1881.

MUNICIPAL PUBLIC WORKS

A DISCUSSION OF MATTERS OF INTEREST to MUNICIPAL OFFICIALS

By ERNEST McCULLOUGH

1900

SAN FRANCISCO 1887 LEWISTON 1898

ERNEST M'CULLOUGH

Late Consulting Engineer to the Merchants' Association of San Francisco, Cal.

LEWISTON, IDAHO

Consulting and designing engineer for Municipal Works and Improvements. Old waterworks plants economically developed. Estates drained, irrigated and improved. Construction superintended.

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A STREET IN SHAKESPEARE'S TIME.

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MUNICIPAL PUBLIC WORKS

AN

ELEMENTARY MANUAL

OF

MUNICIPAL ENGINEERING

BY

ERNEST M'CULLOUGH, C. E.

AUTHOR OF

Country Roads; Farm Drainage; Topographical Surveying; The Vrooman Act; etc., etc.

1900

A. S. ALOE COMPANY,
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1900.

This Work is
Affectionately Dedicated to
MY FATHER.

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PREFACE TO "PUBLIC WORKS."

The following articles were written for the trustees of a California town, the intention being to discuss from an engineer's standpoint, the various problems with which the trustees would have to deal. As the subjects of municipal ownership and bonds are economic propositions it has been considered that there is nothing amiss in an engineer having his say about them.

In the belief that many municipal officers would appreciate the work the articles are now published. It is hoped they may prove useful to some.

San Francisco, Cal., Sept. 1894.

THE AUTHOR.

PREFACE TO SECOND EDITION.

There still exists an inquiry for the little work which met with a reception so gratifying to the author and as the book is out of print it has been entirely re-written in this new edition and the title changed to better express the character of the work.

The number of pages has been more than doubled and a few illustrations added. Chapter IV. is entirely new. Chapter V. containe the gist of the matter in the former Chapters V., VI., VII. Chapter VI. contains practically all that was in the former Chapters VIII. and IX. together with much new matter—but the opinion of the author on municipal ownership has undergone no change in six years although he has altered his ideas on many other points.

Chapter VII. has been written for the engineers of small towns, who were the most appreciative and numerous purchasers of the former edition, and contains much of the matter given in Chapters V., VI. and VII. of the first edition, together with new matter of interest to engineers only.

The book however is not written for engineers but for non-technical readers for whom it may be a primer in municipal engineering. The subjects discussed come under the jurisdiction and control of thousands of men annually elected by their fellow-citizens to positions of trust and honor, but who generally are not well enough acquainted with such matters to deal intelligently with them.

Lewiston, Idaho, June 1900.

THE AUTHOR.

WATER TANK WITH STEEL TOWER

Cut loaned by the W. E. Caldwell Co., Louisville, Ky.

MUNICIPAL PUBLIC WORKS

CHAPTER I.

CONCERNING STREETS. Perhaps a logical method of treating the subject of streets would be to commence with the laying off of the town, next take up the subject of grades and then discuss the various methods of improvement, commencing with the cheapest, and thus step by step parallel the steps taken in the improvement of the thoroughfares of a city.

But the streets have already been laid out. The cupidity of the owners of the land or the advice of the real estate agent fixed the lines. The grades were perhaps left to take care of themselves. The question of getting out of the mud in winter and the dust in summer concern the people far more than anything else at the time we step in to advise on the subject of "fixing up" the streets. Therefore the truly logical method is to commence with materials and say a few words later about grades and lines.

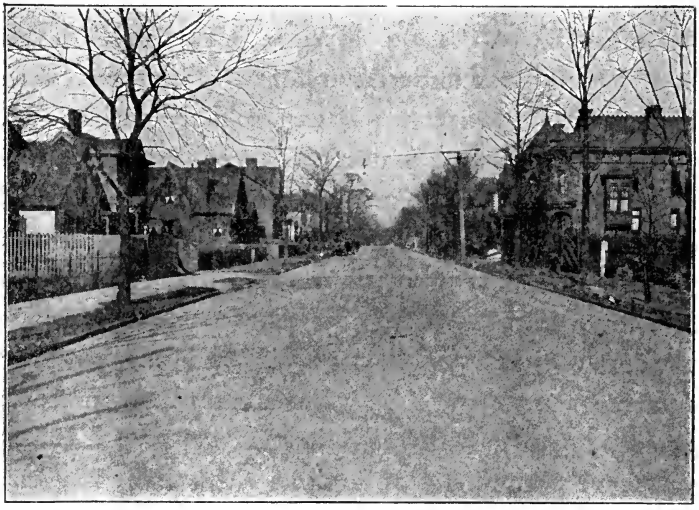
It is an axiom in street paving as in all other work that the material cheapest in first cost is the most expensive in the cost of maintenance. Therefore when improving a street get the best pavement which the taxpayers can afford. But it is sometimes cheaper to put down something to be replaced

later by the best rather than wait indefinitely for improvement. A first-class pavement may mean bankruptcy to many property owners and the effect be to retard improvement and thus delay the progress of a town, while a cheaper pavement would arouse enthusiasm and cause many other parts of town to be improved.

It is easy to generalize and easy to give the experience of other cities. The average taxpayer will not take any other person's word, but will judge for himself when it comes to spending money for improvements. If a desire for improvement is manifested it is a wise lot of City Fathers who will allow the property owners, to be taxed for an improvement, to vote on the material to be used. Of course it is premised that an endeavor has first been made to educate the property owners on the merits of the various materials and then if a mistake is made "I told you so" is a sweet remark to repeat a few times later on. But rather than kill the desire for improvements by advocating high priced pavements remember the German proverb "best kills better," and seek merely for improvement until conditions render perfection possible.

Away from cities with good railroad communications the question of material is entirely local. Where one material can be laid down as cheaply as another the fancy of the individual may be indulged and the city streets be a patchwork if the people vote that way. But when freight rates are high and first-class material is imported at great cost the question is a burning one. This should be remem-

bered in reading articles on paving in magazines and other publications. The writer in New York or London cannot settle the matter nearly as well for the people of Timbuctoo as the people of Timbuctoo can themselves after they have had some little education and have a slight idea of the comparative merits of all materials used. A little knowledge is a dangerous thing and the little knowledge



AN ASPHALT STREET

possessed by the average citizen on the subject of paving has been responsible for the mis-spending, stealing and otherwise wasting of millions of dollars of good money on worthless pavements. Still every citizen believes he knows all that is to be known on the subject after a hasty jaunt through a few cities. And the little knowledge possessed by many City Fathers (obtained at large cost to the taxpayers by

jaunting trips—investigating tours, save the mark) has proven dangerous alike to the purses, streets and consciences of the people. But a little—a very little—more knowledge may be useful and saving. "It is not knowledge," said the wise old bishop of Canterbury, "that makes a man conceited, but the want of it."

Gravel is the first thing tried. There is one kind which is very fine and has sharp edges. It is not rounded like marbles and cobblestones and is pretty good material to use on streets with little travel. But it is the most expensive form of improvement which the taxpayer can fool with. If rounded river gravel is used there is no improvement at all. When stone is used it should pack and bind by reason of the corners and angles interlocking and preventing a movement. But if the stone have rounded sides and there are no angles and corners it must hold together by some binder or cementing material. If this cementing material sets and never softens, as in the case of cement, then there can be no objection. But if it is a clay or earth which will soften when wet the stone gets a chance to move around and the larger ones work to the top by reason of the smaller ones sliding under first one side and then the other, the cementing material acting as a lubricant. Yet many people use gravel and advocate its use because "it will let the water through." This after a century of education in roadmaking.

