection."

Sections 7 and 116 of the Indiana Act are substantially copied from corresponding sections of the Wisconsin Act except that the Wisconsin Act provides for treble damages and was interpreted by the Wisconsin Supreme Court to be penal and hence covering only wilful breaches of duty, or breaches in which there is some element of wilfulness, wantonness or evil design. The Indiana Appellate Court calls attention to the omission of the word "treble" in the Indiana Act "thereby making the trespassing corporation liable to the person, firm or corporation injured only in the amount of damages sustained in consequence of its violation of the law."

This significant statement is embodied in the decision of the Appellate Court: "The question involved was the interpretation of the statute, and we must confine ourselves to its interpretation as it is written, and if when so interpreted it seems to inflict undue hardship upon the parties affected thereby, that is a matter for the future consideration of the legislative department of the State."

The utility has asked the Indiana Supreme Court to take jurisdiction in the case and render a decision in the premises on the grounds that the Appellate Court in its decision overrules ruling precedents of the Supreme Court and erroneously decides a new question of law. As stated, several briefs have been filed by "friends of the court" and others may be filed if it is felt all points have not already been covered.

Of course this magazine has no way of knowing whether the Supreme Court will take jurisdiction in the case or not and if it does what its decision will be. But this much is evident to all: The opinion of the Appellate Court, if upheld, will create an intolerable and hazardous situation for every water, or similar public utility, in the State of Indiana. Moreover, as all the State public service laws are fundamentally much alike, a final adverse decision in Indiana is bound to make expensive trouble, when cited as a precedent, for public utilities in other states. The case, therefore, is of national importance.

This case, based on the condition of a fire hydrant, ideally illustrates the impracticability of assuming such liabilities as the Appellate Court reads into the Indiana Act. Every water works man knows that the use of fire hydrants for unauthorized purposes is a very difficult thing to control. A water department or company may leave a hydrant in perfect condition when along comes an employee of the Street Department, or a contractor's foreman, and opens the hydrant. He may injure the mechanism of the hydrant in closing it, or may not completely close it and it fills with water and freezes. Revolving nuts are sometimes turned the wrong way and broken, or so battered by pipe wrenches that standard wrenches, when later applied, will not open the hydrant. Practically speaking, it is an absurdity to hold utilities legally responsible for such common occurrences as these which cannot be entirely eliminated by painstaking routine inspection.

No time should be lost in planning amendments to State public service acts, where they are needed to restore and safeguard the original, common law rights of public utilities, and these amendments should be enacted into law at the earliest possible moment; for so long as there are courts who are at all likely to view this matter as the Indiana Appellate Court has done, such provisions as are contained in Section 116 of the Indiana Act are a menace to the existence of public utilities. Such legal decisions will make the ownership of public utilities so hazardous that communities as well as private business corporations may well decline to engage in such enterprises. The menace of such decisions must therefore be removed by amending the basic laws.

BITUMINOUS CONCRETE PAVEMENT BETWEEN INDIANAPOLIS AND GREENWOOD, IND.

By G. R. Harr, Office Engineer, and R. E. Simpson, Project Engineer, in charge of construction of this Project, Indiana State Highway Commission, State House, Indianapolis, Ind.

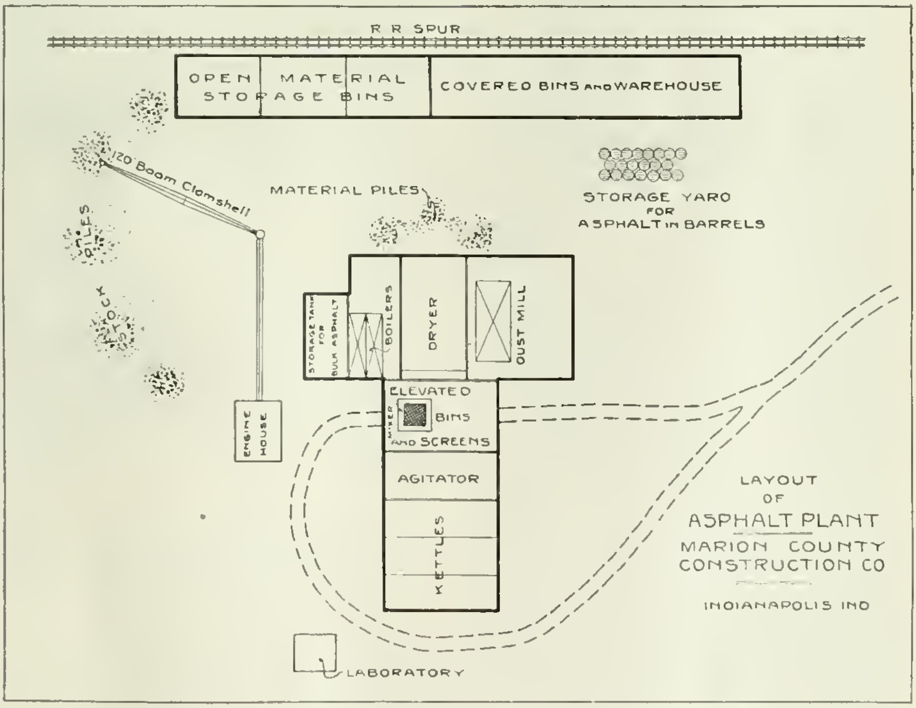
Although estimates are made and bids are received by the Indiana State Highway Commission for three types of hard surfaced pavements on every road improved by it, in but two instances have roads been constructed with Bituminous Concrete. One of these is that part of the Michigan Road between South Bend and the Michigan State Line and the other is the Madison Road between Indianapolis and Greenwood, a part of the Jackson Highway, known as State Road No. 1, Sections A and B.

Surveys were made and plans partially prepared by the first commission which was organized under the 1917 law. When the commission was reorganized, in May, 1919, the plans for the Madison road were revised and rushed to completion. In the preparation of these plans it was intended that the old macadam roadbed should be used as a foundation for the new pavement wherever possible. Consequently the excavation was rather light, averaging 3,150 cu. yds. per mile.

At the first letting held by the commission the contract for the improvement of this road was awarded to the Marion County Construction Company, Indianapolis, Ind., the only bidders, for a Bituminous Concrete Pavement. This pavement consisted of a 6 in. concrete base course, 1 in. binder course, and a 1½ in. wearing course. The contract was awarded on July 19, 1919, and construction was started a few days later.

Central Mixing Plant Used at Outset

The contractor's scheme of construction was to begin at the north end of the project, the south corporate limits of Indianapolis, and work south. A central mixing plant, for the construction of the concrete base, was erected about two miles south of the city, to which materials were to be brought by truck and the concrete was to be transported to the grade in other trucks. For this purpose five 2½ton Nash Quad trucks were rented from the commission. As soon as sufficient base was laid to permit the asphalt plant, which was located in Indianapolis, to operate continuously for a few weeks it was intended to lay the surface, starting at the southern extrem-



LAYOUT OF ASPHALT PLANT OF THE MARION COUNTY CONSTRUCTION CO. ON THE INDIANAPOLIS-GREENWOOD, IND., BITUMINOUS CONCRETE ROAD.

ity of the base and work north. The bituminous concrete was to be hauled from the plant in 5 ton trucks owned by the contractor, the average haul being about seven miles.

Bonding Binder and Base

Considerable trouble was had in finding a local gravel plant that could furnish material which would meet the specifications for mechanical analysis and work on the base course was not started until Oct. 13, 1919. Meanwhile the contractor had completed the cross drain culverts and grading for a distance of about two miles south of the north end as well as considerable grading further south. About 2,500 lin. ft. of base was built. It was found that tamping the concrete with a tamp having a smooth face left the base too smooth, for a good bond between it and the binder course, so several reinforcing bars were fastened across the face and the desired roughness given the base with it. Construction was continued until Nov. 22nd, when work was closed down for the winter.

Central Mixing Plant Discarded

During the winter the contractor made arrangements to use crushed stone for coarse aggregate and as the progress with the central mixing plant, on the construction of the base course, had not been what was desired, they decided to abandon it and use another construction scheme. Stock piles of stone and sand were distributed at intervals of 500 ft. along the finished grade. An 18E Koehring Paver was obtained and when the construction season of 1920 was opened the aggregates were loaded into two-wheeled one-horse dump carts in the proper proportions, hauled and dumped into the skip of the mixer. Cement was brought in sacks from storehouses on a light truck and was dumped directly into the skip. As the crushed stone was difficult to handle with shovels, a Keystone Skimmer which had been used in making the grade was tried out at the stone stock piles and very satisfactory results were obtained using it to load the stone.

The concrete base is 6 ins. in thickness at all points, the sub-grade being given the same crown as the pavement. A curb 6 ins. wide and 2½ ins. in depth is built on each side of the base. This curb was built monolithic with the base, although the mix for the base is 1:3:6 while that for the curb is 1:2:3. The total width of the pavement is 18 ft. and the pavement is given a crown of 2 ins.

The Bituminous Surface

On May 3, 1920, the laying of the bituminous surface was begun. This consisted of 1 in. of closed binder and 1½ in. of surface, a Topeka type of asphalt concrete. This first run was made with Trinidad asphalt, although Aztec Mexican oil asphalt was used on some other runs. No more binder was laid in one day than could be covered by the following day's run of surface course. A sketch of the layout of Bituminous plant used for this work, shown herewith, was a very well arranged and efficient plant.

Transportation difficulties and inefficient labor common to all construction work during the 1920 season retarded the progress of the work so that the end of the season found the contract only 74 per cent complete. A feature of last year's construction was the last run of surface laid in the first week in December with a haul of 7½ miles. In spite of the low temperature and long haul, this run was closed even better than some of the surface laid earlier in the season. This was due to the efficient work of the men both at the plant and on the road.

All grading was completed before the construction season opened up in 1921 and rapid progress was made with the base course when the work was started. This year, with more efficient labor and better transportation, the true efficiency of the scheme of construction was demonstrated. An Indianapolis plant was able to furnish satisfactory gravel and the last part was constructed with it as the coarse aggregate. The last surface was laid on June 30th and the road was immediately opened to traffic.

Cost

This project is 7.307 miles in length, constructed at a cost, exclusive of bridges over 20 ft. clear span, of $284,065.48. Two bridges of over 20 ft. clear span were constructed under separate contracts at a cost of $14,768.12. This added to the cost of the road makes a grand total of $298,-833.60. Average cost per mile, including bridges, $40,896.89; exclusive of bridges, $38,721.30.

USING SEWAGE SLUDGE GAS FOR POWER PURPOSES

The possibilities of sewage sludge gas as a driving power were discussed before the Engineering Section of the British Association meeting at Edinburgh recently by Mr. John D. Watson, engineer to the Birmingham, Tame and Rea District Drainage Board, and reported in The Surveyor of London, as follows:

At Birmingham, said Mr. Watson, recent experiments had shown that it was practicable and economical to drive a suction gas engine with gas derived from sewage sludge. That organisms acting on decaying vegetable had contributed to the formation of gas capable of being put to use was not unknown to the scientific world, but, suggested the speaker, to employ gas emanating from sewage sludge to drive plant which formed an essential part in an installation for the purification of sewage was an achievement calculated to interest the economist.

Mr. Watson pointed out that the volume of wet sludge dealt with at Birmingham was not less than 400,000 tons per annum. Similar volumes were sent out to sea from Glasgow and Manchester, and correspondingly less from Dublin and Southampton, but from London not less than 2,000,000 tons were shipped every year. He estimated that from Birmingham alone 9,000 tons of dry solid matter were available to produce 320,000,000 cu. ft. of gas, which was equal to 16,000,000 horse-power hours, taking 20 cu. ft. per brake horse-power, which was equivalent to 4,400 horse-power per day of 10 hours. If one were to be guided by the yield of gas from sewage at Parramatta, New South Wales, these power estimates would be considerably higher, but even after allowing for errors in calculations the volumes of sludge capable of being gassified in our great cities were startling. What was possible in a climate like Australia's, however, was not necessarily obtainable in the British Isles, and he therefore confined himself to facts and experience obtained from Birmingham sewage and the experimental station which formed part of an auxiliary work in course of construction at Cole Hill, where neither electric nor coal-gas mains were available for power.

The plant was designed to give 25 brake horse-power for a working period of six hours per day. It was working under many disadvantages at present, which would not have been the case had there been more knowledge of the subject available when the plant was designed and more confidence in the ultimate success of the experiment. For instance, the gas holder, which was an essential feature of a smooth working plant where gases of varying quantity had to be evenly diffused, was not yet erected, its erection having been delayed until the result of the experiment justified the expense.

Notwithstanding drawbacks, the material fact arising out of the experiment was the successful trial run of the engine and pump and the low cost of gas production. The engine was a standard town gas engine, capable of giving 34 brake horse-power maximum with town gas having a calorific of 500 to 550 B. T. units, and judging from the experience already obtained there was every reason to expect gas of a higher calorific value, probably 650 to 700 B. T. U. Given a regular supply of gas perfectly satisfactory results were assured, and it might be assumed that the engine would require no more attention than the standard gas engine working on town gas.

It was, remarked Mr. Watson, in conclusion, too early to dogmatize upon what were the most favorable conditions, but it was the duty of every local authority in these days of enforced economy to see that the gas that had hitherto been disposed of as something which was of less than no value was utilized when possible and practicable.

USE OF DRAINAGE WELLS ON HIGHWAY CONSTRUCTION IN NEW MADRID COUNTY, MO.

By Edwin S. Austin, Secretary, State Highway Department, State House, Jefferson City, Mo.

Building roads in Missouri requires the solution of more types of engineering problems, perhaps, then in any other state. Because of its peculiar topography, highway building necessarily takes on difficulties of mountain construction, and on the prairie land a different construction is required. The flat country in Southeast Missouri requires the solution of even more difficult problems in road building. Particularly is this true on a new road now under construction in New Madrid County.

New Madrid is the oldest settled county in the state, and was the center of what was known as the "New Madrid Earthquake," which destroyed many lives, 150 years ago. This land is of peculiar formation, and until drainage ditches were constructed the land itself, in many parts of these counties, was covered mostly with swamps. The construction of the drainage ditches eliminated the swamps, and resulted in the formation of large tracts of almost level land for miles and miles, as rich as any land in the valley of the Nile. The soil is composed of rich loam, in which at intervals are what is known as "Sand Blows."

South of Sikeston, in Scott County, and through New Madrid County, is a ridge of land that is hardly discernable without the use of instruments. The surface of this ridge is perhaps 10 ft. higher than the surrounding country. It extends for many miles, and takes the name of "Sikeston Ridge." It has an average width of two miles, and it is right down the center of the ridge, south of Sikeston, to New Madrid, a distance of some 20 miles, that a road is now being constructed.

The road itself is part of the "King's Highway," and will be one of the most important thoroughfares of the state after it is hard surfaced. At present it is a gravel project 16 ft. wide. The contract price was at the rate of $9,735 per mile, and the total cost will be $189,839.76 when completed.

Drainage Presents Greatest Difficulty

The particular feature of this road, and the greatest problem which had to be solved in its construction, was the matter of drainage. Owing to the level surface of the ridge it was impossible to carry off the water in any other way than to construct what is known as "wells" at intervals on both sides of the road. These wells are built of 36 in. vitrified pipe, placed in the ground to a depth varying from 17 to 20 ft. At that distance a coarser sand is found, and the water, when it reaches there, is dissipated, and taken up in quantities. There are some 20 or 30 of these wells in the 20 miles of construction, and the water flows to the points where the wells are located and disappears. This method of disposing of surface water had been in vogue in Southeast Missouri at a number of points for a great many years. It had been found that it was the most satisfactory method of securing proper drainage and the disposal of surface water. So far as completed, these highway wells keep the surface of the ground practically clear of water, even when the rains are severe.

Outside of this Southeast Missouri district such methods of drainage have not been undertaken at any other point in the state. But here, in the flat country, it is absolutely necessary to make some provision for drainage, and these wells have been entirely satisfactory, and, it is believed, will prove so in the future.

For that reason this 20-mile project in New Madrid County is something unusual in the way of surface drainage and an interesting problem in highway construction.

REVOLVING SPRINKLERS FEATURE NEW SEWAGE DISPOSAL PLANT AT LEBANON, IND.

By L. A. Geupel, Director of Water and Sewage Department, Indiana State Board of Health, State House, Indianapolis, Ind.

The sewage of Lebanon, Ind., flows into a 24-in. tile interceptor and empties into Prairie Creek. Prairie Creek is a very small stream which can be crossed by a single step in dry seasons. The sewage, about 500,000 gal. per day, flowing into the small stream putrified and an offensive odor came from the stream for many miles below Lebanon.

Local Conditions

The nuisance created became so bad that in February, 1914, a petition was sent the State Board of Health stating that "the city of Lebanon, in Boone County, is discharging and is permitting to be discharged into said Prairie Creek the sewage from the city and is thereby materially injuring, for domestic use, the character of the water in said Prairie Creek to the injury of the public health and comfort."

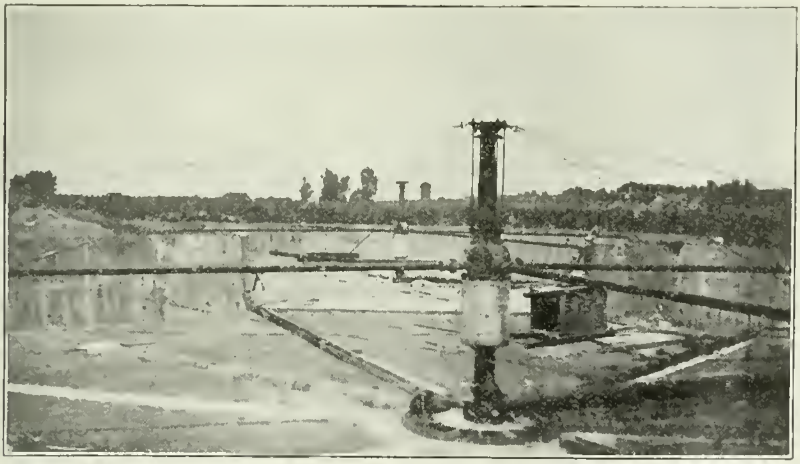
On receipt of the petition an investigation was made by the Water Works and Sewage Department of the State Board and a recommendation made that "the city of Lebanon be ordered to abate this nuisance by elsewhere disposing of its sewage or by the construction of a purification plant." An order was issued by the State Board of Health on October 9th, 1914, to the city of Lebanon to cease the pollution of the water in Prairie Creek by the discharge of its raw and unpurified sewage and to make an order waiving a trial and hearing before the State Board of Health. The records show that on Nov. 9, 1914, the Common Council acknowledged service of notice and made an order waiving its right to trial and hearing before the State Board of Health.

On June 29, 1915, the Secretary of the State Board of Health finding that the order of the Board had not been carried out, addressed the Attorney General of Indiana advising him of steps taken and requesting his legal advice. On June 30, 1915, the Attorney General replied that since the order had not been complied with by the city of Lebanon he would take legal action at once. Records, however, show no such legal action to have been taken. On Nov. 13, 1919, a conference was held at Lebanon with the City Attorney, City Clerk, City Engineer, and one of the petitioners and the information gained was that at this time the city was trying to buy the land around the outfall of the sewer. The City Council passed a resolution directing the City Engineer to make investigations relative to the construction of a sewage plant for the city. After delay caused by the high prices of materials and labor, Mr. Charles Brossman, Consulting Engineer, Indianapolis, Ind., was retained, made investigations and drew up the plans and specifications for a sewage disposal plant, the construction of which started early in the year 1921.

Essential Features of the Plant

The sewage from the city of Lebanon flows through a 24-in. tile under the Pennsylvania Railroad fill and into an intercepting concrete manhole, where it can either be led by shear valve control into the sewage disposal plant or by-passed to the creek through the old line. As the sewage enters the disposal plant it flows into the concrete screen chamber where again by sluice gate control it may be by-passed to creek if necessary. The sewage passing through an inclined bar screen with openings about 1 in. wide is pumped by either of two Midwest motor driven centrifugal low head pumps into distributor canal. One of the centrifugal pumps is piped up and controlled by valves which makes it possible to pump from and to any one of the three compartment settling tanks or from and to the sludge chamber. A third suction line is placed through the screen chamber concrete walls for use with a future pump and is blanked in the pump room.

The sewage flows from the pumps into a reinforced concrete distributor trough through three tee openings in the pipe line so as to give an even distribution in the trough. From the trough the sewage flows through six 12-in. openings striking on an inclined baffle built across No. 1 concrete sedimentation basin making an even flow and distribution into the first basin. The sewage in No. 1 basin rises to a certain height and is allowed to flow evenly over the side opposite to distributor trough into No. 2 basin and from No. 2 basin flows into No. 3 basin. Between No. 1 and No. 2 basins and No. 2 and No. 3 basins there are baffles (wood construction) so as to retain the scum. There are also gates constructed in the baffles through which the scum can be conducted from one basin to another.



VIEW OF SPRINKLERS ON SEWAGE FILTERS AT LEBANON, IND., BEFORE BUILDING WELLS AROUND THEM.

The bottom construction of the concrete sedimentation basins is an inverted pyramid, with the apex down which is the low point and forms the sump for the sludge line suction. Each basin also is connected so the sewage can be pumped out of the basin without breaking the scum or pumping sludge. From the third basin the sewage rises through adhesion racks to a reinforced concrete canal leading to the dosing chamber.

Adhesion Racks

The adhesion racks are made up of wooden grids with openings about ½ in. wide. The racks can be raised so that they may be cleaned. The function of the racks is to retain any floating moss or matter carried along with the sewage.

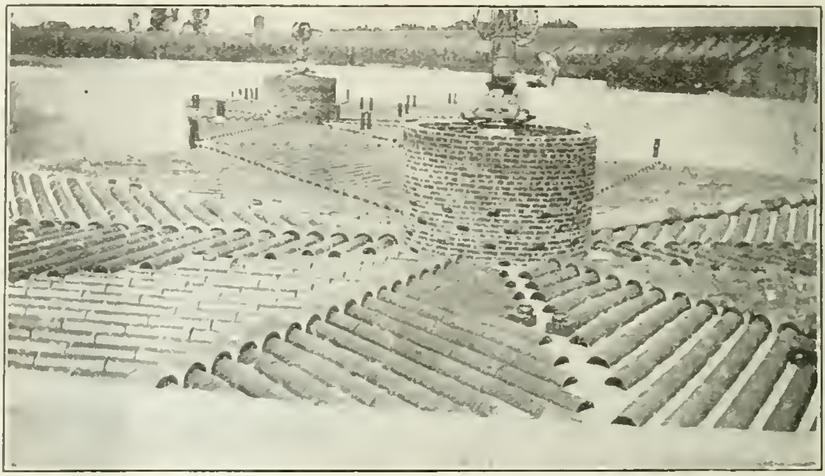
The dosing chamber is built to the left of No. 3 sedimentation basin and has a flat bottom and one corner of it forms the inlets to two syphons with a connection for the third. The sludge chamber is built to the left of No. 2 and No. 3 sedimentation basin and has the same bottom construction as sedimentation basins so that the sludge may be pumped in or out.

Over the screen chamber, pump room, three sedimentation basins, sludge chamber and dosing chamber there is constructed a common roof frame construction covered with prepared roofing.

As the sewage flows from the syphons it leaves the pumping and sedimentation building thereby having completed its first treatment, which is the treatment and action performed by the anaerobic bacteria.

The Filters

The sprinkler filters (two in number) are constructed of reinforced concrete, circular in form, about 80 ft. in diameter intersecting each other. The under-drain system consists of eight main laterals radiating from a brick receiving manhole constructed around the sprinkler machine. The main lateral channels are constructed in the concrete floor draining to the center manhole and are covered with split tile which covers also the mouth of each lateral. The laterals are placed 18 ins. apart and are made of 8-in. spilt tile imbedded ½ in. in the concrete floor. The sprinkler beds are built up cf 14 ins. of 2-in. sharp rock and covered



VIEW OF TWO SPRINKLING FILTERS AT LEBANON, IND., SHOWING UNDER-DRAINS AND WELLS IN PLACE.

Revolving Sprinklers

From the syphons the sewage is forced through tile lines into the sprinklers. These sprinklers are unique as they operate revolving and spraying the filter beds under a very low head (2 ft.). The sprinklers are of galvanized metal construction and are manufactured by the Adams Hydraulic Limited, London. The sewage flows into the center of the sprinkler which operates in a water seal and flows out through four openings from which spray pipes lead on horizontal right angular axes out over the bed. The spray pipes are held in place by wire rope guys and braces. Three-sixteenth holes on one side equally spaced to give good distribution over the width of the bed, produce the centrifugal force which causes the sprinkler to revolve.

with 4 ft. 4 ins. of 1-in. sharp rock. After the sewage is sprayed on the beds it passes through 5 ft. 6 ins. of gravel, through the tile underdrains back to the manhole in the center from hence by an 18-in. tile line to the creek.

The inspection showed the concrete work smooth and hard. Every precaution was taken to make the plant watertight and difficulties were encountered due to part of the plant being built under the ground water level.

The writer is indebted to Mr. Charles Brossman, Consulting Engineer on the plant, for courtesies received while on his visit to this plant and also for the pictures shown herewith.

LANCASTER, OHIO, PAVES ALLEYS WITH BRICK FROM PAVEMENT BUILT 33 YEARS AGO.

By Walter W. Graf, City Civil Engineer, Lancaster, Ohio.

The city of Lancaster, Ohio, had an experience with vitrified paving brick this summer that thoroughly demonstrates the durability of this wearing surface for heavy traffic city streets and country highways. The question, "What is a worn-out brick?" remains unanswered so far as our experiences are concerned.

Brick Laid in 1888

In the spring of 1888 the city paved South Broad street, its first hard surfaced thoroughfare, with 2½x4x8 in. vitrified brick on an 8 in. local gravel foundation and a 1½ in. sand cushion with bituminous filler.

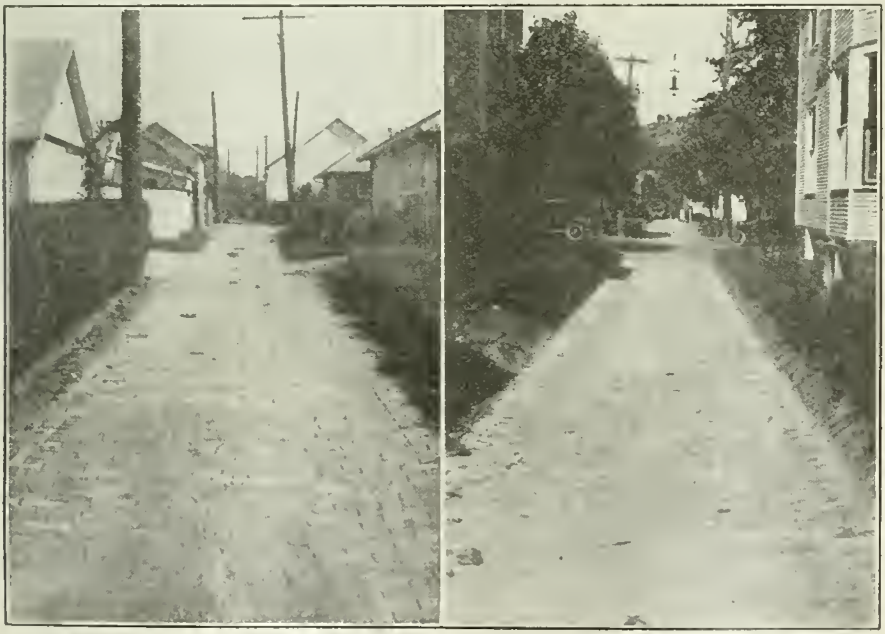
It is said by old residents that neither the gravel base nor the sand cushion was rolled, but that the brick were placed on a loose foundation and rolled with a wooden roller weighted down with pig iron.

This street has had probably the heaviest traffic in the city. All of the freight for several large manufacturing plants, one a heavy castings foundry, has been hauled over Broad street for the last 33 years. Traffic was particularly heavy during the world war.

All traffic seemed to travel in one path as on a country dirt road from the day the pavement was laid. A street car track divides the 52 ft. roadway down the center. As was the practice in that early day, the street was built with an unnecessarily high crown and this also tended to keep traffic in the beaten path. The result of this was that all weight, impact and wear and tear was centralized instead of being distributed over the entire pavement.

Repaving Ordered

With the unexpected increase in heavy motor traffic in recent years the gravel base as constructed proved unequal to the task, and the pavement became rough in the tracks made by the traffic. Repaving was ordered.



VIEWS OF ALLEYS IN LANCASTER, OHIO, PAVED WITH BRICK TAKEN FROM A STREET PAVEMENT 33 YEARS OLD.

When the work was begun the engineering department had no idea that the old brick would be of any value and a steam shovel was started through them. Upon cutting into them it was discovered that those brick in the traffic tracks, although worn down in some instances to not more than 1 in. in thickness, remained unbroken, which speaks very well for brick as a type of pavement for heavy traffic.

Property Owners Want Old Brick for Use in Alleys

It was also discovered that by far the

larger number of brick still were in excellent condition. These were ordered piled up along the street by Service Director Ernest Rowles. Very soon there came a demand from property owners who wanted the used brick for the purpose of paving alleys.

The city offered to furnish the brick to property owners who would agree to pave an alley of at least one block in length. Very soon the demand far exceeded the supply and the brick were all hauled away before the contractor had an opportunity to pile them alongside the street. The property owners sent their own teams and trucks, assorted the brick as they were torn up, and hauled them away.

Mr. Carl Garling, a local contractor, was hired by the property owners to do the construction work and the city engineering department furnished the necessary engineering without cost. The contractor did the work on a cost-plus basis which was pro-rated on the abutting property according to the frontage on the alley.

The Alley Pavements

The type of construction was as follows: 5 in. rolled gravel foundation, 2 in. sand cushion and sand filler. The worn side of the brick was turned down, leaving the smooth side for the wearing surface. With an average of about 1 ft. of grading to do, the cost per abutting foot was about 60 cts. for a 9-ft. alley. Five squares of city alleys were paved.

It is the opinion of this department that the improvement is good for 50 years under alley traffic conditions. This would mean a service life for the brick of 83 years. We were informed the other day that all of the old brick have been spoken for in case we repave any more brick streets.

HIGHWAY ILLUMINATION ON ALBANY-SCHENECTADY ROAD

By C. H. Huntley, General Office, General Electric Co., Schenectady, N. Y.

The danger of glaring automobile headlights to motorists, to pedestrians and to the drivers of horse-drawn vehicles has long been apparent. Continued reports of accidents due to this cause show how great the menace is. How to overcome it has been one of the principal problems confronting those anxious to promote the safety of highway travel and reduce the shocking number of casualties that figure so constantly in the news columns.

A new lighting system for highways has been devised by the General Electric Company; and, tried out under exceptionally exacting conditions, it has proved a solution of the problem according to those who have observed its effects—and this number includes motorists, pedestrians, engineers and people living along the roadway where it has been installed.

Essential Feature of Lighting System

Its essential feature is a nest of three parabolic reflectors, one inside another, and with an opening in each reflector on each side of the Mazda lamp enclosed. Thus, the greater part of the light that would otherwise be lost by reflection upward, and outward to the neighboring fields, is collected and cast both ways

HIGHWAY ILLUMINATION ON THE ALBANY ROAD NEAR SCHENECTADY, N. Y.

along the highway. The inner reflectors pick up the rays of light that would escape if only one reflector were used, and direct them toward the surface of the road at an angle of 10 degrees below the horizontal, giving the same effect as an overhead reflector 15 ft. in diameter. The glare from the incandescent lamp is reduced by the white reflecting surfaces of the unit without the aid of diffusing globes. The bracket which holds the unit is adjustable either vertically or horizontally, so that the unit may be placed on poles near the roadway or some distance from it, and may be turned so as to illuminate curves and hillsides. This range of adjustment makes it possible to keep the opening in the lower part of the reflector parallel and in line with the surface of the roadway under any condition. The light may be thrown just where it is needed.

Two Miles of Road Illuminated

This system has been installed along a section of the Albany-Schenectady state highway for a distance of about two miles eastward from the Schenectady city line. The lamps are bracketed on poles, 30 ft. above the roadway, at intervals of from 300 to 500 ft., one 250 candlepower Mazda lamp, consuming 159 watts, being used in each fixture.

Travel over this road is very heavy. The highway is the main thoroughfare between Albany and Schenectady, and it is also a link of one of the great east and west routes of general tourist travel. Conditions are complicated by the fact that there is a large suburban population living along it, especially near the city lines, and the road is therefore much used by pedestrians. Casualties have been numerous among both motorists and pedestrians.

By the installation of this new system the glare of approaching headlights has been eliminated. The roadway is so thoroughly illuminated that motorists can drive in perfect safety with the lights of their cars turned off. Pedestrians and approaching vehicles are plainly visible for a long distance, and the dark spot between two passing cars is eliminated.

Comments on Results Attained

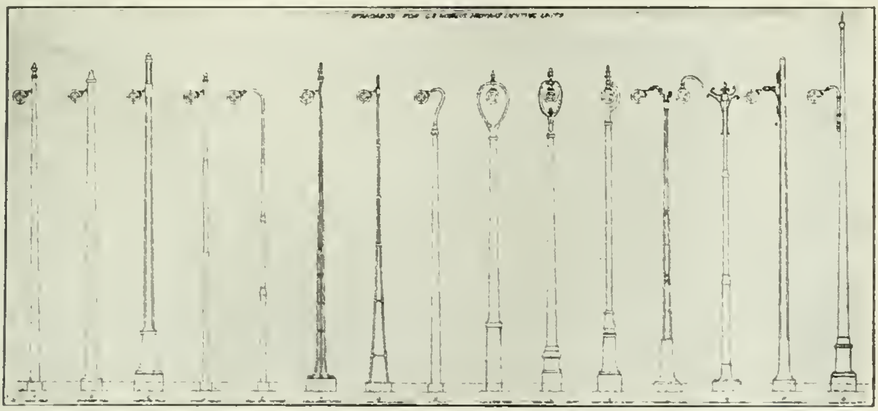
Motorists who travel over this road, and persons living along it, are enthusiastic in their endorsement of the illumination. Two comments on it, made from different standpoints, are typical of the others:

"The lights are a great improvement," says a physician who lives in the territory traversed by the lighted section. "Only those who live out here and have been without lights can appreciate them. Sunday night it was pouring, but all the people coming from church walked out on the road and felt that it was perfectly safe to do so. I was able to read on the front porch of my house by the light from the highway lamps. Inside the house, with all the lamps in the house out, the rooms are flooded with light, very much as they would be when the moon is full—and it is only reflected light we get."

An eminent engineer, viewing the installation from the standpoint of a motorist and a citizen desirous of remedying the dangerous travel conditions of the highway, says of it:

"I have examined the lighting installation which has been made upon a section of the state road between Schenectady and Albany and want to express my opinion of the great value of this improvement, which, by a very simple, durable and inexpensive means, removes all the great dangers and inconveniences of night travel on this road where fatal accidents have for years been of frequent occurrence, and where night travel has been a worry and a strain to all who have had to use it.

"This arrangement distributes the light generated by a small power consumption along the line of the road in such a manner that cars and people can be seen a mile ahead, so that it is as easy and safe to run without headlights as with them. Even the glare of headlights on approaching cars does not for a moment obscure the road or its borders. The addition of such lighting would increase the expense of construction and maintenance of a road by a very small percentage. The improvement afforded is certainly greatly in excess of such expenditure, and this lighting should be put upon every important highway, particularly where it runs through populous districts, as is very frequently the case near cities. The facility of automobile travel on these roads causes residences to be distributed along them



VARIOUS STANDARDS FOR G. E. NOVALUX HIGHWAY LIGHTING UNITS.

for many miles, near and between cities. The state highways are generally not provided with sidewalks and are used by many pedestrians at all hours."

Illumination Idea Is Spreading

The town of Colonie, near the eastern end of this installation, is so pleased with the result of this system that it has contracted with the Adirondack Light and Power Company for 30 of the units. One hundred units of this type have been ordered for a highway near Detroit. A similar system is in operation near Swampscott, Mass. Officials connected with the Ideal Section of the Lincoln Highway, which is to be built in Indiana, and which is to be made as nearly perfect a stretch of highway as can be constructed, have witnessed a demonstration of these lights and are contemplating installing them along the section mentioned. The engineer of the Bronxville Parkway Commission is interested in them, and they may be used for lighting the roads that traverse that beautiful park.

The cost of installing the system is low, and adds but a very small percentage—5 per cent or less in ordinary cases—to the expense of building the road, and the maintenance cost is small.

Important Incidental Benefits

Various incidental benefits result from it. One is the lessening of the danger of hold-ups. Another is that it helps to solve the problem of supplying current for light and farm power to the rural sections. Central stations which may not see their way clear to construct transmission lines for such territory on account of the expense, may find it entirely feasible to do so if the line can also be used to transmit energy for highway illumination.

That highway illumination is destined to play a very important part in the Good Roads cause is apparent, and the day seems already at hand when lighting will be considered a regular item in highway construction and maintenance appropriations.

SUPERPOWER PROJECT FOR REGION BETWEEN BOSTON AND WASHINGTON

A gigantic scheme for consolidating the generation and distribution of electrical power in the region between Boston and Washington is described in a report recently transmitted by Secretary of the Interior Fall to the President. The engineering study was conducted by the United States Geological Survey. The project aims to accomplish economy of fuel, labor and material in trasportation and industry. To connect all the large generating plants—both steam and water power—in one great system means more and cheaper electric current, because each ton of coal will be used to the best advantage and idle rivers will be made to turn wheels, especially in the regions farthest removed from the coal fields.

Looking Ahead to 1930

Looking ahead to 1930, with the increased demand for power that can then be reasonably expected, the total coal saved annually under the unified system will be 50 million tons. Under motor operation the industries could save $190,000,000 annually in their power bill and could make a greater output of product. The ordinary citizen also ought to profit directly by the superpower system because it promises a reduction of 1c a kilowatt hour in the first cost of the current as put on the transmission lines. Cheaper electricity and more of it will bring comfort to the home as well as efficiency to the workshop, even though the reader may search this engineering report in vain for any basis whatever for the pleasant vision of electric-heated homes throughout our land. Superpower does not stand for the impossible, but only for the wider application of practical engineering and sound economics.

The success of the Government's short-period study of so large a subject is due to the hearty cooperation, with the Government bureau selected to administer the work, of the engineering profession and of all the industries affected by the proposed larger electrification. Mr. W. S. Murray of New York, who had been the moving spirit in urging the advantages of a unified power system, was appointed chief of the engineering staff and promptly organized the work. An advisory board of business men representing the railroads and industries interested added driving force to the investigation and gave a larger practical value to the completed report, which is now published by the United States Geological Survey as Professional Paper 123. Secretary Fall has asked the members of this board to continue their public service in the further consideration of the legal and financial aspects of the superpower project, only the engineering features of which are presented in the report.

Why this Region was Selected

The North Atlantic coast region, to which it is proposed to supply more and cheaper electric current, was selected for this study because its industries and railroads have the maximum requirements for power. Unfortunately, this region is not blessed with the abundance of water power that is possessed by the Pacific coast States, so that the plan of power production includes large steam plants at tidewater or on rivers large enough to furnish sufficient condensing water and hydro-electric power plants wherever they can be economically built on the rivers within the zone or within transmission distance of it. After 1920 cheap power from the proposed St. Lawrence improvement and from additional capacity at Niagara Falls may be available for Western New England and New York State, which will benefit greatly by the development of these new sources of energy.

Economy of investment and economy of operation are the two ends sought by this plan, outstanding feature of which is a great network of inter-connecting transmission lines which makes a system out of many units. "In interconnection is superpower" is the new version of an old adage, and here interconnection will mean 970 miles of 220,000-volt lines and five times that mileage of 110,000-volt lines. With these major lines, the 1,200 miles of lines now operated at 33,000 volts or more will become simply distribution lines for the local public utilities. This transmission network and its substations would require $104,000,000 by 1930, and the total investment cost of the system the same year is given by the engineers as $1,109,564,000, of which $693,218,000 would be new money, for more than $400,000,000 worth of existing steam-electric and hydro-electric plants are retained in service.

"Superpower"

Mr. Murray's use of the word "superpower" simply puts emphasis on the magnitude of the undertaking of furnishing electric power to the railroads and industries within the territory between Boston and Washington, an area that includes only 2 percent of the United States but that contains 22 percent of the total population. This region is in fact the most crowded workshop of our country. It contains 96,000 manufacturing establishments, 76,000 of which used power in 1919 to the amount of more than 12½ billion kilowatt hours. Nearly three-fourths of this power was generated by the industries themselves, largely in units of small capacity, with low efficiency as compared with the large units of the central stations of the electric public utilities. So it has been found that most manufacturing plants in this region can economically purchase power, and if they had purchased it in 1919 they would have saved 13½ million tons of coal. With the industrial growth expected by 1930 the complete electrification of the manufacturing and mining plants in this area would show an annual saving of $190,000,000 to the industries themselves above the fixed charges against an investment of $185,000,000 for motor equipment.

Railway Electrification

The 35 pages of the report devoted to the proposed electrification of the heavy-traction railroads presents results of even more general interest than the detailed analysis of the industrial use of electric power. The question of railroad electrification must be decided according to density of traffic, and so it is that of the 36,000 miles of main line, yards, and sidings in this superpower zone, only about 19,000 miles could be profitably electrified. This electrification would cost nearly half a billion dollars, but it would save from 11 to 19 per cent on the investment, or an average of 14 per cent. Electrification is the next step in railroad expansion absolutely necessary to increase both the capacity and the efficiency of our transportation system. Incidentally, the annual saving of 9,000,000 tons of coal by the railroads would greatly increase the available car supply. The report figures no returns resulting from the abolition of the smoke, cinders, and noise of the steam locomotives, but the ordinary citizen will find some comfort in the abatement of these nuisances.

This study of power needs is forward-looking and throughout expresses with confident American optimism the conviction that our industrial development is to continue without check. In this letter to the President, Secretary Fall refers to the obvious fact that it is by multiplying our man-power by machines that American labor can best meet the competition of cheap foreign labor. Secretary Fall also says:

"I believe the engineering facts and economic conclusions here presented will command the attention alike of the financiers, railroad executives, public utility officials, industrial leaders, and others of that large group of our citizens of large vision who are building for the America of tomorrow. Our present-day achievements have largely come through our country's unparalleled wealth in raw materials. The larger use of our sources of energy must be planned with every effort to avoid waste. Had the superpower project outlined in this report been in operation in 1919 it is believed that 25 million tons of coal could have been saved, and with the rapid growth expected in the present decade the saving possible in 1930 by the interconnected electrification of industries and railroads would be 50 million tons. However, these economies on a truly national scale will affect not only coal but capital expenditures as well, and especially the output of human energy. More and cheaper electricity must surely add to the comfort and prosperity of our citizens."

SUGGESTIONS ON THE DESIGN OF TILE DRAINAGE SYSTEMS

By J. W. Dappert, Consulting Engineer, Taylorville, Ill.

(Concluded from Sept. issue)

I have before me a table of "Drainage Co-Efficients," used by a firm of engineers in Southern Minnesota, in which is shown the drainage area in acres, sizes of channels and tile drains planned, gradients, and other data, and I am impressed with the quantity of run-off provided for. When I compare the quantities with those we have formerly used in Illinois, I begin to inquire if we have not been overlooking some of the very fundamentals of good drainage in Illinois. The table mentioned shows a drainage co-efficient of ⅝ in. for open ditches upon areas of 1,172 to 43,000 acres, 1 in. run-off upon areas of 1,100 to 20,336 acres, and 1½ ins. run-off upon areas of 3,850 to 9,545 acres, all in terms of depth of water to be drained off in 24 hours. For larger tile laterals the same table shows run-off provided for as follows: 1 in. upon areas of 7,300 to 5,000 acres; ¾ in. upon one area of 828 acres, noted as very flat; 1½ ins. upon one area of 3,400 acres; 1 in. upon one area of 8,166 acres, all in terms of depth of water to be carried off by the tiles in 24 hours. By persistent effort upon the part of the writer, some modifications amounting to 50% reductions were made before the final report was submitted, and even then the run-off provided for was unnecessarily large, requiring the use of much larger tiles than needed, thus doubling the already high costs of construction. I remark that if a run-off of from ¾ to 1½ ins. per 24 hours is required in Southern Minnesota, it is also required in Illinois, where rainfall is greater, and, if so, we have all designed our tile-drainage systems too small.

Mr. C. G. Elliott, in his Manual of Engineering for Land Drainage, gives a maximum run-off of 1.03 ins. per 24 hours for a district in Louisiana, where annual rainfall is twice as much as in Minnesota, and that is an extreme case, most of the maximum run-off even in the Southern states being less than ¾ in. per 24 hours.

Based upon experiences, after a trial of 25 years or more, I find that for most flat and moderately flat lands in central Illinois a run-off of ¼ in. per 24 hours is a reasonable figure to assume. If the areas are quite large, with considerable open ditch to convey floods, a quantity as low as ⅛ in. will be sufficient against which to provide. If the areas are small, surface drainage wholly deficient, as much as ¾ in. per 24 hours should be provided for. It is evident again that many variations from these figures might be proper, where the circumstances differ, and the engineer should make a close topographical survey and a keen, intelligent study of each tract of land designed to be drained, before arriving at his conclusions in the matter.

I find it convenient to have a table showing the run-off from areas of one to one million acres of land, in quantities of 1 in. down to 1/32 in. of run-off per 24 hours, said table being used in conjunction with a table of velocities and capacities of various sized tile pipes from 4 to 72 ins. in diameter, figured from Kutter's formula at gradients of from one-hundredth up to 1 ft. per 100 ft. Such tables can be prepared with a moderate cost in time and labor by calculating each fourth or fifth quantity from the formula and interpolating the others, or can readily be produced in the shape of graph.

To use such tables, having determined from the survey the area to be drained, its characteristics, and rate of run-off to be applied, the table of run-off quickly gives the quantity, which may be in gallons per minute or cubic feet per second, preferably the latter, which must be cared for upon the given tract. You now turn to the table of capacities and under rate of gradient available quickly find the size of tile which will convey as much as or a trifle more water than the run-off as determined. In making such table I generally use a value of N = .012 in Kutter's formula, for the best grades of drain tile, clay or concrete. I know that many engineers say that the value of N in such formula at .012 is too low, but my observation is that the assumption works out all right in a practical way, and the tile drains designed upon this basis have performed satisfactory service. By means of tables, curves, or graphs you will readily proportion one drain with the other, and avoid making the capacities of the sub-mains and laterals combined much greater than that of the main drain, which often results where no calculations are employed.

Soil Tests, and Impervious Soils

Without considerable equipment it is impossible to make elaborate soil tests. The simple test as to quantity of water which a given soil will retain can be readily made by weighing the sample when fully saturated and again when thoroughly dry. The State University laboratories have made tests of most all soils found in the state, and when the engineer wishes to do so, and at a nominal cost, he can send in samples and have both mechanical and chemical tests made. The principal tests the drainage engineer cares for are mechanical relating to pore space, fineness of soil particles, voids, or water-holding space, and not so much the chemical composition. The soils which give up their waters most freely are those containing large percentages of organic matter, with large pore space, but they do not necessarily contain the greatest percentage of water. There is always left, even with thorough tile drainage, quite a large percentage of water in soils where tile drainage is required, and it is not the function of tile drainage to remove all but only the surplus water from the soil, or that which is injurious to plant growth.

There are some soils which are almost impervious to water. Frequently I have seen tracts of land which contained a surface soil of black, decomposed vegetable matter from 6 in. to 2 ft. in depth, underlaid with a very compact, impervious white clay subsoil. The sub-soil was somewhat of the nature of fire-clay or soap-stone, and by test, when cubes of it were submerged in a bucket of water for one hour or more, the moisture did not penetrate 1/32 in. deep into the cube. Where soils of this kind cover large areas of land I would proceed rather cautiously with the design of extensive systems of tile drainage. Usually, where found at all, the areas of this character are not large, and their drainage may still be effected by means of a system of catch basins and surface water inlets placed at the low places. Also, filling the trenches with top-soil, with a mixture of soil and vegetable matter such as corn-cobs, hay, or straw, will often result in the complete drainage of such areas.

I have even found it profitable to haul black top soil by wagons for some distance to treat a few exceptional cases of bad "scalds" of impervious clay. In soils of this character it is best to lay the tiles quite shallow, just safely below danger of frost and plow, and space the drains very near each other. The redeeming feature about tile drainage in soils of this character is that, gradually, minute run-ways are formed in the soil by action of the water, aeration takes place, and the tiles, if well laid, become more efficient every year.

Muck soils and gumbo such as are found in the American bottoms, along both sides of the Mississippi river in Illinois and adjacent to us, and such as are rather generally found along the lower stretches of the Illinois river, have all responded to tile drainage. It was not as rapid nor as effective at first as the tile drainage of the wet prairie lands in central Illinois, but after a few years the drains laid in muck and gumbo soils serve their purpose to remove the excess soil water just as effectively as those in the prairie soils.

Sand, Quicksand, and Soft Soils

Many instances of considerable difficulty have been encountered by reason of an unstable soil at or near the grade line of the drains, and a few instances are known where drainage projects were abandoned and waste lands allowed to remain so, by reason of the difficulties encountered in laying the drains in such places. In all these difficult places there is probably not one which could not have been surmounted by a skillful engineer. In some cases probably the cost would not be justified by the benefits derived, but more often than not it would be. These "bottomless pits" do not usually extend far in any direction and they may be bridged over by driving piles, crib-work, grillage, or some such method, and laying the tiles on top of planks fastened to the piles or crib-work. It may be best in some instances to cement the joints or use sewer pipe and make cement joints, lay the tiles in a bed of cement grout, or any of a dozen methods which any ingenious engineer may devise. Frequently the source of the excess water, as in the case of spring holes, may be tapped by a lateral or other drain, and when the excess water is prevented from reaching the "bottomless pit" or sink hole, it will gradually dry up and admit of easy construction of the drain through it.

Where much fine sand or silt is encountered at or near grade of tile drain, it is desirable to exclude it by some method. Wrapping the joints with jute, burlap, or any kind of cloth, straw, or hay is frequently very effective. Getting rid of the excess water by the method before described may also be a necessary part of the operation. The working end of the drain during construction should be kept free from water, as much as possible, and this may require the use of a trench pump operated by any motive power most available, even by hand labor if necessary. A wooden plug cut in size and shape to fit over the end of tile, having a few small holes bored in it to allow accumulating water to enter the end of a tile drain, should be kept constantly on hand to cover the tile during periods of suspension of work.

Bulk-Heads or Outlet Walls

This is usually the last work done in the construction of a system of tile-drainage. The money having all been spent in paying for tiles and labor, the outlet is allowed to go over to some other time. I have seen large systems of expensive tile drains laid, costing thousands of dollars, with not a thing done at the outlet beyond driving a stake or two to hold the end tile in place until the drain was completed. I have seen main tiles washed out for 40 rods above the original outlet, with a small canyon formed by erosion, of such age that timber and brush of considerable size grew along its banks. I have seen other tile outlets where thousands of dollars were expended in laying the tiles, and the outlets were so lost that they were hard to find in dry weather, and in one case completely buried by 2 ft. of soil over the top of a 12-in. tile at its outlet. When opened up and connected to a new drain, it ran almost full for two days, although very dry weather, and I know that system of drainage did very little effective work for some years previous to its repair. The method of repair is generally to go downstream for some distance to some available outlet in the same water course, build a massive concrete retaining wall, put a grate on or bars through the outlet tile, bring up the new drain, preferably outside the old open ditch, and join the old drain above the point where deposits exist in it.

In rare instances it is not possible to find a water-course or depression deep enough within a reasonable distance, to provide a clear outlet, and I have in a number of instances built a well of bricks, laid up in cement mortar, at outlet of tiles, dropped the grade of tile sufficiently to keep it well covered, as much as 3 ft. if need be, and let the water rise in the well to surface of ditch and flow away, using a grated iron catch basin frame and cover at top of well. I find that this method destroys from 20 to 30% of the effectiveness of the drain, depending upon the height to which the water must rise above the hydraulic grade line of the tile drain. It is a last resource, and ought not be employed where possible to secure a good free outlet otherwise.

The ideal outlet is into a small water course which does not overflow its banks greatly, but this is not always obtainable. The tile drain should be pointed somewhat downstream with the creek and located where a bank is rather high. The general plan may be a V-shaped wall or a straight face with two wings, a segment of a circle, or an L, depending upon the particular location of the work. It should especially extend as deep as bed of stream and be made massive enough to insure stability; the wings extending back into the solid earth helps to insure stability against toppling over. The tile pipe should be well cemented to the wall and have a grate over the end to exclude muskrats and other vermin. These grates are frequently made by drilling holes through the periphery of the tiles, about 2 ins. apart on centers, and inserting iron bars ⅜ to ½ in. in diameter, and it requires a rather patient workman properly to drill and fit such bars. There are patented gates and other devices upon the market, but none of them seem better or last longer than the iron rods, which can be replaced when they finally rust out.

Just below the tile outlet, joined to the base of the wall, an apron or platform should be provided to prevent the water from undermining the wall as it emerges from the tile. Where drop is considerable this apron should extend several feet and may require being a foot in depth, never less than 6 ins. thick. In several instances quite elaborate watering places for cattle have been made by paving the bed of the stream and making a large trough-shaped basin instead of such apron, out of concrete. I usually require a 1:2:3 mix in such concrete work, with no reinforcement, and the work is most frequently done by common labor. Supervision is not always possible, and a few failures have occurred, due to not following the plans, the most usual deficiency being failure to go down to the depth required, because of the large amount of pumping required to keep the new concrete from washing out of cement. After one case of failure I measured a section of the wall which was presumed to be 18 ins. thick, and found it to be actually 2 ft. thick at top and but 7 ins. thick at a point 3 ft. below the top, and generally 7 to 9 ins. thick down to the base, which had not been put within a foot of where it was designed. The contractor was presumed to be a crook, so I appointed an inspector and instructed the contractor to let my inspector know when he started work, but the contractor hurried through the job, got it done without any inspection, and collected his bill for more than twice the yardage, after a casual inspection by the drainage commissioners. As the wall looked even more massive than the plans called for, and actually was at top 6 ins. thicker than necessary, the bill was paid freely, and the fraud discovered when the wall broke down during a flood several months later.

NEED OF SAVING NATURAL GAS

By Samuel S. Wyer, Consulting Engineer, Hartman Bldg., Columbus, Ohio.

There are over two and one-half million domestic consumers in the United States and more than ten million people are dependent on natural gas. Of all of the towns in the United States that have gas about one-half have natural gas; of all of the gas that is sold for public utility service about three-fourths is natural gas; of the 2,180 natural gas using towns in the United States 1,944 are too small to maintain manufactured gas plants, and it would not be feasible to build large central gas plants and pipe gas through the present natural gas transmission lines, therefore the smaller towns will be without gas service when natural gas is gone.*

Put Natural Gas Industry on Conservation Basis

There is no regeneration of natural gas and when it is gone it is gone forever. There has been a marked decline in production and the supplies available for future service are becoming less each year. The situation is acute now, will become worse each year, and the only thing that will permit continued service in the future is to place the entire neutral gas industry on a conservation basis, which means a marked curtailment in volume and a marked increase in price per unit of volume.

Natural gas is worth twice as much as manufactured gas in heating value. The flame temperature of manufactured gas and natural gas is, however, practically the same, but in ordinary domestic opertions the intensity of temperature is of no consequence, for what the consumer is interested in is not higher temperature, but a larger volume of relatively low temperature which is controlled by the heating value of the gas, and, as the heating value in terms of ordinary heating units is twice any manufactured gas that can be made, for all domestic purposes natural gas is worth twice as much as the average manufactured gas used.

Price of Natural Gas Must Go Up

The only way that natural gas service can be maintained in the future is to use the residue supplies that have been allowed to go to waste in the past. The fixed charges in a natural gas utility are larger than for any other public utility and represent about 70 to 73% of the income received from the public. These fixed charges go on regardless of the volume of business done, and this feature, coupled with increase in production cost, means that the cost per unit of volume will be greatly increased in the future if the residue supplies are to be secured, therefore the price of natural gas must go up—not because of the economical law of supply and demand, but because operating costs have greatly increased and only profitable operations will induce prospecting for new supplies. The live question is not how cheaply natural gas can be obtained but whether it can be obtained at any price to assure continuity of service for the future.

This increase in price must take place even if every other commodity price goes down. However, by carrying out the waste elimination recommendations of the U. S. Government, the consumer can pay the higher price per unit and still get the same service without any increase in the annual bill, due to the fact that intensive conservation can make one foot of gas do the work where three are now misused.

The Gas Waste

The gas waste in production, transmission and utilization has been enormous. At the present time, as an average for the entire United States, about one-third of the gas that starts to the ultimate consumer is lost in transit, due to leakage,

*For extensive discussion see Bulletin 102, Part 7—Natural Gas: Its Production Service and Conservation—Smithsonian Institution, Washington, D. C.

and of the 66% delivered to the ultimate consumer, on an average, the consumer wastes about 80%.* That is, while one-third is lost in transit more than three fourths of the remainder delivered is wasted by the consumer's inefficient method of utilization. The waste in the ordinary home will usually average about one-sixth of the total gas received. It is not ordinarily appreciated that leakage goes on continually—every hour of the day—and a leakage rate of only 1 cu. ft. per hour produces a loss of 8,760 cu. ft. in a year.

Much natural gas is still used in ordinary coal or wood stoves. Tests on stoves of this type show that 30 cu. ft. of gas is required to do the work that could be done by 6 cu. ft. in a correctly applied and properly adjusted gas range.

It was because of the acute general situation that the late Secretary Lane called a National Conference on Natural Gas Conservation in Washington, D. C., on Jan. 15, 1920. This conference resulted in the creation of a National Committee on Natural Gas Conservation, and resolutions were adopted by this committee to be carried out in every community.†

The State Superintendent of Public Instruction for the Commonwealth of Pennsylvania, Harrisburg, Pennsylvania, appreciating the vital interest of prolonging the supply of natural gas to the homes, authorized the use of a 16-page pamphlet on 'Use and Conservation of Natural Gas Especially Adapted for Use in Schools" in all of the natural gas using towns in Pennsylvania.

The State Director of Instruction in Geography is laying special stress on the outstanding features of natural gas in all of the geography classes, and the State Director of Home Economics Education is having all of the Home Economics teachers in the public schools teach the pupils how to cut down waste and thereby prolong the life of natural gas.

Waste in Distributing Plants

Much of the waste in distributing plants is due to the absence of accurate measuring data showing the exact relationship between input and output of a particular part of a gas transmission system. Many million dollars in property is destroyed annually in the United States by stray electric currents that have leaked off of or wandered away from defective return circuits of single trolley electric railroads. Much of this damage has been on underground pipes of natural gas distributing plants, and these stray current features have been an important means of increasing gas leakage and, therefore, waste. It would be to the public's interest that each municipality should make the local electric railroad responsible for its stray electric currents as well as for the protective measures that must be installed to protect underground property from the ravages of such currents.

Various substitutes for natural gas can, of course, be used, although they would all be much more expensive than even $1 natural gas. The equivalents for various competitive fuels per 1,000 cu. ft. of natural gas would be as follows: Manufactured gas, 2,000 cu. ft.; 200 lbs. of calcium carbide for acetylene; 9 gals. of gasoline; 8½ gals. kerosene; 15 gals. alcohol, and 322 kw. hours of electricity.

It has been shown by tests in cooking dinner, the fuel cost for the meal with five different fuels was as follows: $1 natural gas, 1.1c; $6.50 soft coal, 2.5c; 27c gasoline, 4.6c; 3c electricity, 5.1c, and 15c kerosene, 5.4c.*

Pressure Generally Too High

The pressures carried in most distributing plants are too high to have good service and municipal authorities should insist on lower and more uniform pressure. Very much better service can be gotten with pressures in the neighborhood of 2 ounces and not 4 ounces, and the distributing plant leakage will not only be much less but the consumer's combustion conditions with properly adjusted appliances for such pressures will be greatly improved.†

Recommended Conservation Measures

Municipal authorities working in the public interest ought, at once, to arrange for:

1. Reduction of stray electric currents to a point where they will not be substantially injurious to underground pipes so as to decrease the injury to the pipe and curtail leakage.

*See Technical Paper 257—Waste and Correct Use of Gas in the Home—U. S. Bureau of Mines, Washington, D. C.

†Resolutions adopted by the National Committee on Natural Gas Conservation—June 11, 1920—U. S. Bureau of Mines, Washington, D. C.

*Kitchen Tests Relative Cost of Natural Gas, Soft Coal, Coal Oil, Gasoline and Electricity For Cooking—Department of Home Economics—Ohio State University—Columbus, Ohio.

†How to Get Better Service with Less Natural Gas in Domestic Gas Appliances—U. S. Bureau of Standards, Washington, D. C.

2. Attainment of the distributing plant leakage standard of 1,000 cu. ft. of gas per mile of 3-in. pipe, recently fixed as a fair standard by the United States District Court of Kansas.[1]

3. Lowering the distributing plant pressures and maintaining more uniform pressures. In all cases the pressures should be in the neighborhood of 2 ounces.

4. Should arrange for the gas company's inspection of all appliances so that the consumer would know what is right and what is wrong.

5. The prohibition of natural gas use in all coal burning appliances, since usually 3 ft. of gas are required in such appliances where only one would be required in the properly applied natural gas appliance for the same service.[2]

6. Prohibition of solid top low set burner cooking stoves. Grid tops only should be used and the burners should be about 1¼ in. below the cooking vessel.[3]

RELATION OF STREET LIGHTING TO TRAFFIC ACCIDENTS.

By Earl A. Anderson and O. F. Haas, Illuminating Engineering Staff, National Lamp Works of General Electric Co., Nela Park, Cleveland, Ohio.

The seriousness of the accident hazard on the streets of American cities as a factor to be reckoned with in every-day life becomes evident from even a casual inspection of statistics which show the losses incurred in this continuous waste of life, time and property. For example, in a recent paper Simpson[4] gave figures showing 25,000 fatal industrial and 2,000,000 total industrial accidents annually, causing lost time of a total cost of $2,000,000,000, or a cost averaging $1,000 per accident. The total annual fatal accidents from all causes, including industrial, are estimated to be 75,500 from statistics compiled by Dr. Crum[5], and of these approximately 7,800 are railway and 15,500 are street traffic accidents. Therefore the loss of life in traffic accidents is twice as great as in railway accidents and equal to over half the total industrial loss.

Automobile Accidents[5]

As to an evaluation of the annual personal and property loss from automobile accidents in terms of money, Dr. Crum states that while an accurate computation is not possible, the annual sacrifice is fully $1,000,000,000. This figure appears very reasonable when one considers that in the survey of traffic accidents numbering 800 fatalities, reported in this paper, there are 31,000 other accidents of sufficient severity to be reported to the police, and that personal injuries were sustained in approximately one-half of these cases.

To the development of high speed traffic brought about by the very extensive adoption of automobiles must be charged practically all of the increase in street traffic accidents. In 1906 there were less than 400 deaths in the United States from automobile accidents, while in 1920 the total

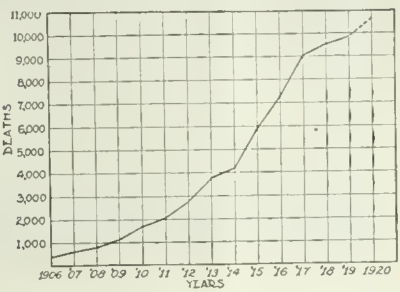


FIG. 1—INCREASE IN DEATHS FROM AUTOMOBILE ACCIDENTS IN UNITED STATES, 1906-1920.

was greater than 10,000, representing an increase of 2,500 per cent. Further, as shown by the curve of Fig. 1, this total is mounting steadily. In recent years efforts have been directed toward reducing the accident rate by more stringent traffic regulations and by widespread educational publicity work on the part of safety organizations. Definite evidence of the value of such safety measures may be seen in statistics which show a check in the growth of the accident rate in those cities and localities where the most careful attention has been given to the development of accident prevention efforts.

The figures presented by Dr. Crum show that at least two-thirds of all traffic accidents have occurred in cities of 10,000 inhabitants or more, and on this basis it would appear that the traffic accident problem is of greatest immediate importance in these larger communities. It is worthy of note, however, that the increasing amount of inter-city touring has

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[1]Federal Reporter—Page 433.
[4]R. E. Simpson, Travelers Insurance Company—I. E. S. Transactions, Vol. XV, No. 8.
[5]F. S. Crum, Statistician, Prudential Insurance Co., Automobile Fatalities.
[2]For discussion of Governmental power to control this—see Amicus Curiae—"Can Preventable Waste of Natural Gas in Home Be Prohibited by Rules Authorized by Public Service Commission?" by Samuel S. Wyer, Consulting Engineer, Hartman Building, Columbus, Ohio.
[3]How to Get Better Service with Less Natural Gas in Domestic Gas Appliances—U. S. Bureau of Standards—Washington, D. C.

brought a heavy highway traffic to villages of even the smallest size, and it is, therefore, apparent that even in smaller communities public safety demands an increased attention toward means for reducing the street traffic accident hazard.

Proper Illumination a Factor in Prevention of Traffic Accidents

The purpose in instituting the survey reported in this paper was to obtain, if possible, some definite measure of the value which should be attributed to the proper illumination of streets as a factor in the prevention of traffic accidents. In order to obtain as high a degree of uniformity as possible in the collection of the data, blank forms were prepared providing for a charting of all traffic accidents in a given city during the period of one year and for distributing them as to the month and hour of the day at which each occurred, with notations as to whether or not the accident resulted in a fatality. A representative group of cities was selected and individuals in each who were known to be interested in problems of public safety were requested to arrange for the tabulation of the data. The work of tabulating accidents from the city records was often tedious on account of the way in which the accident reports were filed. In some instances the accident data were not available. The very cordial response to the request for cooperation in this survey is, however, attested by the fact that tabulated reports in form to be directly applied were obtained from 32 cities with a combined population of over 7,000,000. From each of these cities the report covered a full year's accidents; in most cases during the period from the middle of 1919 to the middle of the year 1920. The names of the cities and an abbreviated summary of the tabulation for each city is given in Table 1. The total number of street traffic accidents reported for one year in these 32 cities was 31,475, of which 9,534 or 30.3% occurred during hours of darkness. It was anticipated that there might be considerable variations in conditions existing in individual cities located in different states, and it was, therefore, particularly desired to obtain a sufficiently diverse group of cities, including a large enough total of population to give the presumption of a reasonable degree of accuracy in the results.

FIG. 2—EFFECTIVE STREET ILLUMINATION AS ILLUSTRATED BY EUCLID AVE., CLEVELAND, OHIO.

This Famous Street is Lighted by 1,500-Candlepower Mazda Lamps in Ornamental Lanterns Spaced 85 ft. Apart.

Monthly Variation in Accidents

The 31,475 traffic accidents are charted in Fig. 3, according to the total number during each month. In certain cities special local influences, such as an excess of traffic at some one season of the year, changed the distribution of accidents considerably, but in most cases the individual reports adhered to the trend shown by the average curve in Fig. 3. At first thought it is somewhat surprising to note that there were a greater number of accidents in the summer months than in winter, as there are a number of influences which tend to increase the hazard in winter, such as stormy foggy weather, slippery streets, and the impediment of heavy clothing. However, as a matter of fact, the traffic is so much greater during summer months than in winter that even in spite of the unfavorable conditions in winter the accidents are more in the summer than in the winter months in most cities.

Hourly Variations in Accidents

The total accidents reported for the year are charted in Fig. 4, according to the hour of the day during which they occurred. This chart also shows the apparent importance of density of traffic as a factor in causing accidents. It will be noted that relatively few accidents are reported in the hours from 1 to 7 o'clock in the morning, the period of the day in

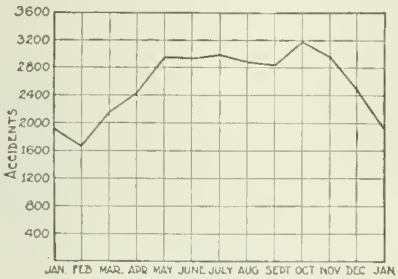


FIG. 3—DISTRIBUTION OF TRAFFIC ACCIDENTS BY MONTHS.

which street traffic is least. On the other hand, the accident rate becomes greatest in the hour from 5 to 6 in the afternoon, when in practically every city the streets are congested with the home-going population from offices, stores and factories.

An obvious and simple way of determining how many of the 9,534 accidents which occurred after dark would have been avoided had daylight or its equivalent been available, is to compare the accidents which occurred during the hours in the evening which were daylight in summer with the number of accidents which occurred during the same hours in winter, when, because of the shortness of the day, it was dark. Consultation of tables of sunrise and sunset applying to the different cities involved indicated that the hours 6 to 8 p. m. were the two hours of the day which are fully light in the months of May, June and July, and entirely dark during the months of November, December and January.

It is evident, however, that a ratio between the accidents occurring from the hours 6 to 8 p. m. in summer as against the number that occur during the corresponding hours in winter would not directly show the influence of light because of the numerous other variables referred to above which have an influence that must be taken into account.

Fortunately the accident statistics for the hours of the day which are light in both summer and winter or which are dark, in both summer and winter, offer a convenient means for determining a correction factor to take into account the variables other than light which affect the number of traffic accidents in winter and summer. The periods of 3 to 5 p. m. and 9 to 11 p. m. are the logical selections because of their adjacency and the consequent similarity of traffic to that in the 6 to 8 p. m. period. In Table I there is shown a tabulation by cities and the totals of accidents for the respective periods of 3 to 5 p. m., 6 to 8 p. m. and 9 to 11 p. m., separated so as to show the number of accidents during these hours in the summer months of May, June and July, and the winter months of November, December and January combined.

Referring to the totals in Table I, and taking first the hours from 3 to 5 p. m., which are daylight in both summer and winter, the numbers of accidents are found to total 1,429 in summer and 1,095 in winter. The winter accidents from 3 to 5 p. m. are, therefore, 76.6% of the summer total. Considering next the totals for the period of 9 to 11 p. m., which is dark both in summer and winter, it is noted that the accidents are respectively 740 and 495. The winter accidents from 9 to 11 p. m. are, therefore, 66.9% of the summer total. If these two percentages of 77.6 and 66.9 are averaged it is indicated that for the group of cities in this

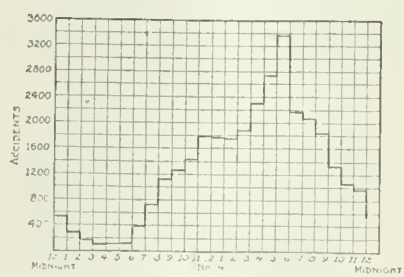


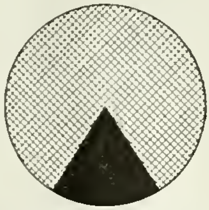
FIG. 4—DISTRIBUTION OF TRAFFIC ACCIDENTS ACCORDING TO HOUR OF THE DAY.

survey, traffic conditions are such that, excluding the influences of illumination, the winter accident rate in the afternoon and evening is approximately 71.8% of the summer accident rate.

Considering next the period of 6 to 8 p. m., which in summer is daylight, Table I shows a total of 1,200 accidents in the

32 cities during the three months of May, June and July. Hence, applying the average percentage of winter to summer accidents (71.8%) determined as above* it would be anticipated that in the three winter months of December, January and February there would be 862 (71.8% of 1,200) accidents during the hours of 6 to 8 p. m. However, the survey shows a total of 1,046 accidents to have actually occurred during these hours in the three winter months or 184 more than anticipated provided there had been the same effectiveness of illumination in the winter months as in summer. Hence, there is the strongest evidence that 184 accidents or 17.6% of all those at night must be attributed to the lack of light during the winter months. Applying this same percentage to the 9,534 accidents which occurred after dark in the 32 cities covered by this survey, it appears that 1,678 would have been avoided if adequate illumination had been provided.

NIGHT ACCIDENTS



17.6% Attributable to Lack of Adequate Street Illumination

FIG. 5—SURVEY INDICATES THAT 17.6 PERCENT OF NIGHT TRAFFIC ACCIDENTS ARE ATTRIBUTABLE TO LACK OF SUFFICIENT ILLUMINATION.

Accidents Attributable to Poor Street Lighting

Assuming that the same proportion of day and night accidents which was found to exist in this survey holds in all cities, last year there must have been out of the total of 10,640 killed 3,223 deaths from night automobile accidents, and 17.6% of these, or 567 were, therefore, directly attributable to lack of sufficient illumination. In addition to this loss of life, a similar computation shows that the very substantial amount of $54,000,000 of the billion dollar annual street accident loss estimated by Dr. Crum may also be attributed to lack of light. According to census reports the total expenditure for street lighting in the United States is not in excess of $50,000,000.

Poor Lighting May Cause 50 Percent of Night Traffic Accidents

The percentage of 17.6 arrived at as the proportion of night accidents which may be attributed to lack of light is undoubtedly an extremely conservative figure to use in evaluating the usefulness of illumination in preventing traffic accidents, for, as a matter of fact, the streets of all of the cities covered in the foregoing survey were illuminated at night by artificial lighting of varying degrees of effectiveness. In an individual city where the need for better street lighting is especially evident the percentage of night accidents chargeable to the lack of light is likely to run as high as 50%. On the other hand, in the case of those districts where fairly high levels of artificial street lighting are provided by so-called White Way systems, the percentage of night accidents chargeable to lack of illumination can be said to be fairly low. It was hoped to have data from this survey to show the difference, but it was not found practical to separate the statistics for the better lighted sections in a sufficient number of cases to arrive at an average figure.

While in the present state of the art it is not practical to provide artificial street lighting approaching actual daylight levels, it is entirely feasible to increase the quantity of light to a level from 3 to 10 times higher than that provided by average existing systems, and when this is done with properly installed equipment it may be confidently expected that a large measure of the benefit of light in reducing accidents will be secured.

It is, perhaps, pertinent to emphasize that these higher levels of artificial street illumination, the expenditure for which is so amply justified as an accident prevention measure, have many other important advantages in contributing very greatly to the prevention of crime, to the comfort and convenience of all those traversing the streets, and to commercial and industrial progress.

Growth of Night Traffic Will Call for Better Lighting

Modern illuminating engineering has been of great assistance economically in making possible "double shift" operation of industrial plants, thereby in many cases reducing the overhead charges on the investment in plant and machinery by

*The percentage for 6 to 8 p. m. actually is probably nearer the 9 to 11 p. m. figure of 66.9% than the average of 71.8% since both periods are during the evening hours. However, the more conservative figure is used. Had 66.9% been used, the computed percentage of accidents due to lack of light would have been 23.3%.

as much as one-half. In the development of a level of street lighting such as will enable night traffic at the same density, speed, convenience and safety as by day, there is offered a similar important opportunity for community economy. Large as the expenditures are already for improved thoroughfares and highways, engineers estimate that at the present rate of traffic growth duplicate roadways must be built very soon in many districts. This congestion, however, will be greatly relieved and the time when duplicate road construction is required will be postponed for years in many cases provided a larger proportion of the traffic can be diverted from the crowded day hours. In line with this Mr. Arthur Williams of New York recently presented a paper in which reductions as great as one-half in trucking cost were estimated to be possible by the increased utilization of equipment and terminal facilities and the avoidance of traffic delays by the use of streets during the less congested night hours. It is apparent that the density of traffic which would result from such a "double shift" utilization of thoroughfares and highways would greatly increase the total of night accidents. Furthermore, the greater density of traffic at night would undoubtedly result in a larger proportion than 17.6% of the accidents being chargeable to lack of light unless adequate street lighting is provided. But the annual cost to the community of lighting entirely sufficient for safe and convenient night traffic is small indeed compared with the construction and maintenance cost of the additional roadways which will otherwise be required.

The foregoing paper was presented before the Illuminating Engineering Society, September, 1921.

"MIXPEN" BITUMINOUS CONCRETE.

By Geo. A. Henderson, Consulting Engineer, of International Bituconcrete Company of Delaware, St. Albans, W. Va.

Many articles on bituminous pavements have recently appeared as a result of the increasing popularity of bituminous foundations which have been demonstrated, by more than 20 years heavy street traffic in the opinion of many engineers, to have many features superior to foundations of hydraulic concrete.

Notwithstanding this there seems to be very little change or improvement in such bituminous structures over those built many years ago. It is the purpose of this

TABLE I—TRAFFIC ACCIDENT STATISTICS FOR 32 CITIES DURING A PERIOD OF ONE YEAR

TRAFFIC ACCIDENTS REPORTED

	Total	Night	Total Fatal	Night Fatal	3-5 P. M. W'ter*	3-5 P. M. Sum.	9-11 P. M. W'ter*	9-11 P. M. Sum.	6-8 P. M. W'ter*	6-8 P. M. Sum.
Philadelphia, Pa.	5231	1485	190	66	175	251	71	98	164	183
Cleveland, Ohio	3549	1059	174	56	120	120	89	73	154	121
Boston, Mass.	3380	1001	89	38	108	159	57	69	117	131
Pittsburgh, Pa.	2950	982	6	2	119	183	57	100	74	109
San Francisco, Cal...	3014	1092	76	32	127	106	58	73	110	84
Jersey City, N. J.....	672	223	28	13	18	38	8	17	36	32
Rochester, N. Y......	2570	735	29	9	70	111	34	71	62	119
Portland, Oregon	1230	411	31	8	45	43	11	21	38	48
Columbus, Ohio	193	95	17	9	7	11	6	13	8	7
Hartford, Conn.	1389	300	19	6	38	72	12	17	37	57
Grand Rapids, Mich...	255	78	12	4	9	8	1	7	10	12
Youngstown, Ohio ...	702	258	33	15	33	31	12	17	28	25
New Bedford, Mass...	699	189	7	3	34	40	6	17	20	31
Lynn, Mass.	818	278	7	2	35	40	19	20	36	42
Utica, N. Y..........	652	150	9	3	22	43	2	25	16	33
Fort Wayne, Ind.....	1010	241	9	2	42	30	14	13	29	19
Peoria, Ill.	131	26	7	3	5	11	1	1	5	1
South Bend, Ind......	143	46	6	3	6	6	5	6	7	5
Portland, Maine	620	177	1	..	16	24	9	16	20	18
Charleston, S. C......	192	52	13	3	6	8	..	7	8	3
Rockford, Ill.	181	45	11	3	5	15	3	5	3	9
Saginaw, Mich.	120	48	3	..	..	7	2	3	8	5
Holyoke, Mass.	287	79	5	2	15	13	5	2	5	15
Gary, Ind.	281	78	10	4	5	11	3	13	6	12
Malden, Mass.	187	56	3	..	3	9	..	5	3	13
McKeesport, Pa.	74	30	2	..	1	1	1	3	2	6
New Castle, Pa.	74	31	3	1	3	2	..	5	2	12
Mt. Vernon, N. Y.....	264	78	2	1	11	12	3	7	8	12
Evanston, Ill.	287	81	9	4	7	17	2	7	6	11
Austin, Tex.	169	75	2	2	9	3	2	2	16	9
Muskogee, Okla.	42	20	2	..	..	3	1	1	2	9
East Cleveland, Ohio.	109	35	6	4	1	1	1	6	6	7
Total	31,475	9534	821	298	1095	1429	495	740	1046	1200

*Winter refers to November, December and January.
Summer refers to May, June and July.

article to refer to some of the present possibilities in this direction.

Mixing and Penetration Methods

In the more expensive "mixing method" of producing "bituminous concrete" the mineral ingredients of coarse and fine aggregates are carefully graded and then mixed with a normally semi-solid bituminous binder in a power mixer when all of the ingredients have been sufficiently heated to remain hot while being separated as to sizes of the mineral aggregate, mixed with the bitumen, hauled to the road and there spread and compacted over its cold base.

In the less expensive "penetration method" for producing "bituminous macadam" the cold stone in *situ* in the road is coated with a relatively light bituminous material (more of a lubricant than a binder) that can be rendered sufficiently fluid to penetrate into its voids.

The bituminous cement used in the mixing method when of consistency about 50 to 60 penetration, represents its maximum binding value in bituminous structures and is in itself of greater inherent stability than that bituminous material used in the penetration method, which is generally of from 125 to 150 penetration, as tested for consistency, and of minimum binding value.

In the mixing method, scientific grading of the aggregate, and the comparative density and stability of the viscous binder, are relied upon for stability, whereas in the penetration method mechanical clasp of the larger sizes of compacted aggregate, wth stone screenings for filler of the voids, is relied upon for the structure's stability more than is any binding function of the penetration material.

On the other hand, if the mixing-method binder be used in the penetration method of construction, it would prematurely congeal upon being spread over the cold stone in *situ* before penetrating its interstices, and would form a surface mat which would peal off in time.

Efforts to Combine Advantages of Mixing and Penetration Methods

Efforts to combine the economy of the penetration process with the superiority of the product of the more expensive mixing method have included the following:

It has been proposed to "cut back" the heavy mixing method bituminous cement with about 50 per cent of naphtha, and rely on evaporation of the latter, in time, to leave the heavy binder in the aggregate's voids where it is deposited by using the naphtha as a carrying agent; but on recent tests such a structure has been found to be more or less porous and absorbent (like hydraulic concrete) when the naphtha (like the water of portland cement mixtures) is evaporated from the mass of which it was a part; and, too, the cost of the naphtha, so temporarily used, is economically prohibitive.

In the writer's experiments he has temporarily liquified such a 50-penetration bituminous cement chemically, and during escape of residual gases to the atmosphere on impinging under pressure the binder into the interstices of previously heated and absolutely dustless aggregate unfilled with stone screenings in *situ* on a road, he has succeeded in completely filling its voids with the semi-solid bituminous cement; but due to lack of grading of the aggregate (as in the mixing method) so that the smaller particles will, as nearly as they may, fill the voids between the larger ones, it is found that notwithstanding the normal mechanical clasp of the larger aggregate, the pavement still lacks that inherent stability of the mixing method, the interstices being filled exclusively with pure asphaltic cement, the most expensive ingredient of a bituminous structure, which forms "lakes" in the voids, and during hot weather, softens.

The "Mixpen" Process

With these basic conditions in mind the "mixpen process" has been finally evolved by Reiman G. Erwin, chemist; H. K. Stephenson, engineer, and the author, from a combination of the mixing and the penetration methods, in which a mastic is employed, consisting of 50-penetration bituminous mixing method cement in which 50 per cent of its weight of clay dust is colloidally suspended when the bituminous material is temporarily reduced to a state of liquefaction by the interaction of sulfurous gases in the presence of traces of moisture under the influence of agitation and heat above the boiling point of water, which results in a constantly changing cellular or honeycombed condition of the mass, on the thin films of which the dust is separately lodged in steam suspension, and the mass then completely dehydrated before passing, while still in a gaseous condition, through penetration nozzles of a pressure distributor in which the entire mass is constantly agitated by the ordinary asphalt pumps. Notwithstanding the stiffening influence of the dust particles present, it is found that they, (while colloidally suspended in the molten bitumen, so temporarily reduced to the fluidity of water chemically), are carried in *gas* suspension, until, in passing under about 40 lbs. pressure to the square inch, from the nozzles to the road's surface, all gases and vapors escape to the atmosphere on impinging of the mastic within the open, heated, dust-cleared interstices of the larger aggregate in *situ*, forming a matrix of greater inherent stability than the trap rock aggregate it fills and binds.

The heating of the larger mineral aggregate in mixing-method bituminous concrete is essential to secure the greatest bonding efficiency of the asphaltic cement to the aggregate, when dry, in addition to the necessity for such a degree of heat as to maintain the mix sufficiently hot until spread and compacted over the cold base. If the latter were not true the mere *surface* heating of the stone would be sufficient to secure the bond of the matrix to the larger aggregate. In the mixpen method the 1½ to 3-in. macadam stone compacted in mechanical clasp is not filled with screenings or other filler, and the pressure distributor of the mastic above described is equipped with a surface heater, using fuel oil heat mixed with hot air, which is blasted into the interstices as the distributor passes over, to be at once followed by the penetration nozzles on the same machine, within 1 ft. distance of the surface heater's operation. Whatever dust may be left in the larger aggregate's interstices is removed not only by the hot air blasts above mentioned but by severe suction from the surface heater's hood, which suction in volume is equal to the pressure of the hot air from the burners under the hood, thus avoiding lateral suction or pressure at the hood's sides.

The chemicals used to accomplish the above purpose *benefit* the bituminous cement when that cement is the product of asphaltic base petroleum of oil refineries as distinguished from the "natural asphaltic cement" such as Trinidad. This benefit results from exact duplication, both physically and chemically, of Trinidad Lake asphaltic cement both from the same mother substance—asphaltic base petroleum—from which the Trinidad, as well as the "artificial oil asphalts" are all derived, viz.: It is now incontrovertibly determined and recorded in the foremost text books on the subject that: (a) the bitumen of Trinidad is the residuum of asphaltic base petroleum of identical characteristics to that available from oil wells on Trinidad Island, in Mexico, in California and elsewhere, and refined in our local refineries by the volatilization of kerosene, naphtha and the other lighter oils therefrom; (b) that this petroleum deposit at Trinidad is treated by nature in her laboratory set up in the crater of a *constant* volcano that is today active, by subjecting it to volcanic heat in the presence of clay dust mixed with salt water infiltrated thereto from the sea; (c) that sulfur (of identical nature to that available in Louisiana) is by nature provided, and that when all of these ingredients are subjected to sufficient heat hydrogen sulfid and sulfur dioxide *gases* interact chemically on the hydrocarbon (the bitumen) to reduce that residuum of the oil to a constantly changing cellular condition on the very thin films of which the widely dispersed clay particles are found to be separately lodged in colloidal suspension upon complete dehydration of the mass. All Trinidad pavements in use today are made from asphaltic base petroleum containing almost uniformly 38 percent of nonasphaltic matter, towit: clay dust in particles even larger than those locally available throughout the United States, in which local deposits the particles by elutriation tests of the writer have been found to be capable of passing a 200 mesh, 60% smaller than .02 millimeters in gradations down to smaller than two microns.

It is not questioned by any authority that the sulfur content of Trinidad asphalt renders it more tenacious, more ductile, more cementitious, and tougher than such asphaltic residuum containing either that sulfur known to the art of vulcanizing or containing no sulfur at all. It is likewise a fact that the sulfur content of Trinidad asphalt is entirely different and has a different effect on petroleum residuum than the sulfur heretofore used in even rubber vulcanization can have on the bitumens or rubber. This is due to the now demonstrated fact (as last year disclosed by Professor Peachey of the Manchester [Eng.] College of Technology) that those sulfur "derivatives" of Trinidad, viz., hydrogen sulfid and sulfur dioxide *gases* interact on vulcanizable materials to vulcanize them almost instantly (in the nascent period), even in the cold.

It is also generally conceded that to the extent truly impalpable mineral dust can be colloidally suspended in any heavy bituminous binder, is inherent stability and density of the pavement of which it forms a part, and its durability increased. It is likewise conceded that by all methods heretofore known not more than 10 percent of such truly colloidal dust can be so suspended in a mixing-method bituminous cement. While Road Oil will permeate dust, the heavier mixing-method bitumen is found to be in films too thickly surrounding the *separated* particles of microscopic size so to suspend more than 10%, and to the extent any particles are not separated by the bitumen in a pavement is that structure weakened. Hence, except in the case of nature's Trinidad product, all United States standard specifications prohibit the use of more than 10 percent of such truly impalpable filler, and permit that only in the presence of fixed proportions of grains of larger sizes "to take care of the dust."

The subject of colloidal chemistry, being that of bubbles, particles, films and filaments, and that of dispersed colloids, a state of matter as distinguished from an amorphous form, would require a too-technical discussion to be briefly presented here, and it is sufficient to say that in its relation to the provisions of a dense tough mastic forming a matrix binding together an ungraded aggregate in bituminous concrete, the electrical forces that are believed to be present and finally responsible for colloidal disperse of molecular particles, have added to them at Trinidad Lake, and now artificially in the "mixpen" specification, further electrical forces in the form of soluble salts, viz., sodium sulphate, sodium chloride (both present in nature's Trinidad process) and sulphate of copper, and without knowing or claiming any specific chemical reactions on the bitumen, but observing the result of these artificial additions to the sulfuretted bituminous residuum of asphaltic base petroleum, as at Trinidad, reliance may be had on these salts in the formative period of the mastic to sustain such colloidal condition of the particles therein; and further, because of such stiffening influence of the mineral dust, and the sulfuretting of the asphalt, the product representing its mastic, as distinguished from pure asphalt, filling the voids in the *ungraded* aggregate is hardened and is less susceptible to heat and cold without reducing its ductility, to the extent of producing a denser mass of more inherent stability than even the mixing-method bituminous concrete, the reductions in costs of which are due to reducing the quantity of asphalt by using the local dust, the ease and rapidity of placing ungraded, unheated, unfilled, compacted, cold aggregate on a subgrade and then heating, dust-clearing and filling with mastic all voids by the less expensive penetration method.

RE-PLANNING RICHMOND, CALIFORNIA

By Guy Wilfrid Hayler, City Planning Engineer, 1743 Bush St., San Francisco, Calif.

One of the widest schemes of civic improvement west of the Rockies has been proposed by the City of Richmond, California. On Oct. 14, 1921, details of a comprehensive City Plan were laid before the City Planning Commission by Messrs. Carol Aronovici and Guy Wilfrid Hayler, Associated City Planners, who have been engaged on the work for some months.

Characteristics of the City

Richmond is a city of only 20 years' growth and has now some 16,000 inhabitants. It is essentially industrial and is the western terminal of the Santa Fe Railroad and the location of an extensive branch of the Standard Oil Company.

Its situation is on San Francisco Bay almost opposite San Francisco and the Golden Gate and has a backbone of hills on the water front for some distance, a wide stretch of marsh land and a swampy area close to deep water out of which the United States Government has planned to create a harbor.

The city itself has grown eastward from the water front hills and now covers the plateau which extends up to the foothills of the Contra Costa range. Few city sites are so varied and the problem of development, whether residential, industrial or transportation has been further complicated by real estate exploitation which has laid out streets regardless of everything except immediate profit.

The city now finds itself a scattered community covering 29 square miles with inadequate thoroughfares, unnecessary grade crossings, no parks or playgrounds, no centralized business area, small school playgrounds, insufficient transportation facilities, remote public offices and a general confusion of residential, industrial and railroad locations.

Special Maps Prepared

The work of replanning has necessitated a civic survey of an exhaustive character and maps have been prepared which detail the following phases of the city:

1. Existing conditions, showing how land and property is now used, industrial locations, open areas, public property, rail-

road property, schools, etc., together with charts of wind direction, ratio of land and water in city area, relative proportions of land occupancy in the city structure, etc.

2. Distribution of population showing the growth of Richmond since incorporation and density of population expressed by dots. Charts of populational increase and city territory increase are also given.

3. Waterfront and harbor showing the proposals of the U. S. Government for the new Inner Harbor, industrial development of the waterfront, wharfs, landings, ferries, etc., together with the hydrography and topography of the shore line. Charts of land, water and marsh areas, public and private tidelands are added.

4. Public utilities showing the complete sewer system and outfalls, water mains and wells of the various companies, gas lines and source of supply, electrical power cable lines, substations, etc. Charts show the extent of the public utility service in relation to the homes and population.

5. Improved streets showing all paved streets and type of paving used. Charts show the ratio of paved to unpaved streets, proportions of the various types of paving, etc.

6. Major thoroughfares and transportation facilities showing all railroad tracks, grade crossings, industrial spurs, depots, freight houses, switching yards, grade eliminations, ferry lines, street car routes, auto stage lines, motor truck lines, together with the major thoroughfares outlined in relation to the regional districts. Charts show length of transportation lines, major thoroughfares, traffic census figures in graphic form embracing the flow of vehicular traffic at important points, etc.

7. Land values showing the present values of developed and undeveloped land on a front foot and acreage basis, also the value of tidelands in private ownership. Charts show in detail the rise and fall of values in the business district.

Preliminary City Plan Prepared

In addition to these maps which have formed the groundwork for the city planning studies by Messrs. Aronovici and Hayler, a preliminary City Plan has been prepared which outlines the recommendations for improvements. These cover:—(1) New major thoroughfare system. (2) New boulevard system. (3) Proposed new streets. (4) Street widenings. (5) Streets abandoned. (6) New parks. (7) New school extensions. (8) Railroad neutral freight right of way. (9) New street car routes. (10) Sites for new public buildings. (11) Civic Center development. (12) New zoning scheme for the city.

Outstanding Proposals

Amongst these proposals the following stand out as conspicuous. The new major thoroughfares which give arterial access and unite business districts, industrial areas, waterfront, railroads and main regional roads. Considerable attention has been given to this subject because of the future prospects of Richmond becoming a still greater industrial center and the need of facilitating the conduct of business on the most efficient lines. The new boulevard system which creates a tree-lined girdle around and through the city, will make the thoroughfares attractive to the regional motorists and encourage them to visit Richmond, as well as providing enjoyable drives for the citizens and promenades for the people. At present the city is almost destitute of trees, although there is every reason to believe they would thrive here.

Recreation is amply provided for, a large city park, small parks with field houses, an aquatic park on the waterfront and small plazas throughout the city being outlined. In addition there are many school playground extensions as well as the outline of a new high school with large athletic stadium. The City Planners have shown in detail how such recreational areas may be developed.

In line with other progressive cities Richmond is much interested in zoning and a scheme for zones for residence, business, light industry and heavy industry is submitted, with outlying areas where marsh and hilly topography at present render unusable, remaining unclassified until land reclamation and development has brought them into the influence of the city.

The City Planning Commission has tentatively accepted the recommendations of the City Planners, and the preliminary plans for improvements. Instructions have been given to have these placed before the citizens at mass meetings for their approval. A wide scheme of publicity will be given to the proposals with the hope that an early commencement may be made to achieve realization. The City Planners were highly complimented on the plans which will be placed on public exhibition as well as being reproduced by photographs and lantern slides.

WATER WORKS SECTION

SOME FEATURES OF PRESENT WATER SUPPLY PRACTICE

(Editor's Note: The following excerpts from the 1921 report of the Committee on Water Works and Water Supply of the American Society for Municipal Improvements contain much valuable comment on the latest developments in the water works field. Mr. Nicholas S. Hill, Jr., consulting engineer, 112 East Nineteenth street, New York, N. Y., is chairman of the committee.)

Pumping Machinery

In no branch of water works engineering have greater changes developed in the last few years than in the design and selection of pumping machinery. The first really successful water works pump was the direct acting steam pump. Henry R. Worthington, the father of the modern pumping engine, brought out the first of this type of pumps about 1840. The year 1895 marked the introduction of the duplex direct acting pump and various improvements resulted from the efforts ot such men as Blake, Knowles, Cameron, Marsh, Dean and others.

The use of steam pumps on a large scale began about the year 1860, and the crank and flywheel pump appeared about 1868. Various other improvements followed, which were principally improvements in details of the mechanism of the pump. No really fundamental change in design occurred until 1876 when the Corliss pumping engine made its first appearance and proved to be a success. Steam was now being used expansively with a marked increase in economy. Duties by this time had risen from around 50 thousand foot pounds per 1,000 lbs. of steam to around 120 thousand foot pounds per 1,000 lbs. of steam. It was quite logical that the steam pump should follow step by step the development of the steam engine with corresponding improvements in economy.

All of the pumps up to 15 or 20 years ago installed in water works plants were of the reciprocating type, either direct acting or crank and flywheel, or either vertical or horizontal pumps as the case may be. The term "reciprocating pump" covers all pumps in which the water is displaced by a plunger, piston, or bucket, working back and forth in a cylinder. The past 15 or 20 years marks the development of the centrifugal pump, although in 1680 the first centrifugal pump was built,, and 1818 was the year when the first crude pump of this type, called the Massachusetts pump, was built in this country. It is probable that the centrifugal pump did not come into general use because of the fact that it is a relatively high speed machine and there was no motive power well suited to it, but with the introduction of the steam turbine and electric motor, conditions have changed. These high speed machines stimulated the development of the centrifugal pump and we now find an ever-increasing demand for this type of machinery.

Probably another reason for the delay in demand was due to the low efficiencies of the earlier types of centrifugal pumps, but at the present time turbine driven centrifugal pumps of large capacity have been installed in water works plants which have produced duties of from 135 to 165 million foot pounds per 1,000 lbs. of steam as compared with 170 to 180 million for the best types of reciprocating engines.

When the low first cost of the turbine driven centrifugal pump is taken into consideration, it makes a very attractive proposition for large water works. In small isolated water works the electrically driven centrifugal pump offers many inducements, and there are to be found now many installations of centrifugal pumps which are driven by producer gas engines, oil engines of the Diesel type, and gasoline engines. The tendency toward centrifugal pumping machinery is notable and marks a step in the evolution of water works design.

Rainfall and Runoff Records

The source of all water supplies, whether surface or underground, is the precipitation of vapor from the atmosphere, commonly known as rain, but also in the frozen forms of snow, sleet and hail. These last are eventually reduced to water and the recorded quantities of snow, sleet and hail are expressed as equivalent water. Part of this precipitation is re-evaporated into the atmosphere. Another part falls directly on the water surface of lakes, swamps or streams. Some is transpired by vegetation and a portion runs off directly from the ground surface. The remainder enters the soil. Surface waters and subterranean waters feed the water courses at various distances from the point at which the rain falls.

All of these actions take place at irregular intervals, varying in duration and may be much extended, except that direct or surface runoff is generally limited to relatively brief periods, which vary with the topography, geology, geographical location and physical conditions of the watershed and its cover, as well as with the season and climate.

A knowledge of the amount of runoff in various localities and on various watersheds is absolutely essential to the proper design of dams and reservoirs. One of the great difficulties which the water works engineer had to contend with in the past was the absence or paucity of suitable rainfall and runoff data. Great strides have been made in maintaining gauging stations for the purpose of recording the runoff of streams in various parts of the country. These have been of invaluable assistance in the proper and secure design of water works. Few people recognize the value of maintaining rainfall and runoff records. We beg to call its importance to the attention of the municipal officials and to request that they encourage the maintenance of such records in the states in which they live, and of water works officials a request is made that they maintain such records on the watersheds under their jurisdiction and control.

Works for the Collection and Distribution of Water

No great changes have occurred in the design of structures for the collection of water, which include the dams and aqueducts, within recent years, except that concrete, as in every other line of engineering endeavor, has replaced other forms of masonry. Much more care, however, is exercised in the design of dams than was formerly the case, and a greater factor of safety is required than in times gone by. The failure of large dams in this country developed public opinion to a point where it demanded legislation requiring state supervision of dam construction and this has resulted in better design, workmanship and material.

Cast iron is still the stable material for the fabrication of pipes for water distribution in cities and towns, although wood stave and wrought iron and steel pipe are occasionally used in transmission lines. Great strides, however, have been made in the design of the details of the distribution system, including the design of hydrants, valves, corporation and curb cocks and the like, but probably the greatest strides have been made in labor saving devices which have been developed for use in connection with the maintenance of the distribution system. The making of connections under pressure and the insertion of valves without cutting off the water, and other operations of like nature, have greatly facilitated the work of the water works superintendent.

Because of the high price of iron and steel, the use of concrete, particularly for tower tanks and pipes, has increased. Some of these structures were poorly designed and built and discredited the material. However, refinements in the mixing and placing of concrete as well as greatly improved methods for making it impervious to water, have brought it into the reliable class.

For the past few years, maintenance and necessary extension only has been the motto of water authorities, but a period of more active construction is approaching rapidly. Work on the new supply for Providence has been resumed. Large purification projects are under way at Milwaukee, Cambridge, Kansas City and Detroit, while in general the undone work of the war time is only awaiting a stabilized labor market for its doing.

Standards for Water Quality

Standards of quality are steadily rising and bid fair to continue doing so. Communities no longer consider safety sufficient, but demand a drinking water of good appearance. This demand has good scientific foundation for the best appearing waters are frequently the safer.