It is well and highly desirable that the earth on which the road metalling rests should be porous and

easily drained, but the endeavor of the road engineer is to get an impervious covering which is termed "metalling" when composed of gravel, cinders, stone, etc., and which is termed "paving" when composed of something more durable and neater. If the edged gravel can be obtained easily and at a low cost it may be used by placing it on the road in layers of from two to three inches in thickness and covering it an inch deep with sand. Then wet it and roll it thoroughly. It cannot be rolled to much. It is not advisable to make the total thickness much over six inches. The foundation should be well compacted before the gravel is put on.

The only way to use rounded gravel is to put it through a rock crusher and when it gets through call it macadam and put it on the road in accordance with the best possible specifications for macadamizing. It may be pretty good then. And this brings us to macadamizing, one step farther in street improvement.

It is an old story how MacAdam went through England in the early part of this century and renovated the roads of that country. How he took the roads which annually had enough broken stone and gravel dumped in to make them good and yet with each load became worse, and fished the stone out of the mire and mud and cracked it into small pieces and put it back again properly. How he became famous and his roads became famous because he possessed a vast amount of common sense. Hence it is that streets and roads improved by placing on them regular layers of broken stone thoroughly

rolled, are said to be macadamized. MacAdam placed the stone on the natural earth after rolling it until it was hard. Another method called Telford, after the engineer of that name, is to excavate the road some depth and roughly pave it with large stone to form a foundation. Then on this foundation place the crushed rock (broken stone) in regular layers well rolled. As to which method to adopt local considerations must influence.

When the gravel has been tired of and a better pavement or covering for the street is desired the question of material is agitated. It is first necessary to decide between macadam or something else. The arguments for macadam are few when its use in a city is considered. It is cheap in priee, that ,is first cost is low, but expense of maintenance high, though not so high as gravel. It is a good hing when the people are unable to pay for anything bet ter or think they are unable to pay for anything better. Properly made it should be several hundred per cent. better than the best maintained earth or gravel road and can be kept fairly good looking under considerable travel. Sometimes it is an excellent thing to commence improving the streets with and when worn down to a thickness of six or eight inches it can be cleaned off and a covering of good pavement laid on it. Though it must be borne in mind that in such event if any openings are made in it for sewer or gas or water connections the pavement can never be replaced over the cut and kept in good shape afterwards. To replace the material the earth should be well tamped back in

place and a shoulder cut in the macadam around the end of the opening and a concrete covering substituted at that place instead of the macadam. If there is any sinking afterward in the trench the concrete will prevent the pavement sinking or giving way. While not possessing all the advantages of a pavement, macadam has been fairly satisfactory in many places.

A good macadam street is composed of broken stone in three layers usually. The first layer should be half the total thickness of the completed job. It should be covered with about half an inch of clear sand or stone dust which should be wet as thoroughly as possible and then rolled until a narrow tired wagon loaded with about a ton in weight can be hauled over it without materially disturbing the surface. The stone in this layer should not exceed a four inch cube and there should be no fine stuff or dust and the various sized material should be well distributed. The second layer should be composed of stones not larger than a two inch cube and this layer should be about one-third the total thickness of the completed job. It should be also covered with the half inch of sand or rock dust and rolled as the first one. The third layer should complete the job and be composed of stone running from half an inch to one inch cube, the larger size predominating. This should be covered with an inch of sand, not rock dust, and thoroughly wet and rolled until the surface is hard and smooth.

For repairs the city should own a rock crushing plant and road roller, for no street lasts forever.

The "stitch in time" method of repairs is the best and cheapest. The City of Lewiston, Idaho, received in May, 1900, bids for the following outfit: A five ton reversible horse roller, a rock crusher with a capacity of eight tons per hour, a twelve horse power portable engine and a long elevator and a revolving screen for separating the different sizes of stone. The bids ranged from $2,473 to $3,350. Bids for ten ton steam rollers ranged from $2,450 to $3,750 laid down in Lewiston. An idea can thus be had of the possible cost o such an outfit. It is an advantage for a city to own such a plant and rent it to contractors who do work so that by this means competition can be had which will serve to reduce the cost of street work. This is an encouragement for the energetic men with small capital and keeps money at home. Or the city can crush the stone and sell it at cost to the successful bidder besides having all on hand that is needed for repairs. There are few better investments for a city. Even after it grows beyond macadam the plant will be needed for concrete.

A light roller—five tons at least—will do as good work as a heavy roller but the material should go on in thinner layers and the work takes longer, therefore the light roller is the more costly to use A steam roller will do more and better work than a horse roller for the same money—in ordinary cases. But a steam roller costs from five to six times as much as a horse roller and unless it is pretty constantly in use is apt to be a white elephant for a small town. It takes high priced men to run it and

such men cannot always be obtained when needed. Unless it is well housed and thoroughly cleaned and looked after when used it will be ruined. If it weighs more than seven tons careful regulation of the laying of water pipes is needed as it is apt to open the joints if the pipes are laid close to the surface.

A horse roller should not be less than five tons nor more than seven tons in weight, be reversible and have little wood work. A two dollar man and cheap rented horses can operate it. When through with a job the roller can be left on a vacant lot until needed elsewhere (although the writer does not advocate such methods of dealing with machinery). When needed again it requires only a little greasing to make it as good as new.

For a citizen, or a contractor either, having only occasional use for a roller a five or seven ton horse roller is best. If there is contant, or almost constant, use for the roller then it is a vain and foolish and expensive thing to use a horse roller. And when getting a steam roller get the heaviest the street can stand.

OTHER PAVING MATERIALS

The considerations influencing the adoption of materials for paving, apart from strictly local considerations, which we will take up later, are as follows. Appearance, ease of traction, cleanliness, healthfulness, noise and cost. A perfect pavement is durable, noiseless, cleanly, healthy,

easy for purposes of travel and cheap. The perfect pavement has not yet been discovered.

The loads which a horse can draw on a perfectly level roadway, each day of ten hours is given by Haswell, as follows, for the materials mentioned:

Asphalt 6,095 lbs; stone block 3,006 lbs; ordinary stone block 1,828 lbs; hard macadam 1,391 lbs; hard gravel 1,279 lbs; hard earth 1,193 lbs; worn stone block 1,137 lbs; cobble stone 730 lbs; ordinary earth 456 lbs; sand 228 lbs. Brick is not given but it is close to asphalt.

The following figures given by asphalt companies show the comparative cost of haulage on streets paved with various materials. There is little reason to doubt their close agreement with observation even if presented by parties advertising a particular material.

Cost to move one ton one mile by horse power (estimate made in Indiana); asphalt 2.7 cts; block stone pavement (average) 5.3 cts; macadam in good order 8.0 cts; gravel road 8.8 cts; earth road, hard and dry 18 cts; macadam with ruts 26 cts; wet sand 32 cts; earth road with ruts and mud 39 cts; dry sand 64 cts. Again there is no mention of brick but it is close to asplalt.

Next there is the question of slipperyness on pavements. From observations made in various cities in different parts of the world and the authenticity of which there is no reason to doubt, it is claimed that on asphalt as now laid a horse travels 583 miles without falling; on granite block pavement 413 miles; on basalt block pavement the same as

granite until it gets smoothed by traffic when it becomes extremely dangerous; on wooden pavement 272 miles; on rock asphalt pavement (which will be later mentioned) 70 miles. No observations on brick but it should be at least as good as asphalt in this particular, if not better at some seasons of the year and when wet.