In certain sections, the northeast particularly, waters having colors of 25 or more are still used without complaint. These colors would not be tolerated in western cities supplied with lake or filtered river water, or even in New England; public opinion is fast getting in a position to demand water of an average color of 10 parts per million or less with a maximum of 15. Particular objection is made to colored surface waters containing odoriferous organisms; and turbidity, whether due to heavy microscopic growths, to clay, or to iron rust, is also objectionable.

While the bacteriological standard of the United States Public Health Service met with considerable criticism because of its alleged severity and because it excluded certain water supplying communities in which good public health conditions prevailed, it can not be denied that those who are aiming to supply waters of high quality are trying to equal or better this standard which, as is well known, commands that all waters used in inter-state commerce shall contain no gas-forming organisms (presumably B. coli) in at least three out of five portions of 10 c. c. from the sample tested. One reason for this appreciation is the improvement in public health diagnosis; this, in turn, to better vital statistics, better organization of the health authorities and refinements in clinical methods.

Quite recently the significance of certain spore-forming bacteria (B. Welchii, B. Aerogenes and B. Enteriditis), when found in water, has been the subject of much discussion especially in connection with the outbreaks of intestinal diseases, other than typhoid fever, at Shreveport, La., and Montclair, N. J. These spore-forming organisms are more resistant to the action of chlorine than B. coli and other non-spore-forming organisms and are apt to exist in surface waters which have been chlorinated but not otherwise purified or imperfectly purified by rapid filtration. Both the nature of these organisms and their relation to disease are as yet known imperfectly, and Sir Alexander Houston has recently expressed his opinion that the B. coli should still be regarded as the criterion for classifying waters with regard to their connection with gastro-intestinal disease.

Water Softening

Rain water, which is initially pure and soft, acquires mineral constituents as it percolates through the soil, and the mineral content of water, therefore, depends upon the character of the soil and rocks through which the water has percolated before it is tapped into the source of supply. Therefore, hard water is to be expected in countries where limestone, dolomite, sandstone, gypsum and glacial deposits are found. From these and similar sources soft rain water is converted into more or less hard water. Hard waters are objectionable in many ways. For domestic and laundry use they require large quantities of soap. They are unsatisfactory for washing because they have a deleterious effect on the finer fabrics. They are unsatisfactory for bathing because they have an annoying effect on the skin. They increase plumbing bills because of the formation of scale in waterbacks and piping. For boiler use they cause trouble by forming scale in the boilers, which shortens the life of the boilers and fire boxes and increases the bills for fuel and repairs. In certain special industrial processes hard waters are considerably less satisfactory than soft waters, and they can not be used in certain processes, such as bleaching and dyeing establishments.

It is likely, therefore, that the increasing competition for industrial growth and the rising standards for domestic water supplies will lead to a substantial growth in water softening. The need for water softening does not depend on sanitary grounds so much as on economic grounds. The hardness of the water has little or no effect upon the public health, but for both industrial and household uses hard water is unsatisfactory. In particular, the quality of municipal water supply for industrial purposes assumes importance where towns are competing for the location of industrial plants. Many towns depend upon railroad shops and round houses, or large manufacturing plants, for a considerable proportion of their population. The progressive city with an ample supply of soft water will grow while others will stand still. There is a more direct economic appeal, however. Under certain conditions, depending upon the hardness of the water, the size of the town, and other local considerations, the residents of a town will save money by softening its water. The relation between the cost of water softening and the saving resulting therefrom to the ordinary householder is very direct, and in many cases the saving in soap alone is sufficient to pay for the cost of softening, to say nothing of the saving in damage to the finer fabrics, the reduced cost of plumbing, etc.

There is an increased demand for softened water, particularly in residential districts and in textile dry houses and bleacheries now supplied with hard water. In addition to the limesoda process in use for 70 years, artificial zeolites, of which "Permutit" and "Delcalco" are trade examples, have had widespread use in the industries, in hotels and large residences, and are beginning to enter the municipal field. By their use, water may be completely softened, the calcium and magnesium in the water exchanging with the sodium in the zeolite. After the zeolite becomes exhausted, it is regenerated by contact with brine, followed by washing with water.

Water Supply and Disease

Among the worthy accomplishments of the past decade has been the reduction in the typhoid fever death rate in American cities; another was the remarkably low typhoid death rate among the American Expeditionary Forces, a marvelous contrast to the records of the Spanish and Boer Wars. For example, the typhoid death rate of Massachusetts for 1920 was 2.5 per 100,000 and only five of the cities of that state had rates exceeding 5 per 100,000, a glaring contrast with conditions of 15 years ago when leading sanitarians were talking of "residual" death rates much higher than these actual accomplishments.

Notwithstanding these improvements in the public health, due in largest measure to improvements in water supplies by storage, inspection, filtration and disinfection, the goal is not yet reached. Mild outbreaks of gastro-intestinal disease, like a mild type of dysentery, rarely causing death, appear suddenly in many municipalities, especially in the spring, and the distribution of disease is such that the public water supply has seemed in each case to be the cause. The necessity for vigilance and study still exists and the well-known lines of defense against water borne disease must be well supported, for without watchfulness the best designed works may fail, as evidenced by the recent outbreak of typhoid at Salem, Ohio. Material assistance may be given to the water department by the community by destroying infectious material at its source, and by better use of the methods of hygiene and preventive medicine.

Water Purification

Both the advantages and limitations of storage as a method of purification have been the subject of recent discussions—the consensus of opinion being that it is a valuable and perhaps the most reliable single method, but not free from the danger of wilful or accidental contamination.

There have been few changes in the basic design of water purification plants within the past 10 or 15 years, but many improvements have been made in the details of water purification plants, particularly with respect to the pipe galleries in gravity mechanical plants, with respect to the handling and application of chemicals, and other practical matters. The use of the hydraulic pump to mix chemicals with water by J. W. Ellms, in the Milwaukee experiments, seems to be a simple and effective substitute for the older methods of baffled channels, agitators, weirs and other mixing devices.

Where filtration and softening are combined, difficulties resulting from the so-called balling-up of the filter sand, due to the accretion of lime deposits on the sand grains in the filter beds, are being overcome by several methods which have been developed recently.

The knowledge of the handling and application of chemicals used in the treatment of water has been vastly benefited by the researches of physical chemists in recent years.

The difficulties of treating colored waters and waters of low alkalinity to produce an effluent free from color, turbidity and colloidal aluminum hydrate, and one which would not erode or corrode service pipes and plumbing, are well known. While many operators have surmounted the difficulties connected with the purification of such waters, they have done so by methods largely empirical; it was difficult to find a scientific basis for proper treatment or reasons for failure. Recently, however, water chemists have made use of the hydrogen ion concentration, and the method bids fair to explain much which is now obscure.

Briefly, the hydrogen ion concentration is a measure of the reaction of the water, of its acidity or alkalinity, but it is a delicate and discriminating measure and gives information which the ordinary alkalinity determination does not. By hydrogen ion concentration is meant the concentration of disassociated or active hydrogen in the water. The standard alkalinity determination measured the total amount of alkali present, but it did not measure the concentration, either before or at any stage in its neutralization. The determination of the hydrogen ion concentration gives by difference the concentration of the alkalinity at any time, and this is a factor that is often of very great importance to know and which may throw a great deal of light on proper application of chemicals in water purification plants. We will not attempt a technical discussion of hydrogen ion concentration at this point, but simply wish to call attention to the benefits which may result from this method of measuring the re-action of the acidity or alkalinity of water.

Our more progressive officials are beginning to realize that water purification is not only a problem of hydraulics and mechanics, but a problem of chemistry and biology as well, and are giving more encouragement to laboratory work. It is unfortunate that very little attention has been given to the laboratories at water purification plants in the past. The larger plants have had well equipped laboratories from the beginning, and expert chemists and bacteriologists were employed to carry on the routine analyses necessary for the proper operation of such plants, but very few of the smaller plants maintained properly equipped laboratories and fewer still had anyone connected with the plants who had a fair knowledge of chemistry or bacteriology. This practice is fraught with much danger for the reason that the existence of a filter plant gives a feeling of security to a community, whereas a filter plant without proper supervision may be but a blind to camouflage a really critical situation.

Fortunately, however, at the present time boards of health in many cities, and particularly in many of the states, are taking a hand in the supervision of water purification. It has become necessary for the water departments to report to the health boards the result of their chemical and bacteriological analyses. This has resulted in the establishment of laboratories in nearly all except very small plants. Closer attention is given to the results obtained for the health departments are also testing water. In some states the supervision of filter plants has gone so far as to require all operators to be licensed. The State of New Jersey, so far as we know, has been the pioneer in this respect. On February 9, 1918, an act was passed relative to the examination and licensing of operators. This act authorized the State Department of Health to examine prospective operators and to issue a license, providing the examination of the applicant proved him to be capable of performing those duties which would be required of him. It is further provided that every purification plant must have a licensed operator. This is a step in advance and should result in better filter plant operation.

It is to be remembered, however, that the licensing of operators and the making of daily routine analyses are not all that is required. The water works superintendent should give greater attention to the analysis of the water supply under his charge. Analyses are useless unless used, and this observation is true with regard to all operating data in a water works plant. The mere collection of the data is not sufficient. It must be used and applied.

Electrolysis

Ever since the advent of the street railway, water works plants throughout the country have complained of electrolysis of mains and service pipes. The term "electrolysis" embraces the entire process of accelerated corrosion of underground metallic structures due to stray currents.

The practical electrolysis problem is due to stray currents from electric street railways. Instances of stray currents from other sources sometimes occur, but such cases are rare and are not specifically considered.

Electric currents straying to earth from electric tracks frequently find their way to water and gas pipes, telephone and power cables, and other underground structures. When this current leaves these structures through earth, corrosion results. Thus not only are the structures of many different companies subject to injury, but by reason of the different public services dependent on such structures, the public as a whole has a direct interest in this type of electrical interference.

As the investment in pipes and service connections in the towns and cities of this country is enormous, the added depreciation resulting from electrolytic corrosion represents a large economic loss to the municipalities of the country. Suits were brought in several instances to compel the street railway companies to modify or change their system of operation or to secure damages for electric corrosion. No definite beneficial results were obtained from these studies for the reason that the data were not sufficient on which to base a determination of the minimum residual amount of stray current which was permissible and which would not cause injury to underground metallic structures nor whether it was feasible for the street railways to keep the stray current down to this minimum residual.

Believing that the matter was subject to co-operative treatment the American Committee on Electrolysis was appointed. This committee consisted of representatives of the electric railway, electric light, telephone, gas and water interests. Already one report has been made on the subject of electrolysis and a second report will be issued within a short time. It is to be hoped that this committee will be continued and that the results of its work will be to bring about a better understanding of the problem of electrolysis prevention and a closer co-operation between the electric interests and the interests which maintain the structures affected by electrolysis.

It has been found advantageous to form joint committees composed of technical representatives of the several utilities concerned to investigate the local electrolysis situation and determine by agreement the course of procedure to be followed. Such committees should, of course, attack the problem in an open and fair minded manner with the object of effecting mitigation in the most economical way. To this end they should be composed of men, or have men associated with them, who are trained in the technique of electrolysis. Active committees of the kind described are now existent in Chicago, Kansas City, Omaha, St. Paul, New Haven, Milwaukee and Syracuse. The principle of co-operation has been recognized by the Railroad Commission of Wisconsin in an order authorizing an electrolysis committee in the State of Wisconsin. Such committees act as clearing houses of information and keep all of the interested companies informed as to changes in their systems which may affect the electrolysis situation. Under the direction of such a committee joint electrolysis surveys may be conducted and unified methods of mitigation installed and maintained.

MODERN METHODS OF CARRYING BOND ELECTIONS

By R. E. McDonnell, of Burns & McDonnell Engineering Co., Consulting Engineers, Interstate Bldg., Kansas City, Mo.

As a basis for bond elections, municipal officials usually adopt the method of employing a consulting engineer who makes his preliminary plans, estimates of cost, and report on the project. The carrying of the bonds is then usually left to the city officials, who with the aid of civic organizations, endeavor to interest the voters in support of the project.

Successful Modern Methods

The failure to carry many worthy projects has caused the writer to adopt modern methods which, upon trial, have proven so successful that it is believed they could with profit be adopted by any city having a bond election under consideration. Bond elections in growing communities are necessary, once in about every three years, and in one state last year over one hundred bond elections were held. It is a waste of time, money and energy to place any bond issue before the public without fully informing the voters of every phase of the project, such as feasibility, first cost, and cost of producing the commodity, whether it be water, electricity, gas, heat, or ice. Operating costs, fixed charges, revenues, and rates to be paid often decide the fate of bond issues.

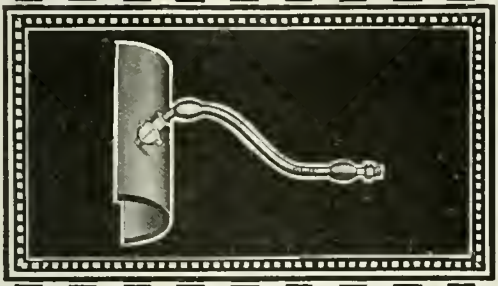
Carrying Bond Elections an Engineering Problem

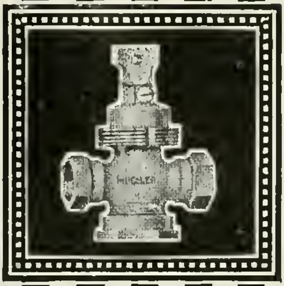
After 25 years' engineering experience in solving municipal problems, the writer is convinced that the carrying of bond elections is an engineering problem and should be handled by the engineer as a part of his duties, rather than that the burden be shifted to city officials, whose offices are political and where supporters of the administration must be appealed to. Many partisan voters, or "outs," decline to enthuse on a bond project because it is advocated by the "Ins." An engineer is employed to handle the work because of his special engineering training and skill, and, having no political ambition, his advice, suggestions and recommendations "listen good" to a great majority of citizens who find politics and good municipal utilities don't mix. Votes for bonds are no longer secured by appeals of oratory to "Support the administration," "Have confidence in them, they will spend it honestly," "Show pride in your city," "Our old run-down utilities are a heritage of the last administration," and similar phrases, but nowadays the voters question and analyze the operating and maintenance cost, the upkeep, life of material, etc., and must be shown wherein they are going to be benefited. This critical and proper analysis by the voters, whether men or women, requires a different campaign, and it must be one of education about the engineering problems involved. To prepare a fine set of plans, or a beautifully bound report no longer satisfies. The job, or bond issue, must be sold to the public and the buyer, or voter, wants facts, figures and absolute proof that the investment is a profitable one for himself and his home town.

Handling Water Bond Campaign at Parsons, Kans.

A successful bond campaign for a half million dollars for rehabilitating the municipal water works plant at Parsons, Kansas, has recently been conducted by our engineering organization and the methods used are outlined as an example of what other cities might accomplish by adopting similar methods.

Preliminary plans, maps, estimates and summaries of the report were prepared on a large scale for use in window displays.






MUELLER

About 75 stereopticon slides were made and used at mass meetings and before civic organizations. Municipal band concerts were held outdoors and following the concerts all features of the project were explained—cost estimates, operating expenses, depreciation allowance, bond sinking fund, revenues and rates, with net income, were shown through graphical diagrams. All engineering features were so clearly explained that a prominent attorney, commenting on the project, said: "The engineering is shorn of its technical features and we are now all engineers and see the soundness of the whole project."

Newspaper Cooperation

"The Parsons Sun" expressed a willingness to publish a series of water works articles, which were prepared by the engineers. These articles were run daily, many of them being illustrated by views showing both the present conditions of the water works system and the proposed improvements. Over 50 of these articles were prepared and used. They were written, not as a technical journal would use them, but as newsy, interesting items. To test their power to interest readers, an interruption was intentionally made which caused many 'phone calls of inquiry and request for the articles to continue. Some knowledge of the 50 articles may be gained by quoting some of the titles: "Why the Women of Parsons Want Pure, Soft Water," "How Good Health Can Be Purchased," "What Happens When a Water Famine Occurs," "The Cost of a Typhoid Epidemic."

Facts and Figures Used

A feature of the improvements was a modern water purification system to displace a very inadequate and antiquated system. Comparative figures were given showing the saving in cost of operating a modern plant, thus showing the voters that they were daily losing money by operating an inefficient plant, besides giving the city an unsafe water to drink. Former bad fires were illustrated, with tables of annual fire losses, showing the fire loss per capita far above that of other cities. Insurance rates were shown to be exorbitant because of the present inadequate protection. Fire losses due entirely to poor pressure were shown to exceed the total bond issue asked. A portion of the improvements consisted of replacing a large amount of small steel and wrought iron pipe, also replacing a flow line of spiral riveted steel and vitrified pipe. The leakage figures were given, showing a loss of over half the water pumped. Exhibits of this worn out pipe were placed at prominent street corners with placards giving age, when removed, etc. The per capita cost of the Parsons proposed improvements was shown to be less than that of about 25 cities similarly situated.

The generation of electricity for operating low service pumps over a ten mile transmission line to the River Station and also low service pumps at the City Station, lighting the grounds, stations, etc., was a part of the improvements strongly opposed by a private company, wanting to sell electricity to the city. This feature involved a fight for municipal ownership with all its advantages to be shown by the engineers. The salesmen with something to sell in the way of machinery, equipment, pipe, oil engines, steam engines, etc., were very active, making it necessary for the engineers to make an unbiased report on each, and thus forestalling opposition to the bonds.

Speaking Campaign

The publicity campaign through the papers and by personal presentation of the plans before civic organizations continued for four weeks, with an intensive speaking campaign for 1 week, when 21 meetings were addressed, in explaining the engineering, economic and health features of the project. Noon meetings were addressed when factory, shop and office employees were reached. Slides were daily distributed to all the picture shows, showing some special features of the improvements. Local speakers were organized and 10-minute talks at all picture shows were made during the closing week. Church announcements were made calling attention to the necessity of good citizens voting either for or against, but leaving them to form their own conclusions.

The women voters, through the Parsons Federated Women's Clubs, sponsored the final mass meeting, bringing before the women voters the importance of the water supply from the standpoint of health, hygiene, sanitation, beautiful lawns, clean streets, swimming pools, school and street drinking fountains, etc.

Various business men co-operated and jointly carried full page advertisements recalling former water famines, bad fires, and showing what the new improvements could offer in the way of securing new industries in Parsons.

Home owners were clearly shown by figures that not a dollar of taxes would be added, but that the revenue would make the plant self-supporting.

Attitude of Engineers Conducting the Campaign

The engineers conducting the campaign

2-inch Service Pipe cast bell down in 9-foot lengths

Cast Iron Service Pipe

Bell and Spigot Joints

One engineer has stated that nothing will ever reduce the loss of water through leakage in distributing systems so much as the general adoption for services of cast iron pipe with joints that will stay permanently tight. Exactly this type of pipe is offered in U. S. Cast Iron Bell and Spigot Service Pipe.

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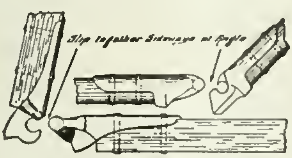

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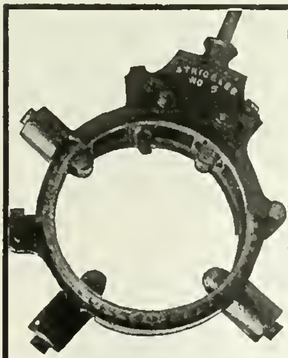

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had the support and active aid of the mayor, but no aid or co-operation from one of the commissioners, and the active opposition of the other commissioner, until two days previous to the election, when his conversion occurred and the three united in a printed statement favoring the bonds. Other early opposition gradually melted away as the project became understood and those who had opposed came out in print favoring the bond issue. In their articles and talks the engineers refrained from directly urging the voters to support the bonds, but took the position of a disinterested consulting physician to a sick utility, and presented their prescription for the patient in the form of plans, estimates and report, and all features of these were clearly explained, leaving the voters to form their own conclusions whether they wanted to vote for or against the bond issue.

Results Secured

The prescription offered was taken, the bonds were carried, and the half million dollar improvement is now being carried out under the guidance of the engineers, with the expectation that the sick utility will soon be restored to health.

The engineers have found from experience that the same character of bond campaign is applicable toward any municipal problem. It has recently been successfully applied on bonds for sewage disposal, electric lighting, and municipal ownership of several utilities. Its success confirms the belief of the writer that real engineering goes farther than the mere preparation of plans, but that the engineer should "put over" the projects instead of leaving them in the hands of laymen to scramble.

THE WATER DISTRIBUTION SYSTEM

By H. R. F. Helland, City Engineer, City Hall, Waxahachie, Texas

In the construction of the water distribution system it is very important that an accurate record be kept of valves put in and connections made, said Mr. Helland in addressing the 1921 meeting of the League of Texas Municipalities. Much valuable time and a great deal of trouble will be saved by having the correct locations of valves and connections. For example, in making a new map of the water works in Oklahoma City, Mr. Holloway, superintendent, found numerous instances where valves shown on his records had never been put in and he found valves in the lines of which there was absolutely no record. In one instance he cites nine valves had to be closed and five miles of main shut off in order to repair a broken main, when, if his old records had been correct, it would have been necessary to close only two valves and shut off one mile of main.

In this connection, provision should be made for the periodical inspection of valves and fire hydrants. A valve or a fire hydrant is of no use unless it is in good working order. A leaking valve can be detected by means of an aquaphone.

The records of valves should show, besides giving the location, the number of turns necessary to open or close. Knowing this, when testing a valve it is easy to tell whether the valve is operating correctly. It sometimes occurs that when opening or closing valves a workman, thinking that the valve is not open, exerts extra pressure on the valve wrench, thus twisting the valve stem in two. By knowing the correct number of turns necessary to open or close, this can be avoided.

A few months ago I found it necessary to repair a hydrant in one section of Waxahachie. We closed, or thought we closed, the two valves that it was necessary to operate, but found that quite a stream of water was still coming through. Had these two valves been in good condition, only two blocks of main would have been shut down. As it happened, it was necessary to close three additional valves and put eleven blocks of main out of service. It was found upon examination that the valve stem of the defective valve had been twisted in two with the gates only partly closed. A periodical operating of the valves of the system will also prevent to a great extent the corrosion and clogging of the valve seats. In the same way, a defective fire hydrant is worse than useless, valuable time being lost by trying to operate such a hydrant in case of a fire.

Meterage

Every city should be 100% metered. It is now recognized that the only proper way in which to sell water is by use of meters. There is as much sense in using the flate rate system as there would be in paying your grocer a certain amount each month regardless of what you used. A meter correctly measures the amount of water delivered to the consumer and the meter reading should govern the amount the consumer pays. The water once having passed through the meter belongs to the consumer and has been delivered to him, and should be paid for regardless of what becomes of it.

Water Works Equipment Service

If in the market for any of the following water works equipment, so indicate by check marks, mail to *Municipal and County Engineering*, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

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—Air Lift Pumps
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—Conduit Rods
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—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
—Liquid Chlorine
—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead Lined
—Pipe, Steel
—Pipe, Wrought Iron
—Pipe, Wooden
—Pitometers
—Pumps, Air Lift
—Pumps, Boiler Feed
—Pumps, Centrifugal
—Pumps, Deep Well
—Pumps, Steam
—Pumps, Trench
—Pumps, Turbine
—Pumping Engines
—Service Boxes
—Soda Ash
—Specials, Cast Iron
—Standpipes
—Steam Boilers
—Steel, Reinforcing
—Sulphate of Alumina
—Tamping Machines
—Tanks, Elevated
—Tapping Machines
—Trench Braces
—Trenching Machines
—Valve Boxes
—Valve Inserters
—Valves, Gate
—Valves, Pressure Regulating
—Water Main Cleaners
—Water Meters
—Water Softening Plants
—Welding Apparatus
—Well Drills
—Well Screens

I do not believe in making adjustments for excessive bills or leaks. It is a responsibility of the consumer to keep his piping in good order. If water is wasted it is not the place of the water company to bear that loss. A flat rate leads to the waste of water and experience has shown time and again that the water consumption is materially reduced after a system has been fully metered. When a meter becomes old and worn, it will under-register and in practically all complaints that a meter registers too much it will be found that the consumer has had a leak on his premises.

Large Feeder Mains

In laying out or extending the distribution system great care should be taken in the laying out of the large feeder mains. In this respect a great deal of care and thought should be given to possible future developments of the city. The laying of long lines of 4-in. main should be avoided as they are too easily overloaded and any future development of the section fed by such a main would require the laying of additional mains. Much expense of this kind could be avoided by a little foresight in regard to the size of mains. This matter of too small mains had been very forcefully impressed upon me within the past year of two, as I have had to take up 5,000 ft. of 4-in. main and replace it with larger main because it was impossible for the 4-in. main to deliver the amount of water required. In Waxahachie we have a 220,000 gal. standpipe about 1 2/3 miles from the pump station. The 4-in. main above referred to led to this standpipe. Before laying the larger main, whenever, for any reason, the pump station was shut down, the water could not flow back through the main fast enough to supply the lower part of the city. Under such a condition the standpipe was of no benefit as a storage tank or pumping cushion and we were practically operating under the direct pressure system. Since that time, larger mains have been put in and we have erected a 250,000 gal. elevated tank 4,500 ft. from the pump station.

DU PONT SELLS HOPEWELL, VA., WATER WORKS

The water works at Hopewell, Virginia, which during the war supplied the great munitions plant of E. I. du Pont de Nemours & Company and adjacent villages, has been sold by the Du Pont Chemical Company to the Industrial Service Corporation of Virginia. The transfer includes electric and steam pumping stations, filtration plant, boiler plant, transmission lines, etc. The new corporation took over the operation of the plant November 1st. The plant has a capacity of approximately 30,000,000 gals. per day which will enable it amply to serve the community and take care of considerable expansion.

J. F. Muhlig is the general manager and operating head of the new corporation, with headquarters at Hopewell, Virginia.

The sale of this water works marks another step in the work of the Du Pont Chemical Company in turning over the property of the former munitions works to peacetime uses. Recently the company gave title to the last of its houses in one of the large villages there. The transfer consisted of 73 dwellings and was the largest housing transaction ever made in the vicinity. Since the campaign was started to turn Hopewell and vicinity over to permanent industrial development, 20 firms have located there.

NEW METHOD OF FIRING T. N. T. IN ELIMINATING MOSQUITO BREEDING PLACES

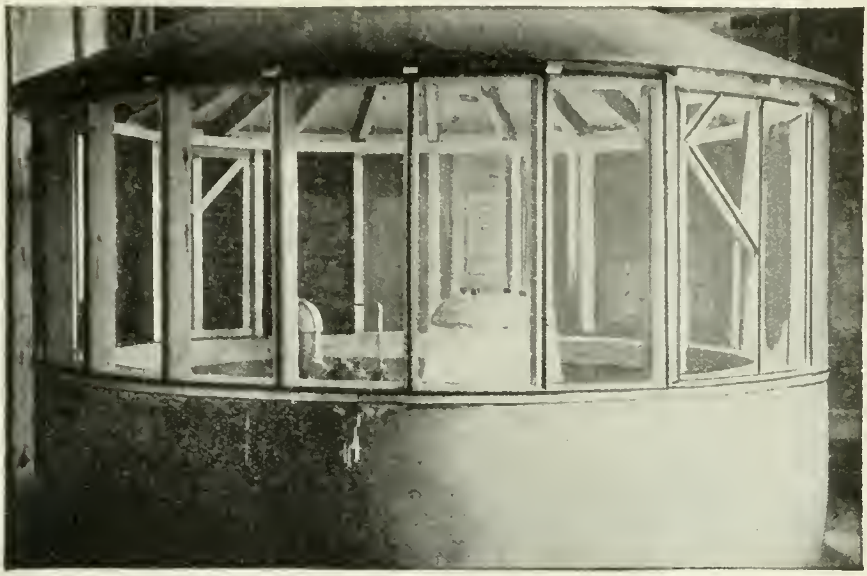
A new method of firing T. N. T. in propagated ditch blasting, which greatly reduces labor costs and saves time, has been evolved by the Mississippi State Board of Health at Greenwood, Miss. It was planned to blast deeper the Walker's Lake Canal to eliminate sources of mosquito breeding.

In describing the new method J. Lyell Clarke, Sanitary Engineer of the Board, says:

Work on the canal was begun in May, was checked on account of the high water, and again discontinued when attempt was made to fire T. N. T. in water by priming each charge with an electric cap connected in series—the usual method.

Owing to the leakage of the electric current through water this method proved a failure, caused misfires and resulted in a labor cost almost prohibitive.

T. N. T. being very insensitive, will not explode by the propagated method, so in an effort to reduce the two main items of cost of ditch blasting, which are labor and caps, a new method has been evolved. Tests were made wherein ¼ lb. charges of 50 per cent straight dynamite were used in lieu of electric caps. Knowing that concussion from the explosion of one



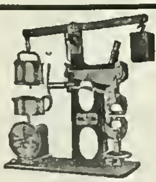
Don't Blame the Well

In most cases we find that the well is not as poor as it is thought to be. It is more often a wrong method of pumping.

Harris Air Lift System has saved the drilling of hundreds of wells. It saves endless expense and trouble, because it does not get out of order and requires no repairs; therefore no maintenance expense. Write for free booklet, *"Pumping Efficiency,"* containing valqable data and facts pertaining to well pumping installations.

HARRIS AIR PUMP COMPANY

421 West South Street **Indianapolis, Indiana**



New Automatic Cement Tester

Grand Prize Panama-Pacific International Exposition, 1915.

Manufacturers of Cement, Concrete, Brick and Road Material Testing Machines and All Auxiliary Laboratory Apparatus

TINIUS OLSEN TESTING MACHINE CO. 500 North Twelfth St. PHILADELPHIA, PA.

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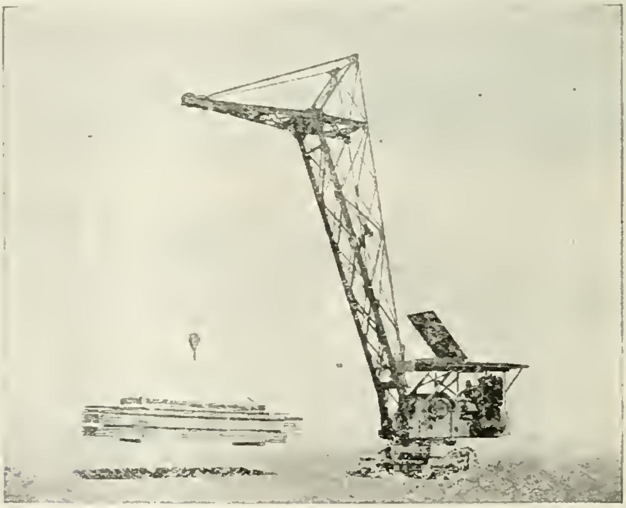
primed charge placed in the center of a line of charges of ¼ lbs. of dynamite, spaced at intervals of 18 ins., would be transmitted throughout the entire line and cause almost simultaneous combustion, it was thought that the explosion of the top charges of dynamite would in turn detonate the large charges of the more insensitive T. N. T. placed beneath it. This it did. The top charges of dynamite exploded the T. N. T. more completely than did the electric caps, shattered the top soil and lifted it well back, gave the T. N. T. an opportunity to heave out the bottom strata in good form, and in addition thereto eliminated the cost of priming each hole, the cost of connecting the caps in series, and the cost of reshooting misfires. Only one cap was required to set off one hundred charges. The resulting ditch was wider, larger and more uniform than that constructed with the T. N. T. detonated by an electric cap placed in each charge; besides, the work was speeded up about 200 per cent.

The cost of blasting a ditch 10 ft. wide at top, 3 ft. wide at bottom and 4 ft. deep with charges of 1¼ lbs. of T. N. T. (or Picric Acid) detonated with ¼ lb. charges of 50 per cent straight dynamite spaced 18 ins. apart, is approximately $750 per mile, or 14 cts. per cu. yd. of earth removed. Six laborers under average swamp conditions can blast one mile of ditch in one week.

NEW GOOSE-NECK CRANE BOOM

In adapting a P & H 206 Crane of the type shown in the accompanying illustration, to the handling of loads such as unit packages of lumber from high piles, it was found that the lengths of lumber interfered with the straight or standard crane boom. To overcome this and eliminate much of the costly labor required to handle lengths of lumber, pipe, etc., the makers, Pawling & Harnischfeger Co., of Milwaukee, developed the Goose-Neck boom. As the illustration shows, the boom may be lifted almost straight up without having the load interfere. In other respects this boom is like the standard design and attaches to the gasoline-driven corduroy-traction machine in a similar manner.



NEW GOOSE-NECK BOOM, ON P. & H. 206 GASOLINE DRIVEN, CORDUROY TRACTION CRANE, FOR HANDLING LOADS WHICH INTERFERE WITH STANDARD STRAIGHT BOOM. LOAD SHOWN IS 18-FT.x6-FT.x31-INS. AND WEIGHS 3 TONS.

The first plant (a furniture factory) using the Goose-Neck boom on a P & H "206" operated it for handling lumber in aisle-ways 18 ft. wide, taking lumber in unit packages off 20 ft. piles and placing on wagons or trailers spotted in the aisle-ways. Hardwood at 4 lbs. per sq. ft. was handled at the rate of 1,500 sq. ft. per trip. The amount handled per day varied and was limited by the auxiliary equipment—trucks, wagons, trailers—required to carry the lumber to stock, or to the cut-up room or for delivery as the case might be. The company using this "206" crane with new Goose-Neck boom will require only 10 laborers instead of 25 previously used, making a labor saving of $60 per day.

Construction News and Equipment

SUBGRADE WORK ON ILLINOIS HIGHWAYS

(Editor's Note:—Subgrade problems have been much discussed during the past two years and these discussions have influenced practice, of course. The present article describes subgrading work on Illinois highways as outlined in the Manual on Road Construction recently prepared by B. H. Piepmeier, Engineer of Construction, Illinois Division of Highways, Springfield, Ill.)

Subgrade.—A uniform, well compacted, properly drained subgrade has perhaps more to do with the successful completion and life of a pavement than most any other factor. Regardless of the type of wearing surface constructed, the subgrade must necessarily transmit the loads from the pavement to the earth. The subgrade should be recognized as that portion of the road from shoulder to shoulder of the graded roadway. It should be shaped and crowned to drain the water readily to the side ditches and should be as nearly uniform in character as is possible to make it with practical methods. In general, the subgrade that is made by the use of teams or tractors requires very little rolling to secure sufficient consolidation for the pavement. The frequent use of a road drag or planer will usually leave a subgrade in condition suitable for final finishing and placing of the pavement. Where a slight amount of material is moved in the final shaping of the subgrade, a light tandem roller will iron out the surface in a manner that prepares it satisfactorily for the pavement. Special care should be taken to get the subgrade thoroughly compacted immediately under the side forms and for a distance of at least 1 ft. outside. The subgrade beneath the forms must support the load that is applied to the forms and prevent settlement.

Scarifying and Shaping.—After the rough grading has been done, a subgrader or scarifier operated in connection with a power roller may be used to advantage. In some instances light scarifiers are used and pulled by independent power. In either case it is advisable to scarify the entire surface to a depth of at least 2 ins. below the finished subgrade. The pulverized material may then be uniformly spread over the surface to the desired depth and the surface to the desired depth and the surface rolled lightly to bring it to true grade. There are a number of subgrading machines which may be used after the surface has been scarified or loosened. These machines operate on the side forms and trim the subgrade true to the cross section shown on the plans. After the subgrade has been prepared for the pavement, it should not be rutted by trucks or wagons or compacted in such a way that it will not be uniform in character.

Wetting Subgrade.—When trucks are employed very little water should be used for wetting the subgrade in advance of placing the concrete as water will cause some mud to get into the concrete. Under normal conditions and especially where materials are delivered by industrial equipment, the best results are obtained when the subgrade is soaked with water the day before the concrete is placed. This method is much to be preferred and should be used whenever possible. The purpose of wetting the subgrade is to prevent the earth from absorbing an excessive amount of moisture from the concrete during the setting process and to allow the over-compacted earth in the subgrade to swell and obtain its normal conditiou before the pavement is laid.

Rolling Subgrade.—It is necessary that some form of roller be used in the preparation of the subgrade for the pavement. Under normal conditions the light 3-ton tandem roller will prove entirely satisfactory for this purpose. However, the ordinary 3 to 5-ton horse roller pulled by a light caterpillar tractor engine will also meet the requirements of the specifications and prove to be satisfactory. In some instances the 10-ton, 3-wheeled roller will be used, in which case it should go over the subgrade but once as it is very easy to over-compact portions of the roadbed. In such case the subgrade should always be soaked 12 hrs. or more before the concrete is placed. In general, the use of the 3-wheeled heavy type roller for this purpose should be discouraged. Where there are but a few inches of loose material to be compacted, a home-made concrete roller or a hand roller may prove to be sufficient to iron out the subgrade preparatory to the construction of the pavement. In no case should the heavy 3-wheeled rollers be used after the soil has been saturated with water as it will over-compact the earth and cause trouble in the swelling of the subgrade after the pavement is placed. The heavy rollers and traction engines are especially desirable for compacting large fills during the process of construction. The 3-wheeled, 10-ton rollers will locate the soft spots in the fill and assist in compacting the loose material and thereby reduce the settlement to a minimum. When fills are built up in horizontal layers of approximately 18 ins. by the use of wheel scrapers, slips or dump wagons, there is usually no advantage in rolling the fills during the process of construction.

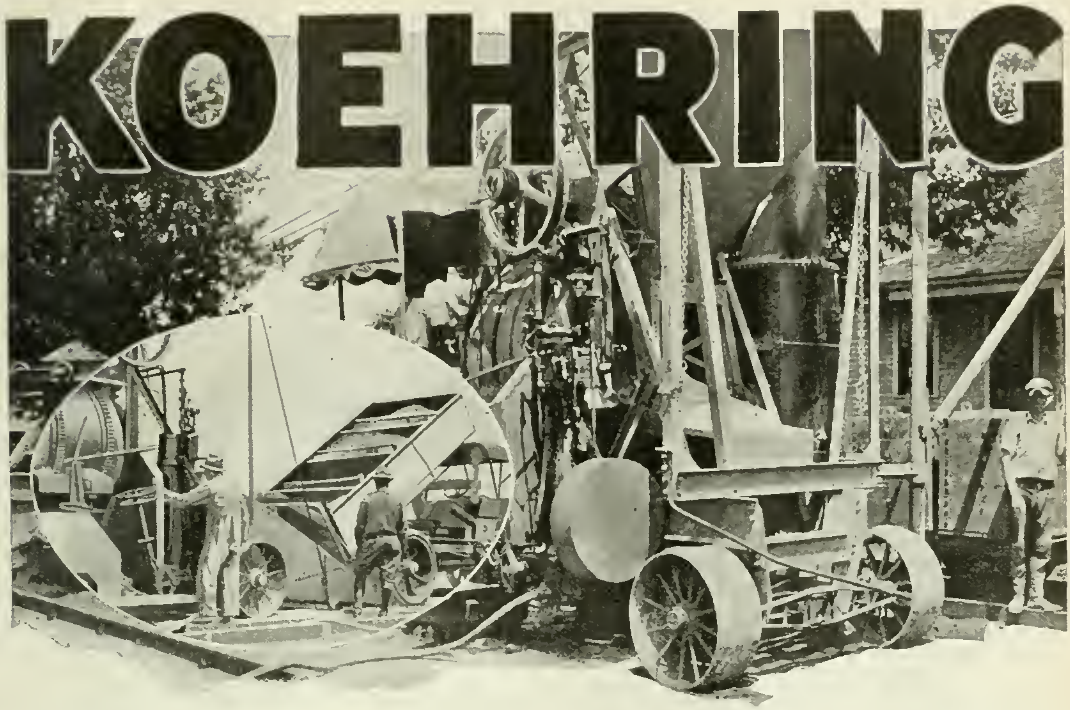
Unrolled Subgrade.—In case the subgrade has been prepared for a distance of several hundred feet in advance of the mixer and there should be a heavy rain causing an undue swelling of the subgrade, no attempt should be made to roll in advance of the mixer or of concrete that is being deposited. In this case the use of a subgrading machine or other means of trimming the subgrade true to cross section before the concrete is deposited is sufficient. The subgrade is in an ideal condition for the pavement after a rain or after it has become thoroughly saturated by means of sprinkling as this will cause the earth to swell and assume its natural condition. The principal object in the preparation of a subgrade is to secure uniformity throughout. Should low places exist they may be filled with earth providing they are compacted the same as the remainder of the roads.

Driving on Subgrade.—There is no objection to motor trucks being driven over the subgrade provided they are not loaded to such an extent that the subgrade is rutted or depressed out of shape. When trucks are used for dumping directly into the mixer they should cover the entire surface of the subgrade in order to compact it more uniformly throughout its full width. Narrow steel tires or teams turning or backing on the subgrade shall not be allowed. When trucks are used for the delivery of batches direct to the mixer considerable time will be saved by utilizing a turn table which may be placed on the subgrade a few hundred feet in advance of the paving mixer. Frequent backing and turning on the subgrade often causes large ruts. This should be avoided wherever possible. There are a few truck bodies that are built so as to dump at the side thereby permitting material to be dumped directly into the skip of the mixer before the truck is turned around. This method permits the trucks to turn when empty. In this case turning on the subgrade is not nearly so objectionable.

Porous Material for Subgrade.—When the subgrade is poorly drained it may often appear to be advantageous to roll in a layer of gravel, stone or cinders before placing the pavement thereon. Generally there is no objection to this method of obtaining a suitable subgrade, but in such instances the porous material beneath the pavement should be carefully drained or it will act as a reservoir for water and thereby result in additional damage to the pavement.

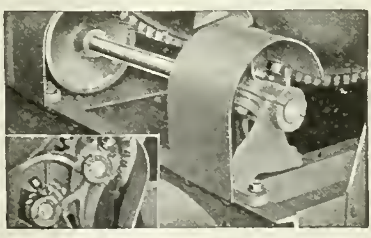
Tiling Subgrade.—If an exceptionally wet subsoil is encountered, it may be remedied by intercepting the flow of underground water by the installation of 4 or 6-in. tile drains. Such tile should be placed from 2½ to 3 ft. in depth and the trench backfilled with porous material. A single line of tile down the center or along the upper side of the pavement with lateral drains at various intervals along the road will usually prove sufficient to drain out the surplus underground water. When two lines of tile are used, they should ordinarily be placed beneath the edges of the pavement to a depth of 2 to 3 ft. and the trench backfilled with porous material. In general a 6-in. tile is a desirable size to use for the draining of the subsoil.

Oiling Subgrade.—After the subgrade has been prepared it may be treated advantageously with road oil. The oil will keep down the dust and prevent the formation of ruts and mud during rainy weather. It will make possible the use of light trucks much sooner after a rain and will eliminate the necessity of wetting down the subgrade prior to the placing of the concrete. For construction purposes the subgrade may be oiled for a width of 15 ft. This would enable trucks to follow the oiled portion of the road in the delivery of materials. If the pavement is to secure the full benefit of the oil the subgrade should be oiled to the full width of 18 ft. The oil should be applied as early in the spring as conditions will permit and when the road is free from dust and loose material. It should be applied at the rate of ½ gal. per sq. yd. in two equal applications. The cost



Look under the drum!

IF it is a Koehring mixer, you will see that the heavy drum is supported by drum rollers, constructed on freight car truck principle. The drum rollers do not turn on a fixed axle, which under the down thrust of heavy drums soon must wear flat on the top side and set up pounding vibrations throughout the mixer. No—the rollers which support the Koehring drums are fixed to shafts which turn in big bearings easily accessible on the main frame! There's a simple, accessible, easily lubricated, long-life construction, right there at a point of greatest strain and wear. But it is only one of the better construction features which make Koehring the *Heavy* Duty Mixer.



The above shows the heavy brackets, mounted on the main frame on which are mounted the extra big bearings in which turn the drum roller shafts. Notice that the bearings are at an angle which brings the load on the full face of bearing. These bearings are extraordinarily long, and easily accessible for lubrication or re-babbitting.

CAPACITIES

Pavers: 10, 14, 21, 28 cu. ft. mixed concrete, steam or gasoline, multiplane traction, loading derrick, power discharge chute.

Construction Mixer: 10, 14, 21, 28 cu. ft. mixed concrete, steam and gasoline, power charging skip, batch hopper.

Dandie Light Mixer: 4 and 7 cu. ft. mixed concrete, low charging platform, power charging skip, light duty hoist.

Write for Bulletin P-10.

KOEHRING COMPANY, MILWAUKEE WISCONSIN

will vary but may be estimated at $300 to $600 per mile of road.

The subgrade that has been thoroughly saturated with oil will resist the raising of subsoil water by capillary attraction and will prevent surface water from softening the subsoil immediately beneath the slab, thereby resulting in additional stability to the pavement.

Frozen Subgrade.—Mixed concrete should not be deposited upon a frozen subgrade for the reason that the frost will be drawn from the subgrade, thus lowering the temperature of the concrete below 40° F. and preventing it from obtaining its proper set. When there is but a small amount of road to be completed during the freezing weather the subgrade may be protected from frost by a covering of straw, which shall be removed immediately in advance of the depositing of the concrete.

Materials on Subgrade.—After the subgrade has been prepared, no materials shall be dumped upon it without the consent of the Chief Highway Engineer. Aggregates may, however, be dumped upon the subgrade or at the sides of the road at intervals of not less than 400 ft. provided the material is placed in large piles and not spread out over the subgrade or shoulders. When material is dumped in this way it should be piled at least three dumps high to prevent spreading and to avoid a surplus of earth being picked up when it is rehandled.

Backfilling Trenches and Bridge Abutments.—When it is necessary to backfill a trench or the space adjacent to a bridge abutment, special effort should be made thoroughly to compact the earth. Numerous pavement failures and bridge failures are traceable directly to negligence in this important operation. The backfill must be made in horizontal layers of not to exceed 1 ft. and each layer thoroughly compacted by means of rolling or hand-tamping until the entire fill is completed. In trench work it is frequently possible to fill the trench with water and make all backfills by dumping material directly into the water; much better results will be obtained in this way, as the fill will settle very little. When backfilling bridge abutments or walls, surplus water should be pumped out before the backfill is made. If this is not done the fill will be softened to such an extent that a fluid pressure will be created that far exceeds the pressure for which the abutment or wall was designed and serious cracking or failure will be the inevitable result. Care should always be taken in backfilling around abutments and wings. All excavated space in front of wings and abutments should be filled simultaneously with the backfill. If this is not done, failure is likely to occur. Do not permit, under any conditions, the puddling of backfills for abutments or the dropping of earth from a great height from drag line buckets or other excavating machinery.

STEEL ROAD FORMS WIDELY USED

A list of the more prominent users of Heltzel steel forms on road construction contains the names of about one hundred of the leading highway contractors and some of the more active of the state and county highway departments. These forms are giving universal satisfaction because of their simplicity, dependability and durability.

The George T. Wilhelm Co. of Helena, Ark., is using 7,000 ft. of the forms and expects, from experience to date, that the forms will last another five years. Depreciation records show almost a negligible amount to be written off against these forms. R. G. Collins, Jr., Contracting Engineer, Cumberland, Md., used the light section on work for the Maryland State Roads Commission, with hand finishing. He used the heavy section on work for the Delaware State Highway Commission, with a finishing machine. He found the forms easy to erect and each section having a bearing on three good pedestals stands up well under the finishing machine. Alan Jay Parrish, general contractor, Paris, Ill., used Heltzel forms on a 29-mile contract of State and Federal Aid Road. He had no form troubles and was complimented by the inspection engineers of the State on having the best line and grade in the State. Heltzel forms were used by the Illinois State Highway Department on the day labor construction on the Lincoln Highway at Frankfort, Ill., as described in the October issue of Municipal and County Engineering.

The Maloney Paving Co., Charlottesville, Va., has standardized on Heltzel forms after considerable experience with other types and assigns six reasons for preferring these forms: (1) Simplicity of adjusting to line and grade, meaning money saved in time and labor required to set them. (2) Fewer parts to get out of order, meaning longer life and less upkeep. (3) More easily cleaned, having fewer places for cement adhesion. (4)

Ease of removing any section along the line, which is often desirable, and to replace it again without in any way disturbing adjoining sections. (5) More readily set to a curb line. (6) Much easier to remove after work is set up.

ENGINE BOOKLETS

Oil Engines and Stationary Steam Engines.—These two booklets are two of many pieces of educational literature on machinery, published by the Vacuum Oil Co., 61 Broadway, New York City, pertaining to construction, operation and lubrication. These booklets have wide circulation and are used as text books by many of the larger colleges and technical schools throughout the United States. Those interested may obtain copies free for the asking.

Contracts Awarded

ROADS AND STREETS.

Ala., Ashland—Stanley & Singer Constr. Co. awarded contract to constr. 18 miles of road in Clay Co. connecting towns of Ashland and Goodwater, at $159,098.

Ala., Mobile—Toulmin & Son, Toulminville, awarded contract for hard surface Coden and 5 mile Clubhouse roads, at $52,114.

Little Rock, Ark.—Moreno-Burkham Constr. Co., So. Trust Bldg., awarded contract to constr. 10,000 cu. yds. grading; 14,700 lin. ft. curb and gutter; 24,000 sq. yds. sheet asph. on 5-in. conc. base, etc., $120,000 available.

Cal., El Centro—Los Angeles Paving Co., 2900 Santa Fe Ave., Los Angeles, awarded contract for paving 7:5 miles Brawley-Calipatria county road, 16 ft. wide with Willite, at $145,113.

Cal. Los Angeles—W. D. McCray, 424 Am. Bank Bldg., awarded contr. at $74,400 for paving Kaskell and other streets—abt. 1.38 miles, LaCanada, in Rd. Imp. Dist. 1918, with 5-in. cem. conc. at $74,400.

Cal., Sacramento—Following contracts let: Stanislaus Co., asph. surfacing from pt. near Ceres to Tuolumne River brdg. of 1.89 mi. to Standard Paving Co., Modesto, at $14,154; Kern Co. asph. surfacing of 10 mi. hwy. so. of Bakersfield to Southwest Paving Co., Los Angeles, at $47,953; San Luis Obispo Co., grading 10 mi. hwy., 6 miles no. from San Simeon to northerly boundary, to Blake & Heany, Oakland, at $161,712; R. T. Shea, Riverside, awarded contract for paving 15.74 miles asph. macadam road, San Bernardino Co. at about $226,212.

Cal., Sacramento—State Hwy. Comn., let contract to Hopper & Son, Oakland, for constr. of highway mach. and repair shops to be located at 34th and R Streets, at $57,667; Northern Calif. Constr. Co. awarded contr. for work in Tuolumne and Lassen Cos.; 1st for paving 9.4 mi. hwy. from Knights Ferry to point 1 mi. east of Keystone at $129,300; the other grading on outskirts of town of Susanville, at $3,309.

Cal., Sacramento—Healy-Tibbits Constr. Co., San Francisco, awarded contract for grading 9.29 miles road on Black Point cut-off in Sonoma Co. from Fairville to easterly boundary, at $77,404; Riley & Peterson, Oakland, awarded contr. for resurfacing 2.8 mi. bet. Fuuerton and northern boundary of Orange Co., at $54,494.

Cal., Sacramento—Hugh Crummey, Oakland, awarded contract for asph. surfacing of 4.3 mi. hwy. from Perry to Morgan, Santa Clara Co., at $41,830; J. A. Costell, Jr., San Francisco, contr. for resurfacing and repairing 4.26 mi. highway from Delhi to northern boundary of Merced Co., at $30,780; also contr. for asph. surfacing of 6.04 mi. hwy. from southerly bound., Stanislaus Co. to Ceres, at $49,176.

Cal., San Diego—Warren Constr. Co., Portland, Ore., awarded contract for paving Chatsworth

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Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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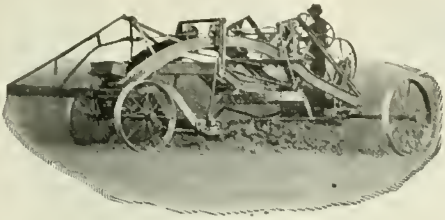
Price: Single copy 25 cents. Annual subscription in U. S. $2.00; Canada, $2.40; Foreign, $2.75.

Municipal and County Engineering is published monthly by Engineering Publishing Company, 702 Wulsin Building, Indianapolis, Indiana, A. P. Fox, President, J. H. Pritchard, Secretary.

Changes of address, subscriptions and remittances should be addressed to Municipal and County Engineering, Indianapolis, Indiana. Editorial and business communications should also be addressed to 702 Wulsin Bldg., Indianapolis, Ind.

Editorial and Advertising Offices also at 702 Wulsin Bldg., Indianapolis, Ind. Samuel C. Hadden, Editor and General Manager.



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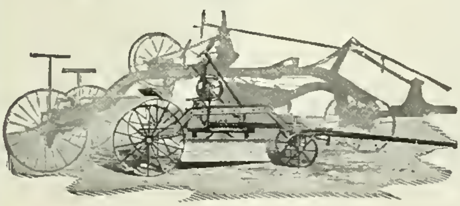

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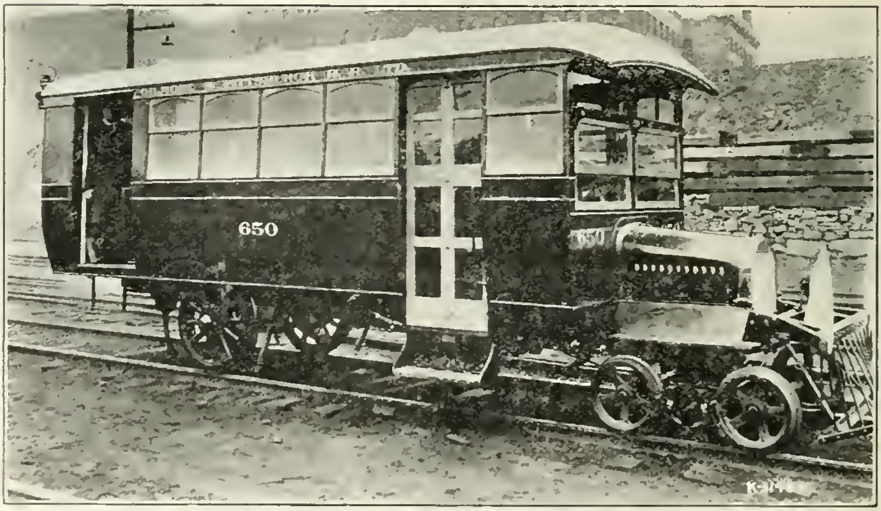
MOTOR TRUCKS

Motor Trucks as Operated in Municipal and County Service and in Highway Transportation



NEW TYPE OF GASOLINE RAIL CAR, MANUFACTURED BY THE INTERNATIONAL MOTOR CO., MAY REVOLUTIONIZE TRANSPORTATION ON SHORT LINES.

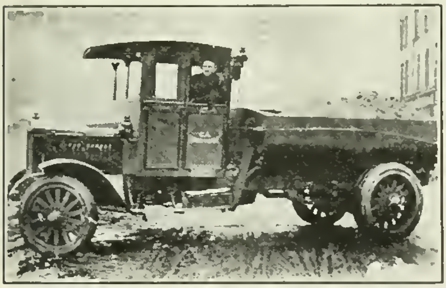
Motor Truck Operation and Accounting—76

TRUCK EARNS OWNER $2,000 IN 27 DAYS ON MINNESOTA ROAD WORK

By C. A. Harrington, 4200 Aldrich Ave., South, Minneapolis, Minn.

Two hundred and forty-eight (248) yard-miles a day is the record of my 3½-ton Acme truck. I purchased this truck in December, 1919, and have been using it pretty steadily on road building jobs, with occasional jobs of excavating. Most of my work has been in the State of Minnesota, and a great deal of it in the northern part, where we often work when the snow is on the ground.

During the 18 months I have had my truck, I have gone over 15,000 miles, averaging about 55 miles a day. On one road building job I averaged over 80 miles a day for 4 months, and on one particular day I went 126 miles in 10 hours and hauled 248 yard-miles of gravel. The conditions were ideal on that occasion, as I had no waiting either to load or unload, and the roads were good. On that day I hauled 8 loads of 4 yds. each a distance of 7¾ miles.



ACME 3½-TON TRUCK AS OPERATED BY C. A. HARRINGTON ON MINNESOTA ROAD WORK.

As a general rule, road building is very hard on a truck. The season is short, so that the truck must work overtime and carry heavy overloads; and the roads are usually bad. I operate only about 180 days a year. The cost of operation, figured on the National Standard Truck Cost System, is $19.40 per day, including driver's wages. This gives me a cost of 34.83 cts. per mile. Actual repairs for the 18 months were $426, including an overhaul of the engine.

When working in the country on sandy roads, I get only about 2 miles per gallon of gasoline; on city jobs I have got as high as 6 miles per gallon. It all depends on the work, and the condition of the roads. A fair average for the 18 months is 3.75 miles per gallon of gas, and 140 miles per gallon of oil.

On the day when I hauled 248 yard-miles the cost of operation was:

Variable expense (126 miles @ 21.30c)	$26.84
Fixed expense (1 day)	2.19
Driver's wages (1 day)	5.50
Total expense for day	$34.53

That day I hauled about 32 yds., making the cost $1.08 a yard, and 14 cts. per yard-mile.

I have hauled as many as 12 loads of 4 yds. each a distance of about 2 miles, traveling about 50 miles during the day. The cost of operation on such a day is:

Variable expense (50 miles @ 21.30c)	$10.65
Fixed expense (1 day)	2.19
Driver's wages (1 day)	5.50
Total expense for day	$18.34

As the truck hauls 48 yds. of gravel, the cost is 38 cts. per yard, and 19 cts. per yard-mile.

Before buying my own Acme, I ran the first Acme dump body truck in this place, and I never heard of a truck of any make which hauled as many yard-miles per day as I did. In 27 days my total earnings with this truck were $2,640. Taking my present average cost of $19.40 per day as a basis, my profits were over $2,000. On the day I hauled 248 yard-miles I received 40 cts. per yard-mile. My earnings on that day were $99.20, and my profits $64.67.

The Acme truck has tremendous pulling power, and is built so strong that it stands the heavy strain of excavating work and road building very well. It has little difficulty in pulling out of bad grades in excavating work, or up heavy grades on road building work.

AVERAGE COST 3½-TON ACME TRUCK ON MINNESOTA ROAD WORK

Cost per Day (Including Driver)	$ 19.40
Cost per Mile	$ .3483
Total Cost for Period	$5,503.23

OPERATION

Days Operated	278
Miles Traveled	15,800
Miles per Day	55
Miles per Gallons of Gas	3.75
Miles per Gallon of Oil	141

ITEMIZED COST

Driver Cost per Day (Included Above)	$5.50
Depreciation per Mile	$ .0715
Maintenance and Repair, Actual, Total	$426.00
Maintenance and Repair, Actual, per Mile	$ .0269
Maintenance and Repair, Estimated, per Mile	$ .0269
Tire Cost, Estimated, per Mile	$ .0377

NEW GASOLINE CAR MAY REVOLUTIONIZE RAIL TRANSPORTATION ON BRANCH LINES

Fostered by the executives of the Northern Pacific Railroad in co-operation with W. F. Sailor, of the International Motor Company, several trial trips were recently made of a new type of passenger carrier which, it is said, may revolutionize rail transportation on branch line runs.

The vehicle which is arousing such unusual interest among leading railroad officials of the country, is a specially designed Mack gasoline rail car mounted on steel flange wheels so that it can be operated on standard railroad tracks.

The experimental trips were made over the Northern Pacific route from St. Paul to White Bear, a distance of about 12 miles. This run includes a steep and winding grade almost 2 miles long, one of the most severe in the Northwest. When it is understood that two locomotives are required to pull a passenger train up this ascent, some idea of the severity of the test may be ascertained.

Such great importance was attached to the first trip, that possibly the largest assemblage of big railroad men of the Northwest were present to take part in the initial tryout over the White Bear route. Prominent among these officials were Charles Donnelly, President of the Northern Pacific; Ralph Budd, President of the Great Northern; J. M. Hannaford, Vice Chairman of the Northern Pacific; W. T. Tyler, Vice President of the Northern Pacific; William Genlo, of the Minneapolis & St. Louis; A. R. Kipp, of the Soo Lines; W. L. Luce, President of the Electric Short Lines, and J. J. O'Neil, General Manager of the Chicago, St. Paul M. & O.

Twenty-three passengers were comfortably carried on the first trip, although the rated capacity of this motorized rail car is 17 persons in addition to a baggage compartment. The rail car, watched by a long line of autoists who had assembled along the route, quickly climbed the steep, curved incline, and completed the run of 12 miles to the entire satisfaction of every one of the railroad officials.

After enthusiastically discussing the performance they had just witnessed, their unanimous opinion was that the experiment proved beyond a doubt that motorized carriers, properly equipped, can be used to profitable advantage in certain phases of railroad service.

When a second trip over the same route was made a few days later, the distance was covered in 29½ minutes, only 4½ minutes longer than it takes the Duluth Limited to make this run. Obviously, a small motor bus could not be expected to save time when competing with steam equipment, yet the railroad men who have carefully considered operating costs, strongly believe that gasoline rail cars will effect a more vitally necessary saving —that of operating expense. Moreover, even under the most unfavorable conditions for running a gasoline car, it has been found that the costs are much lower than those of steam operated equipment. This saving in operating costs, combined with the comparatively small capital investment required, promises to be the salvation of many branch lines, some of which have to discontinue service or will soon be compelled to do so because the expense of operating steam equipment far exceeds the revenues obtainable for the service rendered.

One of the results of these tests has been a radical step away from established railroad precedent recently taken by the Northern Pacific. A number of years ago when James J. Hill, one of the foremost railroad men of his time, ran his first locomotive out of St. Paul, steam equipment was looked upon throughout the country as being the only logical answer to the transportation problem of the rapidly expanding Northwest. Today, his successor, Charles Donnelly, the present head of the Northern Pacific, is turning to the gasoline engine as an economical solution to one form of this transportation problem—short haul passenger traffic—which has never been profitably solved by the conventional railroad equipment. Convinced of the advantages of gasoline motor cars, the Northern Pacific now operates a Mack mail car in regular service on a branch line, and expects shortly to install more of these cars in like and larger capacities. Another big railroad of the West, the Great Northern, is also

planning to install gas-propelled rail cars on its various branch lines.

In the East the New York, New Haven and Hartford R. R. will soon operate 3 such rail cars. Many of the smaller railroads, such as the Narragansett Pier R. R., Aberdeen & Rockfish R. R., Sewell Valley R. R. and Stone Harbor R. R. have been successfully using motor equipment for some time.

THE 1922 ROAD SHOW

Extended discussion by noted highway engineers from all parts of the United States and Canada relative to design, methods and materials used in modern highway construction will form a large part of the program of the American Good Roads Congress, to be held at the Coliseum, Chicago, Ill., on Jan. 17-20, 1922, under the auspices of the American Road Builders' Association ,the oldest and largest organization of its kind in the country.

Three of the 8 sessions of the Congress will be devoted to a discussion of new methods used in building asphalt, concrete, brick and other modern pavements. The economical construction and maintenance of the cheaper types, such as waterbound macadam, sand-clay, gravel and earth roads, which constitute nearly 90 per cent of the 2,273,131 miles of highways in the United States, will also be discussed.

One session of the Congress will be given over to the consideration of problems of highway finance and administration. Because of the high interest rates now prevailing on road bonds, approximately 10 per cent has been added to the cost of road construction from this source alone. Increased freight rates have added a like amount. Since many states are fast approaching their permissible bonded debt limit, the methods of raising and expending road funds are becoming vastly important and road officials are bending all their energies toward securing greatest returns for expenditures.

Invitations to the Congress are being sent to nearly 30,000 federal, state, county and city officials, contractors, engineers and business men in the United States and Canada. It is expected that the attendance will greatly surpass the record set last year and that the Congress will develop a clearer understanding of diverse highway problems, so road officials may, in spending their funds, secure "more roads for less money."

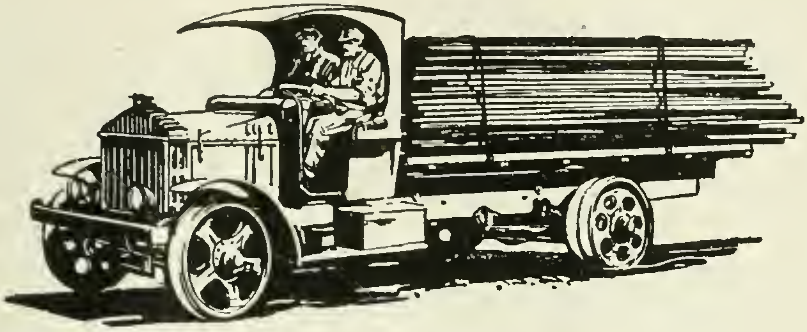
No less important will be the National Good Roads Show to be held at the Coliseum in conjunction with the Congress. This show will contain close to $1,500,000 worth of labor-saving road machinery appliances and materials and highway transport equipment. At the October drawing for exhibition space the entire 40,000 sq. ft. of available space in the Coliseum and Annex was taken, necessitating the lease of additional buildings to care for the manufacturers now applying for room.

The use of labor-saving machinery during the past few years has revolutionized road construction methods and the coming show will offer an opportunity to all persons interested in road work to see in actual operation the most recent mechanical developments in the field. More than $100,000,000 worth of road machinery is being manufactured annually, a sum greater than the combined value of all other construction machinery produced. The machinery and material manufacturers with exhibits will have special representatives at the show to explain their machinery and paving materials.

The annual meeting and "get-together" dinner of the American Road Builders' Association was held at the Automobile Club of America, New York City, on Nov. 15. Following the session of the board of directors at 3 p. m., the annual meeting of the members of the association was held, at which the reports of the officers and committees were received. Officers for the ensuing year were elected as follows:

President, H. L. Bowlby, Chief of the War Materials Division, U. S. Bureau of Public Roads; vice-presidents, Charles J. Bennett, State Highway Commissioner of Connecticut, New Haven, Conn.; Frank Page, Chairman, North Carolina State Highway Commission, Raleigh, N. C.; A. R. Hirst, State Highway Engineer of Wisconsin, Madison, Wis.; W. W. Crosby, National Park Service, Estes Park, Colo.; Secretary, E. L. Powers, Editor, "Good Roads," New York, N. Y.; Treasurer, Senator James H. MacDonald, former State Highway Commissioner of Connecticut, New Haven, Conn.

Several changes to the constitution and by-laws of the association were approved, the most important being a change in the date of the annual meeting from November to May and a change in the method of electing officers. Under the new provisions officers will be elected from among the directors by the directors. Vacancies on tho board will be filled each year by a nominating committee of seven selected



from the board of directors. Another change makes the president eligible for re-election. By holding the annual meeting in May the new officers will have a longer time in which to lay plans for the annual convention and exposition.

The amount of money now being expended on highway construction is greater than that being spent on all other public works combined. The value of road machinery now being manufactured exceeds the total value of all other construction machinery being produced. More than one billion dollars is available in the United States for road construction.

In view of these facts, it follows that the coming convention and good roads show will be the event of the year for highway officials, engineers and contractors, automotive engineers and manufacturers, and persons interested in highway transportation and highway finance. With the present great interest in road matters and because of the central location of Chicago and the excellent facilities offered by that city, the officers of the association are confident that the attendance of members and delegates will surpass even the record attendance at the convention held in Chicago last year.

FACTORS INFLUENCING STREET DESIGN

By P. L. Brockway, City Engineer, City Hall, Wichita, Kansas

Streets should be of five types so far as design is concerned: Park drives, tertiary streets, secondary streets, primary streets and broad boulevards.

Park Drives

First: Informal drives, principally through parks and playgrounds winding here and there to reach vantage points for pleasure driving only; scarcely to be given the dignity of being called streets at all and yet merging into the street system. These do not ordinarily need to be wider than sufficient to provide for two lines of traffic as there is no reason for parking on them and the class of vehicles using them can and should be restricted to those driven for pleasure only. They should be so located as not to invite through traffic even of this class in order to keep them set apart for their intended use. The width which appears to be most economical and still satisfactory is about 20 feet. This gives plenty of room for two lines of traffic without creating an uneasy subconscious impression of being crowded, in the minds of the drivers, and so detracting from the chief business at hand, that of enjoyment.

As to the character of the improvement of the drive, much will depend on the local conditions as to availability of different materials, character of the subsoil, drainage, etc., but the surface most in keeping would be the one which harmonizes best with surroundings, a mixture of gravel and clay well kept up, would be in order almost anywhere but especially so in hilly wooded country. In level localities, where dependence is placed mainly on sodded lawns and group planting of shrubs and trees, the light colored surface of concrete or asphalt mixtures makes a pleasing contrast. Many drives of this kind are, of course, water-bound macadam, or penetration macadam, or oiled roads. The water-bound macadam is objectionable on account of dust. Penetration macadam and oiled roads require considerable maintenance under the impact of the heavy automobiles now in common use.

There should be only the least possible crown, necessary for drainage, depending on the type of surface and no curb whatever.

In gravel or oiled roads, a narrow stone gutter along each edge is advantageous in that it gives a finished appearance which is not possible if the sod is allowed to overlap the edges of the road. It also gives a guide line to follow in driving over the road which adds to the subconscious ease of driving.

We have a drive of this sort two miles in length, completed this last season, which is 20 ft. wide over all, with a monolithic gutter 2 ft. in width on each side depressed 1 in. in the center of the 2 ft. to carry water to suitable outlets and with a 16 ft. width of asphaltic concrete surface crowned 2 ins. in the 16 ft. The inner edge of the concrete is a big help in driving as a guide line and the driveway as a whole has received much favorable comment from landscape engineers. It was purposely laid out without any tangents either horizontal or vertical in order to contrast with our monotonous straight streets and flat uniform grades, being built in sand dunes along a river bank.

Tertiary Streets

Tertiary streets, which would not find much use except in rather rough country or isolated nooks or odd corners occurring in the development of a combination

Vocational Truck Selection

It is the opinion of many in the truck industry that truck buyers will pay increasing attention to the service rendered by trucks in any specific field in buying trucks to use in that field. Of course this is a natural method of selection but many buyers in the past have not paid particular attention to the performance of truck types in their field before placing their truck orders.

It is held by many that within the next very few years the great majority of all trucks sold will be sold on the **Vocational Plan,** because the public will insist on being shown just what trucks have done and will do in actual operation in the line of business in which the buyer is engaged and not in some outside line.

It is now possible for prospective buyers of trucks to secure detailed and accurate information regarding truck performance in every field.

We can assist you, without charge, in selecting trucks that have made good in the municipal and county construction field if you so request.

Municipal and County Engineering

702 Wulsin Bldg. **Indianapolis, Ind.**

of rectangular and radial system of major streets, form the second type. These could be very effectively used in such localities. They should necessarily be short and, if blind at one end, should be provided with a turning loop which could enclose a small landscape planting or fountain and fish and lily pond. A narrow width of surfaced driveway would be necessary in order to be in keeping with the short length of the street, and because of the limited territory served, a width sufficient for a moving vehicle to pass one parked on the street would be sufficient.

These conditions would seem to be fully met by a 20 ft. roadway. The street need not be straight, in fact, if topography were suitable, curves would add to the apparent privacy and exclusiveness. Some courts of this sort have been platted without being formally dedicated as public streets at all, but rather handled by deeding an undivided interest with each building site.

The location of sidewalks, wherever possible, should be far enough back of the curb to permit group planting of shrubbery between them to enhance the sylvan effect. This would not always be possible on account of space and not desirable where the street is joined at both ends with busy thoroughfares. Although probably every city has a few such, and it is never satisfactory to make the street as a whole so narrow that it is necessary to place the walk immediately behind the curb, except of course, in business streets.

The two chief reasons for separating the walk from the curb are that it places pedestrians too close to moving vehicles in wet weather and that it is practically impossible to cross the sidewalk with a driveway from the street without inconvenience, or even danger to both vehicles and pedestrians.

If the sidewalk is separated at all from the curb it should be far enough to give a well balanced planting space between the two, at least twice as wide as the walk and preferably not less than 10 ft. On the type of street under discussion a 4 ft. walk will probably be wide enough. This would require a minimum street width of 20 ft. roadway, two 10 ft. planting strips and two 4 ft. walks, or 48 ft. This would, of course, not always be possible. It could be narrowed to 34 ft. by placing a sidewalk on one side only depending on the location and use of the street.

We have recently improved some streets of the public court character entirely out of line of through traffic and at my suggestion, they were paved only 20 ft. wide with fairly long radii or curbs at street intersections. The parkings have had good plantings and the whole effect is that of a prosperous country place with houses back in the woods.

I have suggested in a very narrow street with walks necessary on both sides, that the curb be omitted and replaced with a gutter sloping up from the pavement 4 ins. in 2 ft. to the usual walk so that a car could cross it anywhere at any angle and the walk would still be separated from the pavement and have no break in the surface. I do not think that arrangement is desirable but I do believe it would be better than cutting a wide driveway through the walk at practically every 50 ft. building site as will be necessary in the block in question. There is a 3 per cent grade in the block so that there would be practically no danger of street water flooding the walk. My suggestion fell on deaf ears because it was "different."

Concerning slopes on the planting strip in this type of street, it would seem to be rather immaterial just so there is sufficient slope for drainage on account of the informal character of the whole layout, excepting that it should be considered as a part of the treatment of the whole layout from the landscape viewpoint. Some regard would have to be given to the grade of driveways, which would also depend on the slope of the lots themselves.

Secondary Streets

Secondary streets serving local districts and acting as feeders to the major street system, form the third type. These would naturally be more formal, follow more direct lines and require entirely different treatment than those already discussed. They would not, and should not entirely disregard topography as is so often done. In choppy, hilly country they should in general, follow the lowest ground as far as possible leaving the interior of large blocks to be reached by the tertiary streets.

If the drainage area is large so that a street at the foot of two hills would too easily flood, it might be desirable to place a street on each side of the lowest ground, treating the space between as a sunken garden with appropriate planting.

Of course if the hillside slopes are long there will be required other streets than

those at the foot. These should be so located as to avoid excessively steep grades. Very pleasing effects may be obtained in rolling country if vertical curves are carefully worked out in long straight streets.

I have sometimes found it necessary to run vertical curves of the third degree making the rate of the change in grade uniform. In such cases grades must be established fairly close together and care must be used to avoid angles due to careless construction. Nothing is more pleasing than curved roadways, either vertical or horizontal, if the construction work is well done or more displeasing than a careless attempt to do the same thing.

Concrete curbs lend themselves readily to this class of work as forms can be lined up far enough in advance of finished work to avoid irregularities. In establishing grades on side hills, it is generally best to favor the lots on the low side as it is much cheaper to shape up and maintain a terrace or series of terraces on the high side than to fill up the rear end of the low lots. The planting space between the curb and walk on the high side should be much steeper than that on the low side in order to prevent as far as possible the optical illusion that the high side is the lowest. This is also helped by building the pavement with an eccentric crown.

In flat, featureless country, the rectangular system of platting is probably best for secondary streets as there is less waste ground. The only landscape treatment of much value in that case is that of giving long vistas and in order to give proper breadth the building line should be well back from the street and group planting of shrubs should not be allowed too far out from the building line.

The width of roadway in secondary streets should be sufficient for three lines of traffic including vehicles parked against the curb. There is some difference of opinion on this point. Nearly everyone is agreed that 10 ft. should be allowed for the first line, after that, recommended widths for the second and third line range from 8 to 10 ft., making the total roadway 26, 28, or 30 ft. On account of the wandering habits of ice wagons and the rather serious blocking of streets by moving vans backed up to the curb together with the much greater ease of turning a car, having a long wheel base, into private driveways, our own practice is to recommend the 30 ft. roadway although we do not refuse to improve with a 26 ft. width.

The width of the planting strip between the curb and sidewalk should also be about 10 ft. in order to give a well balanced appearance to the street. This is about the least width which will support a large tree without crowding one side or the other and it would seem to be rather an essential part of the improvement of this type of street to provide for rows of stately trees, furnishing pleasing vistas. Sidewalks on this type street should be wide enough to allow one person to pass two without crowding. This will require a width of not less than 5 ft.

The total width of street on this basis will be pavement 26 to 30 ft, planting strips, 20 ft., sidewalks, 10 ft., or a total of 56 to 60 ft.

Long Radius Curves at Intersections

One detail in street design which has come into rather considerable importance in the past ten years is the length of the radius of curbs at street intersections. When horse drawn vehicles were the only kind in use, short radii were the rule and were generally satisfactory but with the present traffic, the radius should never be less than 10 ft. and from that on up to anything in reason. Some states prohibit a radius longer than the width of the least parking at a street intersection on account of some vested rights which are supposed to rest with the owner of the abutting lots. This detail furnishes another reason for making the planting strips 10 ft. in width, because if the curve begins very far back of the sidewalk there results an awkward angle where the intersecting walk joins the curb. In passing, it might be remarked that this is no cure-all, as there have been five serious accidents, in as many weeks at an intersection of a major street, having a 40-ft. roadway, with a secondary street, having a 30-ft. roadway, with curbs of 20-ft. radii on all four corners and buildings far enough back to give fair visibility in all directions.

Surface Drainage in Flat Cities

Another troublesome street detail is the matter of drainage in the absence of storm sewers. This may seem a contradictory condition to engineers working in some cities. It is, however, a fact that, in some very flat cities where storm water tends to spread out rather than flood low points, adequate storm sewers are the last improvements the public can be persuaded to buy. There must therefore be some means provided for surface drainage in paved intersections. Three methods may be employed. First: Construct an inlet and outlet on two corners in the direction of flow and connect with an inverted syphon. This is continually silting up on account of sluggish flow and is a constant nuisance. Second: Construct a box culvert in the pavement in the direction of flow. This gives one of two results, either the box is so small as to be constantly choked up, or else the gutters must be depressed so low to give adequate entrance to the culvert that the result is an unsightly and even dangerous corner. I have in mind one thriving little city with curbs uniformly over 18 in. high on this account; it gives one the impression that the whole city is walking on stilts. Third: Depress the surface of the pavement to the elevation of the gutters in the line of flow. This is the surest method of disposing of the water in any kind of storm, but unless handled carefully is very objectionable to vehicular traffic. We have adopted as a standard change in grade in the approaches to the open gutter, 3 ft. distance for each inch of total crown. These slopes do not make an abrupt ditch at their intersection and are not at all objectionable to any type of motor car traveling at any reasonable speed. We have not, however, used this type on streets of our next classification, preferring generally the inverted syphon.

Primary Streets

Streets included in the major or primary thoroughfares constitute the fourth type. These streets to be located primarily for one purpose, to facilitate the movement of all sorts of street traffic to the various centers, from each other, and from the residence and suburban districts and from the surrounding country. To gain this purpose they should be as direct as possible both horizontally and vertically, which would mean that they could not entirely disregard topography and natural obstacles, but that, depending on the traffic requirements and the wealth of tributary territory, considerable money might be spent in reducing grades or bridging rivers in order to obtain more direct routes. In fact, increased traffic concentration in some of the larger cities makes almost imperative the expenditure of vast sums not only to overcome natural but also artificial obstacles.

There could scarcely be any fixed rule as to the location of such streets, beyond the statement already made. Each city presents an individual problem as to its general traffic movement and would have to be so treated. In fact, it would seem wise rather to emphasize this fact in order to give the city individuality.

As to the width of these thoroughfares, this would require individual study of traffic flow, its past, present, growth, and probable future. It would not seem wise, however, to provide for less than four lines of traffic if the street is at all important, which under the rules already mentioned would require a roadway of 34 to 38 ft., tending toward the latter on account of the higher speed of part of the traffic. Streets containing street railway tracks should be just as much wider than these figures indicate, as the space required for clearance of the street cars, probably 18 ft. more in streets having double tracks as the tracks should not be permitted to be so spaced that a person could not walk between them without being "rolled" to death. This would make a total width of roadway of 56 ft. in this case. To residents of many cities this will doubtless seem a waste of ground, but it is quite common and often exceeded in many western cities.

Traffic counts may be misleading unless all the facts are known. If cars uniformly spaced on 100-ft. centers and traveling at 20 miles per hour, passed a given point 1,056 would be counted in a single line of traffic. This could scarcely be realized in actual traffic conditions, especially on city streets on account of interference of cross traffic. For example, a recent traffic count on a street containing a double street car line and of 50-ft. roadway where there was very little interference of cross traffic for 1,000 ft. in either direction showed that over a thousand pleasure cars in addition to a third as many more slower moving vehicles were passing each hour. There was no crowding or confusion and twice as much traffic could have been easily accommodated. Another count on the same street of the same effective width, but with probably half as much cross traffic at each intersecting street showed very little more traffic but constant congestion and delays.

This point is brought out only to emphasize the fact that each street will require individual treatment and different treatment in different places according to local conditions.

Thoroughfares of 38-ft. roadway should have planting strips not less than 15 ft. in width in order to appear well balanced and to insure greater range of vision at intersecting streets. Walks should ordinarily be wide enough to accommodate three abreast; 6 ft., making the total street width 80 ft. Another point in favor of this minimum total width is that, as the business section follows out along the street, the planting strip can be eliminated and the roadway and sidewalks widened to cover it, the relative widening depending on the relative importance of the two types of traffic. It is likely, however, that with this total width the walks should not be less than 12 ft., nor more than 15 ft. on each side. With this ultimate improvement in mind, it would seem highly desirable to fix the cross section of the street as a whole in a rather rigid, formal manner in order to avoid confusion and expense of changing walk elevations later.

Eighty feet is indicated as the minimum desirable width for a really important thoroughfare and, while probably sufficient for most streets, should be increased in important business thoroughfares carrying both local and through traffic to such a degree as to avoid needless delay or else alternate routes provided. This latter course is often the simplest and best way out of a serious dilemma on account of prohibitive cost of moving or cutting fronts from existing buildings. As an extreme measure the front portion of the lower floors of business buildings have been set back, using the space so gained as an arcade and occupying the whole of the original street for vehicles. This is most undesirable and should be employed only as a last resort. However, volumes could be, and have been, written on this particular branch of street design and still each problem is peculiar to itself.

We have used a somewhat different plan in widening roadways from that ordinarily recommended. Certain streets were required to be widened on account of change from residence to business use before the original pavement was worn sufficiently to justify its removal. The crown of the original pavement was also excessive, so that if continued for additional width, it would require an excessively high curb and the ultimate destruction of the whole pavement to make a satisfactory trafficway. Therefore the only change made included the removal of the curbs to the new lines and the construction of pavement in the intervening strips, but with the new portions sloping down toward the original gutter line. This permitted the curb to be set higher to fit existing walks which, of course, sloped down away from the building line, and still have only a reasonable height showing above the pavement. It will be possible also when the surface of the original pavement must be renewed to build up over the old gutter line with new concrete and have a crown of reasonable height and contour over the street as a whole without destroying the base.

Another very satisfactory detail was that of the driveway entrances to certain garages in the block. The driveway approaches were built practically entirely in front of the curb for a distance of about 4 ft. and with easy approach grades at each side. These do not interfere with walk or street traffic either to any objectionable degree. I have thought, in fact, that this might be the best street contour for auto rows or other streets with no planting strips and many driveways across the walks.

Curb heights vary, but most localities use 6 to 8 ins. The best practice would indicate a height which would not be inconvenient to step over, especially in business streets. It is also desirable to raise the gutters up to the top of the curbs at all sidewalk crossings in order to avoid any stepping up and down whatever and, of course, there should be no open, uncovered openings to step across. This detail is easily arranged by raising the elevation of the whole intersection and depressing the gutters for a short distance at the corners of the intersecting walks. This corner depression also serves to keep vehicles off the sidewalk. Adequate storm sewers are necessary with plenty of inlets at all corners toward which there is any surface drainage. Sidewalk slopes of about 1 ft. drop to 40 ft. width are most satisfactory and are fairly representative of standard practice.

Broad Boulevards

Broad formal boulevards designed primarily as pleasure drives with wide vistas and elaborate landscape treatment, often terminated at a monumental civic center or outstanding natural feature of the city constitute the fifth type.

The design may include two or three or even more separate roadways divided by gardens and lawns. In any event so much is involved in the successful design and maintenance of such a project that it should be undertaken only by landscape engineers and architects, of wide experience.

The foregoing paper by Mr. Brockway was presented before the 1921 convention of the American Society for Municipal Improvements.

EDITORIAL

CENTRALIZED MUNICIPAL PURCHASING

The centralization of governmental purchasing is a development of recent years which has much to commend it. Today not only many departments of the federal government, but also many state, city and county governments, maintain departments of public purchase. The movement is right in principle, has succeeded where tried and is growing.

Centralized purchasing is advantageous, in the long run, both to the buyer and to the seller. For some years the city of Indianapolis has maintained a Department of Public Purchase and the experiences of this department serve well to illustrate the advantages of centralized municipal purchasing. The primary duties of the department are: To buy all materials, supplies and equipment for all other city departments; to arrange for all repairs to buildings or equipment; and to sell all obsolete material or equipment after proper appraisal. Requisitions are received by the department from 40 sources and cover everything from pins to motor trucks. Figures on the activities of the department for the past four years are instructive. The number of requisitions received has ranged from 6,827 in 1921 to 8,500 in 1919, and the number of orders placed from 9,273 in 1920 to 9,954 in 1919. The annual volume of business transacted by the department has ranged from $732,027 in 1918 to $1,284,409 in 1921, while the cost of maintaining the department has ranged from $8,935 in 1918 to $13,525 in 1920. The percent of the cost of the department of the business it has done for the past four years has been 1. 2, 1.2, 1.1 and 1.05, respectively. It is stated that the department saves the city $100,000 per year as compared with the old method of buying.

During the 4-year period under discussion the department has been directed by D. S. Ritter as City Purchasing Agent. He has spent nearly a score of years in purchasing work, mostly in the service of large private business corporations. His views on the advantages, from the standpoint of the public, of centralized city purchasing, at the close of his term of office, are therefore of immediate interest and permanent value to all who are working for greater honesty, efficiency and economy in city government. He states these advantages substantially as follows:

It creates an organization of specialists on purchasing, who give full time to studying the needs of the city and the market conditions for supplying those needs; it is the only way to collect a complete set of records as to materials bought by the city and services rendered to it; by issuing a written order for every obligation incurred, the purchasing department enables the treasurer to check expenditures with expected income closely and frequently; it promotes standardization of materials used by various departments; it develops proper specifications for articles needed; it reduces the city purchasing expense; it eliminates verbal orders and no records; it buys the same materials for less money; it curbs extravagance; it collects and distributes valuable information and advice; it exchanges material between departments; it sells material when entirely useless for any department; it promotes quantity purchases of standardized articles; its trained inspection prevents the acceptance of materials not up to quality ordered; good work in this office especially commends an administration to the people; as the department deals in almost every class of material, it is in position to give advice to all the people as to price tendencies; and, last, but not least, it eliminates political influences.

This is an impressive list of advantages and in a properly administered office one may readily believe that they will all be realized. There are at least two disadvantages which may arise unless such a department is conducted with common sense and discretion. The temptation to compile voluminous and hair-splitting specifications is too great for some purchasing agents to resist. We believe that, in general, it is better to have general requirements, with which the merits of things on the open market may be easily tested, rather than to have such elaborate specifications that they frighten the seller away or force him to change his products or his processes before he is admitted to competition. The latter course destroys much, or all, of the economy possible in governmental purchasing. Purchasing agents, it seems to us, will do well to confine their efforts largely to the proper selection of goods on the market, without undertaking to remake the manufacturing world over night. The other disadvantage to which reference was made is the temptation to be too much influenced by price at the expense of suitability, but perhaps other departments can be depended upon, in preparing their requirements, to make sure that price is not accorded too much weight.

So far we have considered only the viewpoint of the public, but we fancy that the seller also derives some real advantages in dealing with a local government purchasing department. Such a department centers all want lists in one office, gives all salesmen the same information as to what is needed, enables the seller to file all his invoices in one office, furnishes a place where he can get all information as to the condition of his account, and opens an easy way for him to present new materials or equipment so they can have consideration for use wherever needed.

We have said that the centralized municipal purchasing plan is growing in favor; we should make clear also that it is already an established success in such cities as: Atlanta, Dayton, Portland (Ore.), Milwaukee, Memphis, Syracuse, Boston, New York, St. Louis, Philadelphia, Denver, Detroit, Rochester, Grand Rapids (Mich.), Salt Lake City, Kansas City, Des Moines, Pittsburgh, Baltimore, Dubuque, Cincinnati, Louisville, Columbus (O.), Cleveland, Los Angeles, Logansport (Ind.), Oakland (Calif.), Indianapolis, Patterson (N. J.), Dallas, New Orleans, Birmingham, Galveston, and Highland Park (Mich.).

As many of our readers doubtless know, there has been in existence for some years a large and active organization known as the National Association of Purchasing Agents. Naturally many of the purchasing agents in governmental service are members of this association. At the 1921 convention of the association a resolution was adopted enumerating certain essential points to be safegnarded in order to establish central governmental purchasing and to make the work efficient. The resolution was formulated because "centralized purchasing for city, county and state governments has proved its value to many localities and their experience is being sought by others." The substance of the recommendations follows:

The department must be independent and accountable only to chief executive; funds for its support should be included in the tax levy. The purchasing agent should be selected with respect to his experience, ability and integrity; he should hold office during satisfactory performance and be removed only on proof of written charges of official misconduct. He should select his own assistants and call meetings of representatives of each executive department to standardize supplies and equipment and prepare proper specifications for describing these standard articles. These standard articles should be bought in proper quantities and kept in a central storehouse maintained by a rotary stores fund and managed by the purchasing department. The department should furnish all materials upon receipt of requisitions describing articles needed and signed by authorized officers, and should have authority to call for requisitions when, in its judgment, conditions of business justify. Purchases should be made at the lowest prices consistent with quality and service. The department should contract for repairs, when needed, to any buildings, equipment or material belonging to any department when that department deems such repairs necessary. All obsolete material should be disposed of when returned to the storehouse. The storekeeper should receive and inspect all materials and make daily reports of all receipts and disposals. The purchasing department should receive invoices from vender, and when they are found to conform with material delivered as to price, quantity and quality, should be vouchered to the finance department for payment from the rotary stores fund. Finally, all records of the purchasing department should be open to public inspection.

There has long been much discussion of putting public business on a "business basis," meaning, of course, on the same basis as private business. For those who sincerely desire such a reform it may well begin with the centralized purchasing of all equipment, materials and other supplies paid for directly out of the public treasury.

In closing this discussion we wish to emphasize our belief, based on conversations with many "supply men," that the cleaner and more businesslike public business can be made the more attractive they will find it. A city that is known to make its purchases on a square basis gets the benefit of all the good, sound competition the country affords. We decline to state the devastating alternative.

FEATURES OF STATE HIGHWAY WORK IN MONTANA

By John N. Edy, Chief Engineer, Montana Highway Commission, Helena, Mont.

Increased Federal Aid

It is by no means certain that Montana can match Federal funds made available to it under the provisions of recently enacted Federal legislation. While all the terms of the new law are not fully known to the department at this time it is understood that Montana's share of the new Federal appropriation will approximate one and one-half million dollars, approximately $500,000 of which is immediately available. The report of the State Highway Department for the month ending November 15 shows that, of Federal funds apportioned to Montana under the 1916 and 1919 Acts of Congress, Montana has yet to match approximately one and one-half million dollars. This amount together with the one-half million dollars immediately available from the 1921 appropriation represents approximately four million dollars worth of work which the department could undertake at once if the local share of the cost could be financed.

Working for a State Bond Issue

In the fall of 1919 Montana counties voted road bonds in total amounts of approximately six million dollars and very much of this money was used in matching Federal funds. However, it appears that many of the counties have reached the limit of their ability to bond for this purpose and the only possibility of covering Federal funds now apportioned to Montana seems to be through a state road bond issue. The State Highway Department has already made public announcement of this fact. Not only will the department support a state bond issue for road improvements but it has already indicated its intention actively to promote and encourage such an issue. It is now believed that a road bond issue bill will be initiated early in the coming spring in order that the matter can be submitted to the voters at the general election in November, 1922. While the details of the bill have not been worked out it is practically certain that the ultimate source of revenue will be an increase in motor vehicle license fees.

Highway Maintenance

The problem which is giving the state highway department considerable concern at this time has to do with the proper maintenance of road improvements already built under its direction. The Act creating the state highway commission authorizes it to take over the maintenance of state highways; but inasmuch as the fund provided for administrative purposes is not sufficient to carry the added burden, it has been necessary to depend upon the counties for maintenance, and this plan has not been generally satisfactory.

An effort is now being made to secure the more active co-operation of counties in the adoption of a suggested and definite form of maintenance organization and practice, particularly in respect to Federal aid road improvement in the various counties. As one manner of state aid the department proposes to purchase and place in operation a number of rock crushers by means of which additional fine wearing surface material will be made available for early spring maintenance use. The department has adopted the gravel surfaced road as representing the most desirable and economical type of improvement for the state highway's system under all prevailing conditions, and by the close of this year will have completed approximately 750 miles of such work.

Highway Standards

While the state highway department of Montana has concentrated its efforts upon the construction of a large mileage of gravel surfaced roads, it has always been felt that because of the possibility of further development of a portion of this mileage, some value of the gravel surface might be lost. However, in the light of the experience of this and other states, it is now believed that the policy of constructing gravel roads fits in admirably with any policy of future development that might be dictated by traffic demands. It is now conceded that there is a place in the state's road program for the construction of bituminous wearing surface upon a black base, over a well-compacted gravel or macadam sub-base. Furthermore, the practice of the department in the future will not permit the placing of concrete pavements directly upon gumbo or adobe soils, but under such conditions will require a well-compacted gravel sub-base. Montana's standard paved road sections now include only Portland cement concrete and bituminous concrete upon a 6-in. concrete base. It is proposed to admit in competition with these types the bituminous concrete wearing surface upon plant mixed black base, as above described, when foundation conditions seem to justify.

Co-operation with Engineering College of State University

The engineering staff of the state highway department is co-operating with the State College of Engineering in a manner more or less unique, but which gives promise of beneficial results for both the department and the college. Arrangements have been made whereby responsible members of the department's engineering staff will deliver a series of 14 lectures at the college during the winter session. The subjects that will be discussed are live and practical, the object being to put the engineering student, and particularly those nearing the end of their college work, in close and intimate touch with the problems confronting the state road authorities. While the ultimate outcome of the plan is yet to be determined, both the engineering college and the state highway department anticipate that material benefit will result.

PAVING BRICK VARIETIES REDUCED TO ELEVEN STANDARD SIZES

(Editor's Note: Wishing to get the manufacturer's point of view as to the results of the conference of the U. S. Department of Commerce on Simplification of Variety and Standards for Vitrified Paving Brick, held in Washington, D. C., on November 15th, we asked the Secretary of the National Paving Brick Manufacturers' Association and he wrote us the following letter:)

To the Editor:

There are two phases of the recent conference in Washington that seem to grow clearer in retrospect.

The first phase seemed very desirable and advantageous in advance of the meeting and since it has become an accomplished fact it has become very important. I refer to the actual elimination of varieties that were recommended. Paving brick varieties are now reduced to 11 by mutual consent of engineers and manufacturers and it is difficult to imagine any paving situation in which brick might be considered that cannot be satisfied by one of the remaining 11 standard varieties.

In addition to the action of the meeting as above indicated, a permanent committee was established to recommend further eliminations as might seem wise.

The second big result of the conference as it appears in retrospect is the fact that it demonstrated, I believe to the satisfaction of everyone present, that engineers and manufacturers can find satisfactory working bases if everyone would discuss with each other matters of fact.

Not the least of the results of the conference, therefore, as it appears to us, is that the conference has demonstrated that relations between producer and consumer, where on the one hand the producer has an organization and on the other the consumer is represented by strong organizations such as the engineers have, can be harmonized by mutual consent.

You appreciate the fact of course that the conference was held in the atmosphere of public interest as expressed by Mr. Hoover. We believe thoroughly that a new relation has been established between the producers and their market.

As a matter of actual operation, it is our hope that the constituent engineers of the conference will look to the conference for policy in respect to brick pavement specifications.

The permanent committee, it seems to us, is something like a supreme court—empowered not only by common consent to decide questions as to variety, but likewise to make such investigations as in its judgment are necessary to shed light on any question which might hereafter assume any of the characteristics of a disputed point in relation to variety.

I believe you can appreciate why we feel that we owe a great deal to Mr. Hoover, the U. S. Chamber of Commerce, through its Fabricated Production Department, and the engineers who were kind enough to attend the conference, all of whom aided in the splendid results obtained.

Very truly yours,
MAURICE B. GREENOUGH,
Secretary.

National Paving Brick Manufacturers' Association, Cleveland, Ohio, Nov. 19, 1921.

GREAT WORKS IN PROSPECT IN CITIES OF WESTERN EUROPE

To the Editor:

I have completed a 6 months' trip through England, France, Belgium, Holland, Germany, Czechoslovakia, Austria, Switzerland and Italy, where I have been collecting information on municipal engineering progress and particularly on city planning.

In all of the European countries which I visited I found great interest being taken in plans for future development of the cities: for better municipal organization, improved public services and transit systems, for new parks, playgrounds and boulevards (the demolition of old fortifications has made this possible in several instances), and particularly in making comprehensive plans for the orderly growth of the cities. Because of extreme poverty few of the cities are undertaking construction of important works, except for municipal housing to relieve the shortage, which is being done, under various methods of finance, by nearly every important city in central and southern Europe. However, to cite a few examples of projects actually under construction, or proposed for construction soon, Paris is planning to increase its water supply very soon; Brussels has completed a new connecting link between the east and west railway system; Antwerp is about to start work on an enlarged sewerage system; the Emscher district in Germany is continuing (with only a fraction of its former financial resources), to construct sewage treatment works; Berlin's only large public enterprise is the completion of the new municipal subway; Prague proposes very large municipal works, including water works extensions; Milan is at work on a new canal port and other very important works; Marseilles is spending 200,000,000 francs on a huge new port and canal to the Rhine. Partly because of the poverty of the cities the values of the city planning are better appreciated and availed of: to plan for the future in a way to relate the municipal enterprises to each other and each one to a comprehensive scheme for the development of the community, thus to avoid failures, and especially to secure the desired improvements more cheaply and satisfactorily with limited funds than would otherwise be possible. In this way the financial stringency has helped city planning, but the war has also stimulated city planning, especially in the devastated regions, where the re-building is in many instances producing better-planned communities than existed before the war, and with outline plans also for later expansion.

Very truly yours,

JACOB L. CRANE, JR.

Rome, Italy, Oct. 22, 1921.

(Editor's Note:—Mr. Crane expects to return to the United States this month and may be addressed at Robinson Hall, Cambridge, Mass.)

MUNICIPAL ASPHALT PLANTS

The extent to which American cities and other municipalities are now doing their own street repair work with the aid of their own asphalt plants is indicated in reports to The Asphalt Association, New York City, which show that there are in the United States 98 public asphalt plants. Municipal plants are to be found in the following cities: Little Rock, Ark.; Los Angeles, Cal.; Denver, Col.; Wilmington, Del.; Atlanta, Ga.; Boise, Idaho; Chicago, Ill. (3); Indianapolis, Ind.; Bluffton, Ind.; Fort Wayne, Ind.; Topeka, Kan.; Munroe City, Ky.; Shreveport, La.; New Orleans, La. (2); Springfield, Mass.; Fall River, Mass.; New Bedford, Mass.; Northampton, Mass.; Worcester, Mass.; Flint, Mich.; Lansing, Mich.; Detroit, Mich. (3); Highland Park, Mich.; Minneapolis, Minn.; St. Paul, Minn.; Duluth, Minn.; Jackson, Miss.; Kansas City, Mo.; St. Louis, Mo. (2); Omaha, Neb.; Manchester, N. H.; Atlantic City, N. J.; Newark, N. J.; Bayonne, N. J.; Trenton, N. J.; Brooklyn, N. Y.; Syracuse, N. Y.; New York City (4); Niagara Falls, N. Y.; Elmira, N. Y.; Schenectady, N. Y.; Toledo, O.; Cleveland, O.; Columbus, O.; Dayton, O.; Cincinnati, O.; Youngstown, O.; Oklahoma City, Okla.; Portland, Ore.; Harrisburg, Pa.; Johnstown, Pa.; Erie, Pa.; Pittsburgh, Pa. (2); Reading, Pa.; Scranton, Pa.; Philadelphia, Pa.; Providence, R. I.; Pawtucket, R. I.; Nashville, Tenn.; Memphis, Tenn.; Fort Worth, Tex.; Roanoke, Va.; Norfolk, Va.; Portsmouth, Va.; Seattle, Wash.; Milwaukee, Wis.; Superior, Wis.; San Francisco, Cal., and Saginaw, Mich.