Now as to grades. Asphalt should not be laid on very steep grades. Granite and basalt blocks can be laid on about the same grades as asphalt. Wood perhaps a trifle steeper and brick on steeper than wood. Macadam can be used on all grades.

As to cleanliness. This affects the health of the community and the cost of keeping the streets clean and in good repair, asphalt easily takes first rank, brick second, granite or basalt blocks, if grouted between the joints, third place. If not grouted between the joints the stone blocks rank next to wood, carefully laid. Macadam comes next and last, for earth and gravel roads are not capable of being kept clean in any degree. Macadam if swept regularly and sprinkled occasionally and rolled once in a while can be maintained in a condition, or state, several degrees this side of a nuisance.

Durability is another question; as it is closely connected with noise they might be considered together. Cobbles are the most durable, they are an antediluvian pavement and can never be made to look any better by taking up and relaying so their noise can never be lessened. "The cars rattling over the stony street" rattled over cobble pavement. They last forever if the people do not tire of their

ugliness and replace them with something better. Granite blocks come next. They are, as everyone knows, durable but as they wear they get noisier every day. They can be taken up, trimmed and relaid at times and thus made a little smoother but on the whole they have only one thing to commend them—durability. Basalt blocks are as durable as granite but wear smooth much sooner. It has been found by actual experience that asphalt is about as durable as anything short of stone blocks. Brick comes next and then wood. There are instances of an extremely long life on the part of wooden blocks. Macadam is the least durable if we except gravel which is only a bad makeshift. Asphalt is the quietest and brick and wood close competitors for the second place as regards noise.

MACADAM

The writer does not condemn macadam streets for a city. It is good with which to start the improvement ball rolling and gives fairly good service until there is considerable traffic on the street. Being so much superior to earth and gravel it is excellent for streets with light travel and for residence streets and all streets to be improved at low first cost and so situated as to call for little maintenance expense yearly, as for instances on streets with steep grades where better pavements would be slippery. The stone used for macadam, and for all concrete foundations for other pavements should be clean, hard

and durable, free from clay and dirt, not subject to disintegration by the action of air or water, and free from seams or marked lines of cleavage. A rock of igneous character is best and all rock should be tested in a rattler. The rattler is a box which can be partly filled with stone and revolved for a certain length of time to test the wearing power of the stone. It is used in many places for testing macadam and brick for pavements and is a modification of the rattler used in foundries to clean castings.

COBBLES

Cobbles are egg shaped pieces of gravel varying in size from six inches in length and breadth to as much as ten inches. They are laid in a bed of sand upon the shaped street surface and tamped into place with heavy tampers and then covered with sand or very fine gravel and wet and rolled. They are an abomination. They are noisy and not particularly easy to travel over. The first cost is about the same as macadam but they will wear forever with travel which would wear twelve inches of macadam in a year. The interstices cannot be cleaned and hence cobble pavement is extremely unsanitary.

STONE BLOCKS

Granite blocks are durable and much better than cobbles, which in the process of evolution they followed. They are, or should be, cut regularly to shape, and set as closely as possible to make the joints small and thus lessen noise and make them more healthful. The question of healthfulness and noise has been met of late years by filling the joints with cement grout (which sometimes makes the pavement a difficult one on which to gain foothold), or with an asphalt grout. The joints being filled the street can be easily kept clean. Formerly they were laid like cobbles in a bed of sand two or three inches thick on the natural earth surface. But the difficulty of keeping a nice surface has led to the placing of a concrete foundation six or eight inches thick over the surface and placing the blocks on that. Indeed it is this concrete foundation which is the real pavement. The other materials placed on it are only wearing surfaces designed to protect it. When granite is difficult to obtain it is customary to use basalt. With the exception that it sooner gets slippery and dangerous it is equal to granite. In some parts of the world there are varieties of sandstone which make beautiful pavements. They can be trimmed into more regular blocks than any other stone and thus lessen the size of the joints and the consequent wear and noise, while at the same time giving good foothold. If any city is located near a good quarry of such stone the business streets should be paved with it.

WOOD

Still along the line of evolution we come to the wooden pavement. This was tried and used after stone blocks began to show their undesirable features. As laid in various cities and countries of the world wooden pavements have been alternately praised and sworn at. There is no doubt that wooden pavements are in use today which have been down from twenty-five to thirty years and are very satisfactory, while there are other places where the pavements have to be replaced every five or six years, and in some places two to three years has been the life. Cedar block pavements have been extensively used in the United states and it is to be hoped they will vanish forever. Many inventors have wasted millions of dollars of the peoples' money in endeavors give a lasting wooden pavement at too low a first cost. It is now generally understood that a close grained wood must be used. If soft and lasting wood is used it is a disappointment when placed in the street for it is found that mere durability is not enough. Cedar has been a failure because too soft although its lasting qualities in ordinary situations is well understood. But a hard wood is not desirable beeause it gets too hard and smooth and after a little use the edges of the blocks become worn and it is as bad as a stone block pavement for noise and filth producing properties. The proper kind of wood is therefore a close grained wood which cannot be classed as a hard wood. It must be sawed into blocks of a regular shape. Four inch planks cut

into six inch squares make the best blocks. They are set on end thus giving a depth of six inches and the travel comes on the end of the grain. It is absolutely necessary to place the blocks on a concrete foundation and put over this foundation a thin coating of coarse sand to bring all the blocks to a uniform surface. Then the blocks should be dipped in hot asphalt and put in place while hot. The writer knows that many people do not believe with him in the dipping part of the business because they say the asphalt wears off the top and each block becomes a pocket to hold moisture. The argument in favor of the asphalt is that each block is thoroughly coated and the asphalt cements the blocks together, thus reducing the danger of water getting through. The blocks are isolated and the occasional soft block gets saturated, after which the surplus water runs off the surface until it reaches the gutter. When the sun comes out evaporation takes the surface water away and capillary action brings the contained water to the surface and it is evaporated as fast as it rises and thus each block acts alone. If there is no asphalt on the bottom the water can go through the soft blocks and when it reaches the concrete foundation will spread all over and rise by capillary action through every block. In this manner one or two soft blocks can destroy several square yards of pavement.

A few years ago the United States went wild over the Nicholson pavement which consisted of wooden blocks laid upon thick planks as a foundation. In wet weather the blocks swelled; in dry weather they

fell apart and the joints filled with dirt. When the wet weather again came around the expansion of the blocks was checked by the presence of the non-expanding material in the joints and the blocks arched over the street until sometimes horses would break through and the pavement would have to be broken clear to the gutter to enable them to be rescued from a ridiculous position. The city of San Francisco suffered particularly during the Nicholson craze and hence all wood pavements in that city are called Nicholson, and because they are wood another generation will have to arise before the modern wood pavement will gain a foothold there. By that time freight rates may be so reasonable that wood cannot compete in first cost or cost of maintenance with brick or asphalt and will have no show.

An expansion joint must be provided in the wooden pavement. The Australian method is to put a two or three inch plank alongside the curbs and lay the blocks in the roadway between the two planks. When the blocks are all down the planks are taken up and clay tamped in their place. When the blocks expand the clay is forced out. The asphalt between the joints prevents dirt from getting in so there is never afterwards any dangerous bulging. The writer believes the joint made by Thomas K. Muir of Portland, Ore., to be better. It consists of cloth asphalted and coated with grated cork. Laid between the joints it takes up all the expansion and allows for the subsequent contraction. It is cleanly and not expensive.