The City of Salt Lake City, Utah, has just completed the installation of a modern asphalt plant having a capacity of 750 sq. yds. of 2-in. asphalt pavement per day. Newark, N. J., is reported selling $50,000 worth of bonds for a new city asphalt plant. Quitman, Ga., has also installed a plant.

State highway departments owning their own plants are those of Delaware, Illinois, Maryland, Michigan, North Carolina, Oregon, Pennsylvania, Tennessee, Texas, Utah and Virginia. County highway departments owning plants include: Burlington County, N. J.; Fulton County, Ga.; Fayette County, Ky.; Munroe County, Mich., and Allegheny County, Pa.

In Canada municipal asphalt plants are to be found at Brantford, Ont.; Charlottestown, P. E. I.; Chatham, Ont.; Hamilton, Ont.; Kingston, Ont.; London, Ont.; Montreal, P. Q. (4); Ottawa, Ont.; St. Catherines, Ont.; Sherbrooke, P. Q.; Toronto, Ont.; Victoria, B. C.; Winnipeg, Man., and Windsor, Ont.

The governments of Argentine, Ecuador,

France and Peru, also operate asphalt plants, and one is to be found at Honolulu, H. I.

ORNAMENTAL STREET LIGHTING

By L. A. S. Wood, Manager, Illuminating Section, Westinghouse Electric & Manufacturing Co., George Cutter Works, South Bend, Ind.

The lighting of our streets at night is a vital municipal issue, and adequate illumination, besides being a convenience, is, in addition, a protective necessity to every community. Good lighting is an indication of prosperity and an investment in a well-designed ornamental street lighting system returns large dividends to the taxpayers in advanced real estate values.

Good street lighting creates a psychological impression of thrift and progress, advancing civic pride, attracting favorable publicity and promoting other improvements. It assists the fire and police departments, facilitates congested traffic and decreases crime.

In the early days of electricity, street lighting design was a simple problem, the solution of which generally took the form of a suspended arc lamp at street intersections. With the growth of the "City Beautiful" idea, however, and the demand for lighting systems of a more ornamental character, which will eliminate unsightly overhead equipment, many factors not provided for in the earlier systems have to be considered. The more important of these are the size of the city, the character of the buildings, the presence of foliage on the streets, and the local conditions controlling the distribution of electricity.

Standard of Illumination

The standard of illumination on our streets was set by the earlier types of "open" carbon arc lamps, which were later replaced by an improved type having longer burning hours, known as the "inclosed" carbon arc lamp. This latter was not so efficient as the open arc and its substitution in place of the earlier type tended to decrease the standard of illumination, and it was generally lower than was customary in the larger cities of Europe. It will often be found that the energy consumed in lighting a comparatively small room in a public building is greater than that consumed in lighting one mile of the average city street with ordinary pendant units.

Street lighting rates, with few exceptions, have remained practically constant for many years, in spite of the fact that there has been a large advance in the costs of material and labor. The per capita cost of street lighting is generally low, and there are few cities spending over $3 per capita. The average for the 50 best lighted cities is about $2, and for the whole of the United States not more than 71c per capita.

Requirements of an Ornamental Street Lighting System

Since the introduction of the high efficiency Mazda "C" incandescent lamp, which has revolutionized street lighting, eliminating the ornamental cluster post of earlier days and relegating the arc lamp to the museum, development in ornamental street lighting has favored the single light post equipped with suitable lighting

NIGHT SCENE IN NEW CASTLE, PA., SHOWING THE EFFECT OF IMPROVED WHITE-WAY LIGHTING. NOTE THAT MOST OF THE ILLUMINATION IS DOWNWARD SO THAT THE GREATEST EFFICIENCY IS OBTAINED.

unit or "post top" to distribute and direct the light on the plane of illumination.

The first requirement of an ornamental street lighting system is that, while efficiently illuminating the streets during the hours of darkness, it should be inconspicuous in the daytime, blending harmoniously with the architecture of the surrounding buildings. This is very aptly illustrated by the well-designed ornamental lighting system in the city of Chicago, within two blocks of the busiest part of the Loop.

Another important requirement of good street lighting is that the intensity of illumination should be graduated in accordance with the conditions of the various localities and the flexibility of the Mazda system renders it particularly suitable for this class of work. Until the public became aroused to the necessity of well-designed and uniform systems of ornamental street lighting, progressive merchants installed, at their own expense, systems of ornamental posts or "White Ways," which often resulted in the installation of posts of various designs in different parts of the same city.

This activity on the part of merchants should be carefully directed by the municipal authorities and the uncontrolled installation of "White Ways" should be discouraged. An ornamental street lighting system should be considered as part of a plan to beautify the city as a whole, and not as means of advertising one section, perhaps to the detriment of some other locality.

Promotion and Financing

There are various methods of promoting the installation of ornamental lighting systems, but the most successful have been through the Chambers of Commerce or Commercial Clubs. Municipalities are, as a rule, reluctant to consider such lighting until there is a publicly expressed demand.

In a number of states there are existing laws which permit the establishment of Assessment Districts for the purpose of taxing abutting property for the installation of special lighting. In such cases usually 51 percent of the frontage involved must be signed up to make the petition effective. Street Lighting Improvement Acts have generally assisted the progress of ornamental street lighting, and, where available, should be used. The assessment becomes a taxation and the contract is between the city and the central station, thus insuring a uniform installation with continuity of service, under the control of the municipality.

The assessment of property owners for the upkeep of lighting installations is not new, and the following extract from "Municipal Government," by Frank J. Goodnow, LL. D., published in New York by the Century Company in 1910, page 328, describing Paris in 1666, is of interest:

"The expense of lighting the streets was defrayed also from the receipts of a

A STANDARD LOCATED ON THE SIDEWALK WHICH HARMONIZES WITH THE SURROUNDINGS AT MIAMI BEACH, FLA.

tax imposed on the householders. Mildmay says: 'Two persons are generally contracted with for this undertaking, the one to find the lanthorns, cords and pullies; and the other to supply the candles; for the streets are here illuminated by hanging lanthorns on the middle of a cord that reaches across the street; and is fixed to pullies on each side, at about 15 ft. high and about 15 yds. distance from one another. There are 65 lanthorns and consequently as many candles consumed each time they are lighted, which is only 20 times a month, being laid aside during the moonlight nights and are never lighted, but from the last day of September until the first day of April each year; being taken down and set apart during all the summer months.' Elections were held annually in each quarter of the city by the householders. The persons elected had each charge of 15 lanterns and paid, as Mildmay puts it, 'Some menial servant or poor housekeper in the same street to perform the duty; accordingly every evening, as soon as it begins to grow dark, the commissary sends out a person, ringing a hand bell through the streets of the quarter to give notice, as in the morning for cleaning the streets; so now for lighting them; upon which each lanternier's servant immediately sallies out and having a key to the iron box in which the end of every cord is fastened on the sides of the streets, lets down the lanthorn hanging on the same and fixing his lighted candle therein draws it up again; and thus everyone having only 15 lanthorns under his care, the whole city is illuminated in a very short space after notice; though the light itself is indeed a very indifferent one.' "

System of Operation

Owing to its flexibility, the Mazda "C" Lamp is peculiarly adapted to ornamental street lighting, and, when operated on a constant current series system, it affords an efficient and economical street lighting unit, easily installed and controlled, giving a range of from 600 lumens* (60 candle power) to 25,000 lumens (2500 candle power). Any size lamp within this range may be operated in series on the same circuit without changes in the regulating equipment at the central station, and, with suitable enclosing glassware, a soft diffused illumination or a brilliant sparkling light without glare may be obtained.

The regulating equipment generally consists of moving coil type constant current regulating transformers and control panels which limit the current in the circuits, safeguarding the lamps against surges and, at the same time, insuring that sufficient current will flow through the lamps at all times to maintain the rated candle power.

In addition to regulating equipment of the station type moving coil, regulating transformers have been designed suitable for mounting on poles at any point in a high tension distribution network, thus permitting an ornamental lighting system to be connected to a high tension line without the necessity of running special lighting circuits back to the sub-station. This improvement in regulating apparatus, which may be operated either from a time switch or remove control device, materially reduces the cost of installing ornamental lighting systems at a distance from the sub-station. Another method of control for Series Mazda Lighting is the Adjuster or Reactance Socket System. This is generally used for small groups of lighting units and is operated from a constant potential transformer with a reactance coil connected in parallel with each socket. When a lamp burns out, the current is forced through the reactance coil, introducing an impedance in the line equivalent to the energy absorbed by the lamp, thus maintaining the circuit current constant.

MODERN RESIDENTIAL AND PARK LIGHTING STANDARDS IN USE IN VINCENNES, INDIANA.

The earlier types of cluster posts were usually operated on multiple systems, but, while there are still some ornamental lighting systems installed in multiple, the series system is the one generally adopted This condition has made the selection of ornamental street lighting equipment a matter for the engineer's serious consideration, owing to the fact that the equipment—unlike the old cluster posts—is operated on a high tension system, requiring fixtures especially designed for this purpose.

The Underground System

Until the introduction of steel armored and lead covered cable, it was customary

*The Series Mazda Lamp is now rated in lumens instead of candle power and the lumen rating is ten times the present candle power rating.

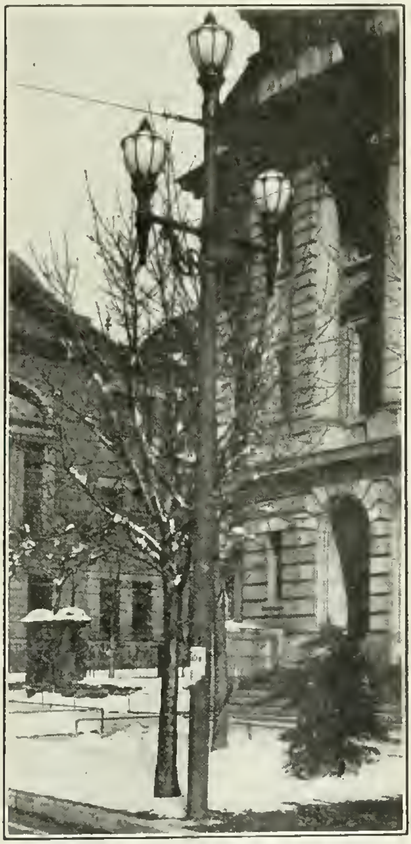
to lay underground cable in conduits, but modern practice favors the use of steel armored cable buried in a shallow trench below the curb or in the Parkway. The steel armored cable consists of a copper conductor (usually of No. 8 gauge) insulated with rubber, over which is a braided cover and jute filling. A layer of tape is then wrapped around and this is enclosed in a continuous lead sheath, covered with a coating of tarred jute. Around this is wrapped two layers of steel tape, so arranged as to insure the steel cover overlapping when the cable is bent. A serving of jute is placed around the cable and affords protection to the steel tape when placed in the ground. If properly installed, the life of this cable is almost indefinite as the lead cover forms an efficient protection from water, while the steel armor protects the cable from mechanical injury. The posts are usually wired with rubber covered and braided cable.

Steel armored lead covered cable should be laid in a shallow trench under the curb or in the "Parkway", if any, and, in this position, it is not likely to be damaged. It is important that ends of the cable, where cut, should not be exposed to the weather. We are all familiar with the precautions taken by Cable Manufacturers to seal the ends of the cable before it leaves the factory, but, unfortunately, very little care is exercised in this direction when the cable is installed. It is quite common, during the installation of ornamental lighting systems, to see the ends of the underground cable projecting through the ground, exposed to all weathers, until the posts are installed and connected, with the result that faults are likely to develop at an early date and the installation becomes a source of trouble and expense.

The best way to install armored cable is to lay it in a prepared trench, leaving a loop at the location of each post sufficiently long to reach the terminal of the disconnecting device in the base of the post and to pour cement around the loop to form the foundation for the post. This is a more satisfactory method than the one usually used of making the post foundations first with the conduit elbows for the cable to be drawn through, as it leaves the cable intact until the time the connections are made in the base of the post.

A disconnecting pothead should be used in the base of the post and this should be of such design as to thoroughly seal the ends of the steel armored cable and efficiently bond and ground the steel armor and lead covers. It should also be designed so that the post wiring is automatically disconnected from the underground system and the circuit in base of post reestablished by a short-circuiting device in the event of the post being accidentally broken.

It is desirable that a device be used in the top of the post for relieving the terminals of the lamp socket from the strain of the weight of the cable used in wiring the post.



IN SALT LAKE CITY, UTAH THE LIGHT STANDARD IS USED IN COMBINATION AS A TROLLEY-WIRE SUPPORT.

In the constant current series system of operation, the high tension current is carried up the post, and, although when properly installed this is not objectionable, several cities have preferred to use a safety coil in the base of the post so that a voltage equivalent to the voltage of the lamp only is carried up the post.

Safety coils have been designed equipped with disconnecting potheads which have all the advantages of the latter device, coupled with the safety feature of low voltage in the post.

Part Night Circuits

Occasionally, in the interests of economy, it is found desirable to decrease the illumination on the streets after midnight when only protective lighting is required and this is best accomplished by dividing the lighting system into two circuits, one operating the "all night" lamps and one operating the "part night" lamps. For this purpose, two single conductor cables may be laid in the same trench, connecting with alternate lamps or any other combination desired. If preferred, a twin conductor cable may be used.

Classification of Streets for Ornamental Lighting

In many of the larger cities will be found some exceptionally wide and important streets which will require special treatment; in general, however, for the purpose of determining the correct size of lamp with the best spacing and mounting height, the streets may be divided into three classes, viz.: Important Business Streets, Side Streets and Residence Streets. The following table gives approximate data on this subject, which, however, may be varied to meet local requirements:

Type of Street	Size of Lamps in Lumens	Spacing in Feet	Mounting Height in Feet
Important Business	6000 to 15000	50 to 75	12.5 to 15
Side	2500 to 4000	75 to 100	11.5 to 13.5
Residence	1000 to 2500	150 to 250	10.6

In the important business streets and side streets, the ornamental posts should be set symmetrically opposite each other on either side of the streets, while in residence districts the posts should be staggered.

For exceptionally wide and important streets, a greater intensity of illumination is required, with higher mounting, and, for this purpose, two-light ornamental posts, for use with 15,000 and 25,000 lumen lamps, have been developed.

The Use of Trolley Poles as Lighting Units

On streets where trolley poles are in service, the best method of lighting is by the use of ornamental trolley brackets with suitable lighting units, either with single or double arm, which may be attached to the trolley poles, presenting a very attractive appearance and eliminating the necessity of cluttering up the streets with additional posts.

Another method of adapting trolley poles as ornamental lighting units is to encase the pole in an ornamental cast iron shell with ornamental brackets attached. An attractive unit has been designed with double brackets immediately below the trolley span wire and a single light at the top. The span wire is attached to the trolley pole through a hole provided in the capital of the top lighting unit.

Types of Commercialized Ornamental Posts

Ornamental Posts may be divided into three classes, viz., Cast Iron, Concrete and Pressed Steel.

The earliest ornamental cast iron post, the history of which is preserved, was installed in the Taj Mahal, Delhi, India, upwards of sixteen hundred years ago, and stands today a monument to the durability and lasting qualities of Cast Iron.

Cast Iron Posts will not corrode, neither will they chip or crack under extremes of temperature. They are designed to withstand severe shocks, such as might be received in ordinary street traffic, and present the slender and graceful appearance so desirable in ornamental street lighting units.

Concrete is one of the most durable materials used in construction work, but it has been found that ornamental posts of this type must be of very heavy and substantial construction to withstand extremes of temperature. Unless manufactured with the greatest care, concrete posts will be found to chip and crack in Northern climates.

Pressed Steel Posts generally consist of a shaft of corrugated pressed steel, mounted on cast iron foundation, with an iron capital, the whole bolted together with three tie rods passing through the center of the shaft. This type of post, owing to its construction, presents a massive appearance, but the shaft is readily dented and bent by shocks which would leave cast iron posts unaffected.

The Mazda "C" Lamp

Until about the year 1913, the filaments of all commercial Electric Incandescent Lamps were operated in bulbs from which practically all the air and gases had been removed. The evacuation of the bulb accomplished two purposes, viz.: It prevented the filament being consumed by the oxygen of the air and also prevented the loss of heat by convection. As the temperature of the filament is raised, the light emitted increases much more rapidly than the energy consumed, but, on the other hand, the rate of evaporation of the filament is increased.

In the Mazda "C" Lamp, the rate of evaporation is reduced by the introduction into the bulb of inert gases, thus permitting the use of a higher operating temperature. Convection losses are reduced by the use of a concentrated type of filament and this renders the use of the Mazda "C" Lamp specially suitable for street lighting purposes.

Constant Current Series Circuits

Alternating current series arc lamps were operated on circuits of either 6.6 or 7.5 amperes and, in consequence, series lighting regulating equipment designed for these ratings became standardized throughout the country. Series Incandescent Lamps were made for use on these circuits in ranges of from 60 c.p. to 1000 c.p., but the larger size lamps did not come into commercial use until the high efficiency Mazda "C" Lamps, operating at 15 and 20 amperes, were introduced. These lamps, owing to the increased size and rugged construction of the filament, have a longer lamp life than the straight series type and are generally adopted for ornamental street lighting systems, except in Residence Districts.

Since the standard rating of series alternating current circuits is either 6.6 or 7.5 amperes, individual auto transformers to step up from the line current to that required by the lamp have been designed, and these are generally mounted in the post top, immediately below the socket. In cases where a safety coil is installed in the base of the post, the auto transformer is omitted and the safety coil serves as the step up transformer. The high efficiency Mazda "C" Lamps are made in the following sizes:

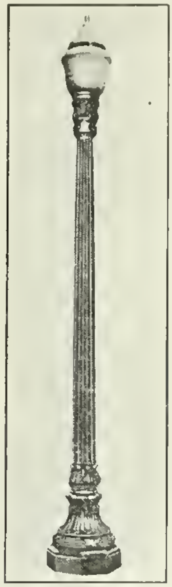
Lumens	Amperes	Average Volts	Watts	Light Center Length in Inches
4000	15	14.9	223.5	9.5
6000	20	15.5	310	9.5
10000	20	25.9	518	9.5
15000	20	37.6	752	9.5
25000	20	60.7	1214	9.5

Note: The nominal candle power of these lamps is one-tenth their lumen rating.

The Light Unit

The problem of street lighting is not like that of lighting a room where the ceiling and walls reflect the undirected light, and provision should be made in the lighting units to direct the light emitted above the horizontal to the plane of illumination. With ornamental post lighting, however, it is desirable that a small amount of light from the upper hemisphere should be directed against the fronts of adjacent buildings, and that glare should be, as far as possible, eliminated.

Glare, within the range of vision of the pedestrian or vehicle driver, should always be avoided. It causes the pupil of the eye to contract in an effort to protect the delicate mechanism of the retina, thus preventing the observer from seeing as well as he would be able to do with a light source of lower intensity, but more perfect diffusion. We are conscious of this phenomenon when entering a moving picture theatre from a street flooded with



A STANDARD OF ORNAMENTAL DESIGN ADAPTED FOR COMMERCIAL USES.

sunlight—at first no details can be seen, but gradually, when the eye becomes accustomed to the light, or in other words, when the pupil becomes dilated, permitting more light to enter the eye, the interior details become visible.

The problem of designing lighting units of high intensity, with a minimum of glare, has been solved very satisfactorily by the Reflecto-Lux Post Tops recently introduced.

The Reflecto-Lux Units are the very latest in ornamental post tops and they have been specially designed to distribute a flood of light on the streets, with a small amount upwards to illuminate the fronts of adjacent buildings.

The units have been developed for "Super Whiteway" Lighting, with 10,000 and 25,000 lumen lamps, or they may be used with smaller lamps, if desired.

The light emitted by the Reflecto-Lux Unit is brilliant and sparkling, and the panels, which are of ribbed glass, assist in diffusion and in the elimination of glare.

The distribution is obtained by upper and lower parabolic reflectors which direct the light outwards; in addition, a portion of the light in the upper hemisphere is re-directed by an opal glass band around the upper portion of the lamp, or by a band of enamel on the lamp itself.

In the post top, the lamp burns in a tip up position, and is easily accessible for cleaning, through the top cover which is hinged.

With the variety of ornamental street lighting fixtures now available, the possibilities of efficient and artistic lighting for the "City Beautiful" are unlimited, and public spirited men who are guiding the destinies of American cities will find an easy solution to their problems by consulting the manufacturers of these devices, who have devoted many years of research to the design of suitable apparatus.

The foregoing paper by Mr. Wood was presented before the 1921 annual meeting of the American Society for Municipal Improvements.

LONG INVERTED SEWER SIPHON OPERATES SUCCESSFULLY ON FLAT GRADE

An inverted sewer siphon of interest to engineers because of its length and exceptionally flat grade, was built during 1920 by the United States Engineer Department at Long Beach, Calif. The siphon, as part of an existing sewer, was made necessary by the construction of silt diversion works for the protection of Los Angeles and Long Beach harbors. The 36-in. siphon was installed at the same time as the 27-in. pipe, not only because the United States desired to complete its share of the work pertaining to the diversion project, but also because in heavy rains enough storm water finds its way into the sewer to exceed greatly the carrying capacity of the 27-in. pipe, in which cases it, for brief periods, overtops the wooden partitions and uses the other pipe also. While standard practice would indicate a minimum slope of about 1 per 1000 for a 36-in. sewer, and perhaps 1½ per 1000 for a 27-in. sewer, the 27-in. side of the siphon described is operating successfully with a slope of about 1 in 1200. The main features of the installation are here described as given by Capt. Burt Harmon in The Military Engineer for November-December, 1921.

The silt diversion channel has a bottom width of 530 ft. and a depth of 14 ft., with side slopes of 1 on 1½. It passes through the industrial district of Long Beach and intersects several branches of the former sewer system, including the 48-in. outfall sewer to which all the others were tributary through pumping plants. To avoid unnecessary channel crossings all the smaller sewers are intercepted by a new one paralleling the channel and emptying into a sump, from which the sewage is pumped into the outfall sewer before it crosses the channel.

The problem before the designers was to provide a structure that would (1) maintain a scouring velocity with the present minimum flow in the outfall—approximately ⅛ its total capacity—and (2) be sufficiently elastic to provide for future increase in flow up to the ultimate capacity of the outfall. As the sewer is below flood height, a bridge was considered impracticable. Pumping was obviously undesirable. The only alternative was a siphon.

The siphon as constructed, consists of 2 welded steel pipes 27 and 36 ins. in diameter, laid 7 ft. below the bottom of the channel. The horizontal distance between manholes is 611.4 ft., and the total length of the siphon pipes is 619.1 ft., of which 32 ft. at each end is inclined on a grade of 2 horizontal to 1 vertical. The total fall is 0.50 ft. This very flat grade required that the intake be so constructed as to cause as little obstruction to the flow as possible. For this reason no gates were placed at either end of the siphon, the diversion from the 48-in. pipe to the siphon pipes being made by curved wooden partitions in the manholes.

The invert through the manhole is semicircular, and so designed that when the natural flow in the 48-in. sewer is just equal to the capacity of the 27-in. pipe under the head available, without increase by backwater, the area of the cross-section of the stream is the same at all points between the end of the 48-in. pipe and the beginning of the siphon proper. The same method was followed in designing the 36-in. side. The upper sides of the inclined pipes were prolonged into the manhole so that the floating material will enter them without colliding against a vertical wall. The discharge manhole follows the lines of the intake.

It is estimated that the 27-in. pipe alone will care for the increase in flow for perhaps two years without creating an undue amount of backwater in the approaching sewer. The diversion partitions will then be replaced by others already prepared to confine the flow to the 36-in. pipe, the sewage being by-passed into the channel while the change is being made. When the capacity of the 36-in. pipe shall have been reached, the second partition will be removed and the flow passed through both pipes, the capacity of the two being approximately that of the 48-in. outfall.

The pipe was built in 50-ft. sections with flange couplings. A trench was dredged across the channel, and a trestle with bents 50 ft. apart driven along it. Screws 1½ in. in diameter and 18 ft. in length, with the lower end bent into a hook, were placed through the caps of the trestle over the center line of each pipe. The pipe was assembled suspended by slings from these screws. It was then lowered by turning the nuts on the screws simultaneously, the pipe being filled with water from the city mains as it was submerged. When both pipes were in place, they were covered with earth to a depth of 1 ft., and the trench then filled with broken concrete to the level of the channel bottom. This fill was permitted to settle for about 6 weeks, when the screws were removed and the piles cut off near the top of the concrete fill, the stumps being left for additional security.

The siphon has been in operation for 11 months without either lodgment of floating matter in the manholes or indications of deposit of sediment in the pipe.

DRAINAGE PUMPING PLANTS

By L. C. Craig, Principal Assistant Engineer, Edmund T. Perkins Engineering Co., 38 S. Dearborn St., Chicago, Ill.

Of the many acres of swamp and overflowed lands in the United States a large percentage is so situated that it cannot be entirely reclaimed without pumping. This is especially true of the 20,000,000 or more acres in the Mississippi River Valley.

The drainage of these lands has been largely a development of the last 25 years. During this period many drainage districts have been formed in the Mississippi River Valley, the first areas to be reclaimed being those so situated that all or a part of the drainage water would flow off by gravity. Gradually as the land increased in value pumping plants began to be installed more and more, as a part of the drainage systems. There exist today many areas with no drainage and others where only partial gravity drainage is obtained, where eventually pumping plants will be installed.

Only a few years ago $20 to $30 an acre was considered a big price to pay for the draining of agricultural land. Today, because of increased land value, many areas are being reclaimed at a cost of $60 and more an acre.

Few Reliable Records on Drainage Pumping Plants

Unfortunately, there exist today few reliable records concerning the capacity and efficiency of drainage pumping plants; such records, where found, usually extend back over a period of only a few years.

Many plants have been installed without adequate means being provided for making tests, or those in authority have failed to realize the necessity of such tests. In many cases no engineer is employed after the construction period.

Those matters are gradually being remedied and during the next few years we will see a very marked development of drainage pumping in this country.

Where Pumping Is Required

A drainage area requiring pumping is usually one with the ground level, so low as to require the raising of the drainage waters over a dam or embankment to a higher level. This dam or embankment may be part of a levee system, constructed to protect lands from flood overflow, as is the case in most river bottom areas, or a dam and pumping plant may be placed in an ordinary drainage ditch at a point where, because of a very flat gradient or lack of outlet, it is found impossible to take care of the drainage waters by ordinary ditch construction.

Size of Pumping Plant

The size of pumping plant required for any particular drainage area depends upon a number of varying conditions, among which are:

1. The size and topography of the drainage area.
2. The amount and distribution of rainfall.
3. The system of ditches and drains used, and the amount of storage capacity available in ditches and reservoirs.
4. The nature of the soil and sub-soil as affecting run-off and seepage.
5. The method of operation of the plant and the degree of drainage required.

The first three factors given above are, of course, the most important in the design of any drainage pumping plant, but all should receive consideration.

For the past 20 years, or more, in Central Illinois and along the Mississippi River pumping plants for removing water from flat drainage areas have been designed for a maximum pumping capacity sufficient to remove in 24 hours ¼ in. in depth of water over the entire area. In Holland and other European countries for a much longer period ¼ in. or a little more has been used as the maximum capacity for drainage pumping plants. Experience in recent years has not shown that the run-off coefficient of ¼ in. should be changed as a standard basis of design under average conditions. But the engineer must be sure to give due consideration to all modifying conditions in each particular case.

All other conditions being equal, the small drainage area of only 1,000 or 2,000 acres will require a slightly larger pumping plant in proportion to its size than an area several times as large. Where some of the area is higher with steep slopes and impervious soil, the run off coefficient for this portion must be made greater; in some cases it will be twice as great.

The amount of rainfall in Central Illinois averages about 35 ins. per year. Of this amount measurements have shown that about 26 to 30 per cent appears as run-off. Rains of 2 to 3 ins. in 24 hours occur occasionally, and rains of 4 ins. in 36 to 48 hours sometimes occur.

In many drainage areas considerable storage exists in lakes and sloughs which it may not be found desirable to drain. This storage capacity, in addition to the storage ordinarily afforded by the drainage ditches, will reduce the size of the required pumping plant. If there exists considerable areas of tiled land, additional storage will be afforded.

Influence of Soil and Sub-Soil

The nature of the soil and sub-soil of the drainage area has a big effect on the run-off, and when the water on the outside of the levees, in the case of a levee district, is at a high stage, on the amount of seepage. If the soil is a close, compact formation, the surface run-off will be heavier from a sudden rain. A sandy subsoil underlying a drainage area is generally an advantage, because the necessity of constructing tile drains and many small lateral drainage ditches may be largely eliminated, but during high water on the outside of the levees the effect may be the opposite, and the amount of pumping increased by an excessive amount of seepage.

Levees exceeding 10 ft. in height are usually constructed with a muck ditch or small ditch excavation 4 to 8 ft. in depth, constructed under the base before the levee is built, so as to bind in and help consolidate the levee fill with the soil formation underlying the base, and levees, when so built, have been found to resist seepage in a marked degree. However, even with a well-built levee and a sand or gravel sub-soil there will be a considerable amount of seepage which rises to the surface of the ground inside the levee or may be intercepted by tile drain or surface ditches. Where such tile drain or surface ditches exist, located parallel to and adjacent to a levee so as to cut off and carry away the seepage, the amount of such seepage waters may be as much as 2 second feet per mile of levee.

A pumping plant should be designed to operate continuously if necessary. Generally, during the winter months little pumping will be necessary, because without growing crops little drainage will be needed, but it will be found to be an advantage to pump occasionally throughout the winter so as to reduce the ground water level and thereby secure an early drying of the soil in the spring. In this manner the run-off from heavy rain coming in the spring will be lessened and the size of the pumping plant which might otherwise be required may be reduced.

Type of Engine and Pump to Use

After the amount of water to be provided for in the capacity of the plant has been decided on, we must next determine the type of engine and pump which should be used.

The importance of a well designed pumping plant cannot be overestimated. Many pumping plants have been installed in drainage districts along the Mississippi and Illinois Rivers which have been operating with very poor economy, because of poor design. In some cases both pumps and engines have been removed and others installed once or more in a period of 10 or 15 years.

A well designed pumping plant does not mean necessarily one having the greatest economy of operation. Usually from 60 to 80 per cent of all pumping is done in the four months, March, April, May and June, and during the late summer and fall months in some localities no pumping at all is needed. It can readily be seen, therefore, that with the plant idle a good share of the time it might not be economical to spend a lot of money on costly equipment in order to secure economy of operation.

As a usual thing, in a well designed pumping plant using steam, the operating expenses are about half of the total cost, including the fixed charges. Where the operating expenses are much less than half of the total cost it will usually be found that the total cost should be reduced by using less costly equipment. The item of fixed charges, including interest, taxes, insurance and depreciation, should always be given full consideration in arriving at the total costs as in any other well designed plant installation.

Reliability a Chief Factor Governing Design

As pumping plants must be depended upon to operate when needed, and any delay may mean a flooding of large areas with resulting loss of crops, reliability is one of the chief factors governing design. Or, as a usual thing, it may be said that a type of pumping plant which has proved itself reliable and will require the least annual cost, including fixed charges, will be the best.

Several kinds of pumps, including scoop wheels for low lifts, rotary, plunger and centrifugal pumps, are used in drainage pumping, but the centrifugal pump has come to be recognized as best suited to conditions usually found in drainage work.

The number and size of the units to be used will, of course, depend upon the capacity and the conditions of operation. In order to have at least one pump in reserve in case of breakdown it is desirable to have at least 2 units, and one of these units should have about twice the capacity of the other, for the reason that the small unit will operate over longer periods with greater economy. This is especially desirable where steam is used as the source of power, as the frequent starting and stopping and firing up of boilers will necessitate the burning of much additional fuel, and shorten the life of the boilers. Where three or more units are used they should be of equal size. The total capacity of the pumps should be sufficient to pump the maximum quantity of water against a static head about 3 or 4 feet below the maximum expected.

The Friction Head

In order to determine the actual or hydraulic head on the pump, we must add to the static head an amount which should not exceed 3 ft. in a well designed pumping plant. This additional head, called the friction head, is due to the friction in suction and discharge pipes, the velocity head and the losses at the entrance and outlet of these pipes.

In many poorly designed plants not enough attention has been paid to eliminating the losses in the suction and discharge pipes. The entrance to the suction pipe should be expanded so as to reduce the velocity to not more than 3 ft. per second; 2 ft. per second is better.

The centrifugal pump operates efficiently only when running at or near the speed which is suitable for each particular head. Therefore, where the total head is variable, as in most drainage pumping, it is desirable to have some method of regulating the speed. This is accomplished in the case of the steam engine by regulating the speed of the engine and in the case of the constant speed induction motor by belt connecting to the pump and using two or more sets of pulleys so as to secure the desirable speed. This latter method is cumbersome and undesirable and there is the further objection of loss of power with the belt drive.

With a pump properly designed it may be found that the source of power can be direct connected to the pump and any loss in efficiency in the pump due to the operation at constant speed will be offset by the elimination of the power loss with the belt drive. With variable speed drive or with the steam engine or internal combustion engine direct connected, it may be found that there will be losses in the engine itself, due to operation at less or more than rated speed, which will make changes of speed inadvisable. It is necessary, therefore, that the engineer, before designing a pumping plant, should make a thorough study of all data concerning the equipment he proposes to use, and if possible he should examine other plants where reliable tests have been made.

Pump manufacturers will usually furnish characteristic curves showing capacity, brake horse power and guaranteed efficiency at various speeds. Curves should be drawn or computations made showing complete operating conditions, including the total quantity of water and the total number of horse power hours for various heads over a typical operating period of one year. These curves or computations should be compared with the characteristic curves of the pump to see that the pump has sufficient capacity and is so designed as to have a good efficiency while pumping the greatest quantity of water. From these data also the maximum horse power of the prime mover and amount and distribution of the fuel consumption can readily be determined.

In the case of variable speed drive a proposed operating chart should be made up, showing the proper speed and other operating conditions which should be used to secure greatest economy. The chart, of course, will be modified as found necessary by tests of the plant after construction.

Prime Movers for Drainage Pumping.

Steam engines, electric motors and internal combustion engines are all used as prime movers for drainage pumping. Which should be used, in any locality, depends upon the size of the plant, its method of operation, the cost of fuel delivered, and the availability of competent labor.

In locations where soft coal can be obtained cheaply, steam may be an economical source of power. In large units one of the advantages of the use of steam is that better speed regulation of the pumps can be obtained. A disadvantage, of course, is the intermittent operation of the plant previously mentioned, and difficulty in delivering coal and supplies. In plants of over 200 H.P., it will usually pay to put in high speed automatic condensing engines with water tube boilers. Higher grade engines, such as the so-called "uniflow engine" with superheat, usually are found suitable only for plants of over 300 H.P., where the cost of operation is a much larger portion of the total cost than in a small plant.

Tendency Toward Electric Pumping

The electric drive has many advantages over other sources of power wherever electric current can be supplied at a reasonable rate. The two principal advantages are low first cost and convenience of operation. Usually the cost of an electric drive pumping plant will be about 60 per cent of the cost of a steam plant. Its depreciation is much less than any other form of plant. It can be operated with ordinary labor with few repairs, and in small plants its operation can be made automatic. The tendency during the last few years has been toward electric pumping.

The Internal Combustion Engine

Because of the low cost of fuel oil the internal combustion engine of the Diesel or semi-Diesel type is now receiving a great deal of attention as a source of power for drainage pumping plants. Up to about five or six years ago there were not over 6 concerns in this country building engines of the Diesel or semi-Diesel types. Now there are at least 16 builders of Diesel engines and at least 30 or more firms building various types of semi Diesel or low compression engines.

Many of the types of internal combustion engines now being placed on the market are still in a state of development or have but recently passed that stage; therefore, before selecting this type of engine for a drainage pumping plant, the engineer should make a thorough investigation of the performance of engines which have been in operation at least two years.

Diesel Engines

The full Diesel is an engine using high compression and high temperatures with complicated valve mechanisms, needing an intelligent, skilled operator. Its first cost is also very high, and although very economical in fuel consumption, its use for drainage pumping is practically limited to large plants.

The semi-Diesel or low compression engine offers better possibilities, I believe, for the small plant. This engine will develop a brake horse power hour on about 0.7 pint of fuel oil as compared with about 0.5 pint for the Diesel engine. At present prices, oil of the grade required for these engines can be delivered in most any locality at a cost of from 3 to 4 cts. per gallon. The first cost of these engines at the present time is about $50 to $60 per horse power, about half the cost of the Diesel engine in small units.

There are various grades of oil used in engines of this type, varying from a gravity test of 20 to 44 deg. Baume. The trade name, fuel oil, is applied to all oil residue left after distillation has removed the gasoline, kerosene and light distillates from crude oil and varies in gravity from 20 to 32 deg. Baume. As oil varies in price, the lighter oils costing more, it is very important to be sure that the engine will run successfully on a low grade oil. Some manufacturers will guarantee operation on oil of a gravity of 24 deg. Baume; others will specify a higher grade. In some cases where the low grade oil is specified, there will be a very low content of sulphur or coke required or some other qualification which may raise the cost of the oil.

I recently had occasion to investigate the quality of fuel oil being used by a number of operators of semi-Diesel engines near Chicago, and found that none of them were using the low grade guaranteed by the manufacturers. The cost of the oil being used exceeded the cost of the low grade oil by from ½ ct. to 2 cts. per gallon.

To be of use in a drainage pumping plant the engine must operate successfully at varying loads, and the regulation of fuel and water supply must be entirely automatic. Some semi-Diesel engines have troubles with their fuel and water regulation under varying loads and this is a matter that requires careful investigation.

With the increasing consumption of gasoline, it is fair to assume that there will always be a good supply of fuel oil and that the cost of this oil will always be low enough so that except in a few localities oil can be used successfully in a well designed engine in competition with coal or electricity. Many central stations are now using Diesel engines and producing electric current at a cost, including all fixed charges, of 2 to 2½ cts. per kilowatt hour.

In conclusion, with reference to the use of the Diesel or semi-Diesel engine for drainage pumping plants, I will say that the development of this form of prime mover for stationary engines has not yet reached a stage where their use can be recommended without very careful investigation of plants now in operation, but I recommend that every engineer, before designing a pumping plant, investigate carefully the possibilities of this type of prime mover.

The foregoing paper was presented at the annual convention of the National Drainage Congress held in St. Paul Sept. 22-24, 1921.

USE OF FINE SEWAGE SCREENS IN NEW YORK CITY

By Kenneth Allen, Sanitary Engineer, New York Bureau of Sewer Plan, Room 1235 Municipal Bldg., New York, N. Y.

The City of New York has five fine-screening plants located as follows: Elmhurst Disposal Plant, Borough of Queens; Thirty-second Avenue Outlet in Flushing, Borough of Queens; Forty-third Street Outlet in Corona, Borough of Queens; Twenty-sixth Ward Disposal Plant, Borough of Brooklyn, and, Dyckman Street Outlet, Borough of Manhattan.

Those in the Borough of Queens are fixed plates, with ⅛x½-in. perforations, cleaned by hand, while those in Brooklyn and Manhattan are mechanically-operated Riensch-Wurl screens. There is also a screen of ¼-in. wire mesh at the Oak Street outlet in Flushing.

The two 14-ft. screens in Brooklyn and their operation were fully described in a paper* read before the American Society for Municipal Improvement two years ago by George T. Hammond, Engineer in Charge of Experiments and Sewer Design, Bureau of Sewers, and a description of the Manhattan plant with a summary of tests made by the late Charles E. Gregory, representing the Borough of Manhattan, and the writer, representing the Board of Estimate and Apportionment of New York City, may be found in the Proceedings of the Society for 1919, as discussions of Mr. Hammond's paper.

Further details of these tests may be of interest.

The Dyckman Street Plant

The Dyckman Street plant was built in 1916-17 at a cost, including grit chamber and submerged outlet, of about $83,700. There are two 14-ft. screens, one having 3/64-in. and the other 1/16-in. slots, housed in a brick building 48 ft. by 35 ft. in size. Their axes are inclined 20 degrees from the vertical. Each screen has a nominal capacity of about 6 mgd., but the present dry weather flow is but half that amount. One screen—that with 3/64-in. slots—is regularly operated, the other being held in reserve, and excess storm water is by-passed to the river. Each screen, with its brushes, is operated by a 2½ H. P. motor at a rate of ½ r. p. m. and is cleaned by the use of a hose for a few minutes about three times a day and spraying with from a quart to a gallon of petroleum with a watering pot once a day. This is found the best way to remove greasy deposits, which were found to occur to such an extent as to render 1/32-in. slots ineffective. The plant is operated from 8 a. m. till midnight in two shifts, during which period

INTERIOR VIEW OF DYCKMAN STREET SEWAGE SCREENING PLANT, NEW YORK CITY.

* Brooklyn (N. Y.) Sewage Treatment Experiments.

the normal current consumption is 0.7 kw.

There is a drop of a little over a foot from the screen to mean high water level. The screened sewage flows to a well and thence by a 16-in. pipe 160 ft. long to an outlet in 40 ft. of water.

Screenings are dropped from the brushes into a can 24 ins. in diameter by 24 ins. deep to a perforated bottom which permits drainage water to pass off. About 6 cansful are collected daily and after sprinkling with chloride of lime, are disposed of with the City's garbage.

Operation requires two men in the first shift and one in the second. Brushes wear at the rate of about 3/16 in. per year and last between one and two years.

The tests above referred to were carried out in June, 1919. The flow was measured by a weir, the depth being recorded by a Friez float gage checked by direct measurement. The head lost in passing the screens was read on a board gage above the screen as compared with the float gage below the screen.

Tests of Screen No. 1, with 3/64-in. slots, were made:
June 4, Wednesday, 11:30 a. m. to 3:30 p. m.
June 5, Thursday, 10:15 a. m. to 2:15 p. m.
June 9, 10, Monday and Tuesday, 10:15 a. m. to 10:15 a. m.
June 12, Thursday, 8 a. m. to 12 m.

Tests of Screen No. 2, with 1/16-in. slots, were made:
June 16, Monday, 10:45 a. m. to 2:45 p. m.
June 18, 19, Wednesday and Thursday, 10 a. m. to 10 a. m.

Gages were read and samples of screened sewage taken every 15 minutes in all but the 24-hr. tests, when they were taken hourly between 10:15 p. m. and 6 a. m. and every 30 minutes the balance of the time.

Suspended and settleable solids in the raw sewage were determined by adding the amounts shown by analysis in the screened sewage to the amount, in parts per million, computed from the dried screenings and sewage flow. In this way, material errors which have occurred elsewhere in testing screens were avoided.

All tests were made during dry weather except that of June 9, when a sharp shower occurred between 12 and 12:30 p. m. A comparison with the results of other days fails to indicate any marked effect due to this cause.

TABLE I—AVERAGE RESULTS OF TESTS IN 16 4-HOUR PERIODS

Rate of flow	1.74 m. g. d.
Raw Sewage—Suspended solids	143 p. p. m.
—Settleable solids	103 p. p. m.
Removed—Suspended and settleable	27 p. p. m.
Screenings—Moisture	80.2%
—Ash, dry basis	11.2%
—Volume per m. g.	20.4 cu. ft.
—Weight per m. g.	1128 lb.
—Weight per cu. ft.	55.9 lb.
Removal—Suspended solids	19.7%
—Settleable solids	24.2%

The loss of head was very small owing to the small flow as compared to the screen capacity, the greatest average for any test being 0.39 ft. on June 12. The difference between the two screens is brought out in Table II.

TABLE II—LOSS OF HEAD AND REMOVAL IN EACH SCREEN

Average of all 4-m. tests

Screen	No. 1	No. 2
Slots	3/64 in.	1/16 in.
Flow	1.84 m.g.d.	1.63 m.g.d.
Head lost	.20 ft.	.04 ft.
Removal—Susp. Solids	23%	16%
—Set. solids	31%	19%

This indicates that the screen with 1/16-in. slots will remove 7/10 as much material under these conditions as the screen with 3/64-in. slots.

The night sewage was found to be abnormally weak and, probably owing to lack of colloidal matter, the percentage of removal was very high. Table III was therefore prepared, showing the weighted results with each screen separately when operating with day and night sewage. (Condensed from Table I of the writer's discussion of Mr. Hammond's paper.)

From Table III the following conclusions are drawn:

1. With day sewage the 1/16-in. screen removes about 1,000 lbs. screenings and the 3/64-in. screen about 1,300 lbs. screenings per m. g. With night sewage each screen removes about 400 lbs. screenings per m. g.
2. The efficiency of removal of suspended solids from day sewage by the 1/16-in. screen is about 14% and by the 3/64-in. screen, 20%.
3. The removal of settleable solids from day sewage by the 1/16-in. screen is about 23% and by the 3/64-in. screen, 27%.

With night sewage each screen removed about 400 lbs. of screenings per m. g., but the results were so erratic that it was not possible to draw conclusions as to the analytical results and efficiency. The removal of suspended solids, for instance, varied from 14.3% between 10 p. m. and 6 a. m., June 19 and 20 with 1/16-in. screen, to 92.5% between the same hours June 10 and 11 with the 3/64-in. screen. This last extraordinary figure is probably due to the fact that the small amount of material removed consisted of sticks, rags, paper, etc., floating in water containing little finely-divided organic wastes.

So far as can be told by the above tests a removal of 20% suspended solids may be considered a fair general figure to assume provisionally in estimating the effect of fine-screening by 3/64-in. Riensch-

Wurl screens with fresh sewage of this character, while nearly 30% of the settleable solids should be removed, these, by the way, being those that are the more objectionable to sight and responsible for the larger part of sludge deposits.

TABLE III—TESTS OF RIENSCH-WURL SCREENS AT DYCKMAN STREET PLANT, MANHATTAN, JUNE, 1919

Average results, weighted in proportion to flow during the individual periods of observation.

Screen	No. 1		No. 2	
Diameter	14 ft.		14 ft.	
Width of slots	3/64 in.		1/16 in.	
Day or night sewage	Day	Nt.	Day	Nt.
Crude Sewage—				
Susp. solids p.p.m.	175	48	151	55
Set. solids p.p.m.	133	48	93	55
Screened Sewage—				
Susp. solids p.p.m.	139	21	129	46
Set. solids p.p.m.	97	21	71	46
Screenings—				
Susp. sol. rem. p.p.m.	36	27	22	9
Moisture %	78	78	82	83
Dry material %	22	22	18	17
Vola. (dry basis) %	88	84	91	91
Ash (dry basis) %	12	16	9	9
Vol. cu. ft./m. g.	27.1	9.5	18.4	9.2
Weight lbs./m. g.	1449	447	1040	447
Weight lbs./cu. ft.	53.4	47.0	56.5	48.6
Efficiency of Removal—				
Susp. solids %	20.6	56.2	14.6	16.4
Set. solids %	27.1	56.2	23.7	16.4

In May, 1920, samples of the Dyckman Street screenings were analyzed with the following results:

TABLE IV—ANALYSIS OF SCREENINGS

Weight per cu. ft.	58 lbs.
Moisture	68.2%
Total nitrogen, dry basis	2.25%
Loss on ignition, dry basis	73.8%
Ash, dry basis	26.2%
Fats (ether soluble), dry basis	21.1%
Phosphoric acid, dry basis	1.11%
Potash, dry basis	0.064%

The analytical work in both the Brooklyn and Manhattan tests was performed by W. T. Carpenter, Chemist.

The foregoing paper by Mr. Allen was presented at the 1921 convention of the American Society for Municipal Improvements.

ADVANTAGE OF A TOPOGRAPHIC MAP IN CITY PLANNING AND ZONING

By Jefferson C. Grinnalds, Asst. Engineer, City Plan Committee, City Hall, Baltimore, Md.

It is a settled fact that a map of a city on which to study and lay out a plan for any proposed extension of the street system is necessary. It is a requisite too for replanning old parts of the city systematically to study traffic conditions, to show offsets that break the continuity of streets, to show bad angles, block distances, dead end streets, inadequate widths and inefficient functioning of existing thoroughfares. A map of some kind on which to lay out a major street plan is absolutely necessary; and since zoning is an essential part of city planning, its requirements must be supplied and maps are indispensable for a zone plan, indeed they are a part of it. There are many other reasons why a map of a city is necessary in planning.

Planning Without Sufficient Information

If it may be accepted as a condition precedent to studies for drawing a city plan, that some kind of diagram of the present layout is necessary, then the kind of maps must be determined. Suppose those at hand are similar to the common well known automobile maps, which show merely street alignment depicted to a scale of approximately 2000 ft. to 1 in. or 1000 ft. to 1 in. Of what service would a map of this kind be? If it were noticed that there were in some places 2 parallel streets which ran thus for, say, 1000 or more feet without a connecting cross street ,the city planner might say "Why not open between these two parallel streets, a cross-town street which is dead-ended on opposite sides of this long unbroken block?" He can see from inspection of the diagram what seems to be a desirable opening. It is not apparent from such meagre information that the grade on the proposed connection would be as heavy as 10 per cent. Why? Because there were no elevations given nor were there contours showing approximately the probable grade.

Imagine another problem that must be solved. Several parallel streets are shown on this diagrammatic map, crossing a railroad yard which lies contiguous to a railroad main line. There is no indication to guide the engineer in his diagnosis of the kinds of crossings over the tracks. Are they at grade, are they elevated above the tracks, or are they depressed below the tracks? If such crossings as exist are dangerous, what is the remedy? He cannot tell positively with no more facts to help the solution. If he had a contour map which showed the relative locations to scale, he would know at once the conditions on the ground and where to look to find the railroad in a cut or on a fill where the streets could cross overhead or underneath respectively. In one or both places he would advocate a bridge. Innumerable cases can be cited where it is absolutely necessary to have a topographic map, showing contours and surface detail for study on which to base a comprehensive city plan.

Kind of Map Necessary

From the foregoing, it seems that a map is necessary and further that it should be a topographic map. Assuming that to be a correct conclusion, the next step is to determine what the map should show. The first consideration is the existing street layout. All streets that are built up or marked on the ground should be recorded by the field survey parties and plotted on the map. Old lanes and drives should be included. The office force should be employed at the same time, compiling all the data accessible for platted parcels of land. Many such subdivisions have been laid out on paper with no streets having been staked off on the ground. All plats on record or of which any information can be obtained should be located on the field sheets when they come in. Improvements such as buildings of all kinds ought to be located on the field maps including railroads, street railway lines, streams, shore line, lakes, reservoirs, retaining walls, dams, bridges, quarries and wooded areas. Fences and their character, such as wire, paling, rail and old fence lines, hedges and rows of trees that might indicate old property lines, are requisite to a good map. The state of cultivation is desirable, differentiating by suitable standard signs, orchards, meadows, plowed land, corn fields, pine woods, etc. Lastly, contours must be located and plotted.

Scales

Having decided what physical features are to be shown on the topographic map, it is necessary to determine the scale and contour interval. The former ought to be one which is readily plotted in the field on a field drawing table. When it is remembered that rows of brick houses are to be shown, it is not practical to draw them at a scale less than about 200 ft. to 1 in. To be able to scale within a foot or two, the width of a street or sidewalk, the above mentioned scale is almost the minimum. The well known map of Baltimore, made by the Topographical Survey Commission of that city in 1894, is a masterpiece of that kind of work. It is drawn to a scale of 200 ft. to 1 in., with a contour interval of 5 ft. It was found to be admirably suited as a base for working out a plan for streets in the hitherto unplanned territory within the city. The contour interval of 5 ft. seems to be right for street design and determination of grades. It may be that over very flat terrain a lesser interval may be necessary for sewer design and to a less degree for water main locations.

Degree of Accuracy

Here it is well to decide how good the map must be from the point of view of accuracy. It should be based on a primary triangulation system, the stations of which may be regarded as nearly permanent and accurate to within 10 seconds for closure of any quadrilateral. The secondary and tertiary stations should be almost as good as the primary. There ought to be one or two accurately measured base lines, corrected for curvature. On the triangulation there should be run out all the main roads and cross-country, a traverse control with a maximum error of 1 in 10 or 15,000. The reason for these standards of accuracy is that after such a map is complete, there is left on the ground a control from which detailed property surveys can be made, street intersections computed and established coordinately in the down-town districts where assessed land values are high. Traverse points should be iron rods or pipes placed in the most protected places along highways or in open country, or copper bolts set in curbs or on sidewalks, all well referenced for future use. A net of precise levels ought to be spread over the area to be mapped, bench marks placed on the most permanent structures at about half-mile intervals. Wye levels can be run to traverse points and temporary stadia stations. Maximum error for precise levels should not be over about 3-16 of an inch to the mile.

Costly Errors Obviated

Why all this elaborate, detailed description of a map and what is the excuse for making it? Cities used to be laid out without one, it is true. What kind of a layout was it? Well, when a street was designed to be a straight street, it was so drawn on paper, so built on the ground and regardless of hills or ravines, it kept on. The costs leaped up for cuts and fills and bridges. If the way led to a railroad, it passed over at grade more than likely, leaving a heritage of danger for several generations, ultimately saddling the taxpayers with the burden of expenditures to eliminate at considerable cost, the death trap. Had a map been available, showing by contours the existing hills, valleys, streams, railroads, etc., it is probable that the entire street plan would have been different. When a large city of today was in the village or town stage, its whole scheme of streets would have been designed to fit the topography, had proper maps been made. The present small town should benefit by the costly lessons that the large ones have learned too late greatly to alter the down-town sections without prohibitive cost.

Steps In Planning

Take the initial stage—suppose a new city is to be built on a proposed site. The topographic map is made. It is possible to determine at once certain rocky, precipitous cliffs, bluffs, wooded ravines, steep hillsides and other suitable areas for future parks. These may be eliminated from the flat or gently rolling terrain so well adapted to building and over which a street plan must be studied. The old country roads, shown on the map, are the existing highways of travel. Some may fit in with a general scheme and others will not. A study will reveal the natural location of the points of ingress and egress for railroads. They will not come into town over the hills. They will enter by certain low grade lines and along them will be suitable territory for industrial development. On the higher ground will be the housing area. It is necessary to determine where the central business area should be. These various districts must now be connected. Radials from the center of town to the outlying sections must be provided. Cross-town and circumferentials must be provided. These streets are the basis for a major street plan. They need not be absolutely straight. The alignment may be determined by the contour of the ground, thereby giving easy grades but with the most direct route consistent with reasonable grades.

New Territory to Be Laid Out and Old City Replanned

An old city that requires a plan for undeveloped or recently annexed territory and that needs replanning in built-up portions, requires a topographic map. In almost every city of that type the street plan was drawn on a flat diagrammatic map. With the general information shown on a complete topographic survey, it is well to work out proposed extensions of the park system, reaching out into the undeveloped country, embracing the ravines, etc., and certain other land suitable for parks. These may then be connected by proposed parkways. These areas being determined, it is unnecessary to lay them off into streets. The city plan is simplified to that extent. The major street plan may be laid down on broad lines. Existing grades may be corrected. Slight alterations may serve to give good results. Certain sharp curves may be eased up by curves of longer radii and offsets may be cured by cutting off some corners. The buildings being shown, studies of the cost of widening may be made and where it is necessary to accommodate the present or future traffic, a new building line may be determined and fixed. The map gives a good idea of the kind of improvements situated within the new lines. In the old parts of town the elevations may show a major street to be necessary on a high grade and not far distant a low grade artery may be indispensable. Prosivion can be made for connections between the two. In outlying territory, similar conditions may prevail. In the absence of a contour map, this could not be seen without a close inspection of the ground and even then the exact locations could not be made unless a survey were available.

Efficiency and Economy

The old checker-board street systems are not practicable, efficient or economic over rolling country. Once upon a time that was the only practice. Closer study with broader information at hand and more intensive efforts at scientific planning have tended to make a street plan more nearly fit the natural ground. Some cuts and fills can not be avoided but they can be reduced in number and in magnitude, by a more rational layout which is not only less costly by being more readily adaptable to the surface, but after all it is more beautiful. The monotony of the long uninteresting city streets so common in all cities will give way to the gently curving and sometimes winding parklike road. A contour map is the best possible guide for the city planner. It is likewise a guide to those who would develop land for sale as lots. They can see from such a map how best to make a street layout involving the least expenditure for grading and which will give the best street connections. New streets can be made coterminous with those already existing or a good reason for not doing so will usually appear on the map showing contiguous property. Much money can be saved to the city and to the land owners by the use of a good survey and its cost will be returned many times. Indeed grading cost alone on 1 or 2 of the existing main highways of some of the large cities has cost more than a topographic map would cost and had it been available, the alignment might have been different, avoiding part of the outlay for grading.

Grade Crossings Avoided

Outside of what we might call the congested part of town and farther toward the outskirts, major streets may be laid out almost a half mile apart and crossings of railroads and deep gullies may be situated at about half mile intervals.

These railroad crossings can be readily determined by studies of the topography. It may be found that where the road is in a cut or fill, there is the logical place to cross instead of at grade any old place as they used to do. The writer emphasizes the grade crossing menace and its abolishment by proper study, because it is so prevalent in all towns.

Sewer Design Depends On Topography

No other feature of city building depends more on the topography than the sewers. The $20,000,000 expended on a comprehensive sewerage system for Baltimore was based entirely on the map of 1894. On it the natural drainage could be traced and the storm water sewers followed it. The drainage area could be readily computed and the size of mains determined. Sanitary sewers were designed too from study of the surface as surveyed and by reasonable deductions as to the use to be made of certain kinds of land. Grades too were an important factor. Water mains are more easily located by having a map showing all physical features so the pipes may conform to the hydraulic gradient and the areas they are to serve will have their bearing on the size.

Rapid Transit

For thorough study of a proposed rapid transit system, a topographic map is essential. Elevations of streets, railroads and streams will give a clear conception of what levels the underground system will have to meet. If an elevated structure is necessary the same data is available and where the way may be in open cut on the surface, or on fill, safe and properly located crossings will be situated at suitable intervals.

Correct Base Map for Zoning

Since zoning is a part of city planning, inquiry as to the kind of a map on which to base zoning studies is apropos. It seems necessary to have a correct and complete representation of all present conditions. The buildings must be shown in order to draw clearly in detail an existing use map of the city to be zoned. A good base map would show on inspection that the buildings are of frame, brick, stone or steel construction. It will appear that some of the buildings are attached, that is, built in rows without side yards. Others will appear to be of the type known as semi-detached houses built in pairs, joined on one side with one side yard to each unit of the couple. Detached houses with two side yards to each house will be noted. Such a map as has been recommended above will show the buildings which sit back from the front lot line and those that are built up to the street line. The fundamental maps on which zoning studies are based can readily be prepared. It will be easy to give each house a color to denote its use, such as 1-family residence, 2-family residence, 3 or more family residence, business, industrial, and nuisance uses. Other sets of fundamental maps can be prepared easily, showing by color the heights of buildings, per cent of area of lot covered by buildings and the assessed land values on a front foot basis.

Necessary Guides in Selecting Zones

Certain other studies preliminary and essential before drawing a tentative zone plan, can be made from the topographic map. The built-up areas are noticeable at a glance. The trend of growth out the main highways and the development between them is apparent. Parks and cemeteries, where people do not dwell and therefore, where zoning for residence or business will not be necessary, show on the map. It will show by the contours and physical features, the lands suitable for future parking; along the streams, ravines, cliffs, etc., where the land is not so adaptable to building purposes. Low flat lands along the waterfront and railroads, suitable for industrial sites, for railroad yards, warehouses, piers, docks and shipyards are ready determined. The topography directs attention to the areas suitable for residential development. They can be so designated on the proposed use district maps. Housing areas convenient to industrial districts, to insure ample and satisfied labor supply are necessary. They are chosen with great care and discrimination, with due consideration for the existing developments. The engineer can with understanding, with knowledge of the growth of the city, with information shown by contours, select major traffic streets which will probably become retail business streets or heavy commercial haulage ways. Parkways and boulevards for the highest class residential frontage may be well chosen. All of these aspects of a zone plan are at once before the engineer or city planner who has an accurate, comprehensive topographic map upon which to work.

Maps of Baltimore Ideal

In 1894, the Topographical Survey Commission of Baltimore began the preparation of a topographic map of that city on a scale of 200 ft. to the inch, with contours at 5 ft. intervals. The map covered 30 square miles, the city's area at that time. The old part of the city prior to the annex of 1888 had been planned in

1819 without reference to topography. On the new map a plan was drawn and adopted for the development of the territory annexed in 1888. The city is now following that plan. In 1914 another map showing all the buildings in the city was made with the surveyed street plan as the frame work. In 1918 an additional 60 square miles of territory were annexed. Now the topographic map of 1894 is being extended to embrace the new addition and should be complete by 1922. These maps will give ample information on which to extend the street plan, design sewer extensions and water mains and to draw a zone plan, which ought to be the very best obtainable since it will be based on a mass of data not usually available for zoning studies.

Cost and Compensations

Does the cost of making such a map pay? Well, if Baltimore's sewerage system cost $20,000,000, it is conservative to estimate that 1 per cent of that amount or $200,000 would have been spent for surveys had not the map of 1894 been made. The map was paid for then by saving on one project. Thousands of dollars have been saved to property owners and taxpayers by reason of having a map available for the use of surveyors and engineers. By planning streets with reference to the contour of the ground the expenditure has been paid for many times over. City planning pays and the use of the term "city planning" ought to include the topographic map as the first step toward a comprehensive plan.

The foregoing paper by Mr. Grinnalds was presented before the 1921 annual convention of the American Society for Municipal Improvements.

SLUDGE HANDLING AT THE ROCHESTER, N. Y., SEWAGE DISPOSAL PLANT

By N. Adelbert Brown, Engineer in Charge of Sewage Disposal, City Hall, Rochester, N. Y.

The sludge beds at the Rochester (N. Y.) sewage disposal plants were designed on the generally accepted rule of 1 sq. ft. to 3 persons, and under the local climatic conditions this area has proven satisfactory. The Irondequoit Plant handles combined sewage. The 10 Imhoff tanks are preceded by grit chambers and Reinsch-Wurl screens and are designed to serve 200,000 persons. There are 40 individual beds, each approximately 44 ft. square. The tanks are built in double units with a common sludge trough. This trough is on the wall between two rows of four beds, allowing the sludge from any tank to be diverted to one of eight beds. The troughs have a slope of 1 in 50 which gives a high velocity and are nearly self cleansing. The sludge is discharged onto the center of the bed through an 18-in. opening controlled by stop boards in the side of the trough. The sludge falls onto a concrete splash plate. A depressed channel extends transversely to the sludge troughs between the first and second and the third and fourth beds of each tier. This channel is 4 ft. below the top of the bed and 9 ft. deep and 9 ft. wide. In this channel is laid a narrow gauge track for the sludge cars and on the walls are tracks for a Gantry crane.

The beds are level and consist of 2 ins. of fine sand, 3 ins. of coarse sand, 8 ins. of gravel and 6 ins. of broken stone. They are under-drained by 3-in. farm tile laid with open joints on 8-ft. centers. These tile discharge into an open drain under the track channels.

The Imhoff tanks have two rings of perforated pipe in each hopper and the sludge is agitated each week. The sludge pipes are also blown out and left filled with clear water after each drawing. No cones are found in the sludge surface and no plugging of the pipes has been experienced.

Drawings

Drawings are made during the season as often as the removal of the dried sludge permits. Nine inches of wet sludge are drawn on a bed. The drawing season is reasonably constant as shown by the following table:

Year	First Drawing	Last Drawing	Period In Days
1918	April 15	Nov. 15	214
1919	April 29	Dec. 10	225
1920	May 7	Dec. 21	228
1921	March 24		

While the season is nearly the same each year the number of drawings varies according to the weather. In 1920 each bed received nine fillings, an average of one every 25 days. In 1921, an extreme drought permitted 7 drawings between March 24 and June 23, an average of one every 13 days with the longest drying period 22 days and the shortest 10 days. Up to Aug. 10, 1921, four additional drawings have been made which gives a season's average to date of 12.6 days per bed.

Sludge Handling Equipment

To remove the dried sludge, two trains of six 1½-yd. Koppel cars are used. The trains are run in the depressed channel under the Gantry crane which lifts the car bodies from the trucks and sets them on the bed and replaces filled bodies on the trucks. In loading cars stone forks are used and the sludge lifted in cakes approximately 12 ins. square. A few extra car bodies set on the beds permit the moving of trains without delaying the labor force. The trains are hauled by storage battery locomotives and the crane is electrically operated as power is developed at this plant from the effluent.

Organization

The usual force consists of one foreman, one hoist man, two locomotive runners and eleven laborers. Eight men do the loading, one is on each train to dump the cars and one is at the dump to keep the track clear. This crew will remove on an average 200 cu. yds. of loose dry sludge in 8 hours. With labor at 50 and 55c. and neglecting power costs, this sludge is delivered to the spoil bank at 33c per cubic yard.

During much of the season, the sludge is sold to farmers as removed from the beds. The cars are run to the tipple and dumped directly into the wagons or trucks. As the tipple is located farther from the beds, the additional haul and delays in dumping increase the cost of removal 10 percent.

Moisture Content

The sludge, when drawn, contains from 79 to 86 percent of moisture. It is more dense in the first drawing each season and is thinner as the season progresses. At the time of removal the moisture is reduced to from 50 to 60 percent. A rain on the beds after the cracking has occurred packs the sludge so that it is difficult to reduce the moisture below 60 percent in any reasonable time. The shrinkage in drying is normally a little more than half of the wet volume. Analysis of a dry sample yields 2.2 percent nitrogen and 56.3 percent mineral matter.

Due to the depth of the tanks, the entrained air bubbles expand greatly when drawn onto the bed and make the dried sludge a light, porous cake.

Quantity of Sludge and Use as Fertilizer

The quantity of sludge varies, but the average for three years has been 1.51 cu. yds. of wet sludge per million gallons. In a large plant the disposition of the dry sludge becomes a problem. Realizing this, the plant at Rochester started in 1918 to develop a demand for it as a fertilizer. During that time it was given to any farmer who would load and draw it away. The plant is located in a fruit and truck garden section having a sandy loam soil. Reports of the use of this fertilizer were not enthusiastic. This was in part due to a belief that enthusiastic reports would increase the price. In 1919 a charge of 50c a load was made, the buyer loading from the dump, and more was drawn away than in the previous year with no charge. A proposal came from the farmers that with a more convenient method of loading they would pay a higher price. The tipple was erected and the price put at 75c per car, the car holding nearly 2 cu. yds. When sludge is not being removed, the dump is still open at 50c per yard. During 1920 the income from this source was $1,015. To July 1, 1921, it has been $650. The income is small but the disposal of continually increasing quantities is preventing an accumulation on the grounds of the plant.

It is being hauled for distances up to five miles. In peach, cherry and pear orchards it is used as a top dressing spread around the trees. On the truck farms it is spread with 50 yds. to the acre and ploughed under. The truck men use it under corn, tomatoes, celery, cabbages and melons. It is still impossible to obtain reports favorable to sludge, but the same farmers are drawing it after four years of trial and using more than ever before.

The foregoing paper by Mr. Brown was presented at the recent annual meeting of the American Society for Municipal Improvements.

MANDAN, NORTH DAKOTA, DISCARDS OLD AND INSTALLS NEW STREET LIGHTING SYSTEM

Even in these days when so many cities and towns are realizing the necessity of better street illumination and are installing new and improved types of lamps and standards in large numbers, the discarding of its entire street lighting system by a municipality and replacing it with a new one is sufficiently interesting to make it worthy of remark.

The city of Mandan, North Dakota, which has a population of about 4,600, has done so; and in so doing it has attained the distinction of having, probably, more ornamental light standards than any other place of anything like the same number of inhabitants. It has 447 in use, or approximately 1 to every 10 inhabitants.

The New Units

For a number of years its streets were lighted by 50 arc lamps. These have been removed and replaced by a system that is coming into very general favor—Mazda lamps enclosed in ornamental globes supported by ornamental iron posts. The change has been made at a cost of less than $100,000, while the gain in the appearance of the city and in the efficiency of its street lighting has been extremely noticeable and gratifying.

The lighting units, which are of the Novalux type, were made by the General Electric Company, Schnectady, N. Y. In the business district the Form 9 unit, with diffusing globe, glass canopy, and series film socket is used; in the residential sections, Form 8 is employed, the equipment being similar to that used in the business district. Ten and one-half foot ornamental iron standards and 100-candlepower lamps are used in the residential sections, and 12-foot standards and 250-candlepower lamps in the business district. It was originally intended to use a 400-candlepower lamp in the latter, but it was decided to employ those of 250-candlepower, which proved to be ample. The standards, which were made by the King Manufacturing Company, are uniform in design in both the residential districts and the business section, and are of graceful and pleasing pattern. The system is arranged and operated in four circuits, that of the business district being separate from those of the residential sections, and in each case the corner lights are on a different circuit than the intermediate lights.

The installation was designed by Black and Griffin, consulting engineers, of Mandan, and the contract was let, under competitive bids on plans and specifications prepared by them, to M. S. Hyland of Fargo, N. D. The type of standards used was selected by the City Commission.

Amount of Breakage

The breakage of lamps, globes and canopies has been very small, it having been as follows from December 20 to June 16:

Month	Lamps	Globes	Canopies
December	12	1	1
January	22	1	1
February	32	6	6
March	16	1	1
April	13	2	2
May	31	2	2
June	13	1	1
TOTAL	139	14	14

Features of Installation

Mandan has about 9½ miles of street lighting and approximately 3½ miles of paved streets. A number of standards were, of course, installed along unpaved streets. In these cases the posts were placed on the curb line at what will be the grade and street line when the street is paved, and 6-ft. sections of curb were set in for protection. All the cable was laid 12-ins. below the paving grade on unpaved streets, just under the edge of the sidewalk where the sidewalk extended to the curb, and across streets at right angles to the center of the street in 2-in. iron conduit pipes. All pipes crossing paved streets were pushed across, and no pavement was cut. It is interesting to note that in making the installation, approximately two carloads of cement, 1,200 cu. yds. of concrete and 140,000 ft. of No. 8 single conductor cable were used.

Operating the System

All the lamps are operated until 9:30 p. m. The corner lights are then turned out and only the intermediate lamps are burned until morning except on Saturday nights and special occasions, when the entire system is operated. The cost of maintenance and operation is paid out of the general fund for street lighting made by the usual levy. Power for operating the system is supplied by the Mandan Electric Company, a privately owned corporation, but the city installed and owns the switchboard panels, meters, etc. The lights are controlled by employes of the company under the direction of the City Commission. The rate paid is 5 cts. per kw. hr.

Consumption of Current for Six Months

The lighting schedule and the consumption of current for the first half of the year were as follows:

January	5:00 p.m. to 7:00 a.m.	11,750 Kw. hr.
February	5:30 p.m. to 6:20 a.m.	10,080 Kw. hr.
March	6:00 p.m. to 5:00 a.m.	8,540 Kw. hr.
April	6:30 p.m. to 4:00 a.m.	7,470 Kw. hr.
May	7:00 p.m. to 3:00 a.m.	5,500 Kw. hr.
June	8:00 p.m. to 2:40 a.m.	5,400 Kw. hr.

Costs

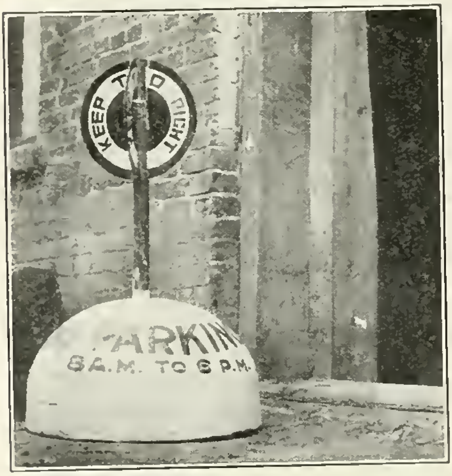
The job was divided into three contracts, other districts petitioning for the improvement after the first contract was under way. The total of the three was $95,721.84, including engineering, assessing and advertising as required by the laws of the state. The cost of the installation was met by special assessment against the property directly benefited. It was decided by the special assessment commission that all lots were equally benefited whether or not there was a light directly in front of the lot or opposite, provided they were equally spaced on the street around the entire block. The cost per lot was higher on the last two contracts let, and the average of a 50 x 140 ft. lot in the residential section on the main contract was $90.16, and on a 25 x 140 ft. business lot, $48.63, these costs being based on cash payment. The assessment was spread over a period of 5 years and warrants were issued bearing interest at a rate of 6 per cent. In the residential section the assessment commission held that a corner lot received no more benefit than an inside lot, even though there might be lots on the side; but in the business district the corner lots stood the cost of the light on both sides.

SATISFACTORY TRAFFIC STANDARDS AT LA GRANDE, OREGON

To the Editor:

I send herewith a photograph of a traffic standard which has proved to be very satisfactory since its installation here some two months ago. Thinking perhaps that it might be used in other cities with the same results I am taking this opportunity to describe it to you.

The base is of reinforced concrete 2 ft. in diameter and 1 ft. in height of which 5 ins. is vertical. The disks are 9 ins. in diameter and are cut half in two and placed at right angles in a piece of 1¼-in. pipe, 30 ins. long, 6 ins. of which is embedded in the base. The disks are placed in slots sawed in the pipe which cuts the pipe into 4 pieces, these pieces are bolted together in pairs. We made 11 of these standards at an approximate cost of $9.56.



HOME MADE TRAFFIC STANDARD USED WITH SUCCESS AT LA GRANDE, OREGON.

Several machines have collided with these traffic signs but have done very little damage to the standards and the same machine has not hit the standard the second time.

Trusting that this information will prove of benefit to other cities, I remain

Very truly yours,

GEORGE GARRETT,
City Manager.

LaGrande, Ore., Dec. 1, 1921.

IS THERE AN AMERICAN PRECEDENT FOR REDISTRIBUTION OF RECLAIMED LANDS?

To the Editor:

It sometimes occurs in the progress of flood control undertakings that we should like to provide for the reclamation and *redistribution* of low lying lands.

In various countries of Europe there are laws which allow municipalities to re-subdivide areas which are badly adapted to their purposes, and to redistribute these areas among the former owners, giving each owner an area of equivalent value, or, if there is any failure in the equivalence, to pay him damage or charge him benefits, as the case may be, but not necessarily to return to him the identical area which was surrendered. The best known statute of this sort is the Adickes Law, or Lex Adickes, of Prussia, passed at the instance of Dr. Franz Adickes of Frankfort.

So far as we can learn, no similar legal provision ever has been made effective in this country. In 1806 the United States Congress made such provision for the City of Detroit after the city had been burned. The replatting and redistribution of property took place, but I think the matter never was determined in court.

If any of your readers know of any American precedents for this course, we should be pleased to learn of them.

Very truly yours,

DAYTON MORGAN ENGINEERING CO.,
Arthur E. Morgan, Pres.

Dayton, Ohio, Nov. 21, 1921.

EXCEPTIONAL OUTPUT FOR ASPHALT PLANT

With a guaranteed capacity of 1,850 sq. yds. of 2-in. sheet asphalt top mixture per day, an Iroquois Semi-Portable Asphalt Mixing Plant recently produced 4,240 sq. yds. of 1½-in. closed binder in one day.

Fort Fisher Highway, New Hanover County, N. C. Treated with "Tarvia-B" 1915-17-18-19-21, and "Tarvia-A" in 1916.

Wrightsville Turnpike, New Hanover Co., N. C. Treated with "Tarvia-A" 1915, and with "Tarvia-B" 1917 and 1921.

Tarvia
For Road Construction Repair and Maintenance

"The Best Investment the Board Ever Made"

Mr. Addison Hewlett, Chairman of the Board of Commissioners of New Hanover County, N. C., writes, under date of July 25, 1921:

"We have been using Tarvia for surface treating the macadam roads of New Hanover County for the past six years, and we find this treatment satisfactory in every respect.

"Before we started the use of Tarvia we had great difficulty in maintaining our roads, as they became very dusty in dry weather and washed away in wet weather, leaving our road surface full of holes and ruts. Since using Tarvia the surface of the road has been well protected in all kinds of weather, and today our roads have smooth, hard surfaces and our maintenance problem has been very easily solved. The Tarvia treatment is very inexpensive.

"It is unquestionably the best investment the Board of Commissioners has ever made and the Commissioners would not consider for a moment discontinuing Tarvia on our roads."

Additional comments on Tarvia are made by R. A. Burnett, County Superintendent of Roads:

"Tarvia treatments are given to some of our roads every year while other roads, such as the Wrightsville Turnpike, have lasted as long as three years before requiring another treatment.

"These Tarvia treatments have cost us in the neighborhood of $300 per mile per year and have proved to be the best, easiest and cheapest method of maintaining our roads. We have always had the best of co-operation from your engineers * * *.

"We feel that we have a finer system of roads than any other county in the State."

No matter what your road problem may be—new construction, maintenance, or repairs—there is a grade of Tarvia made especially for the purpose. Write for free illustrated booklet describing the various uses of Tarvia.

The Barrett Company

New York, Chicago, Philadelphia, Boston, St. Louis, Cleveland, Cincinnati, Pittsburgh, Detroit, New Orleans, Birmingham, Kansas City, Minneapolis, Dallas, Nashville, Syracuse, Salt Lake City, Seattle, Peoria, Atlanta, Duluth, Milwaukee, Bangor, Washington, Johnstown, Lebanon, Youngstown, Toledo, Columbus, Richmond, Latrobe, Bethlehem, Elizabeth, Houston, Denver, Jacksonville, Buffalo, Baltimore, Omaha

THE BARRETT COMPANY, Limited: Montreal Toronto Winnipeg Vancouver St. John, N. B. Halifax, N. S.

In a period of two weeks, which included several rainy days, this plant, owned and operated by the Detroit Asphalt Paving Company, turned out 34,336 sq. yds. of 1½-in. closed binder. Figuring on 10 working days, this is an average daily output of 3,433 sq. yds.

These exceptional output records, made in the regular course of a paving operation, indicate the service given by the mixing plant, which was purchased by the Detroit Company during 1920.

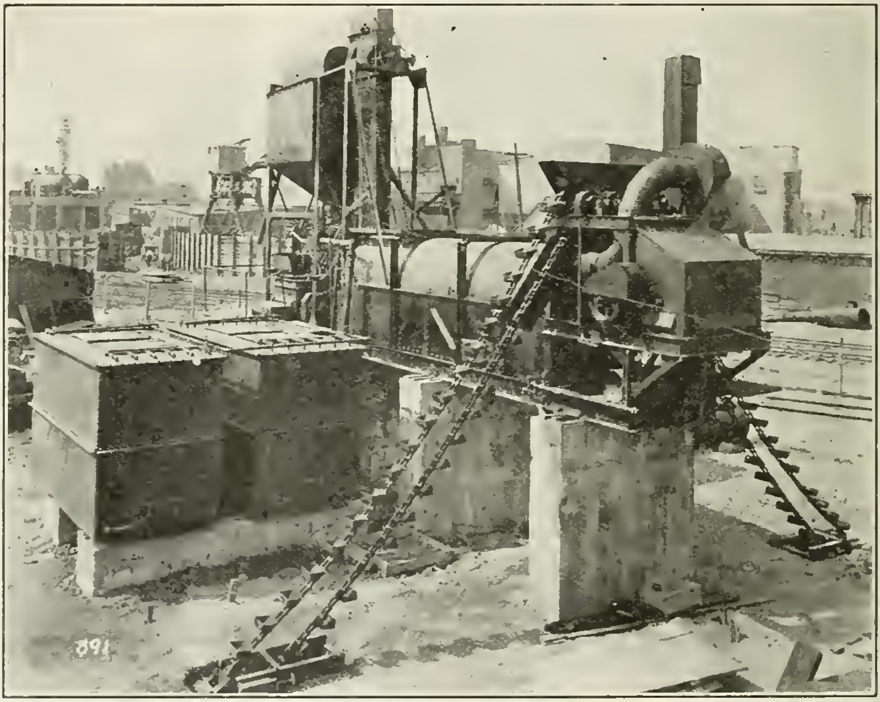
Because of its compact arrangement, the Iroquois 1,850-yd. straight-line plant was selected to meet the exacting requirements of the Detroit Paving Company. Its rated capacity has been consistently exceeded, according to officials of that concern.

The plant is of the same type as the two purchased recently by the City of Philadelphia and which now also are surpassing the guaranteed output.

Although designed primarily as a stationary plant, the Detroit Company plant can be moved from one operation to another with comparative ease. The whole plant is on a single frame and all shafts, gears and other units are held constantly in line.

Not only is the plant capable of greatly exceeding its rated capacity, but it can be operated with a minimum force.

The Iroquois 1,850-yd. plant was produced by the Barber Asphalt Paving Company's works at Buffalo, and the plant of the Detroit company was one of the first of this model made. Incorporated were many features which make for economy and efficiency. The plant is elevated to a height of 8 ft. above the ground level, so that ample room is provided for teams or motor trucks to load.



IROQUOIS SEMI-PORTABLE ASPHALT MIXING PLANT AS OPERATED BY DETROIT ASPHALT PAVING COMPANY.

TRADE LITERATURE

Valves, Governors, Regulators, Etc.—Atlas, Ideal and Victor Reducing Valves, Pump Governors, Pressure Regulators, Hot Water Tank Regulators, Control Valves and Damper Regulators are described in Junior Catalogue No. 21 just published by the Atlas Valve Company, 282 South Street, Newark, N. J. This little catalog of 20 pages gives complete information—illustrates, describes, lists all sizes and gives prices. A copy will be sent free on request to any reader of this publication.

WATER WORKS SECTION

PERFORMANCE OF THE DE LAVAL PUMPS AT THE PUMPING STATIONS OF THE INDIANAPOLIS WATER COMPANY

The Indianapolis Water Company has six pumping stations, two of which are booster stations to overcome friction loss in pipe lines and to increase the water pressure in the eastern part of the city, which is relatively the highest part of the City of Indianapolis. The pumps installed in the last eight years in these stations have been of the DeLaval type. These stations are designated Fall Creek, Riverside, Washington, Broad Ripple, Booster Station No. 1 and Booster Station No. 2.

Fall Creek Station

The entire water supply for the Fall Creek Station is obtained from wells averaging 325 ft. in depth, drilled through rock. At the present time there are 12 wells in active service, yielding a maximum daily supply of 6 m. g. The supply from each well is obtained by means of 4 and 5-in. DeLaval centrifugal pumps, electrically driven by 10 h. p. and 15 h. p. motors located in concrete well pits. The speed of these pumps is 1,730 r. p. m. and they are designed to pump 350 gals. per minute against a total head of 60 ft., with an efficiency of 62 per cent. The discharge pipe lines from these wells empty into a reservoir of 1½ m. g. capacity. From the reservoir the water is pumped into the distribution mains by means of two high-pressure pumps, each of 6 m. g. daily capacity, the one an Allis-Chalmers horizontal cross compound condensing crank and fly wheel pumping engine, the other a 6 m. g. DeLaval pump driven by a 500 h. p. steam turbine. The DeLaval pumping unit consists of two 12-in. single stage double suction horizontal centrifugal pumps. The suction and discharge are 12 ins. in diameter, the speed is 1100 r. p. m., and the pumps are designed to pump 4,160 gals. against a gauge head, including suction lift, of 270 ft., with an efficiency of 75 per cent. This unit was placed in service in January, 1915, and was started and kept in constant operation for 30 days without stop. There has been no replacements of parts on this unit or repairs since it was installed in 1915.

The booster pumps heretofore referred to are all of the DeLaval type. They are used in connection with the Fall Creek pumping engines during "peak" loads in the summer or at other times. Booster No. 1 is equipped with an 8-in. centrifugal pump purchased in June, 1913, operated by a 75 h. p. motor. The pump when operated at a speed of 1120 r.p.m. delivers 2,100 gals. against a head of 88 ft.; efficiency 71 per cent. Two DeLaval pumps operated by 25 h. p. motors are designed to deliver 1,050 gals. per minute against heads of between 88 and 98 ft. Booster No. 2 is equipped with two DeLaval 12-in. centrifugal single stage pumps, each driven by a 250 h. p. motor. When operated under a speed of 1760 r. p. m. the pumps will deliver 4,166 gals. per minute against a head of 162 ft.; efficiency 78 per cent.

Riverside Station

The Riverside Station is the main pumping station of the Indianapolis Water Company and is operated by steam power. The pumping units are as follows:

	m.g.daily capacity
Hamilton-Rarig vertical triple expansion high duty pumping engine	30
Snow vertical triple expansion high duty pumping engine	20
DeLaval steam turbine driven centrifugal pump	30
DeLaval steam turbine driven centrifugal pump	10
DeLaval motor driven centrifugal pump	3
DeLaval steam turbine driven centrifugal pump	6
Total	99

The main water supply for this station is obtained from the filter plant through a 40-in. conduit. The normal daily capacity of the filters is 30 m. g. At this station there are two reservoirs, one of 5½ m. g. capacity and the other 10 m. g., which was completed during the last month and will be put in service before January 1, 1922. At the site of the Riverside Station, supply is also obtained from

43 deep wells, 18 of which are air wells operated by air compressors at the central station. The remaining 25 wells have electrically driven DeLaval pumps located in concrete pits similar to those at the Fall Creek Station.

Turbine No. 1 at the Riverside Station, which has a capacity of 10 m. g. per day, was installed in November, 1911. The speed of the turbine is 9,000 r. p. m., the pump speed is 760 r. p. m. The pumps will deliver 5,600 gals. per minute against a total head of 160 ft. This pump was the first installation made by the DeLaval Steam Turbine Co. for direct pumping into the distributing system. This unit has been in operation at least 75 per cent of the time since it was installed, and it is subject to hard service due to starting and stopping from 5 to 25 times per day to meet the demands of the city on fire pressure. The only replacements which have been made on this unit have been on the high speed bearings and two packing bearings. The oil consumption is about 1 barrel per year.

Unit No. 2 at this station is of 6 m. g. capacity and was installed in September, 1912. The speed of the turbine is 10,700 r. p. m., the pump speed is 900 r. p. m. and is designed to pump 4,200 gals. per minute against a total head of 165 ft. In connection with this unit there is a motor driven booster pump which is used to increase the head for fire pressure service. The piping is so arranged that the booster pump may operate independent of the steam unit and will deliver 3 m. g. for domestic service. This unit in connection with Unit No. 2 will deliver 6 m. g. under fire pressure or 9 m. g. for domestic service. Only one high speed bearing has been replaced on the No. 2 unit since its installation.

The third DeLaval unit was installed in 1920. It has a capacity of 30 m. g. per day. At a speed of 610 r. p. m. this pump delivers 20,800 gals. per minute against a head, including suction, of 160 ft. with an efficiency of 80 per cent. It requires 1,050 brake horse power to operate this pump; the steam pressure at the throttle is 175 lbs. For domestic service it will pump 20,800 gals. per minute against a head of 160 ft. With 1-in. absolute vacuum the guaranteed duty is 130,000,000 ft. lbs. per 1,000 lbs. of dry steam. Under 2-in. absolute vacuum the guaranteed duty is 122,800,000 ft. lbs. Increasing the speed to 735 r. p. m. for fire service, the pump will deliver 30 m. g. against a total head of 250 ft. with an efficiency of 77 per cent. It requires 1705 brake horse power. The guaranteed duty under these conditions and 1-in. vacuum is 135,000,000 ft. lbs. per 1,000 lbs. of dry steam and with 2-in. vacuum, 125,500,000 ft. lbs.

The above data are contract provisions. All tests of DeLaval pumps in Indianapolis have exceeded the guaranteed duty by from 2,000,000 to 5,000,000 ft. lbs.

Washington Station

At the Washington Street Station there are three 4-stage DeLaval pumps, each pump driven by two American Water Turbines. Each unit has a capacity of 5 m. g. per day under a total head of 300 ft. These units are operated 24 hours per day. The only replacements which have been made have been one set of wearing rings and two thrust bearings. These pumps require two barrels of oil per year for lubrication.

Broad Ripple Station

This station is operated during the summer months to give additional pressure during sprinkling hours. It is equipped with one DeLaval 2-stage 5-in. single suction horizontal type centrifugal pump operated by 60 h. p. motor. This pump will deliver 550 U. S. gals. against a head of 230 ft.; efficiency 60 per cent.

The Indianapolis Water Company has purchased and will install within the next month a DeLaval steam turbine driven boiler feed pump.

The satisfactory service which the DeLaval pumps have given, the efficiencies of these units, especially the pumps of larger capacities, the small number of replacements of parts which have been required on the older pumps since they were installed, the relatively quiet running of the Helical reduction gears, the familiarity of the engineers with the operation of the DeLaval pumps, the absence of water hammer in the force mains, all have been factors which have led to the purchase of DeLaval centrifugal pumps by the Indianapolis Water Company.

The pumping units have been installed under the direction of B. J. T. Jeup, Chief Engineer, Wm. Curtis Mabee, Assistant Chief Engineer, and T. C. M. Mauch, the Superintendent of the pumping stations of the Indianapolis Water Company.

WACO WATER WORKS BURNS FUEL OIL UNDER BOILERS

To the Editor:

We have just completed our installation for the burning of fuel oil under our boilers. There will be quite a saving between this and the burning of coal or lignite, we have been burning in the past. past.

We have paid a price for lignite $4.25 in the bin. Today I closed a contract for fuel oil for one year at $1.35 a barrel, f. o. b. plant.

Taking these two figures for coal and oil and we save possibly $35 per day, or rather $1,000 per month. We were burning about 20 tons of lignite a day against 25 barrels of oil, besides saving the salary of one fireman, which is $110 a month. You can readily see the advantage in regard to saving in the burning of oil.

Very truly yours,
E. L. Fulkerson, Superintendent
Waco City Water Works,
Waco, Texas.

October 5, 1921.

THE CHLORINATION OF NEW ENGLAND WATER SUPPLIES

By William J. Orchard, of Wallace & Tiernan Co., Inc., Newark, N. J.

At present 1996 communities in the United States chlorinate water or sewage or both with Liquid Chlorine. Only 128 or 6 per cent of these are in New England. Twelve are treating sewage, leaving but 116 New England communities chlorinating drinking water. Nearly half, 43 per cent, of these are in Connecticut where 51 communities used Liquid Chlorine to safeguard their water supplies, 24 are in Maine, 18 are in New Hampshire, 11 in Rhode Island, Massachusetts has 9, while Vermont has 3 communities using Liquid Chlorine for their water supplies.

Scoring the states in this country in accordance with the number of communities using Liquid Chlorine and starting with New York in first place with 254 and ending with Nevada in 48th place with but one lone chlorinating community we find Connecticut stands 11th, Maine 25th, New Hampshire 30th, Rhode Island 36th, Massachusetts, 41st, and Vermont, 47th.

A manufacturer of chlorinating equipment naturally asks: Why this relatively small number of communities using Liquid Chlorine in certain sections of New England?

Now, in trying to answer that question, the speaker appreciates that he is skating on thin ice—dangerously near a deep hole labeled "The Johnsonian Controversy," and caution dictates that he skate the other way.

But it is a fact that there is more resistance to the chlorination of drinking water in New England than in any other section of the country. Some of this is due to a firm, honest conviction in the purity and safety of unsterilized water supplies—some of this is due to complete deep rooted faith in the absolute efficacy of storage and water shed patrol—but, in the speaker's opinion, the principle cause for this resistance to chlorination in New England is the marked aversion found in some quarters to the application of chemicals in any form to drinking water. It matters not if, as in the case of sterilization, a barrel full of chlorine will suffice for a Woolworth building filled with water. The objection is to the application of chemicals in any form—no matter what the chemicals may be. This attitude was clearly expressed by one of New England's most prominent engineers who said to the speaker "Up here we don't want medicated waters."

We do not agree with the opponents of chemical treatment but we have absolutely no doubt of their sincerity. We can only hope that they will believe that the rest of us are equally sincere as we try to persuade them to change their minds.

Boston, for instance—or rather the metropolitan district—is the only large community west of the Rockies that does not chlorinate its water supply as an added precaution.

But Boston points to its low typhoid records with justifiable pride, and takes the stand that perhaps other cities have to chlorinate their water supplies to obtain low typhoid rates, but Boston can get a low typhoid rate without chlorination, so "Why put chemicals in the water?"

Of course then comes the question of the potential danger of an untreated supply, especially where reservoirs are easy of access, but here again we approach the controversial and turn the page for such is not the purpose of this paper. But, as though to compensate for some of its seeming neglect of the manufacturers of chlorine and chlorine control apparatus, New England has made many contributions to the development of the process of chlorination.

As time brings to light more facts concerning its nativity, it seems more and more likely that the experimental work of Sedgwick and Phelps at the Massachusetts Institute of Technology in Boston a score of years ago was the corner stone of our present practice in the Chlorination of Water Supplies.

It was at Torrington, Connecticut, that Tiernan—then struggling with Wallace in the development of a practical ozone generator for the sterilization of water—worked with Phelps in checking a water-borne epidemic, made use of bleaching powder to sterilize the water supply and caused them to transfer their energies from ozonation to chlorination. It was at Stamford, Conn., that the first automatic chlorine control apparatus was developed, thanks to the patience and co-operation of the late and highly esteemed manager of the Stamford Water Company—Mr. E. L. Hatch, one of the earliest and always one of the staunchest supporters of chlorination.

The first recorded reduction in color obtained by treating water with chlorine was secured at Branford, Conn., by Minor, of the New Haven Water Company where, under his patronage and with his keen interest, an entirely new type of equipment, that holds great promise, has been under test for nearly a year. It was at Exeter, N. H., that Weston first introduced liquid chlorine to water before the coagulant in order to reduce alum requirements—a procedure that has now been adopted with success by many operators. And at the Abattoir at Brighton, Mass., Liquid Chlorine was first used to sterilize wash water used about the packing plant—a procedure that is now universal in the packing Industry. At Waterbury, Conn., the Y. M. C. A. was one of the very first to use Liquid Chlorine to sterilize swimming pool water.

So you see New England has a considerable responsibility for the position in which the process of chlorination now finds itself and has contributed almost as much to this as it has to other developments in the field of sanitation.

There is much that New England still can do. We seem to be at a turn in the road where new standards of water are to be developed or else new interpretations placed on existing standards. With the increased attention being given to the chemistry of colloids and to the electrolytic dissociation theory as exemplified by the interest in Hydrogen Ion concentration, chlorination presents a wide field for study. And in that study the whole-hearted assistance of all New England water works men is needed.

In New England, more than in all the rest of the country, are located the men who, since the late eighties, have guided the development of water treatment to its present stage. Their help is needed in the developments that are to come. That help will speed the day of arriving at a proper appreciation of the merits of various modes of water supply protection.

The foregoing is from a paper presented by Mr. Orchard before a recent meeting of the New England Water Works Association.

OPERATING AND NEW CONSTRUCTIONAL FEATURES OF BALTIMORE WATER WORKS

By James W. Armstrong, Filtration Engineer, Baltimore Water Department, Hillen Road, Baltimore, Md.

Baltimore is at present dependent for its water supply upon the Gunpowder River, a relatively small stream, whose flow is sometimes less than the city's requirements for water, but from a sanitary point of view it is more fortunate than many cities, whose supply is taken from streams too large to warrant any kind of sanitary control.

Water Shed Control

The Gunpowder Watershed, comprising 306 square miles, lies almost wholly within Baltimore County, Maryland, only a small area near its source lying in Pennsylvania. It is thus possible to have under fairly close supervision the activities of the entire watershed, and to control absolutely all streams for a considerable distance above the city. The department believes, that as far as possible, it should control its entire water supply from the time it is given up by the clouds until it is drawn from the pipes for use.

Obviously complete control in a thickly settled area is not possible, but very much has beeu done in the past few years to prevent contamination of the city's water supply. First—by the purchase of land along the streams. The city now owns between 2,000 and 3,000 acres of land, and when the new improvements are completed will own 5,000 or more acres, and will have absolute control of both banks of the river as far north as Phoenix, which lies about 19 miles north of Baltimore. Second—by moral suasion, an effective method of water purification not usually described in technical papers, but nevertheless, one that should receive more attention from those in charge of the water supply of cities.

For years Baltimore has had an inspector who has systematically visited every premise on the Watershed, and by good natured persistence has been the means of getting rid of the worst sources of pollution. His policy has been to lay before the people the importance of pure water supply. Most of them see the point, and many have been willing to spend a considerable amount of money to eliminate sources of pollution. Probably the most effective work has been done in supervising and preventing the spread of typhoid fever. Every case is reported by the State Board of Health to the Department, and the inspector at once visits the premises to see that there is no possibility of contaminating the water supply. The necessary sanitary instructions for care of the patient are given, and disinfectants are supplied. The inspector does not drop the case with a single visit but follows it to a conclusion. In this way everything possible is done to free the water supply from a suspicion of typhoid.

Forestration

Baltimore County is full of hills. Many of them are covered with clay which at times of heavy freshets is washed into the river, making the water very turbid. On one occasion it reached Montebello Filters with a turbidity of over 5,000, and it frequently exceeds 1,000. Such water is difficult and costly to treat.

In order to prevent the washing of the soil and to retain as much water in the earth as possible, the Department aims to cover all ground with grass or timber. They have already planted over a million trees, mostly white pine and spruce, and as soon as the new improvements are completed, they propose to continue the plantings over most of the ground owned by the city.

Need of Greater Supply

During the year 1910, there were 6 consecutive months when the flow of the Gunpowder River was less than 75 million gallons per day, and there was one month when it dropped as low as 54 million gallons per day. The recurrence of such a condition at the present, when the daily consumption is between 90 and 100 million gallons, would prove a calamity to the city, as it is not possible on account of the extremely high suction lift imposed upon the pumps, to withdraw water much below the existing level.

For a number of years the engineers of the water department have had a very keen realization of the situation confronting the city, and in their effort to find a solution of the problem, have investigated every source of supply from the Susquehanna to the Potomac.

It seemed best to develop the Gunpowder River, the existing source of supply, to its ultimate possibility before going to other sources. Accordingly, it was planned to create a large impounding reservoir at Loch Raven by raising the existing dam from elevation 188 to 240, a distance of 52 ft. Raising Loch Raven reservoir 52 ft. would permit Montebello Filters to be fed by gravity, but in order to do so, the existing tunnel would have to be relined or a new one built.

In order to use the existing tunnel and pumping station, a plan was adopted of building a balancing reservoir near Loch Raven, which increased the head on the tunnel about 8 ft., and offers a satisfactory means of equalizing the flow of water admitted from Loch Raven. This work is now under construction, and will cost at contract prices based upon estimated quantities about $50,000.

Loch Raven Dam

The first step toward carrying out the new improvements was taken in March, 1921, when a contract was awarded for the raising of Loch Raven Dam 52 ft Fortunately, the old dam had been built with foundations fully able to carry the new structure. When completed, the new dam will have an over all length of 637 ft., an ogee spillway section 288 ft. long, and will contain about 40,000 cu. yds. of concrete. The gravity type of dam was selected instead of the hollow or Amburson type, as offering greater security against the action of frost and ice, extending over a long term of years, and as providing a better means of raising to a higher elevation at some future date.

A feature that complicated construction, was the necessity of providing an additional gate chamber as a terminal for a new tunnel, which it will be necessary to build before Montebello Filters can be fed by gravity.