Wooden pavements have given satisfaction for many years in England, France, Germany and Australasia. They are being replaced by asphalt and brick whenever competion permits a reasonable difference in price to make one pavement as cheap as anather. For cities in the vicinity of a plentiful wood supply it may be the best material to use until asphalt or brick can be put down at the same first cost. Wood can be treated with creosote instead of asphalt but it has been found cheaper in San Francisco where either method could be adopted, to coat with asphalt rather than creosote. A mistake made in the United States has been to use wood only on streets having light travel. It is almost impossible to have too much travel on a wooden paved street as experience has proven. The travel compresses the ends of the blocks and makes them lasting. A wooden street also requires plenty of water. The sprinkling cart should keep the surface in order to insure long life as alternate wetting and drying hurt it. One objection to wooden block pavements in California cities is the long period of dry weather.

It is thus seen that several things are necessary in order to secure a satisfactory wooden pavement. First there must be a concrete foundation and on this the blocks must be laid as closely and compactly as possible in regular shapes and well coated with asphalt or treated with creosote. The wood must be close grained and in Portland, Ore., yellow fir has proven to be the most satisfactory. There should be expansion joints provided and over the top of the pavement should be spread a thin coating

of hot asphalt and a half inch of clear sand. The sand to be brushed off after a weeks use of the street and the asphalt coating to be replaced every year or two.

The question of the healthfulness of wooden paved streets has been urged against them. Statistics have been given of the immense numbers of germs found in the joints between paving blocks. There are germs and germs. Our only danger from germs is from a comparatively few species which exist on living matter. The kinds found in the joints of wooden block pavements are our best friends who spend a short but useful life converting dead animal and vegetable matter into matter which becomes plant food and they thus help to render human life possible. With the filling of the joints with asphalt and the covering of the blocks with the same material the opportunities for the existence of germs are lessened. With the old round cedar block there was danger to health because of the opportunity given for harmful germs to live, but with a modern wooden block pavement the talk of germs is like the nurse's tale of the "bogie man."

ASPHALT

Next in order chronologically comes asphalt. The asphalt used in Europe for many years was an asphaltic limestone or limestone impregnated with asphalt (bitumen). It was good but very slippery, being put on the street in its natural state after just enough soft-

ening by heat to make it easy to lay and roll thin. In wet weather it was necessary to sand it to keep horses from slipping. This slipperiness was a great objection and therefore asphalt did not grow rapidly in favor until the discovery of the asphalt lake in Trinidad and the formation of great asphalt paving companies with American capital. It has grown steadily in favor ever since and many other sources of supply are now exploited. In fact within the past year it has been claimed that an asphalt trust has been organized which controls all the known supplies. The material is refined and brought to the street in barrels where it is softened by heat and mixed with sand and a filler of very fine material, preferably limestone, and laid on the street hot. Before it completely cools it is compressed and rolled to its final thickness with a heavy roller. It is useless without a concrete foundation or a foundation of good macadam used several years and thoroughly cleared of dust before the asphalt is laid on it two to two and one-half inches thick. The mixture of asphalt, sand and limestone or rock dust must be varied according to climate, grade of the street and conditions of traffic. For this reason it demands an amount of skilled scientific supervision few small places can afford or are unwilling to pay for or cannot command.

This, then, the proper supervision, is one of the local considerations influencing the selection of paving materials. It must be given proper weight. If the small place is bound to have asphalt pavement without expert advice and guidance the autho-

rities should be careful to award the authority only to some very strong company which can afford at a small profit to put in a good pavement and guarantee it for at least ten years. Yet a large company is not always so careful about a small job in an out of the way place as a small company might be with a small capital to lose and a reputation to jealously guard. A smaller company to whom non-success might mean absolute failure and bankruptcy is sometimes more particular than a large company overcrowded with work and sometimes pushed to obtain competent foremen. The writer does not advise the putting down of asphalt without competent advice and careful selection of inspectors, for every ordinary man is not fitted to be an inspector on asphalt work.

A properly laid and maintained asphalt pavement cannot be too highly praised. Being monolithic (in one piece without joints) it is cleanly and sanitary, can be cleaned and repaired easily and on account of the rubber like consistency of the material is practically noiseless. It comes as near being the perfect pavement as anything yet discovered.

There is another form of asphalt pavement known as "bituminous rock." It differs from the asphaltic limestone of Europe in that the bitumen impregnates beds of sand instead of limestone. It is a fairly good material and in all respects but one, the equal of the best asphalt. The one defect is that as all beds of sand contain more or less loam and earth and decayed matter the mixture is not uniform.

Therefore when laid on streets it goes to pieces irregularly. Some parts may last for years and some parts for only a few months. It has been largely used in California, where the best deposits have been found, in cities where the freight rates prevented competition with asphalt brought in from the East and before any good deposits of California asphalt had been developed. Where it has come into competition with asphalt its use has been practically abandoned.

BRICK

Brick pavements run asphalt very close. The use of brick is another instance of the part local considerations play in the adoption of a paving material. The material of which vitrified paving brick is made cannot be found in every part of the country. The clays known as "surface clays," which every brickmaker has knowledge of, cannot be successfully used for this class of brick, the range of temperature at which they can be vitrified being very narrow on account of too much silicia or too much lime. So the brick will be either unburned and thus be too soft or else will be misshapen and cannot be used. It is well to remember this when dealing with the local brickmaker who pleads for an opportunity to burn brick for the paving of a street. Surface clays have been abandoned for this purpose. An impure fire clay can be used and the more impure the better for the purpose. Care must be taken however to

see that the brick is not too soft as it requires a very high heat to vitrify the fire clay. These clays make a tough brick when properly vitrified. The impure fire clays mentioned are better known by the majority of persons as "pipe clay." But the material which should be used for vitrified paving brick is a shale found generally in the vicinity of coal measures. The common names are "soft slate" and "soapstone." They must be ground up and then when mixed with water become plastic and can be molded satisfactorily.

It can be readily seen that if the proper material is not found in sufficient quantity near the town it will be difficult to count on vitrified brick as a paving material The price in the Middle, Central and Eastern states is from $5 to $8 per thousand and in the West from $15 to $25. At a price not to exceed $15 they can compete in price with asphalt. When the brick is brought any great distance the freight kills all consideration of its use for paving. The cost is too great, for it must be borne in mind that the whole wearing surface has to be transported, whereas as in the case of asphalt the asphalt alone is brought in and it comprises about ten per cent of the wearing surface. The sand and filler mixed with it are local materials. It was because the entire wearing surface comprised in a bituminous rock pavement had to be transported which led to its use being confined to places near the mines as it was ninety per cent sand.

Brick pavement in every way gives as good satisfaction as asphalt where tried in competition,

speaking generally again. There are enthusiastic believers in the superiority of each material. The writer prefers brick if found close enough to be laid at no greater first cost than asphalt. The cost of maintenance is no higher. It is practically as noiseless and the clicking sound of the horseshoes is a pleasant one. If not properly put down there is apt to be a distressing rumble under continuous traffic but it is not a characteristic inseparable from the use of the material. The great argument in favor of brick as in the case of wood is that the highly trained scientific supervision is not so necessary as in the case of asphalt and there is no necessity for a complete reliance upon the honesty of the contractor in the absence of special counsel. Given proper specifications, a careful selection of material by an honest man of the most ordinary education, with honest supervision by men of little or no education but with common sense and an ability to do well what they do, and the use of brick and wood pavements can be made possible.