Impounding Reservoir

The raising of Loch Raven Dam will form a reservoir covering an area of 2,390 acrse, and having a capacity of about 23 billion gallons. It will extent north as far as Phoenix, and will necessitate abandoniñg the cotton mills at that place. It will practically wipe out the picturesque village of Warren, and the mills of the Warren Manufacturing Company.

About 6 miles of county road and 2 or 3 large highway bridges will have to be built in order to replace those destroyed by flooding.

A large force of men have been engaged in cutting timber from the area to be flooded since April, 1920, and considerable work still remains to be done.

Loch Raven Tunnel

Water is conveyed from Loch Raven to Montebello Filters through about ½ mile of 10 ft. cement lined steel pipe, and 6½ miles of 12 ft. tunnel cut through solid rock. Some portions of the tunnel are unlined, some are lined with brick, and others, the weakest portions, were relined with reinforced concrete in 1914. Tests made last December revealed the fact that the tunnel leaked badly at 2 points, under pressures far below that which would be put upon it by the water impounded back of the new dam.

The weakness of the existing tunnel makes it very desirable to do one of two things; either to reline it with reinforced concrete, or to build a new one. On account of the large volume of water consumed, it is impracticable to shut down the tunnel long enough at one time to do the relining.

A new tunnel is eminently desirable, and could probably be built for about $4,000,000. Such a tunnel would insure the safety of the city's water supply, would permit the relining of the old tunnel, would permit the filters to be supplied directly by gravity, would effect a saving at the present time of over $100,000 a year for power, and would provide a greater impounding reservoir without resorting to pumping, as the friction losses between Loch Raven and Montebello would be reduced four-fold.

The cost of a new tunnel at the present time, however, is prohibitive, and in order to use the tunnel as it exists today and to insure it against pressure of water back of the dam, and to permit adequate control of the water being withdrawn by the pumps, some means had to be provided for its proper regulation.

Balancing Reservoir

A knowledge of operating conditions is essential to an understanding of the new balancing reservoir now under construction. The pumps at Montebello are set in a pit 24 ft. below the ground, and have their center line about 5 ft. above the normal water surface at Loch Raven. Friction losses between Loch Raven and Montebello lower the water level in the suction well, a further distance of from 3 to 9 ft. The present method of operation is to open wide all Loch Raven gate valves, and to control the flow of water by means of the pumps at Montebello.

If, however, the water level at Loch Raven should be raised 52 ft., as it will be on completion of the new improvements, it would be impossible to open the gates at the dam, without subjecting the tunnel to the full hydrostatic pressure of the water back of the dam, and it would be impossible to control, with sufficient accuracy, the flow of water by means of the gates at Loch Raven, as too wide an opening would subject the tunnel to pressure, or too small an opening would cause the pumps to lose suction. It was, therefore, determined to obviate this difficulty by converting an old quarry pond located over the tunnel near Loch Raven, at a point where leakage occurred during the test made last December, into a small balancing reservoir whose water surface will be maintained at elevation 200.

A shaft sunk to an intersection with the tunnel through this reservoir, will thus permit water to flow freely in and out, and it is obvious that if it is admitted from Loch Raven, whose surface is 30 ft. above that of the balancing reservoir, at a rate greater than that required by the pumps, the excess will pass over a spillway into a nearby stream, and the tunnel will be relieved of pressure.

If the reverse condition holds, and the pumps should require more water than was being supplied, the deficiency will be taken from the balancing reservoir, and there will be no danger of the pumps losing suction.

While the primary purpose of building the balancing reservoir was to obtain a means of controlling the flow of water, that would permit the use of the old tunnel without subjecting it to pressure, and to utilize the present pumping station, it further serves the purpose of reducing the suction lift of the pumps 8 ft., thereby effecting a saving of about 20 per cent of the total cost for power.

The balancing reservoir will have a capacity of about 10,000,000 gals. in the upper 5 ft., and will be formed by building an earth dam across a ravine. It will have a crest of 15 ft. wide and a 3 to 1 slope on the upstream face, and 2 to 1 on the downstream face. It will be built without core wall, but will have a toe wall extending to rock and will be faced with concrete.

Surge Tank

Power for operating the pumps is transmitted through underground cables, from the Monument Street Power House, where connection can be made either with the transmission lines from McCall's Ferry Hydro-Electric Plant, or from any of the large generating stations owned by the Consolidated Gas & Electric Co. One of the difficulties of operating the pumping station with power received over long distance lines, is that there are occasional interruptions in the service. If power goes off the line for a single instant, all the pumps are automatically thrown out of service, and the sudden stopping of pumps causes water hammer due to the sudden checking of a column of water 7 miles long, and 12 ft. in diameter.

Fortunately, the enclosed shaft forming the suction well is amply strong and has a great air cushion to help withstand the water hammer. It is believed, however, that it would be much safer if the shock could be avoided, and in order to overcome this, a shaft is to be sunk intersecting the tunnel line just before the pumping station is reached. The top of this shaft will be left open at elevation 200.5 or just ½ ft. above the level of the spillway of the dam at the balancing reservoir. In case of a surging of water in the tunnel, it will simply overflow this shaft and discharge into the washwater reservoir at Montebello.

Low Lift Pumping Station—Economy of Motor Driven Centrifugal Pumps

The low lift pumping station is located at Montebello, is circular in form and 36 ft. in diameter. The pumps are arranged radially around a closed suction well 16 ft. in diameter, which forms the terminus of the Loch Raven Tunnel. They discharge into a 6½ ft. concrete conduit formed in the foundation wall of the building.

There are 5 different pumping units which operate against a total head of about 40 ft. The combined capacity of the pumps is about 240 million gallons per day, but the different units vary in capacity, and advantage is taken of this fact to secure the most economical combination necessary for the required volume of water. The pumps are operated by 3-phase, 25-cycle, 500-volt induction motors, ranging from 275 to 600 horse power. The power supplied to each motor is registered by a graphic watt meter.

An interesting feature of operating record is the low cost for labor as shown during the past 6 years. The station is operated by 3 shifts of 8 hours each, and never, since the plant was put in service, has more than one man been employed on a shift. The small number of attendants required to care for motor driven centrifugal pumps is sometimes lost sight of in comparing the economy of different types of pumping machinery.

Chemical Treatment

As it is impossible to get a railway siding at the Filter plant, all chemicals are transported by truck from the B. & O. siding, which is approximately two miles away. On reaching the plant both lime and alum are passed through a small crusher and elevated by means of a bucket conveyor into overhead bins, which are capable of holding something over 1,500,000 lbs. From these bins the chemicals are drawn by gravity into buckets which are pushed along over-head trolley tracks, to the dissolving boxes, where they are put in solution and prepared for addition to the water.

A 96x48 in. Venturi Meter placed between the pumping station and the filters is used as a means of determining the rate of applying chemicals. The chemicals were automatically controlled at first, but as the pumping rates vary by fixed amounts, it was found to be less trouble to operate the feed controllers manually, and the automatic features were abandoned.

Mixing and Coagulating Basins

After the application of the alum to the water, it passed backward and forward through the mixing basin where it is thoroughly incorporated with the water. The basin is constructed with baffles of the around-the-end type, which are instrumental in securing a large well formed floc which settles out readily in the coagulating basins. There are two coagulating or settling basins, each of which has a capacity of about 8,000,000 gals., and, figured on displacement, they have a normal capacity of about 3 hours. From 90 to 95 per cent of the sediment is removed from the water and settled out in these basins.

Filters

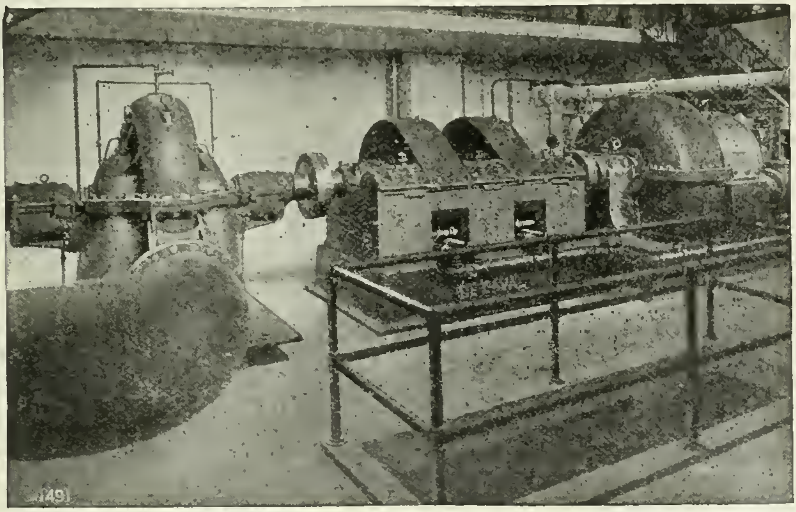
Montebello Filters are of the mechanical or rapid sand type, and consist of 32 separate units, each having a daily capacity of 4,000,000 gals. or a total capacity of 128,000,000 gals.

They are situated in surroundings of more than ordinary beauty, and the plant is housed in red brick buildings, covered with green tile roof.

The filters are located above basins which are directly connected with the Filtered Water Reservoirs, all of which have a combined capacity of a little over 17,000,000 gals. While the capacity of these basins is relatively small, their value has been demonstrated many times, as we have been able to shut down the plant for short intervals without interrupting the supply. The application of liquid chlorine to the water as it enters the Filtered Water Reservoir is the last step in the process of purification.

New Filters

During the summer of 1919, the filters were taxed to the utmost, and if money had been available at that time, a new plant in all probability would be a reality today. But, due to a careful and systematic conservation plan, and to decreased use for manufacturing purposes, the water consumption has been reduced to such a



point that the design of a filter plant can be postponed until the more urgent need of a greater supply can be met.

Tentative plans for the new filters, involving a completely equipped plant have been made. They contemplate a number of new features, among them a plant for the manufacture of alum. The new structures will be built on ground acquired for the purpose, adjacent to the present plant on the opposite side of Hillen Road. It is expected that before long, the new plans will be worked out in brick and concrete.

The foregoing paper by Mr. Armstrong was presented at the 1921 annual meeting of the American Society for Municipal Improvements.

MUNICIPAL HYDRO ELECTRIC PLANT AT FORT DODGE, IA., EARNS 12% NET

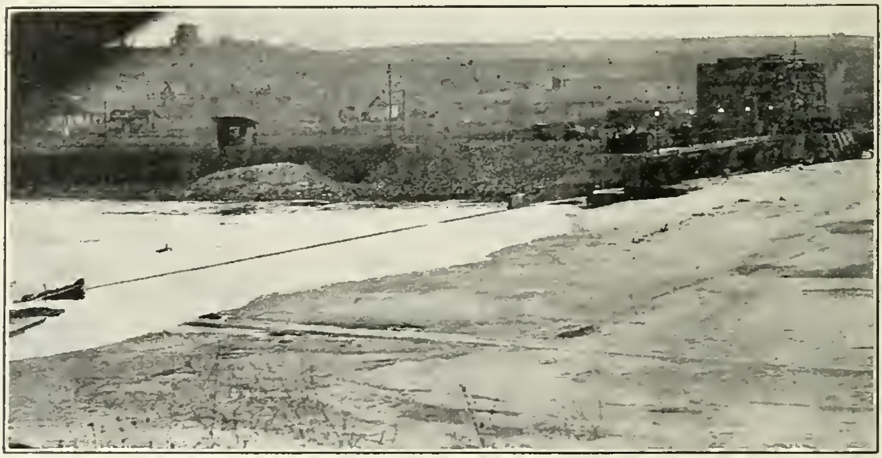
By R. E. McDonnell, of Burns & McDonnell, Consulting Engineers; Interstate Bldg., Kansas City, Mo.

(Editor's Note:—About 4 years ago Burns & McDonnell designed a municipal hydro-electric plant on the Des Moines River for the City of Fort Dodge, Iowa. In conducting the bond campaign for the funds for the construction, the engineers stated publicly that the investment would be sound financially and should yield a net return to the city, on the investment, of about 10 per cent. After 4 years of operation, an analysis has been made of the operating expenses, cost, etc., and it is found that the project has a gross return of 30 per cent and a net return, above operating expenses, interest on the bonds, depreciation and sinking fund of 12.18 per cent. The lake impounded above the dam is also utilized as a pleasure resort, many summer cottages being built on the bluffs of the river where motor boating, fishing and bathing are enjoyed.)

Cities do not always leave their undeveloped resources to be handled by private companies who make excellent profits out of the development. Fort Dodge, Iowa, 4 years ago, voted bonds and built its own municipal hydro-electric plant across the Des Moines River near that city. While it was anticipated that the financial investment would be profitable to the citizens for the saving of power it would develop, that was not the sole reason for building the dam. One of the chief reasons was the creation of a lake that could be utilized for pleasure purposes. The municipal dam has been successful from both standpoints and after 4 years of operation, the financial returns have proven so much greater than the expectations that a brief review of results may be of interest.

The project had been advocated by private parties which sought a franchise but upon the assumption that if the project was financially sound for private parties it ought to be equally sound for the municipality, the citizens under the leadership of Mayor John F. Ford, decided to vote bonds for the project to be handled entirely by the municipality.

The construction difficulties encountered were numerous because of various floods occurring during the construction period, but about 4 years ago the hydro-electric development was placed in operation, the city utilizing part of the current for the operation of its own water works plant and the surplus current being sold to the local light and power plant, whose rates



MUNICIPALLY OWNED HYDRO-ELECTRIC PLANT ON THE DES MOINES RIVER AT FORT DODGE, IOWA.

were correspondingly low because of the purchase of the surplus electric current. While the city was not owner of the local distributing lighting property, the citizens benefited through reduced rates because of utilizing the municipal hydro-electric plant.

The opponents of municipal ownership in the operation of public utilities must receive a severe shock when they analyze the excellent financial showing made by this municipal plant, operated by John W. Pray, superintendent of the municipal water and hydro-electric plant. The net profits are so large that the municipality is in grave danger of being charged with profiteering.

The dam is 412 ft. wide, 18 ft. above bed rock and is a reinforced concrete structure. The project was built under contract following the plans and supervision of Burns & McDonnell, Consulting Engineers of Kansas City, Mo. The engineers also conducted a bond campaign under the auspices of the Commercial Club and at public meetings, illustrated lectures were given, describing fully all of the features of the proposed development. Four years ago the project was placed in operation. It is gratifying to know that the return on the investment exceeded the claims made by the engineers during the campaign for the bonds.

The turbine and generators are in duplicate, with total capacity of approximately 2000 H. P. The entire cost of the project was $160,000. The bonds are for 25 years, bearing 4½ per cent interest. Of the $160,000, $100,000 was raised by bond issue and the balance of the $60,000 used for construction was paid out of the earnings from the municipal water works plant where a portion of the electricity is used for the operation of the pumps.

The gross revenue, operating expenses and net revenue from April, 1920, to April, 1921, are as follows:

	Gross	Expenses	Net
April	$2,854.03	$1,741.16	$1,112.87
May	3,806.41	815.80	2,990.61
June	4,254.27	685.07	3,569.20
July	3,710.86	1,064.80	2,646.06
August	3,372.06	1,603.23	1,768.83
September ...	4,179.13	909.37	3,269.76
October	3,324.03	935.37	2,388.66
November ...	4,535.70	1,539.33	2,996.37
December ...	3,769.28	645.50	3,123.78
January	3,967.76	710.37	3,257.39
February ...	3,788.83	665.44	3,123.39
March	3,968.61	978.64	2,989.97
	$45,530.97	$12,294.08	$33,236.89

The above gross revenue shows a gross return on the investment of about 30 per cent. Allowing a depreciation on the assumed life of the dam as 60 years, at 3 per cent, and a depreciation of 3 per cent with the life of 25 years on machinery and power equipment, the total annual depreciation fund is $2,220. The sinking fund for discharging the entire original investment in 25 years amounts to an annual sum of $4,320; the bond interest at 4½ per cent amounts to $7,230, giving a total, including operating expenses, of $13,740.

Total of interest, depreciation, sinking fund and operation...$26,034.08 which deducted from the gross revenue of $45,530.97, leaves a net clear profit of..........$19,496.89 or a net revenue of 12.18 per cent on the total investment.

The question naturally arises as to how many privately-owned undertakings are able to show better than 12 per cent net on the investment. At this rate of return, the city will have the project entirely free from debt before the expiration of the bonds and toward the close of the period at which the bonds will expire, on account of reduced interest and sinking fund, the project will be paying the city over 20 per cent net on the investment. All of this is accomplished in spite of selling the surplus electric current at the very low rate of 0.085 cts. per kilowatt hour and the water works pumping plant is charged for its current at the rate of 1c kilowatt hour for power used there.

In view of the splendid investment by the City of Fort Dodge, other cities throughout the country should not hesitate to undertake and develop their own valuable water powers. Many projects of equal merit to the one at Fort Dodge lie undeveloped and while private companies are clamoring for high rates and are having a struggle to get funds for financing these projects, the municipalities themselves should utilize their own credit and develop these industries. It is of interest to see that the City of Fort Dodge utilizing its own credit borrows its money at 4½ per cent for this development and a private company would have undoubtedly had to pay at least twice this rate for funds to carry out the same development. This difference between the credit of the city and credit of the private company, itself, makes the rates of many privately-owned light and power plants 30 to 50 per cent higher than they otherwise would be. By reason of having power available at a low rate a strong inducement exists for securing new industries. The lake formed above the dam has transformed Fort Dodge into a pleasure resort now enjoyed by thousands, so both from the standpoint of pleasure and profit, it is a decided success.

Water Works Equipment Service

If in the market for any of the following water works equipment, so indicate by check marks, mail this page to *Municipal and County Engineering*, 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
—Air Lift Pumps
—Ash Handling Mach'y
—Backfillers
—Brass Goods
—Chimneys
—Chloride of Lime
—Chlorinators
—Coal Handling Machinery
—Concrete Hoisting Equipment
—Concrete Tanks
—Condensers
—Conduit Rods
—Cranes, Locomotive
—Cranes, Traveling
—Curb Boxes
—Curb Cocks
—Derricks, Pipe Laying
—Derricks, Steel Portable
—Drinking Fountains
—Dry Feed Chemical Apparatus
—Engines, High Duty
—Engines, Gas
—Engines, Oil
—Engines, Pumping
—Explosives
—Fence, Iron
—Fittings, Wrought
—Filter Equipment
—Gates, Sluice
—Gauges, Recording
—Gauges, Steam
—Gauges, Water
—Goose Necks
—Hydrants, Fire
—Indicator Posts
—Lead
—Leadite
—Lead Furnaces
—Lead Wool
—Leak Indicators
—Liquid Chlorine
—Lime
—Meter Boxes
—Meter Couplings
—Meter Testers
—Motor Trucks
—Motors, Electric
—Oil, Lubricating
—Pipe, Cast Iron
—Pipe Cutters
—Pipe, Lead-Lined
—Pipe, Steel
—Pipe, Wrought Iron
—Pipe, Wooden
—Pitometers
—Pumps, Air Lift
—Pumps, Boiler Feed
—Pumps, Centrifugal
—Pumps, Deep Well
—Pumps, Steam
—Pumps, Trench
—Pumps, Turbine
—Pumping Engines
—Service Boxes
—Soda Ash
—Specials, Cast Iron
—Standpipes
—Steam Boilers
—Steel, Reinforcing
—Sulphate of Alumina
—Tamping Machines
—Tanks, Elevated
—Tapping Machines
—Trench Braces
—Trenching Machines
—Valve Boxes
—Valve Inserters
—Valves, Gates
—Valves, Pressure Regulating
—Water Main Cleaners
—Water Meters
—Water Softening Plants
—Welding Apparatus
—Well Drills
—Well Screens
—Well Strainers

Engineers' and Contractors' Directory

11-21-25

Construction News and Equipment

CAREFULLY PLANNED LAYOUT SPEEDS CONSTRUCTION ON NORTH CAROLINA ROAD JOB

A carefully planned construction plant layout has speeded up the construction of State-Aid Project No. 510, Guilford-Forsyth Counties, located between High Point and Winston-Salem, N. C., and the contractor is making unusually good progress on the work, says the North Carolina Highway Bulletin.

Royer-Ferguson Company, Inc., of Roanoke, Va., have the contract for the construction of this highway and began work on July 11th. Approximately $428,000 will be expended in the building of this project which embraces 10.59 miles of road, the construction being of plain concrete, 18 ft. wide, 6 in. thick on the edge, and 8 in. thick in the center.

By closely coordinating the operations of the various units of his outfit the contractor is making steady progress on the job, averaging about 1½ miles per month, and expects to finish his contract well within the specified time limit.

Central Proportioning Plant

All materials are proportioned at a central plant which is located adjacent to a railroad siding in High Point and which is about 1 mile from the beginning of the work. Arriving by rail, the sand and stone is unloaded directly from the hopper cars into pits beneath the tracks, while the cement is unloaded into the warehouse. A "Brownhoist" 15-ton revolving locomotive crane is used to transfer the sand and stone from the unloading pits to the stock piles, or into the storage bins, as necessity may demand. These bins have a capacity of 100 cu. yds. of material and are fitted with automatic chutes for measuring the proper quantity of aggregates.

Hauling Materials

The contract for hauling the raw materials from the proportioning plant to the job was sublet to a local transfer company on a per-ton-mile basis. The entire distance to be covered is over the paved streets of the town which made the use of rubber tired trucks imperative. "Acme" trucks, each pulling a "Troy Trailer," are used in transferring the proportioned aggregates and the method is proving very satisfactory. Each truck carries three "Lakewood" steel batch boxes, having an Individual capacity of 22 cu. ft. of dry material, while the trailers are loaded with four similar boxes. Upon arrivel at the proportioning plant the batch boxes on the truck are loaded with the correct proportion of cement from the warehouse; the truck is then detached from the trailer and turns, coming under the chutes of the

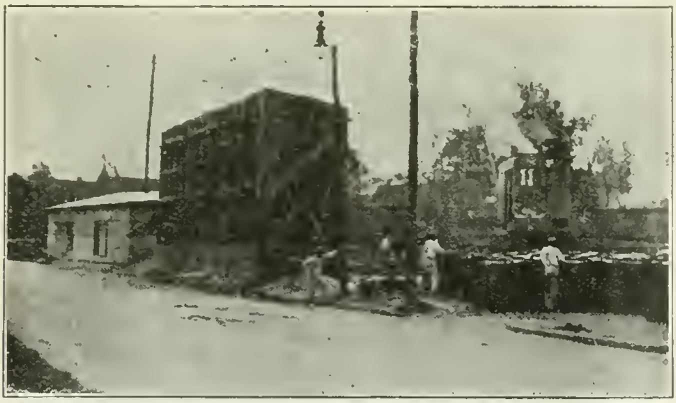


FIG. 1—CENTRAL PROPORTIONING PLANT ON CONCRETE ROAD CONSTRUCTION BETWEEN HIGH POINT AND WINSTON-SALEM, N. C.

storage bins. At the same time the boxes on the trailer are being loaded with cement, those on the truck are being filled with correctly proportioned aggregates. Following this operation the truck is again connected to the rear end of the trailer and pulls the latter under the chutes of the storage bins where the trailer is loaded with stone and sand. This method eliminates the necessity of reversing the trailer, which is fitted with a drawbar in each end, thus reducing the time required for loading, averaging at the present time about 4 minutes.

As previously stated, there is a haul of approximately a mile between the central proportioning plant and the beginning of the project but as it is entirely over paved streets the distance is covered very quickly by the trucks.

Industrial Railway

Fig. 3 shows the method of transferring the batch boxes from the trucks to the industrial railway. The loaded truck is driven under the gantry and by means of a chain hoist the boxes are transferred to the cars of the industrial train, an empty box being conveyed from the car to the truck at the same time. As soon as the loaded boxes on the truck have been placed on the cars the trailer is pulled under the gantry to be unloaded, and the truck is detached and after being turned, is again attached to the rear end of the trailer, ready for the return trip to the proportioning plant. By the installation of an "Ingersoll" air-hoist, which the contractor has on the ground, the number of men required at the gantry will be reduced from 6 to 2 while the operation of changing the boxes will be hastened. One and one-half miles of track are available for the industrial railway, which parallels the job, and when this limit is reached the gantry will be moved forward on the new pavement and the track laid ahead of it. By the time this move is necessary the pavement will have

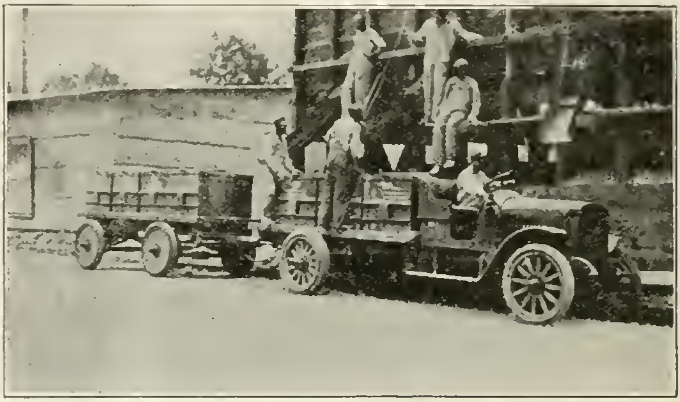


FIG. 2—LOADING TRUCK AND TRAILER FROM STORAGE BINS.

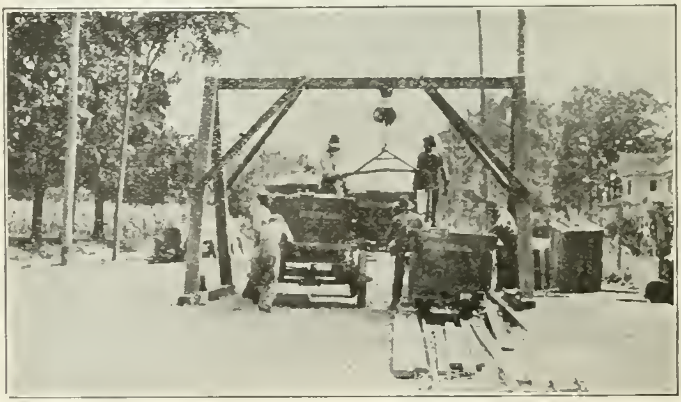


FIG. 3—TRANSFERRING BATCH BOXES FROM TRUCK TO INDUSTRIAL TRAIN.

cured sufficiently to bear traffic and the materials from the proportioning plant will be hauled over it.

Three trains, 2 of 8 cars each and 1 of 6 cars, are used at present in supplying the mixer with materials from the transfer point, this number to be increased if found necessary. Each car carries two batch boxes, making 16 batches to the train. Motive power is furnished by "Burton" 5-ton industrial, gasoline driven, locomotives. The movements of the trains have been carefully timed so as to furnish a constant supply of material to the mixer at the same time avoiding an over-supply. Two sidetracks are included in the layout, one at the transfer point and the other ahead of the mixer. After being loaded, the first train of the day pulls up with the mixer, while the second is run out of the side track near the gantry and down to the transfer point to be loaded. Upon arriving at the mixer the first train cuts off the two rear cars and runs ahead on the main line to a point past the switch of the siding ahead of the mixer. By the time that the third train, consisting of 6 cars, which has been standing on the siding, is shifted back opposite the mixer the 2 cars previously dropped by train No. 1 have been emptied and these are coupled to train No. 3 and the train run back to the siding near the loading point where it remains until train No. 2 is started to the mixer. As soon as the former train is clear of the mixer the first train backs down and is unloaded after which it runs up into the siding and awaits the arrival of train No. 2. This system supplies a steady flow of materials to the mixer and the maximum output is secured.

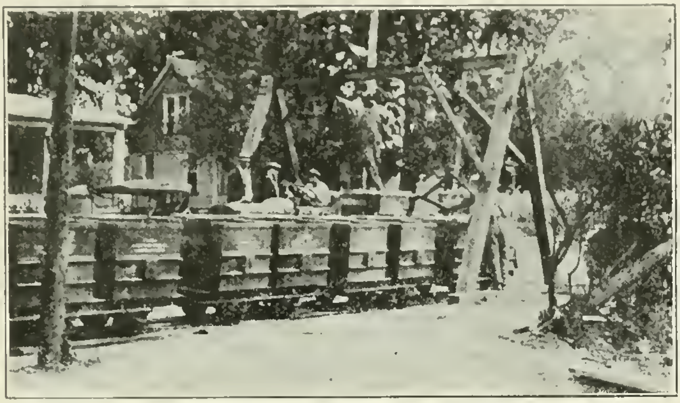


FIG.4—ANOTHER VIEW AT THE TRANSFER POINT.

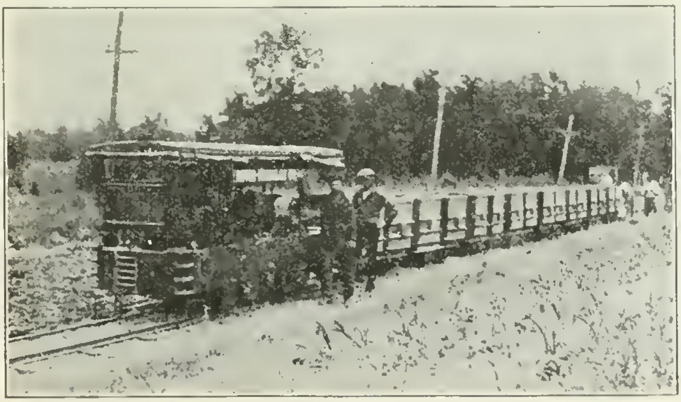


FIG. 5—A VIEW OF THE INDUSTRIAL RAILWAY EQUIPMENT.

Concrete Mixing

The concrete is mixed in a "Lakewood" type E-14 paver of 4-bag batch capacity, driven, as is all of the other equipment on the job, except the locomotive crane, by a gasoline engine. The batch boxes are automatically unloaded from the cars and the contents dumped into the skip of the mixer by means of an ingenious derrick arrangement on the front of the mixer. The motion of lowering the empty skip is transmitted through sheaves to the derrick and raises a loaded batch box from the car by means of hooks engaging lugs on either side of the car. The box is then swung over the skip and emptied after which it is swung back into position over the car and lowered by the action of raising the loaded skip. This is another point in the general scheme whereby the contractor has substituted mechanical means for labor.

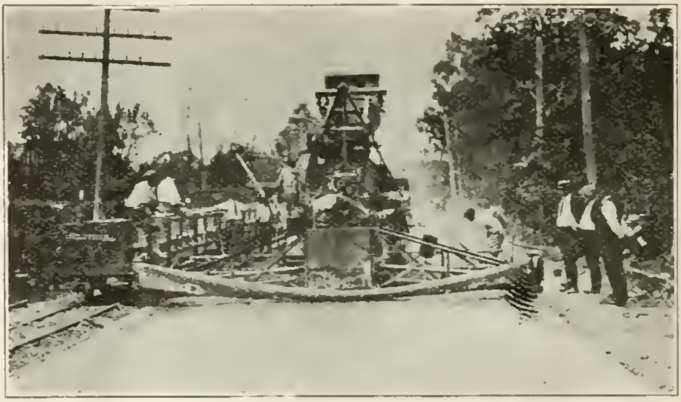


FIG. 6—UNLOADING THE INDUSTRIAL TRAIN AT THE MIXER. LAKEWOOD FINISHER IN THE FOREGROUND.

Finishing

In a great deal of concrete road construction very little attention is paid to the forms that are used which results in the edges of the finished pavement presenting a ragged appearance. On this job, however, the contractor has been very careful to secure forms which will insure a finished appearance to the roadway. By using "Blaw-Knox" steel forms of the heaviest type the contractor is enabled to run the "Lakewood Subgrader" ahead of the mixer to prepare the subgrade prior to laying the concrete pavement. The machine rests directly on the forms and is pulled along the subgrade by means of a "Kelly-Springfield" gasoline driven roller. After being brought to grade the subgrade is thoroughly rolled and sprinkled before any concrete is poured, and with the exception of the mixer, which furnishes its own tractive power, no hauling is done on the subgrade after it has been prepared to receive the concrete.

FIG. 7—SPRINKLING THE SUBGRADE AHEAD OF MIXER.

Still carrying out the idea of using modern equipment and doing away with labor the contractor is using a "Lakewood Finisher" to give a smooth, easy riding surface to the pavement. This machine also travels along the steel forms.

Curing

After the pavement has been finished it is kept covered for 24 hours with strips of burlap, thoroughly saturated with water to prevent too rapid drying. At the end of this time, the pavement is covered with a layer of earth which is also kept saturated for a period of 21 days or longer, after which it is cleaned off and the road opened to traffic.

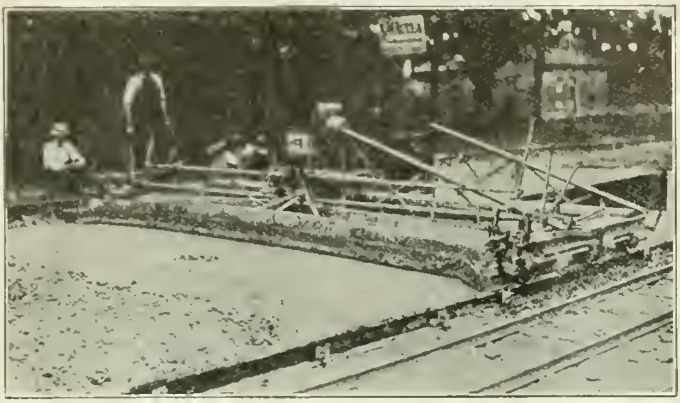


FIG. 8—LAKEWOOD FINISHER USED TO GIVE SMOOTH SURFACE TO FINISHED PAVEMENT.

Throughout the entire job a spirit of co-operation has seemed prevalent and a more smoothly functioning organization is seldom seen. Mr. R. Stuart Royer, president and general manager of the contracting firm, a civil engineer of wide experience, has established an office in High Point and spends the major portion of his time on the work. The superintendent, Mr. Oates, has had long experience in this line of work. Representing the State Highway Commission on the job are Mr. J. W. Mills, resident engineer, and Mr. J. M. Hobbs, inspector, who is on the engineering staff of Mr. John D. Waldrop, District Engineer, in charge of all work in the Fifth District.

To summarize, a more complete equipment or a more carefully planned layout for a job of this kind is not to be found in North Carolina and it is a credit both to the contractor and to the engineer of the Lakewood Engineering Company who planned it. If the job is completed in the same careful manner in which it has been started, and there is no reason to doubt but that it will be, this road will be one of the best, if not the best, examples of plain concrete highway construction to be found in the State. By reason of its location, between two of the most progressive cities of North Carolina, it will be called upon to bear heavy traffic and will thus afford an opportunity for further study of the life and wearing qualities on concrete highways.

FIG. 9—LAKEWOOD SUBGRADER USED TO SHAPE SUBGRADE AHEAD OF MIXER.

Contracts Awarded

ROADS AND STREETS

Ariz., Phoenix—Twohy Bros. Co., Phoenix, warded contract for improving portions of Washıgton St. involving 29,137 sq. yds. paving at $2.92 d.; 29,233 sq. yds. grading at 30c yd.; 11,048 lin. t. comb. curb and gutter at $1.50 ft. and incidental ems.

Ark., Dermott—Oliver Constr. Co., Litle Rock, warded contract to build graveled pike from erome to Nordman, 9 miles, at betw. $100,000 and 150,000.

Cal., Bakersfield—Rogers Bros. Co., 350 Merrick t., Los Angeles, awarded contract for paving ith conc. 5.78 miles on Reward Rd., from Mc-Kittrick, northwest in Rd. Imp. Dist. 15, at $288,700.

Cal., Los Angeles—W. D. McCray, 424 Am. Bank Bldg., awarded contr. for impvt. of Coringa Drive t $36,796; E. A. Baker, 833 Edgemont St., awarded ontract for improving Fountain Ave. bet. Hyperion nd Sanborn Ave. at $5,049; Geo. R. Curtis, 2440 E. 26th St., awarded contract for impvt. of 2nd t. at $3,636; S. M. Kerns, 1076 Cerritos Ave., Long Beach, awarded contract for constr. of 5.77 miles Harbor Truck Blvd. at $81,664; A. E. Burns, 407 I. W. Hellman Bldg., awarded contract to grade, ravel and oil streets; also constr. cem. curb, walk nd gutter in 60-acre tract now being subdivided et. Santa Barbara Ave. and 39th St.

Cal., Los Angeles—E. L. Garretson & Son, 1346 Fairfax Ave., awarded contract for paving with onc. Firey Ave. from Covina Blvd. to Foothill Blvd., about 1 mile, Rd. Impvt. Dist. 172, at $16.-00; Geo. R. Curtis, 2440 E. 26th St., awarded conract for improving 5th St. bet. Norton Ave. and 32 ft. west, at $1,662; G. T. McLain, 1184 N. Serendo St., awarded contr. for improving Merwin t. betw. Marathon and Kent, at $5,041; V. C. McLain, 227 E. Diller St., Watts, awarded conract fro grading and constructing cem. curb, walk nd gutter on Alma St. —st St. to Mich. Ave., Rd. Imp. Dist. 202, at $3,745; S. M. Kerns, 1076 Cerritos Ave., Long Beach, awarded contract for rading, and constructing disint. granite base and ulverts and bridges on 5.77 miles Alameda St. et. Compton and Wilmington, at $81,664.

Cal., Sacramento—Lee Moor Constr. Co., 402 Two Republics Bldg., El Paso, Tex., awarded contract or paving with conc. 7.4 miles Coast State Hwy., Los Angeles Co., betw. Las Flores Canyon and Santa Monica, at $206,739.

Cal., San Bernardino—W. D. Bohan, awarded contract for paving 2nd St. from Carter to K Sts. and on portion of K St., about 28,809 sq. ft., with 4-in. conc. at 17.2c sq. ft.; E. W. Seccombe, awarded contr. for paving 16th St. from B to E Sts. about 73,548 sq. ft. with 4-in. conc. at 16.7c sq. ft.

Fla., Daytona—Atlantic Bithulithic Co., Richmond, Va., awarded contract to construct 120,000 sq. yds. paving and sewers. $100,000.

Fla., Live Oak—J. Y. Wilson, Jacksonville, awarded contract for road work at $255,033; Clayton and Mitchell, awarded contract for various drainage and construction projects for approx. $100,000.

Fla., Tallahassee—Following contracts let for road work: Clayton and Mitchell, Thomasville, Ga., awarded contracts on fed. aid projects 11, 21, 22, 23 and 24 which involve draing. structs, covering abt. 50 miles road in Duval, Nassau, Baker and Columbia counties at total cost of $9,968; also contr. for draing. constr. on projects 26 and 32 covering 21 miles thru Columbia and Alachua Cos., at $47,322; Luten Bridge Co., York, Pa., contrs. for draing. constr. on proj. 33, 12½ miles, at $26,-534, in addn. to awards for other drainage structs. in Volusia county from DeLeon Springs to Putnam Co. line, at $26,219; Florida Engrg. & Constr. Co., Oviedo, contr. for draing. constr. on proj. 18, nearly 13 miles, at $19,789; J. D. Donahoo, Perry, contr. for excavation of draing. canals at Choctawatchee River brdg. at $32,000; W. P. Kennedy, Quincy, contr. for timber brdg. near Lloyds, Jefferson Co. at $3,837.

Fla., Tarpon Springs—J. B. McCrary Engrg. Co., Atlanta Ga., awarded contract for paving 4 miles of streets, brick, at $236,000.

Fla., Titusville—Maule Paving Co., Ojus, Fla., awarded contract to construct 15 miles of road at $120,000.

Ga., Savannah—City Council let following paving contracts: Pritchard, Raines & Hazlehurst, at $70,-000, to pave Dale Ave., 10,946 sq. yds. oil street asph. at $27,940; Houston St. 13,000 sq. yds. conc. at $34,397; 37th St. 4,200 sq. yds. conc. at $9,450; Dixon Constracting Co. at about $5,000 to pave portion of President, Clifford and other streets.

Ida., Ontario—Hauser Constr. Co., awarded contract for 15 miles grading on Oregon Trail Hwy. from point opposite Weiser on Ore. side to Baker Co. line, at $106,000.

Ill., Moline—Victor McLain, E. Moline, awarded contracts for paving 8th and 9th Aves. for dist. of 22 blocks, at $100,896, also paving of Third Ave. to city limits at $11,019. Material to be used is reinf. concrete and work will begin this winter if weather continues favorable.

Ill., Springfield—Webber & Co., Ionia, Mich., awarded contract by St. Div. of Highways, for constr. of 12.33 miles hard roads in Bureau Co., at $359,906.

Ill., Springfield—N. C. Finley Constr. Co., Hoopeston, awarded contr. for constr. of hard road connecting Springfield and Jacksonville, at $273,800 without cement and average cost with cement at $28,500; Shidler Constr. Co., Kankakee, awarded contract for 5.19 miles of roads in Jefferson Co., at $22,337 per mile without cement or $116,139 for job.

Ind., Terre Haute—Carpenter Construction Co. awarded contract for constr. of road (Charles F. Hill Road). Est. cost of work $130,000. Work will start in spring. Type: brick.

Ky., Frankfort—Following contracts for road work let by State Rd. Department: Ohio River road contracts, McCracken and Livingston Cos., (in former 2 4/10 miles Kentucky rock asph.) to M. E. Stone & Co., Madisonville, at $26,621; Smithers, Ellis and Costellow, Knoxville, Tenn., contr. for grading and draining 12 miles in latter county, at $58,703; M. E. Stone & Co. contr. for 7 miles in Trigg and Christian Cos. at $81,095. Road is to have gravel surface.

Ky., Hopkinsville—State Hwy. Comm., Frankfort, let contract to M. E. Stone & Co., Madisonville, Ky., at $81,095 to improve 7 mile sec. of Cadiz-Hopkinsville Rd. Christian and Trigg counties.

Mich., Marquette—G. P. Scharl, Muskegon, awarded contract for grading and draining constr. of 11½ miles Baraga Trunk Line St. Rd. 35-5C, Ishpeming Twp., at $175,387.

Mo., Monticello—W. A. Ross, Kansas City, Mo., awarded contract for constr. of 8.37 miles State Rd. from Canton southward and westward, Lewis Co., FAP 38, at $85,827.

Mo., St. Joseph—Moritz & Oren, Effingham, Ill., awarded contract for 6.639 miles St. Rd. from St. Joseph to Dearborn, Buchanan Co., FAP 180, at $211,550.

N. M., Santa Fe—Following contracts let by State Hwy. Comn.: W. T. McClure, Magdalena, N. M., awarded contract for FAP 57, Chaves Co., 14. 242 miles, at $44,350, exclusive 10% for contingencies for engrg.; J. V. Stryker Constr. Co., East Las Vegas, N. M., awarded contract for FAP 63, Curry Co., 13,024 miles, at $87,445, exclusive of 10% for engrg. and contingencies.

N. C., Bayboro—Union Paving Co., Phila., Pa., awarded contract to construct 12.03 miles roadway in Pamlico Co. from Craven Co. line to Bayboro, at $263,022.

N. C., Charlotte—Blythe Bros. awarded contract to pave 14 miles of streets at about $525,000.

N. C., Graham—Elliott-Sholes Co., Durham, awarded contract by State Hwy. Comn. for constr. of 5.22 miles hard surface road from Trollingwood to Orange Co. line, Topeka surfacing on concrete base, project 564, Alamance Co., at $140,115; also contract at $334,294 for 11.70 mi. hard surf. rd. from Gibsonville toward Greensboro, Topeka surfacing on conc. base, proj. 532, Guilford Co.; also contract in conjunction with R. E. Boggs, Spartanburg, S. C., for constr. of 10.24 mi. hard surf. rd. from Lexington to Rowan Co. line, Topeka surfacing on conc. base, proj. 525, Davidson Co. at $292,958.

N. C., Goldsboro—Union Paving Co., Philadelphia, Pa., awarded contr. to constr. 10.01 miles roadway, Wayne Co., from Goldsboro to Lenoir Co. line, at $268,357.

N. C., New Bern—Union Paving Co., Phila., Pa., awarded contract to construct 9.93 miles roadway, Craven Co., from New Bern toward Morehead City, at $246,078, and $16,609 for structures.

N. C., Newton—Union Paving Co., Philadelphia, Pa., awarded contract for 10.85 miles hard surf. road in Catawba Co. betw. Newton and Burke Co. line, at $322,040; Topeka with conc. base, proj. 622.

N. C., Raleigh—Contracts for a million dollars worth of hard surfaced hwys. constr. in 4 counties let by State Hwy. Comn.: work in Wayne (10 miles Topeka asph.), Craven (10) and Pahlico (12) will be done by Union Paving Co., Philadelphia; West Construction Co., Kinston, will build road in Greene Co. (6.7 miles).

N. C., Snow Hill—West Construction Co., Kinston, N. C., awarded contr. to construct 6.81 miles roadway, Greene Co., at $196,116.

N. C., Statesville—R. M. Hudson Co., Salisbury, awarded contract for 10.59 miles hard surf. road in Iredell Co. betw. Shepherd and Statesville, Topeka surfacing on conc. base, proj. 639, at $332,544; structures to Luten Bridge Co., Knoxville, Tenn., at $19,181.

N. C., Washington—P. G. Ligon & Co., Baltimore, and Robt. G. Lassiter, Oxford, N. C., awarded contracts to constr. brick and sheet asph. paving, 30,000 sq. yds., at $197,000.

Okla., Bartlesville—Hamilton Construction Co. awarded contract to construct 25,000 sq. yds. conc. pavement at $100,000.

Okla., Bartlesville—Bartlesville Construction Co. awarded contr. for paving 12 streets and 24 alleys, at $91,500.

Okla., Okmulgee—A. M. Ammerman, Wichita, Kans., awarded contr. for constr. of an 18-ft. road so. from Okmulgee to Henryetta, 12 mi., at $411,000.

Okla., Pauls Valley—Standard Paving Co., Tulsa, awarded contract for paving N. Pine St. at $72,671.

Ore., Baker — Copenhagen Brothers, local awarded contract for bldg. river section of Baker-Cornupopia Rd., at $105,641 (13.2 miles).

Ore., Portland—Following contracts let by State Hwy. for road work: McAuliff & Healy, Portland, $16,395 for grading 7.8 miles Cow Canyon sect. Dalles-Claif. Hwy. Wasco Co.; Bauer & Bauer, Dayton, Wash., for grading and macadamizing Sherman Valley section Sherman Hwy. at $61,-218.50; Bauer & Bauer, grading and macadamizing 7.5 miles Moro-Sherman Hwy. at $65,397.

S. C., Beaufort—J. T. Blassingame, Greenville, awarded contract for grading and foundation work on 20.781 miles Beaufort to Pocotaligo Hwy. at $84,295.

Tenn., Knoxville—Murray Constr. Co. awarded contract for paving Churchwell, Tarleton Sts. and alleys, at $100,000.

Tex., Big Springs—Womack Constr. Co., McKinney, awarded contr. for constructing 34.25 miles gravel road on State Hwy. No. 1 at $250,744.

Tex., Breckenridge — Womack Constr. Co. awarded contract for constr. of Bankhead Hwy. in Stephens Co. at about $1,000,000 for stretch of road.

Tex., Edinburg—W. L. Pearson & Co., Houston, awarded contract to constr. 33.9 miles gravel and caliche rd. from Edinburg no. to Brooke Co. line at approx. cost of $200,000.

Tex., Marshall—F. P. McElrath, Corsicana, awarded contract for finish Jefferson Hwy. No. 11 at $114,274.

Tex., Midland—Womack Constr. Co., McKinney, awarded contract for constructing 26.91 miles gravel road on State Hwy. No. 1. at $205,704.

Tex., McKinney—D. H. Purvis, Ft. Worth, Tex., awarded contract to surface 25 miles of road, rock base and gravel top, at $66,000.

Tex., Odessa—Womack Constr. Co., McKinney, awarded contract for constr. of 24.74 miles gravel road on State Hwy. No. 1, at $209,355.

Tex., Palestine—Gulf Bituluthic Co., Houston, awarded contract by City Council for paving and street impvts. $250,000 bonds sold recently. Total amount of paving to be done here, $750,000.

Tex., Pecos—W. E. Hamilton awarded contract for constr. of protion of Bankhead Hwy. from abt. 2 miles west of Hermosa thru Toyah to Reeves Co. line near Kent, at $107,471.

Tex., Sherman—T. J. Larkin & Sons, Dallas, Tex., awarded contract to construct gravel roads in Gunter, Howe and Southmayd Dists. at about $500,000.

Tex., Stanton—Womack Constr. Co., McKinney, awarded contract for constructing 12.79 miles gravel road on State Hwy. No. 1 at $93,898.

Tex., Waco—McCall-Moore Engrg. Co., Waco, awarded contract to pave Mary St., vitr. brick, $90,000.

W. Va., Charleston—Monongahela Construction Co., Fairmont, W. Va., awarded contract to Proj. 3010, Mineral Co., 10.35 miles northwestern turnpike, grading and draining only, at $70,628; Chas. Spindler, Kingwood, W. Va., contract for Proj. 3003, Monongalia Co. 4 mi. Fairmont to Morgantown, grading and draining only, at $62,479; Ronedy Constr. Co., Parkersburg, W. Va., awarded contract for Proj. 3005, Wood Co. 3.6 miles Parkersburg-Williamstown pike, grading, draining and paving with concrete, at $94,936; Newark Paving and Construction Co., Newark, O., awarded contract for Proj. 3073, Ohio Co. 2 mi. National Pike, grading, draining and paving at $77,020; Hunt-Forbes Constr. Co., Ashland, Ky., awarded contract for Project 112, Putnam Co., grading, draining and paving 6.45 miles Midland Trail betw. end of Proj. 46 and point near Kanawha Co. line, bitum. penetration macadam, at $193,115; J. M. Randish & Co., Huntington, W. Va., awarded contract for Proj. 3100, Gilmer Co., 2 miles Glenville-Weston pike, grading and draining only, at $26,776; A. L. Kickolich, Fairmont, W. Va., contract for Proj. 3004, Marion Co., 1.7 miles Fairmont-Morgantown Rd., grading and draining only, at $14,037; Kenedy Constr. Co., Parkersburg, W. Va., contract for Proj. 3040, Fayette Co. 6.8 miles Midland Trail, Longacre to Kanawha Falls, grading, draining and paving with bitum. penetration macadam at $213,916; C. S. Waugh, Williamson, W. Va., awarded contract for grading, draining and paving Proj. 3042, Kanawha Co., St. Albans to Putnam County line, 2.6 miles Midland Trail, bitum. macadam, at $100,382.