Each place must study carefully local considerations and improve the streets in the best way possible in that particular place with reference to the good of the community and the least legitimate cost. Penny wise and pound foolish methods are not the best. Any of the leading materials will make a first class pavement under the proper conditions. It only requires common sense and a regard for the value of the advice of men possessing a training in the work and possessed likewise of common sense in its application.

No street will last forever without some sort of repairs and maintainance. Constant attention is required and there must be wise ordinances well enforced to keep the streets properly preserved in a state to travel upon with comfort and satisfaction. The laying of street car tracks in streets has a great tendency to shorten the life of a pavement. When a franchise is granted for a street railway it should specify the manner of constructing the roadbed and should prescribe the kind of rail to be used. There is only one kind to use and that is a grooved girder rail.

It has been the practice of street railway companies to lay as light a rail as they could but experience has shown them, as it has shown steam railroad managers, that a light rail is a costly thing. A gauge was used which enabled every vehicle in the city to "track" the rails and when wagons followed the tracks with one wheel on and the other outside (in order to turn out of the way of a car easily) the streets were badly cut up. Of late years cities which have had expensive pavements ruined by this "tracking" have investigated the rail question with the result that European practice is being followed more and more and grooved rails required. These rails are flat on top and are flush with the pavement on each side. Down the middle runs a groove for the flange of the car wheel to travel in and this groove is too narrow for wheels to catch in. It is almost impossible for any wagon to track on such rails. There has been an objection on the part of street car men to the use of grooved

rails, claiming they are difficult to keep clean. The difficulty is overestimated and in actual practice not found to be a valid objection. Even if it were it is better for the company to do something to prevent destroying the streets they occupy as a privilege and not make the suffering taxpayers stand all the cost.

In the case of macadamized streets it has been found by actual observation that a street car track on such a street increases the cost of maintenance fully one third. On such streets a T rail can be laid under proper specifications but a provision should be put in the franchise that when the street is paved with wood, brick, stone or asphalt that a grooved girder rail will be substituted.

As tending also to the preservation of the streets may be mentioned the question of electrolysis. This is a matter which becomes of vital importance when electric street railways are built. If the single trolley system is used the return current goes back underground and at every possible opportunity it leaves the conductor and attacks metal pipes in the ground. This necessitates frequent opening of the streets to repair breaks in service pipes. The only remedy thus far proposed which has been found efficiemt is to require the double trolley system to be installed, if a trolley system is used at all.

To avoid destroying a street by too frequent opening for water, light and sewer connections, some regulation of pipe laying is necessary. The subject needs too long a discussion to be handled in a work of the scope of the present volume. Briefly, how-

ever, it would be well to have every pipe on streets running in a certain direction at one depth and on intersecting streets one or two feet deeper. They should be certain specified distances from the curb and before a street is paved house connections should be run from the pipes every 25 feet to a point one foot inside the curb line.

Maps of the lines with locations of all house connections should be kept in the office of the city engineer.

The cleaning of streets is an expensive item which becomes yearly greater. Until some good way of utilizing the refuse is devised there will be no escape from it. It has been stated in public print that in Belgium several cities let the contract yearly for the removal of street refuse to the one who will give the most for the privilege. The refuse is used by stock breeders and manufacturers of artificial manures. This may be true but there must be some exceptional facilities for refuse disposal.

CURBING

Every street requires a curb. It serves to definitely fix the line between the roadway and the sidewalk, to serve as one side of the gutter and to improve the appearance of the street. On macadam streets wooden curbs are often used. The best are sixteen inches deep and four inches thick. The grade of the

street is two inches higher than the top of the curb and the wooden sidewalks when built are spiked to the top of the curb.

Concrete curbs are very satisfactory in appearance and when well constructed are durable and being lower in cost than granite are so far preferable. Granite curbs are laid in pieces averaging from four to eight feet in length. In some cities they are clamped together but generally however they are laid end to end and well bedded. Granite and concrete curbs are generally six inches wide on top, eight inches on the bottom and sixteen inches deep. The top is on the official street grade and elevation.

The shaping of corners presents considerable variety. The most handsome street intersection is one where the two intersecting curbs meet on a radius equal to the width of the narrower sidewalk. For this reason concrete curbing is desirable, for molds can be made for any radius. It might increase the cost of granite curbing if stone had to be cut for a different radius on every job, in the case of a city where there are many streets of different width, so a common corner of about 10 foot radius can be used. But many cities use a radius as small as three feet and some of eighteen inches. The appearance of the corners is not at all handsome and the corners jut pretty far out into the roadway. Wooden curbs can be placed on a radius by either cutting the four inch plank into sections about one foot in length with a bevel or by driving 4x4 posts into the ground, on a curve four inches inside the

curb curb and about three feet apart. Four thicknesses of one inch boards can be bent around these posts and spiked to them.

SIDEWALKS

In general the sidewalk space on each side of the steet should be one-fifth of the total street width. The roadway would then be three fifths the width of the street. The curb will define the line between the roadway and sidewalk reservation. On business streets the whole space will be utilized but on residence streets the sidewalks can be narrow and on each side the space be planted with grass and trees.

Wooden sidewalks are only temporary affairs and should not be allowed to remain after they commence to wear. The boards get loose and the nails stick up. They trip the pedestrian in summer and squirt muddy water on him in winter. They should be made of two inch plank not more than eight inches nor less than six inches wide and be spiked with about a 20-penny nail. The top of the nail should be driven a quarter of an inch below the surface.

Stone flag sidewalks are not satisfactory as they wear unevenly and get loose after much travel. Brick sidewalks have the same objection although they look neat. If constructed with vitrified paving brick grouted with cement they are not bad.

The best sidewalk is the concrete and cement walk properly laid. There should be good specifications

and competent supervision and every property owner should be compelled to comply with specifications prepared by the city officials. The glare of the light colored sidewalk on a sunshiny day is objectionable but it may be overcome. By the use of lampblack or other colored pigments the color of the sidewalk can be greatly modified. There is danger, hower, of injuring the cement by such mixtures and they also fade out after a while unless the work is done by skillful men. There are some preparations designed to be mixed with the water used to temper the mortar. These preparations are very satisfactory in use and are lasting.

GRADES AND IMPROVEMENTS

There are no set rules to follow in establishing grades and improving streets. The streets are to look well, are to serve as drains and as avenues of travel. They are to be improved at the lowest possible cost to attain these ends. All other considerations are matters of detail.

Business streets should all have if possible, a level cross section, or a cross section nearly level. They should be improved from property line to property line. It is generally easy to do this as the business portion of a town is as a rule laid out in the first place in the most level part of a tract of land. A

level cross section is one where the curbs on each side of the street are at the same elevation.

For drainage the sidewalks slope toward the gutter and the roadway is high in the center. The shaping and crowning of the roadway depends upon the width of the street and the material used for paving, as a smooth impervious pavement needs very little crowning. When one side of the street is a few inches or a foot higher than the other considerable study may be required to secure the proper crown.

Some towns are laid out on a hillside and the streets follow the contour of the ground. In such cases the difference in elevation of the two sides of the street may be as much as 20 or 30 feet, although 10 to 15 is more common. These sidehill streets are generally residence streets and should be improved at as slight cost as possible to give them a handsome appearance and accomplish the desired end. The grade when established should be the grade of the roadway. This need not be more than 20 to 25 feet wide. On the inside next the bank should be placed a curb and gutter and on the outside a curb and sidewalk and railing. The sidewalk need not be more than five or six feet wide. Terraces should connect the edge of the sidewalk and the curb on the inside of the aoadway with the ground at the fences on each side. These slopes can be planted to grass or flowers and cared for by the adjoining property owners. In fact in some places the adjoining owners are permitted by the city to fence down to the edge of the improved por-

tion (on a lease terminable at the pleasure of the council) and the effect of the narrow winding roadway through flower beds and nicely sodded slopes has an enchanting park effect. By some such method of improvement it is possible to save handsome old trees by winding the roadway round them.

In establishing grades two things must be considered—drainage and traction. Any slope will cause water to move but the least grade should be limited, if possible, to four inches in 100. The writer however, has had to establish grades on streets of one and one-quarter inches in 100, and has known of some towns where the streets were perfectly level from one end of a block to another. This is not good practice to follow but it simply emphasizes the remark above made that there are no set rules to follow and serves to show how necessary it is to have proper advice in such work. A grade cannot be fixed for one block alone but each block has to be studied with reference to surrounding blocks. For streets having a light grade or no grade, a grade for the surface water is created in the gutter by raising one end or by raising the gutter in the middle of the block. This can be done and the curb be level although it is not the most sightly thing to do.

It having been shown that water can be made to run off a level street it is necessary to see the limiting effect of traction. Horses can do without it, therefore street grades should be limited between the lightest possible for efficient drainage and the steepest a team with loaded wagon can as-

cend with ease. The steepest grade should not exceed, if possible, a five foot rise in 100. Heavier grades, as well as extremely light grades should only be adopted after most careful study.

Calling the load a horse will pull on a level surface 100, then on a grade of

1 in 100	a horse	will	pull	90
2 in 100	"	"	"	81
4 in 100	"	"	"	52
5 in 100	"	"	"	40
10 in 100	"	"	"	25

In establishing grades the question of expense has to be taken into account and this must be figured as other business matters have to be figured. If the street is important enough to justify the greater expense of a better grade—of several under consideration—then the best grade is the more expensive one. But if it is only a side street or cross street, or unimportant residence street, the property owners should have a voice in the matter and a considerable influence. There is nothing in all the work of a municipal officer which requires more pure grit and courage than the work of establishing a grade preliminary to improvement of a street. No matter how it is finally settled he meets with the approval of a very few and makes enemies of a great many. and some of the enemies are vindictive and their enmity pursues the unfortunate object to the grave. Until a regular grade is established each man has regarded the street in front of his own lot as so much of his own property and it is hard to persuade him that anyone else has jurisdiction over it. He has sidewalked, drained and paved (?) it to suit him-

self and whether above or below the general level is confident that his floor line is exactly where the grade should be. The councilman who does not agree with him has an enemy and the engineer he is convinced is ignorant of the first rudiments of municipal engineering.

The first step taken in the improvement of the streets of any village or small town is to build a sidewalk. All improvement generally stops then until some day a mighty upheaval is had and a regular job is commenced of work like that done in a large city, but in one town a gradual evolution was proceeded with and the result was extremely gratifying to all concerned. In the first place grades were established so that surface water could be disposed of. These grades were not in all cases the permanent grades but were established so the improvements could be carried on at the least possible expense.

Sidewalks were built to these grades. On the curb line wooden curbs were set of not less than 3x14 timbers on edge. These curbs were required whenever a sidewalk went in and the corners were connected with curves of large radius. On the low lying streets a gutter was rounded outside the curb lines and when the city afterwards purchased a road machine the roadway was rounded every spring and again in the fall. On the hill streets a plank was nailed to the curb at an angle and served as a flume gutter to carry off surface water. On the business streets the plank was two inches thick and made a very good gutter. As time went on certain prop-

erty owners put in stone or concrete curbs and the wooden gutters were replaced with cobble stone. On the flatter streets stone gutters were also used.

The line of improvement being thus indicated and the different sections of the street defined, every step taken was one forward. Some of the people in different parts of town commenced hauling gravel and broken stone on the roadway in front of their property and the town purchased a road roller and sprinkler and kept the streets looking well. All the streets, even those on which no gravel or stone had been hauled, gradully assumed a fine appearance. As the place grew the area of traveled streets seriously taxed the taxable resources of the city to keep them up. So the council declined to take care of any streets not graveled at least. This led to such an increase of graveled roadways that the line had to be drawn at macadam and finally when nearly every street in town had been macadamized some of the heavier traveled streets were paved with brick and wood, and again the council had to draw the line. No streets thereafter would be kept in repair unless they were paved with some approved material. The council kept the gutters clear and the streets clean but charged the expense of repairs to the owners of abutting property until such a time as a more lasting covering was put on, when the city assumed the entire cost of future perpetual maintenance.

In some states this can be done while in others it is doubtful if such a proceedure could be followed. Still common sense would seem to indicate that a

time must come when some rule must be followed in street maintenance or a city can be bankrupted by the unprogressive element.

Whatever the proceedure adopted for gradual bettering the condition of the streets the first step is to provide for proper drainage. A dirt road can give fairly good satisfaction if it is rounded up in the center and kept well rolled and has gutters on each side to conduct the surface water away to a place where it can be disposed of. In improving a town much can be done by concerted action of the property owners. Improvement clubs and arbor societies and such organizations are wonderful helps. Where such influences exist the towns contrast favorably with places where everything is left to a small body of unpaid men who cannot devote much time and attention to public affairs. A backward town is more often backward by reason of neglect by the citizens than by reason of neglect by the council.

The appearance of the streets of a city have as much to do with its growth or failure to grow as any other thing. Strangers get their first impressions of a place from the streets and nothing can be said in praise of the wealth or enterprise of the inhabitants or the logical advantages of the location of the city to counteract the effect a poorly kept street has as a first impression. First impressions are said to be most lasting, therefore the streets should be attended to first and the matter of water supply and sewerage—in up to date methods—can be left until the place has at least one good looking street.

Better sewerage facilities will be demanded when the city grows and an improved water system will be required when there is a population to demand it. The population however will go to the most enterprising towns always and the most enterprising looking towns grow fastest.

Taxes are higher in towns and cities where the streets are neglected or are of earth. It costs more to keep up a poor street than it does a good one. A street on which about $300 per annum had been spent and no appreciable improvement made was paved at a cost which was equal to $200 per annum capitalized. The annual maintainance cost was nothing for three years. After that the annual maintenance cost was less than $25, making quite a saving and adding considerably to the comfort and convenience of the people.

CHAPTER II.

DRAINAGE AND SEWERAGE

A distinction is made by engineers between drainage and sewerage, the former term being applied solely to the disposal of surface water and the latter to the collection and disposal of liquid household wastes. Solid wastes from households is termed garbage. Street sweepings and non-putrefactive waste matter is called refuse.

DRAINAGE

In the majority of cases the drainage of a town offers few difficulties. The whole practice is simple. Keep the water on the surface as much as possible in easily controlled channels and dispose of it in the most convenient stream or river. It is clean and can offer no detriment to the health of the community to discharge it into any running stream. It is only when allowed to collect in low lying places and become stagnant that it is harmful.