W. Va., Wheeling—Newark Paving and Constr. Co. awarded contract for paving 4 miles of National Pike so. of West Alexander, at $77,020.

W. Va., Wheeling—Kennedy Constr. Co., Parkersburg, awarded contract for National Pike, Ohio Co., at $73,639.

Wash., Seattle—J. L. Smith, Pioneer Bldg., awarded contract for paving 15th Ave., N. W., at $188,934.

SEWERAGE AND SEWAGE TREATMENT

Cal., E. San Diego—Hickey & Harmon, 58 2nd St., San Francisco, low bidder and will probably be awarded contract for constr. of 29 miles of sewers for E. San Diego at $232,742.

Cal., Madera—W. J. Tobin, 527 Santa Rey Ave., Oakland, awarded contract for constructing vit. pipe sewer system, approx. 36,000 ft. and sewage pumping plant, at $39,985.

Ont., Hamilton—Following contracts for sewer construction awarded: Wellington St. Sec. No. 1 at $181,198 and Sec. 2 at $174,261 to A. Cope & Son; small sewer on Wellington St. to J. J. Armstrong & Sons at $689.

Fla., Sarasota—J. W. Crawford awarded contract for $16,164 bonds, less 15% for cash, making cash bid $13,740.

Ida., Caldwell—Morrison-Knudsen, Boise, awarded contract for construction of combined drainage and sewer system for North Caldwell at $50,485.

Ia., Dubuque—Even-Ulrich-Staner Co., 446 Garfield Ave., Dubuque, awarded contract for constr. of sewer impvts. in no. sect. of city at $30,000.

Minn., Albany — Hammen & Co., Mankato, awarded contract for san. sewerage system, including disposal plant, at $25,519.

Minn., Rochester—Following contracts let for sewers: Secs. 1, 2 and 3 to Mankato Constr. Co., Mankato, approx. $42,000; Secs. 4, 6, 6 and 7 to Wm. C. Fraser, 810 Guardian Life Bldg., St. Paul, at approx. $26,000.

Minn., St. Peter—Lars Overn, St. Peter, awarded contract for constructing Walnut-5th-Cedar Sts. sewer at $19,000.

N. C., Charlotte—Myers Constr. Co., Meridian, Miss., awarded contract to constr. storm sewers; Tucker & Laxton, Charlotte, contract to constr. sewers in unimproved portion of city at $36,836. Total cost of system, $100,000.

Okla., McAlester—Jno. W. Roos awarded general contract for sewers at $31,752.

Pa., Reading—J. M. Davenport and E. S. Fry (both of Chester) awarded contract for about 6 miles of house sewers in northeast section at $70,000.

Tenn., Memphis—Moreno-Burkham Constr. Co., St. Louis, Mo., awarded contract to construct Binghamton san. sewer outlet main at $56,816.

Tex., Dalhart—Gordon Constr. Co., Denver, Colo., awarded contract to construct sewage disposal plant and extend sewer system at $22,765.

Wn., Seattle—Fiorito Bros., 650 6th Ave., Northwest, awarded contract for installing sewers in E. 70th Street et al. at $52,237.

Wn., Spokane—Standard Asphalt & Paving Co. awarded contract for Fifth Ward Sewer No. 13 at $61,600.

Wis., Valders—W. O. Baer, Manitowoc, Wis., awarded contract for sewerage system at $50,000.

WATER SUPPLY AND PURIFICATION

Ariz., Tucson—Corbett Hardware Co. awarded contract at $22.15 per cwt. for furnishing city with 2,500 ft. 2-in. water pipe f. o. b.

B. C., Burnaby—Paige-Horsey Co., Toronto, Ont., awarded steel contr. for water works extensions at $29,795.

N. S., Halifax—Steel, brickwork and plumbing contracts for pumping station costing $6,100 awarded to MacKinnon Steel Co., Ltd., Drummond Rd., Sherbrooke, Que., and Briggs Constr. Co., Metropole Bldg., Halifax, and Mitchell and McRae, 29 Grafton St., Halifax.

Ont., Mille Roche—Kyer & Scott, Mille Roche, have general contract for constr. of "Eastman" drain at $10,000 for Cornwall Twp.

Que., Montreal—Ross & Grieg, agents for Goldie McCulloch Co., Ltd., awarded contract for 12-million gal. elec. pump for the McTavish St. reservoir station at $16,842.

Que., St. Lambert—Contract for conc. pipe for town awarded to Independent Concrete Pipe Co., Ltd., Huron street, Woodstock, Ont. Contract for laying pipe and san. sewers awarded to Leger, 76-A Rird Ave., and Tardiff, 60 Adams St. Project will cost $53,000.

Iowa, Stanton—Dunnegan & Briggs, Shenandoah, awarded contract for extension of municipal water works at 28c per ft. for excav., backfill and laying pipe. Abt. 7,200 ft. of 4-in. cast iron pipe line, including 8 hydrants, 11 valves and boxes and specials, totalling 79 4-in. and 13 6-in. bells.

Kans., Parsons—Following contracts let: American Cast Iron Pipe Co., Birmingham, Ala., contract for Sec. No. 2 (cast iron pipe) at $127,200; Ludlow Valve Co., Kansas City, Mo., contract for hydrants and valves at about $4,543.

Mass., Boston—National Water Main Cleaning Co., Inc., awarded contract for cleaning water pipes in N. Beacon St. Wash., etc., at $3,680.

Mich., Grand Rapids—The Owen-Ames-Kimball Co. awarded contract for concrete work on new municipal filter plant at $174,691.

Minn., Cloquet—Pastoret Constr. Co., 303 Sellwood Bldg., Duluth, awarded contract for water mains, well, pumphouse, build power line, install pump and motor, at $21,886.

Minn., McKinley—Mr. Pearson, Ely, awarded contract for constr. of new pumphouse at $2,138.

Minn., Forest Lake—F. G. Bauer, Forest Lake, awarded contract for well and pumphouse at $7,321.

Neb., Lincoln—Following contracts let for water works equipment: Boilers to Murray Iron Works Co., Burlington, Ia., two 500-h.p. tubular, $21,300; Coal handling equipt., Jeffrey Mfg. Co., coal conveyor, crushers, $18,650.

Neb., Lincoln—A. A. Dobson Co. awarded contract for work in Water Dist. 11, at $19,976; Knudson and Bruce awarded contract for Water Dist. 23, Northside Ave. bet. 15th and 17th Sts, at $1,182.

O., Cleveland—Stange & Walsh Co. awarded contract for 125,000,000-gal. conc. reservoir on Baldwin Road, at $1,824.

S. D., Madison—Ole Helmey, Madison, awarded contract for diffing and refilling approx. 1,800 ft. water main ditches at 18c per running ft.

Tex., Edinburg—Gulf Machinery & Ship Supply Co., 2128 Strand, Galveston, Tex., awarded contract by city to construct water works and power house, erect 60,000-gal. capy. tank with pump supplying 150 gals. per min., approx. cost $5,000; install $2,000 pump; 40x60 ft. dam and power house, wood constr., conc. floor, cost $16,000, 1 mi. transmission.

S. D., Mobridge—Pittsburgh-Des Moines Steel

Highway Construction Equipment Service

If in the market for any of the following highway construction equipment, so indicate by check marks, mail this page to *Municipal and County Engineering*, 702 Wulsin Building, Indianapolis, and price quotations and descriptive literature will be forwarded to you.

—Air Compressors
—Asphalt Plant, Portable
—Asphalt Plant, Railroad
—Asphalt Tools
—Asphalt Tool Wagon
—Bar Cutters and Benders
—Bars, Reinforcing
—Bins, Portable Stone
—Bodies, Dump Truck
—Brick Rattlers
—Catch Basin Covers
—Cement Testing Machinery
—Clam Shell Buckets
—Contraction Joint
—Cranes, Locomotive
—Crushers, Stone
—Drag Scrapers
—Dragline Cableway Excavator
—Dump Cars
—Dump Wagons
—Excavator, Crane
—Elevating Graders
—Gasoline Locomotives
—Gravel Screener
—Heaters, Asphalt
—Heaters, Tar
—Hoisting Engines
—Industrial Cars
—Industrial Track
—Manhole Covers
—Mixers, Building
—Mixers, Hot
—Mixers, Paving
—Motor Trucks (1-3 tons)
—Motor Trucks (over 3 tons)
—Oil Distributors
—Portable Conveyor
—Portable Drilling Rigs
—Pile Drivers
—Reinforcing Steel
—Road Drags
—Road Forms
—Road Graders
—Road Mesh
—Road Planes
—Road Plows
—Road Rollers
—Road Scrapers
—Sand Dryers
—Saw Rigs
—Scarifiers
—Scrapers, Power
—Sheet Piling, Steel
—Skimmer, Scoop
—Steam Shovels
—Stone Elevators
—Stone Screens
—Stone Spreaders
—Surface Heaters
—Tampers, Road
—Tractors
—Trailers
—Turntables
—Unloaders, Car
—Wagon Loader
—Wheeled Scrapers
—Wire Mesh

Co., Tuttle and S. W. 10th, Des Moines, Ia., awarded contract for constr. of water works plant system near Milwaukee bridge, 32,000-gal. capy., $167,850.

W. Va., Mullens—West Va. Engrg. Co. awarded contract to construct water works at $60,000; install 105,000-gal. capy. steel tank.

Wn., Seattle—Schulz Constr. Co., San Francisco, awarded contract for constr. of a distributing sys. for Citrus Heights Irrigation Dist., Northern Sacramento Co., at $163,000. Dist. is comprised of 30,000 acres. Work will consist of principally rehabilitating and enlarging existing system. Main line pipe will be built 5½ miles in length.

Wash., Seattle—Scalzo & Co. awarded contract to install water mains in 39th Ave., S. and Court street, at $1,879; Romano & Rosello Bros. Co., 822 Corwin Place, contracts for water mains in Miller St. at $3,491; also in Harris Pl. et al. at $1,394.

Wis., Taylor—Following contracts let for water works system: Tank and tower to Pittsburgh-Des Moines Steel Co., Tuttle & S. W. 10th, Des Moines, Ia.; valves, hydrants and valve boxes to Iowa Valve Co., Oskaloosa, Ia.; labor to Mierswa Constr. Co., Oshkosh; well to Bowman & McMahon, Durand; c. i. pipe to Am. Cast Iron Pipe Co., 712 Plymouth Bldg., Minneapolis, Minn.

Prospective Work

ROADS AND STREETS

Ala., Clayton—Barbour Co. will construct roads $150,000 bonds voted.

Ala., Tuscumbia—Bids will be asked about Jan. 1st by State Hwy. Dept. for constructing 4 mile hard surf. and 4 mile gravel roads. $225,000 available. A. P. Henderson, Div. Engr., Montgomery.

Cal., Arcadia—City Engr. O. A. Gierlich estimates cost of completing city's streets at $260,000. Paving of important streets will be taken up first.

Cal., Pomona—The $200,000 street impvt. bonds voted in Dec. have been sold at par. Sale of bonds will enable city to start paving campaign comprising abt. 13 miles of streets in business and residential sections. First paving will be done in business dist. City will pay cost of improving 24 streets from bond issue and prop. owners half. Total cost, $400,000. F. C. L. Froedhe, City Engr.

Cal., Sacramento—Expenditure of approx. $15,-000,000 for roads in 1922 on state hwy. work mapped out at conference of division engrs. T. E. Stanton, Asst. St. Hwy. Engr.

Cal., San Diego—Petition referred to city manager by Com. Council to pave Penn. Ave.—Front to 5th Sts.—with 4-in. conc. base and one-in. asph. wearing surface. Engrg. Dept. reported to Council prelim. est. of paving and improving Grim and Wightman Sts.: Paving, 180,034 sq. ft.; curbs, 6,805 lin. ft.; curb removals, 5,134 ft.; walks, 6,206 ft.; also plans and specfs. for paving Sunset Blvd. from St. James Pl. to Ft. Stockton Drive. Material is to be Portland cem. conc. base. Prelim. steps taken for paving Roosevelt Memorial Dr. from end of Prospect St. to LaJolla to Biological grade. Council ordered City Engr. to prepare plans and specfs. for this paving. Council also plans to pave Encanto Hwy.

Cal., San Francisco—Board of Pub. Wks. has ordered paving of Columbus Ave. and apporpriated $100,000 for the work. Street will be widened betw. Wash. and N. Point Sts. $128,683 appropriated for constr. of Cliff House pavement.

Ont., Brantford—By-law passed providing for raising $20,000 for purchase of road-making machinery and appliances. H. F. Leonard, City Clk.

Fla., Tampa—Millsboro Co. will repair Bayshore Blvd. and other roads; $100,000.

Fla., West Palm Beach—City will improve streets at cost of $150,000; construct walks, $75,000; also boulevards and parks, $100,000. Bids will be advertised about Jan. 1st, 1922.

Ga., Greensboro—Greene Co. will construct 14 miles of Greene Hwy. from Greensboro to Watson Springs; $300,000 state aid.

Ida., Idaho Falls—Congress will appropriate $1,-000,000. This amount, with $2,000,000 made available by sale of hwy. bonds, will be used for impvt. of Idaho-Montana Hwy. and Yellowstone Hwy. in state of Idaho.

Ia., Orange City—Plans being prepared for grading 20 miles of No. Iowa Pike Rd., 191, FAP 22. Est. cost, $200,000.

Kans., Topeka—State Highway Commission will authorize new road projects at once to provide work during winter—plan $4,000,000 highway program. M. W. Watson, State Hwy. Engr. Farmers of Leavenworth County, east of Tonganoxie, are requesting St. Hwy. Comn. to approve constr. of Victory Hwy. from Tonganoxie to east county line at once, so as to provide employment during the winter months.

La., Monroe—Clariborne Parish plans to construct 25 to 35 mi. of highway east and west thru parish from Webster to Union parishes at cost of $200,000. H. C. Diagre, Monroe, Hwy. Engr. in charge.

La., Ruston—Lincoln Parish Police Jury will sell $700,000 road construction bonds.

Mich., Iron Mountain—State trunk line constr. work contemplate 1 mile conc. paving, 20 ft. center of Stepheson Ave. in Iron Mtn. One mile macadam in Norway, road constr work and repairs contemplated for next year. Est. cost, $175,000. Jas. D. Cudlip, Co. Clk.

Mo., Clayton—State Hwy. Dept., Jefferson City, Mo., will construct 7.03 miles State Rd. from St. Louis southward at cost of $283,599; FAP 80; also 6.07 miles State Rd. from Weber Rd. westward, $227, 212; FAP 78, both St. Louis Co. H. D. Griffith, Div. Engr., DeSoto.

Minn., Fergus Falls—Ottertail County will expend $300,000 on road next year. Wm. Lincoln, Aud.

Mo., Jefferson City—If Fed. Aid is granted this state, work will start on highways costing bet. $2,500,000 and $3,000,000. Of this federal aid, portion of cost would be bet. $1,250,000 and $1,500,000. Acting Governor Lloyd reports that projects in seven counties of the state are ready for fed. aid and work can begin immediately in these impvts. if additional aid is granted. Counties and amts. include: Miss., $747,000; Harrison, $500,000; Stoddard, $200,000; Dunklin, $750,000; Buchanan, $200,-000, and Jasper, $100,000.

Mo., Marshfield—State Hwy. Dept., Jefferson City, will build 7.733 miles State Rd. from Rogersville eastward. $23,631; Webster Co. State Aid Proj. 20.112. H. P. Mobberly, Div. Engr., Woodruff Bldg., Springfield, Mo.

Neb. Nebraska City—Residents of city plan impvt. of 52 blocks by paving.

Nev., Reno—Federal funds now available for hwy. construction in Nevada amount to $3,246,000. State must match Fed. allotment with $415,000. On Feb. 1st there will be $175,000 available in the highway fund. Total amount available June 1st of next year will be $438,000 or more than enough to match the fed. allotment.

N. M., Santa Fe—State will begin $1,500,000 road constr. program, provided additional fed. aid is made available, as state's share toward relieving unemployment. Governor M. C. Mechem.

Ore., Portland—If prices are right State Hwy. Comn. will award contracts for 120.3 miles of road work of which includes much grading.

Pa., Farrell—Directors of Chamber of Commerce have approved Mercer Co. Bond Issue of $1,300,000 for completion of roads.

S. C., Charleston—$1,000,000 voted for bldg. good highways in county.

Tenn., Memphis—City will widen and pave streets at cost of $2,100,000. Wm. B. Fowler, City Engr.

Tenn., Nashville—Board of Public Works plans paving 10 miles of streets. W. W. Southgate, City Engr.

Tex., Austin—Close to $3,000,000 of aid for hwy. constr. awarded by State Hwy. Comm. at meeting here.

Tex., Boston—U. S. Dist. Engr., Ft. Worth, has approved plans for constr. of 12.3 miles 12-ft. gravel road on Hwy. No. 1 and 8, Bowie Co. Est. cost $165,000. O. B. Pirkey, Co. Judge. Bew Boston; Hess and Skinner, Co. Engr., S. W. Life Bldg., Dallas.

Tex., Ft. Worth—State Hwy. Dept., Austin, Tex., approved plans for surfacing 6.84 miles Hwy. No. 1 from Parker Co. line east with bitum. topping.

BUYERS' GUIDE

Aerial Tramways.
American Steel & Wire Co.

Armor Plates.
Truscon Steel Co.

Asphalt.
Bitosing Paving Co.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Asphalt Paving Co., The

Asphalt Filler.
The Barrett Co.
Bitosisg Paving Co.
Standard Oil Co. (Indiana)
The Texas Co.
Warren Bros. Co.

Asphalt Floors.
The Barrett Co.
The Texas Co.
Warren Bros. Co.

Asphalt Machinery.
Cummer & Son Co., The F. D.

Asphalt Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
Littleford Brothers.
Warren Bros. Co.

Asphalt Railroad Plants.
Cummer & Son Co., The F. D.
Warren Bros. Co.

Asphalt Tools.
Littleford Brothers.
Warren Bros. Co.

Asphalt Tool Wagons.
Littleford Brothers.

Auto Fire Apparatus.
Diamond T Motor Car Co.
Duplex Truck Co.
Garford Co., The
Kissel Motor Car Co.
International Motor Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Back Fillers.
Austin Machinery Corporation.
Pawling and Harnischfeger.

Bar Cutters and Benders.
Koehring Machine Co.

Bars, Reinforcing.
Truscon Steel Co.

Binders, Road.
The Texas Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Bitulithic Pavements.
Warren Bros. Co.

Blasting Accessories.
E. I. du Pont de Nemours & Co., Inc.

Blasting Powder.
E. I. du Pont de Nemours & Co., Inc.

Bodies.
Lee Loader and Body Co.
Littleford Brothers.

Braces, Extension.
Kalamazoo Fdy. & Machine Co

Brick Rattlers.
Olsen & Co., Tinius.

Brick-Testing Machinery.
Tinius Olsen Testing Mach. Co.

Bridges.
Lewis-Hall Iron Works.

Buckets, Dredging, Excavating and Sewer.
Pawling and Harnischfeger.

Buckets, Dumping.
Littleford Brothers.
Pawling and Harnischfeger.

Cableway Accessories.
Sauerman Bros.

Cableway Excavators.
Sauerman Bros.

Calculators.
Kolesch & Co.

Car Pullers, Electric.
Mead-Morrison Mfg. Co.

Car Unloaders.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.

Castings.
U. S. Cast Iron Pipe & Fdy. Co.

Cast Iron Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Catchbasins.
Dee Co., Wm. E.
Madison Foundry Co.

Cement Testing.
Kirschbraun, Lester.

Cement Testing Machinery.
Tinius Olsen Testing Mach. Co.

Chimneys, Concrete.
Truscon Steel Co.

Chimneys, Steel.
Lewis-Hall Iron Works.
Littleford Brothers.

Chloride of Lime.
Pennsylvania Salt Mfg. Co.

Chutes, Concrete.
Heltzel Steel Form & Iron Co.
Littleford Brothers.

Concrete Mixers.
Austin Machinery Corporation.
Koehring Machine Co.
Smith Co., T. L. The

Concrete, Reinforcement.
American Steel & Wire Co.
Truscon Steel Co.

Conduits.
Cannelton Sewer Pipe Co.
Truscon Steel Co.

Conduit Rods.
Stewart, W. H.

Conduits, Wood, Creosoted.
Republic Creosoting Co.

Consulting Engineers.
Alvord, John W.
American Appraisal Co.
Artingstall, Wm.
Brossmann, Chas.
Burd & Giffels.
Chicago Paving Laboratory.
City Wastes Disposal Co.
Dow & Smith.
Fargo Engineering Co.
Flood, Walter H., & Co.
Gannett, Seelye & Fleming Co.
Hill & Ferguson
Howard, J. W.
Hunt & Co., Robert W.
Jones, Sam L.
Kirchoffer, W. G.
Kirschbraun, Lester.
Potter, Alexander.
Van Trump, Isaac.
Wells, James P.

Contractors.
City Wastes Disposal Co.
Sullivan, Long & Hagerty.
Warren Bros. Co.

Contractors' Tools and Machinery.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The
Good Roads Machinery Co., Inc.
Koehring Machine Co.
Littleford Bros.
Smith Co., T. L. The

Contractors' Wagons.
Austin Machinery Corporation.
Austin-Western Co., Ltd., The

Conveying Machinery.
Mead-Morrison Mfg. Co.
Pawling & Harnischfeger.
Portable Machinery Co., Inc.
Webster Mfg. Co.

Cranes and Hoists.
Austin Machinery Corporation.
Heltzel Steel Form & Iron Co.
Pawling and Harnischfeger.

Creosote.
The Barrett Co.
Republic Creosoting Co.

Creosoted Wood Block.
(Factory Floors, Bridge Floors)
Republic Creosoting Co.

Crushers, Rock and Ore.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Culvert Molds.
Austin-Western Co., Ltd., The

Culvert Pipe, Vitrified.
Cannelton Pipe Co.
Dee Clay Mfg. Co., Wm. E.

Culverts.
Newport Culvert Co.
Truscon Steel Co.

Curb and Gutter Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Curb Bar.
Truscon Steel Co.

Direct Oxidation Process.
Direct Oxidation Process Corp.

Disinfectants.
Integrity Chemical Co.

Drag-Line Excavators.
Austin Machinery Corporation.

Drag Scrapers.
Austin-Western Road Machinery Co.

Drain Tile.
Dee Clay Mfg. Co., W. E.

Drawing Materials.
Kolesch & Co.

Dryers.
Cummer & Son Co., The F. D.

Dump Cars.
Austin-Western Road Machinery Co.

Dump Wagons.
Austin-Western Road Machinery Co.

$137,000. Hugh L. Small, Co. Judge; R. V. Glenn, Cons. Engr.

Tex., Mexia—E. L. Dalton, Dallas, Cons. Engr. for Mexia will about 1st of yr. award contracts for considerable paving. $150,000 bonds have been voted.

Tex., Sherman—At public mass meeting citizens indorsed plan for disposing of $190,000 bond issue for constr. of roads.

Va., E. Radford—City will sell $150,000 bonds for purpose of repaving First Street, bldg. sewers, etc.

Wash., Seattle—Road and brdg. impvts. contemplated in Grays Harbor Co. for 1922, according to plans of County Engr. H. S. Shorey, include following: Rd. from Elma to Oakville, 18 miles, is to be rebuilt; rd. from Westport so. to Pacific county line, 8 miles, is to be rebuilt; along no. side Quinault Lake, 5 miles new rd. is to be constructed; from Hoquiam northwest, 13 miles of road is to be rebuilt. All above projects are covered by bond fund voted by county. Numerous other small projects will be taken care of by roads districts and road and bridge funds. 1st undertaking in 1922 King County road program will be stretch of paving 3.69 miles long, 20 ft. in width, est. to cost $120,000. Engr. Beeman expects to advertise for bids soon as weather conditions will warrant. Following the Bellevue-Newport paving will be 2 miles paving on East Valley rd., no. of Pierce Co. line.

Wash., Spokane—Spokane Co. brought 1922 road program to near the $1,000,000 mark when Commrs. voted $140,000 for work on Deer Pk. Hwy.

Wash., Wenatchee—Chelan County is planning extensive program of road impvts. to cost about $500,000. It is planned to finish the 12 miles of pavement betw. Wenatchee and Cashmere on Sunset Hwy.; also lower portion of Blewett Pass Hwy. will be graded and surfaced.

W. Va., Richwood—City will grade and pave road leading from city to Dain along Riverside Dr. on Greenbrief Rd. on roads of upper South Richwood, etc., also construct bridges. Will vote Nov. 29 on $40,000 bonds.

Wis., Juneau—Dodge Co. Bd. voted a $950,000 road constr. program for 1922 under bond issue of $5,-200,000. Following roads are to be constructed: Completion of Waupin-Beaver Dam road, conc.; Randolph-Beaver Dam Rd. work; South Beaver-Dam Rd., conc.; Juneau-Hustisford Rd., 18 ft. conc.; Clyman-Columbus Rd., 18 ft. conc.; Rubicon Rd., conc.; Horicon-Iron Ridge Rd., conc.; Fond du Lac—Milwaukee Rd., conc. E. T. Klug, Juneau, Commr.

Wis., Lake Geneva—County program calls for 32 miles conc. road construction. Concrete rd. from Lake Geneva to Walworth, costing $280,000, and conc. rd. from Lake Geneva to Springfield, as part of the $1,590,000 Walworth Co. rd bldg. program for 1922.

Wis., Madison—Following counties appropriated funds for purchase of road bldg. machy. as follows: Richland Co., $15,000 for rd machy., inculd'g large grader, 6 patrol graders and possibly steam shovel. W. V. Robinson, Richland Center, Commr.; Ashland Co., $10,000, W. E. Dillon, Highbridge, Commr.; Hewaunec, $1,000, Moses Shaw, Algoma, Commr.; St. Croix Co., $10,000, for rd. machy., including heavy grader, wheelers and slips, Joe Caffrey, Hammond, Commr.; Pierce Co., $5,000, C. F. Kenall, Ellsworth, Commr.; Chippewa Co., $8,000, P. O. Lokrantz, Chippewa Falls, Commr.; Eau Claire Co., $20,000, Gay Osborne, Eau Claire, Commr.; Barron Co., voted to purch. gravel crusher, tractor, graders, trucks and other tools for 1922, Ed. Gleason, Barron, Commr.; Price Co., $14,000, for grav. rds. and $10,095 for fed. aid projs. on St. Trunk 13, Westboro-Prentle Rd., B. W. Griffin, Co. Hwy. Commr.; Lincoln Co. Bd. $400,000 for hwys. and bridges in county for 1922, H. H. Kuehling, Co. Hwy. Commr., Merrill.

Wisconsin—Road Machinery: (Lancaster) Grant County Board appropriated $13,500 for equipping county repair shop with machine tools and for petroleum machinery, Henry Mink, Commr.; (Green Lake) Green Lake Co. Bd. approp. $18,000 for equipp'g co. repair shop with mach. tools and for gravel loaders & crushers. D. C. Williams, Commr. Green Lake; Trempealeau Co. Bd. appropriated $20,000 for purch. large grader & tractor and other rd. mach. E. F. Rotering, Commr. Whitehall; Taylor Co. Bd. approp. $15,000 for purch. of various kinds rd. machy. C. Keinhofer, Commr., Medford; Jefferson Co. Bd. approp. $13,000 for purch. of new rd. machy. R. D. Royce, Ft. Atkinson; Adams Co. Bd., $1,000 for purch. of rd machy. J. A. McGregor, Friendship; Clark Co. $13,000 for purch. of screen'g plant, small crusher, scarifier and tractor. Otto Weyhmiller, Neillsville, Commr.; Columbia Co. Bd., $35,000 for purch. of rd. machy. J. T. Henton, Court House, Portage; Pepin Co. voted $1,500 for rd. machy., Gale A. Goes, Durand, Commr.; Vernon Co. Bd. approp. $3,100 for new rd machy. Alex. Ristow, Commr., Ciroqua; Price Co. Bd. appropriated $8,000 for purch. of crusher, tractor, graders and wheelers for 1922, B. M. Griffin, Commr., Phillips; Douglas Co. Bd. $15,000 for new rd. machy.; Winnebago Co. $5,000 for new rd. machy., including one paver, Jas. Binning; Oshkosh Co. Bd. approp. $90,000 for purch. of rd. machy., includ'g crusher outfit and other equipt., W. F. Meyer, Shawano, Commr.; Fond du Lac, Wis. Co. Bd., Fond du Lac County, voted to purch. dragline, conveyer, grizzley, bins and screen for gravel plant, Geo. Treleven, Fond du Lac, Commr.; Lincoln Co. Bd. voted $10,000 for purch. of rd. machy., including patrol graders and other small equipment, H. K. Kuehling, Merrill, Commr.

SEWERAGE AND SEWAGE TREATMENT.

Cal., Los Angeles—Plans completed by City Engr. Jno. A. Griffin, for the constr. of the proposed Arroyo de la Sacatela storm sewer sys., which will necessitate laying 37 miles pipe lines. Est. cost $2,500,000. Actual work of installing the system will start about Feb. 1st if everything runs smoothly and proj. is not delayed by reason of majority protest, which is not likely, as absolutely necessity of impvt. is generally acknowledged by the people. System will be established in northwestern section of city. Pipe will vary in size from 18 ins. in diam. to an outfall conduit 11 ft. high and 20 ft. wide.

Cal., Piedmont—$65,000 bonds voted here for constr. of an outlet sewer from lower Piedmont to estuary.

Cal., Richmond—San Pablo sanitary district is being formed to carry out establishment of sewer system for all the north environs of Richmond, the fall of which is toward San Pablo bay.

Cal., San Diego—Engr. Dept. preparing plans for 10-in. sewer to be built down Powder canyon thru Balboa park. New sewer is intended to provide sewerage facilities for large territory no. of park that is now served only by septic tanks.

Ont., Brantford—City Council intends to construct storm sewers in various streets at estimated cost of $30,694. City Clerk, K. F. Leonard.

Ont., Hamilton—Constr. of sewer at cost of $150,-000 in Paradise Rd. from King Street for 2,000 ft. north, is being considered by City Council. E. C. Gray, Engr.

Ont., London—Bd. of Works recommended to City Council the constr. of a $200,000 storm sewer system to serve the Pine Lawn survey of Housing Comn. Bd. will also ask City Council for $130,000 for sewers in vicinity of Duchess Ave. and Emery St., So. London. Plans being prepared for another $271,000 storm sewer system for High St. Dist., work on which will start in spring. City Engr., H. A. Brazier.

Fla., Dunedin—Sewer and street impvt. work planned for Dunedin will call for expendt. of more than $100,000. Geo. S. Iredell, Tampa, Engr.

Fla., Inverness—$75,000 sewer and water bonds voted; constr. 5 miles sewers and 5 miles water works.

Fla., Lakeland—City plans to extend sewer system including additional sewers at cost of $144,000. C. D. Mendenhall, City Engr.

Ida., Coeur D'Alene—Council has ordered installation of sewer system in northern section of city. Est. cost, $100,000.

Ky., Ashland—(H. R. Dysard, Mayor) will install and extend sewers. $250,000 bonds voted.

Ky., Paducah—City will construct trunk line sewers, install laterals and drains in Dist. No. 3. $600,000 bonds voted. Alvord and Burdick, Cons. Engrs., Chicago, Ill. F. W. Katterjohn, Mayor.

Mass., Andover—Bldg. of sewers is planned here. Abt. $250,000. Engineer not announced.

Mo., Joplin—Following appropriation of $25,000 by City Comn., City Engrg. Dept. announces that work will begin on the $35,000 Turkey Creek septic tank as soon as weather is favorable. Urias Johnson,

BUYERS' GUIDE

Dust Laying Compound.
The Barrett Co.
Standard Oil Co. (Indiana)
The Texas Co.

Dynamite.
E. I. du Pont de Nemours & Co., Inc.

Edge Protector.
Truscon Steel Co.

Electrical Wires & Cables.
American Steel & Wire Co.

Elevating Graders.
Austin-Western Road Machinery Co.

Elevators.
C. H. & E. Mfg. Co.

Engineering Instruments.
Kolesch & Co.
Lufkin Rule Co., The

Engines.
C. H. & E Mfg. Co.
Midwest Engine Co.

Excavating Machinery.
F. C. Austin Machinery Co.
Pawling and Harnischfeger.
Sauerman Bros.
Smith Co., T. L. The

Expansion Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
Truscon Steel Co.

Explosives.
E. I. du Pont de Nemours & Co.

Fence, Iron.
Cincinnati Iron Fence Co.

Fillers (Paving Joint).
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Fire Brick.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Flue Liners.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Forms, Sidewalks, Curb & Gutter.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms, Road.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Forms (Sewers & Conduits).
Heltzel Steel Form & Iron Co.

Forms (Wall Bldg., Construction, Etc.).
Heltzel Steel Form & Iron Co.

Gas Pipe.
U. S. Cast Iron Pipe & Fdy. Co.

Graders.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Granite Block.
Granite Paving Block Mfrs. Assn. of the U. S., Inc.

Gravel Screener and Loader.
Good Roads Machinery Co., Inc.
Jordan & Steele Mfg. Co., Inc.

Heaters (Rock and Sand).
Littleford Bros.

Heating Wagons (Oil and Tar).
Good Roads Machinery Co., Inc.
Littleford Bros.

Hoists (Concrete, Gasoline and Hand).
Pawling and Harnischfeger.

Hoists, Electric.
Mead-Morrison Mfg. Co.
Pawling and Harnischfeger.

Hoists, Steam.
C. H. & E. Mfg. Co.
Lewis-Hall Iron Works.
Mead-Morrison Mfg. Co.

Hot Mixers.
F. C. Austin Machinery Co.

Hydrants.
The Flower Company.

Inlets (Sewer).
Dee Co., Wm. E.
Madison Foundry Co.

Insulating Material.
The Barrett Co.
Pioneer Asphalt Co.

Joint Fillers (Paving).
The Barrett Co.
The Texas Company.

Kettles (Portable).
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Loaders.
Brown Portable Conveying Machine Co.

Manhole Covers.
Madison Foundry Co.
Dee Co., Wm. E.

Mastic.
Pioneer Asphalt Co.

Meter Boxes.
McNutt Meter Box Co.

Mixers, Asphalt.
Austin Machinery Corporation.
Cummer & Sons Co., The F. D.

Mixers, Concrete.
Austin Machinery Corporation.
Koehring Machine Company.
T. L. Smith Co.

Mixers—Mortar.
C. H. & E. Mfg. Co.

Molds (Pipe & Culvert).
Heltzel Steel Form & Iron Co.

Motor Fire Apparatus.
Acme Motor Truck Co.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Trucks.
Acme Motor Truck Co.
Duplex Truck Co.
Diamond T Motor Car Co.
Federal Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Motor Truck Flushers, Sprinklers and Oilers.
Acme Motor Truck Co.
Austin Machinery Corporation.
Diamond T Motor Car Co.
Duplex Truck Co.
Federal Motor Truck Co.
Garford Motor Truck Co., The
The Gramm-Bernstein Motor Truck Co.
International Motor Co.
Kissel Motor Car Co.
Lewis-Hall Iron Works.
Packard Motor Car Co.
Pierce-Arrow Motor Car Co.

Municipal Castings.
Dee Co., Wm. E.
Madison Foundry.

Packing.
Pioneer Asphalt Co.

Paints (Asphalt).
Barrett Co., The
Pioneer Asphalt Co.

Paving Blocks (Creosoted).
The Barrett Co
Republic Creosoting Co.

Paving Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
National Paving Brick Mfrs. Assn.
Springfield Paving Brick Co.

Paving Contractors.
Warren Bros. Co.

Paving Joint Compound.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Joint Filler.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Company.

Paving Machines.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Warren Bros. Co.

Paving Plants (Asphalt).
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Smith Co., T. L. The
Warren Bros. Co.

Pipe Cutters.
W. W. Strickler & Bro.

Pipe Dip and Coatings.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.

Pipe Manufacturers.
U. S. Cast Iron Pipe & Fdy. Co.

Pitch Filler.
The Barrett Co.
Warren Bros. Co.

Plows (Rooter and Wing).
Austin-Western Road Cach. Co.

Portable Paving Plants.
Austin Machinery Corporation.
Cummer & Son Co., The F. D.
East Iron & Machine Co., The
Good Roads Machinery Co., Inc.
Littleford Brothers.
Warren Bros. Co.

Portable Stone Bins.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.

Powder (Blasting).
E. I. du Pont de Nemours & Co., Inc.

Pumps.
C. H. & E. Mfg. Co.
De Laval Steam Turbine Co.
Harris Air Pump Company.
Midwest Engine Co.
Smith Co., T. L., The

Reinforcing For Pavements.
American Steel and Wire Co.
Truscon Steel Co.

Road Building Material.
Kentucky Rock Asphalt Co.
The Texas Co.

Asst. City Engr. will have charge of the constr.

N. J., Newark—Engineers are urging Passaic Valley Sewerage Comn. to apply to War Dept. for permission to use Newark Bay as temp. outlet for trunk sewer, and ask that $2,000,000 be appropriated for completion of outfall work to Robin's Reef in New York Bay.

N. C., Enfield—City will expend $190,000 to construct sewerage, water and elec. lighting systems. Wm. C. Olson, Cons. Engr.

N. C., Mount Holly—City will expend $95,000 to install sewer and water systems. Carolina Engrg. Co., Engrs., Wilmington, N. C.

Okla., Devol—City will construct sewer system. $50,000 bonds issued.

Pa., Harrisburg—State health authorities have approved plans for extensions of sewers systems in W. Chester, Sayre, Carlisle, Charleroi, Grove City, New Castle, Youngsville, Sewickley and Carnegie.

Pa., Phila.—Plans drafted by Dept. Pub. Wks. for constr. of 8 main sewers; $920,000 available for project.

S. C., Charleston—City will purchase and establish sewer system. $500,000 bonds voted.

S. C., Greenville—City considering enlarging sewer system; plans voting on $100,000 bonds.

Tex., Brownsville—$75,000 bonds voted for constr. of sewage disp. plant here. Bids in Feb., 1922. J. A. Spencer, City Engr.

Tex., Fort Worth—$725,000 sewage disposal plant will be constructed here. Hawley & Sands, Ft. Worth, Engrs.

Va., East Radford—City will sell $150,000 bonds to construct sewers, repave streets, etc.

Va., Richmond—Mayor Ainslie approved resolution providing for construction of sewer; $200,000 available for impvts.

Va., So. Norfolk (Norfolk P. O.)—City will improve sewer system and streets. $300,000 bonds voted. F. L. Rowland, Mayor.

Wis., LaCrosse—Plans completed for trunk sewer and laterals in 16th St. from Mississippi to Green Bay Sts., lats. on Johnson, Adams and Hood Sts. City Engr., Geo. F. Bradish. Abt. $88,000. City Clk., M. Birnbaum.

Wis., Plymouth—City will issue $36,883 bonds for sewage disp. sys. Jerry Donahue Engrg. Co., Sheboygan, will prepare plans this winter.

WATER SUPPLY AND PURIFICATION

Ont., Almonte—Plans will be prepared for water works system to cost $300,000 for town. James, Proctor and Redfern, Ltd., Cons. Engrs., Excelsior Life Bldg., Toronto.

Ont., Petrolia—It is proposed to install elec.-driven pumps at pumphouse at Lake Huron and to constr. million-gal. auxiliary reservoir for town. Est. cost $42,000. James, Proctor & Redfern, Engrs., in charge of work. Constr. will commence early in 1922.

Fla., Tallahassee—Prelim. surveys for extensive hydro-electric plant, to be established on Ocklocknee River, 12 miles no. of here, started by corps of experts under direction of Guy Winthrop.

Ga., Atlanta—City will offer for sale bonds totaling $8,850,000 which consist of four items: Schools, $4,000,000; water works, $2,850,000; sewers, $1,250,000, and Spring St. viaduct, $750,000. In water works department impvts. will consist of following: Intake basin at river from which water will be taken, mud allowed to settle before water is pumped to Hemphill station; 48-in. main from river sta. to Hemphill sta., present equipt. being 30-in. and 36-in. main; additional pumps at river sta.; enlarged coal storage facilities and automatic stokers and enlarged boilers at both stations; enlarged boilers at both stations; enlarged distribution sys. thru city, enlarged filter plant at Hemphill station and enlarged clear water basin at Hemphill station.

Kans., Pratt—Benham & Mullergreh, Cons. Engrs., Kans. City, Mo., retained by City as Cons. Engrs. for development of new water supply and extensions and impvts. to water plant and system. Est. cost $100,000. N. S. Young, City Clk.

Ky., Hazard—City will install water works. $75,000 bonds voted.

N. C., Mt. Holly—City will expend $95,000 to install water and sewer systems. Carolina Engrg. Co., Engrs., Wilmington, N. C.

Okla., Chickasha—City will extend water and sewer systems. $50,000 bonds voted. Jno. C. Milliken, City Engr.

Okla., Hobart—Water works bonds voted here in sum of $110,000 and sewer bonds $12,000—total of $122,000.

Okla., Okla. City—In order to put sewer system into operation it is proposed to lay 22 miles of 6-in. water mains and one mile 3-in. mains. Est. cost $210,000. Valves and special attachments will cost approx. $61,000. New fire hydrants approx. $9,792. A. S. Holway, Supt. Water Dept.

Okla., Tulsa—City Comn. plans to improve Spavinaw water supply project; will constr. 50-ft. dam on Spavinaw Crk.; 55-mile conduit furnishing daily maximum supply of 25,000,000 gals. to connect water by gravity to point 5 miles from city; erect high pressure distribution pumping station to lift water 300 ft. to high pressure distribution reservoir; construct Tiawah Tunnel. J. D. Trammell, Cons. Engr., Ft. Worth, Tex. (Holway Engrg. Co., 332 Atco Bldg., Tulsa; Pres., W. R. Holway.)

Ore., Portland—Water Dept. considering constr. of 1st unit of proposed third pipe line from Bull Run headwks., 30 miles east of Portland, to reservoirs at Mt. Tabor. Completed pipe line, estimated to cost $2,000,000. Fred M. Randlett, Chf. Engr. Water Bureau.

Pa., Harrisburg—State health authorities have approved plans for impvt. of water systems in Bolivar, New Kensington, Du Bois, Indiana, Freeport and Downingtown, Penn. New Holland authorized to add 2 springs to town's water supply.

Tenn., Memphis—Geo. W. Fuller, of Fuller & McClintock, Cons. Engrs., New York City, retained by Water Comn. to make survey of available water supplies in city. Work will be done prior to extensive impvts., contemplated in Memphis artesian water system and for which bond issue of $2,000,000 was authorized by last legislature. F. G. Proutt, Chrmn. Water Comn.

Tex., Cameron—City Council has accepted report of J. D. Fowler of the Engineers' Serv. Corp. Dallas, on probable cost of new water and light plant for city, also sewerage exten. and sewage disposal plant. Est. cost $200,000.

Tex., Cleburne—City Water Comn. (Mr. Hockaday, Supt.) will improve water works; plans impounding Brazos River for permanent water supply. Burns & McDonnell, Engrs., Kans. City, Mo.

Tex., Coleman—City (E. P. Scarborough, Mayor) will enlarge water supply; construct reservoir. Vote Dec. 20 on $160,000 bonds. W. E. Dickerson, Engr.

Tex., Corpus Christi—City will lay 6-in. mains and install fire hydrants in Nueces Bay Heights.

Tex., Gatesville—Election carried for issuance of $425,000 bonds; funds to be used for bldg. adequate water sys. or purchasing and improving the one now in operation.

Tex., Greensboro—City (P. C. Painter, City Mgr.) will expend $300,000 to extend water works; constr. dam and filtr. plant, extend mains.

Tex., Marlin—City will install water works, construct reservoir, standpipe and mains. L. Goodrich, City Engr.

Tex., Pampa—$80,000 bonds voted here for water works.

Tex., Port Arthur—City will extend water mains. $123,791 bonds voted. E. R. Thomas, Clk.

Wn., Walla Walla—New plans for water works extensions are expected to reach Walla Walla within a few days. W. Craig Ferguson, Commr. of Finance. Ernest B. Hussey, Engr., Seattle, reports plans nearly finished. If received soon it may be possible to open bids about January 1st.

W. Va., Elkins—Work will be started at once on constr. of water and filtr. plant to cost $125,000.

Wis., Cedar Rapids—Will ask bids in Spring for reservoir, Grand Ave. near Bever Ave. Engrs., Holmes & Anthony, 323 Masonic Temple, Cedar Rapids. 226-ft. diam. Election in March on $300,000 bond issue. L. J. Storey, City Clk.

Wyo., Guernsey—Water users of No. Platte Valley authorized constr. of dam and power plant to cost $2,000,000.

BUYERS' GUIDE

Road Binder.
The Barrett Co.
Pioneer Asphalt Co.
Standard Oil Co. (Indiana)
The Texas Co.
Uvalde Asphalt Paving Co.
Warren Bros. Co.

Road Forms.
Heltzel Steel Form & Iron Co.
Truscon Steel Co.

Road Graders.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Road Machinery.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The
Cummer & Son Co., The F. D.
Good Roads Machinery Co., Inc.
Littleford Brothers.
Midwest Engine Co.
Warren Bros. Co.

Road Planer.
Austin-Western Road Machinery Co., The

Road Oil and Preservatives.
The Barrett Co.
Standard Oil Co (Indiana)
The Texas Co

Road Rollers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Rock Crushers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Roofing Material.
The Barrett Co.
Pioneer Asphalt Co.
The Texas Co.
Warren Bros. Co.

Sand Dryers.
Cummer & Son Co., The F. D.
Littleford Brothers.

Sanitary Supplies.
Integrity Chemical Co.

Saw Rigs.
C. H. & E. Mfg. Co.

Scarifiers.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Drag Line.
Pawling and Harnishchfeger.
Sauerman Bros.

Scrapers, Graders, Plows, Etc.
Austin-Western Road Machinery Co., The
Good Roads Machinery Co., Inc.

Scrapers, Power.
Sauerman Bros.

Sewage Treatment.
Direct Oxidation Process Corp.

Sewer Braces.
Kalamazoo Fdry. & Mach. Co.
Dee Co., Wm. E.
Madison Foundry Co.

Sewer Cleaning Machinery.
Stewart, W. H.

Sewer Forms.
Heltzel Steel Form & Iron Co.

Sewer Pipe.
Cannelton Sewer Pipe Co.
Dee Clay Mfg. Co., W. E.

Sewer Rods.
Stewart, W. H.

Slide Rules.
Kolesch & Co.

Sluice Gates.
Coldwell-Wilcox Co.

Snow Removal Machinery.
Austin Machinery Corporation.
Good Roads Machinery Co., Inc.
Phoenix Mfg. Co.

Soaps—Liquid.
Integrity Chemical Co.

Special Castings.
The Flower Company.
U. S. Cast Iron Pipe & Fdy. Co

Sprinklers.
Austin Machinery Corporation.
Austin-Western Road Machinery Co., The

Steel Joists, Studs and Sash.
Truscon Steel Co.

Steel Tapes.
Kolesch & Co.
Lufkin Rule Co., The

Stone Crushers.
Austin-Western Road Machinery Co., The

Stone Elevators.
Austin-Western Road Machinery Co., The

Stone Spreaders.
Austin-Western Road Machinery Co.
Burch Plow Works Co.

Stone Screens.
Austin-Western Road Machinery Co.
Good Roads Machinery Co., Inc.
Littleford Brothers.

Street Cleaning Machinery (Horse Drawn).
Austin-Western Road Machinery Co.

Street Flushers (Horse Drawn).
Austin-Western Road Machinery Co.

Street Paving Material.
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Street Sprinklers (Horse Drawn).
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Structural Steel.
Lewis-Hall Iron Works.

Surveyors' Instruments.
Kolesch & Co.
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Tamping Machines.
Pawling and Harnischfeger.

Tanks, Water Supply.
Mensch, L. J.
Littleford Brothers.

Tar and Pitch.
The Barrett Co.

Tar Heaters.
Littleford Bros.

Tarvia.
The Barrett Co.

Testing Chemists.
Dow & Smith.
Walter H. Flood.
Howard, J. W.
Kirschbraun, Lester.
Van Trump, Isaac.

Traction Engines.
Austin-Western Road Machinery Co.

Traction Engines (Oil or Kerosene).
Austin-Western Road Mach. Co.

Tractors.
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Trailers.
Lee Loader and Body Co.

Trench Braces.
Kalamazoo Fdry & Mch. Co.

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Austin Machinery Corporation.
Kalamazoo Fdy. & Machine Co.
Pawling and Harnischfeger

Turbines, Steam.
De Laval Steam Turbine Co.

Valves.
Coldwell-Wilcox Co.
The Flower Company.

Wall Coping.
Cannelton Sewer Pipe Co.

Warrenite.
Warren Bros. Co.

Water Main Cleaning.
National Water Main Cleaning Co.

Water Pipe.
U. S. Cast Iron Pipe & Foundry Co.

Waterproofing.
Barber Asphalt Paving Co.
Barrett Co., The
Pioneer Asphalt Co.
The Texas Co.
Truscon Steel Co.

Water Purification.
Direct Oxidation Process Corp.
Pennsylvania Salt Mfg. Co.

Water Softener.
The Refinite Co.

Water Works Supplies and Equipment.
Coldwell-Wilcox Co.
The Flower Company.
Mueller Mfg. Co.
Pennsylvania Salt Mfg. Co.

Wheeled Scrapers.
Austin-Western Road Machinery Co.

Wire Rope.
American Steel & Wire Co.

Windows (Steel).
Truscon Steel Co.

Wire-Cut Lug Brick.
Medal Paving Brick Co.
Metropolitan Paving Brick Co.
Murphysboro Paving Brick Co.
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Barrett Co., The
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