The first step in the drainage of a place is to provide broad, deep gutters along the sides of the streets after grades have been established thereon. On the steeper side hill streets V flumes can be laid

with boards under them at each joint going down for at least a foot vertically and coming up on each side level with the top of the flume. This will turn the water back into the flume in case any gets under and threatens to wash out a deep and dangerous gully The surface water should be carried in the flumes and gutters as far as possible and at every opportunity the streams should be divided and sent off in different directions to guard against too great an increase in flow and consequent difficulty in handling. It should not be taken under ground except where unavoidable.

Much of the rainfall is absorbed as it falls but as a town becomes more closely built over and the area of paved streets increases, a less quantity goes that way and proper conduits must be provided for it. When the town becomes a city then a portion of the sewerage system will have to be of large sewers sufficient in size to take care of the surface water.

SEWERAGE

At the time the plan for surface drainage is made there should be prepared a complete plan for a sewerage system. It should not be a matter of haphazard growth as it too commonly is, but should be gone at systematically. Because a complete plan is prepared does not mean it will be all constructed at one time, but simply that as a sewer is put in it will be in the right place and constructed in the right manner. In a growing place the work is never complete but sewer building is going on all the time and plans prepared must take into consideration this growth.

It has unfortunately happened many times that for lack of proper attention to this detail by the council many private sewers are built by parties who can afford it. When a proper plan is prepared it has been found impossible to use these sewers in the general system and expensive lawsuits and vexatious delays result. If a plan had been first prepared these private sewers could have been constructed in a way to have formed a part of the complete system and thus helped instead of hindering the final work of putting the town in a complete sanitary condition. The combined system of sewerage is that in which provision is made for the disposal of surface water and sewage in the same pipes or channels. It is necessary in a large city but in smaller places it is too expensive on account of the size of the conduits. By keeping the surface water on the surface as much as possible a great saving can be effected in the building of sewers. It has been thought necessary in many places to carry both water and sewage in the one system and on account of the cost the sewers are never built.

Modern sewerage systems are generally spoken of as the "sanitary" system of sewerage, where small pipes carry the sewage and separate conduits are used for surface water. Many term this system of small pipes the separate system as distinguished from the combined. It is the only system to use in small places, and in fact in large cities there are different sewerage districts, each sewered on the separate plan and carrying the surface water in gutters to central points where there are larger sewers to

carry everything finally to the point of ultimate disposal

In planning sewers for a system of sanitary sewerage it is necessary to have the pipes large enough to flow half or three-quarters full. They will then keep themselves clear. If built of too large a size to carry the constant flow the sediment in the sewage will be gradually deposited until the sewer becomes choked. A small channel is left at the top sufficient to carry the regular daily flow and no more. If this sewer is intended to carry storm water also it is generally found full of decaying matter and refuse when the storm comes and the street is flooded until the sewer is cleaned.

In addition to the choking up of the drain and thus rendering it unfit for its purpose as a storm drain, the continual deposit of excrementitious matter is a menace to health. The large empty spaces invite accumulations of sewer gas until the sewer is filled when the bad odors and poisonous vapors get out into the open air. The remedy is to flush with a hose from the nearest hydrant. To illustrate how much good this does let us compare the comparative sizes of the sewer and the stream of water in it. Take a 15 inch pipe as an example and the absurdity can be further seen when a larger pipe is considered. Disregarding decimals the area of a 15 inch pipe is 177 square inches. The area of a stream of water from a 2½ inch hose is 5 inches. How much good does it do.

The grade of a sewer is everything. Without a proper grade it is costly and dangerous. It should

have a grade sufficient to give the sewage a velocity of at least three feet per second in order to have a cleansing flow. A light grade produces such a sluggish movement that solid matters cannot be moved and so remain to clog the pipe, while too steep a grade produces so rapid a current the solid matters are stranded because there is not enough flow to carry them. Either extreme is bad.

In a separate system small pipes must be used and it often occurs that a 3 or 4 inch pipe would be amply sufficient for the work were it not for the difficulty of access to the pipes for cleaning and the liability of something catching in them which has been forced down the house drain. Therefore the smallest size should be six inches. Until the population has grown sufficiently to keep a constant cleansing flow in the pipes a flush tank should be attached to the upper end, and there should be a flush tank at the upper end of all laterals. Flush tanks are necessary for efficiency and economy.

A flush tank should be capable of discharging from 60 to 300 gallons of water in less than one minute into a sewer and should be adjusted to discharge at least twice a day. They are automatic in action and a common form is a siphon. A large tank like a man-hole is built of brick and a pipe from the bottom of it connects with the sewer. Underneath this tank is a small chamber containing a tilting pan which holds a few gallons of water and when level is full of water. A large iron siphon is attached to the tank and goes from the pan through the bottom of the tank and near the top curves

downward to within a few inches of the bottom. A small stream of water enters the flush tank and gradually raises the level until it commences to flow over the bend in the siphon and then down into the small tilting basin which gradually fills and seals the bottom of the siphon. When this is down the water keeps rising and flowing over the bend until the siphon gets so full of water that the weight is too much for the tilting basin which tips over and thus opens the seal. The water is sucked rapidly through the siphon until the tank is emptied when the basin resumes its horizontal position and is ready once more to seal the siphon. There have been many variations on this idea, some good and some poor.

In general the advantages of flush tanks may be summed up as follows. The sudden discharge of a large volume of water into a small pipe momentarily compresses the air in front and forces it out at every opening. This creates a temporary vacuum which is filled with fresher air from the outside and thus simplifies the question of ventilation. The frequent volumes of cool water thrown in, together with the

ERRATA

"Disease germs cannot multiply to any extent except in a temperature exceeding sixty degrees, etc."

Eighth line from bottom of page 53.

of water in large quantities into the pipe helps to start them going. The tendency of sewers to silt up until they get a cleansing flow was the primary reason for the adoption of flush tanks. A confervoid growth attaches itself to all sewers just below the line of continual flow, especially if there is a slight velocity, and an occasional full flow of short duration tends to loosen it.

A certain width, not less than ten feet, in the middle of the street should be reserved for sewers and no water, gas, or other conduits should be permitted there. The sewers depend upon grade and the other things go by pressure. It would be better of course to have two lines of sewer, one under each sidewalk, in a large conduit which would carry all wires and pipes and thus avoid tearing up the streets. It is too much to hope for in many places.

In putting down a sewer system the question arises of the depth. The depth should be sufficient to drain the lowest cellar and provide for a free discharge at the outlet. Sometimes in flat districts there is a discussion as to whether to put in a long sewer on a slight grade or construct several outlets with short mains and laterals. Such questions had better be left entirely to the engineer who plans the system, presuming of course that he has been selected for his known ability in such work. It is well when the system is planned to have the engineer prepare ordinances also for the proper maintainance of the system in good condition and have him prepare proper specifications for doing the work. All house connections should be made by

licensed plumbers or licensed drain layers and the city engineer charged with the duty of inspection of all openings made.

Sewers need cleaning at intervals. Flush tanks are of great benefit but there still exists a necessity for cleaning the sewers occasionally. Sewers large enough for a man to enter are cleaned by men with shovels and the material taken out in buckets at convenient man-holes and put in wagons to be carried away. The process of cleaning a system should commence at the lower end and proceed towards the last lateral and then go back over the system in reverse order to clear out all accumulations. Small pipe sewers are sometimes cleansed by putting in a wooden ball of diameter a little smaller than the pipe. This ball floats until it meets an obstruction when it is stopped and the water dammed up until enough accumulates to force the obstruction on or wash it out.

Sometimes a scraping is necessary, especially when there is a heavy confervoid growth. A small wooden float weighed so it will remain an inch or so under water is attached to a string and dropped down a man-hole or inspection hole. It floats to the one below where an attendant catches it and then a small rope is tied to the string and hauled through. A heavier rope is tied to this and when the man at the lower end has one end of it the scraper is attached to the other end and dragged. It should go through twice. The writer has used for a scraper a heavy chain having in each link a piece of wire twisted until the chain resembles in

appearance a brush used to clean a nursing bottle tube. The chain may be several feet long and should be at least two or three feet long. If steel wire is used the scraper may be used for sewers from six to twelve inches in diameter. Attached to the rear end of the scraper is a gunny sack filled with excelsior or shavings. This should be hauled through rapidly. Then the water should be turned on full force in all house connections along the line for an hour at least when the scraper can be run through the sewer again to catch the stuff forced out of the house connections and which was crowded in on the first round of the scraper. The second time the scraper should be inside the gunny sack and the shavings can be dispensed with. If sand deposits in the sewer the scraper should be a long heavy chain and taken through several times before the sack is used.

SEWAGE DISPOSAL

It is not enough to have a system of sewers designed and leave the disposal to luck. It is no longer safe to discharge sewage into rivers and streams as the population of the country is increasing too rapidly. Every day some decision is reported from different states in which complaint has been made of the pollution of water. A case has been decided that a city has no right to pollute with sewerage its

own source of water supply. This is indeed carrying things with a high hand when people are not allowed to do as they please when they are the only sufferers. If they wish to do harmful things then they should be permitted to die off.

But people residing along a stream should not be so placed that they hold their lives and health subject to the will of those above them. For such the courts give ample protection and the trend of the decisions is more and more severe and confining until it is likely in a few years not the slightest contamination will be permitted of any water course. Modern sanitary science has shown more diseases to result from impure drinking water than from lack of sewerage facilities and the drinking water must be protected. The seepage through the soil of the wastes of living does much to purify the atmosphere. Whatever gases escape are seldom of a harmful nature but the liquids being removed from the beneficial influence of oxygenizing agencies percolate through the soil to contaminate the underground water. This is why wells are so objectionable as a source of supply in a thickly settled community. But these liquids can percolate through the soil and rise with springs into a river from its bottom and be rendered comparatively innocuous by dilution. When delivered however in quantities into the river near its surface together with all the waste matter in a solid form the result is anything but good and in fact is absolutely dangerous. If the sewage can be discharged into a tidal bay or directly into the ocean it can

there be rendered harmless by dilution but some day there will be a stop put to that and the day is not far distant.

It costs money to handle large quantities of sewage and therefore as necessity compels the sewage to be treated to rid it of its harmful qualities the separate system of sewerage will grow in favor as it provides the least possible amount of liquid matter to be treated. The surface water, as stated before, can be disposed of anywhere without harm.

There are four methods in general use for the disposal of sewage. Briefly described they are as follows, it being borne in mind that many modifications of each kind exist.

MECHANICAL SEPARATION

This method separates the solids and fluid matter by straining. The liquid is discharged into a stream or lake comparatively colorless and with slight odor. It is not entirely harmless however.

CHEMICAL PRECIPITATION

This is an improvement on mechanical separation. The sewage is run into tanks, and a chemical precipitant is mixed with it. All solids are deposited and a clear odor-

less effluent is discharged.

In both the preceding methods there is a material left, known as "sludge," which is a nuisance to get rid of. Sometimes it is spread over land and allowed to dry and is then plowed in. Sometimes it is dried and burned in kilns. Sometimes farmers take it as a fertilizer and sometimes fertilizer makers take it away. It is almost impossible to sell the stuff and few places can handle it without some expense.

BROAD IRRIGATION

The sewage is run on to land for irrigation. The land is used for raising fruits and vegetables and truck gardening generally. Sometimes the land can be rented for the purpose by the municipality and sometimes it is purchased and rented out to truck gardeners. Properly planned and executed this has in some places proven a cheap and efficient method of disposal. But there are many people who object to eating anything raised on a sewage farm and such farms have been known to be a nuisance.

FILTRATION

This is a cheap method and meets with more approval than broad irrigation. A piece of land with a porous soil is selected and drained or regular filter

beds may be constructed of cinders, coke, gravel etc. At intervals the sewage is discharged on to the filter beds and allowed to percolate through. It is relieved of impurities in suspension by straining and the slow movement through the filtering medium gives time for thorough purification of all impurities in solution by bacterial action, such as is present in all properly constructed filters.

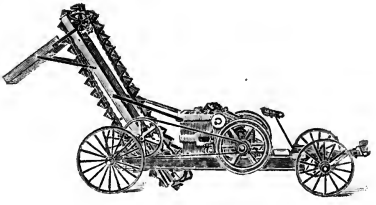
SEPTIC TANK TREATMENT

The name indicates it to be a putrefactive operation and bacterial in action. Really it is partly bacterial and partly chemical. It was the result of a search for a method to liquify the solid matters in sewage and assist the filtering process. There are, as explained in the chapter on streets, two kinds of germs or bacteria, the one living on live animal matter and blood and termed "pathogenic." These are the germs which endanger human life. The other group can only grow in dead or decaying matter and this is again divided into great groups which are known as "anaerobic" which exist best in the dark and "aerobic" which exist best in the light. Both are needed to complete the purification of sewage and wastes. The sewage may be taken into a closed tank where light and air are excluded as much as possible and stored there precisely as waste matters are stored in cess pools and privy vaults. This gives the anaerobic bacteria an opportunity to get to work and if allowed to work long enough they con-

vert all the solid matter into liquid and into ash, which is harmless, therefore the process is akin to combustion, which leaves an ash residue. The liquid allowed to get out into the light and air is attacked by aerobic bacteria which extract all the harmful matter from the liquid and it passes off into the air in harmless gas leaving the purified liquid to flow into any water course as clear as, and sometimes clearer, than the water into which it goes.

The action of the bacteria having been demonstrated in the closed tanks it remained for some one to discover that the same action takes place in open tanks. So there are two kinds used, the closed and the open. The real value of the septic tank treatment is that it destroys suspended matter without forming any great amount of sludge. It also acts largely to prevent a coating over the bacteria beds with a layer of cellulose material more or less impervious to water. It also forms substances that are easily acted upon by the aerobic, or nitrifying bacteria. There is a further advantage, in that in all systems of filtration of sewage there comes a time when the filter is clogged to a certain extent and the little bacteria which demand light die off and the ones which work in the dark without light and air increase too rapidly. As both kinds are needed it may be seen that the filters then do imperfect work. By allowing the bacteria which prefer darkness and no air to work in the septic tank and then expose the effluent to the air and light and

run it over filter beds where the nitrifying bacteria can get to work the purification process is made complete.



CHAPTER III.

WATER SUPPLY

One of the first questions asked by a possible resident, or manufacturer, who may locate in a growing town, is in regard to the water supply. He wants to locate in a place where he can get a plentiful supply of water for manufacturing purposes and for protection in case of fire. And of course if there is a plentiful supply of water he also inquires about a sewer system, for one is needed to carry off the waste.

Water is needed for drinking, manufacturing purposes, laundries and baths, street sprinkling, sewer flushing, irrigating lawns, fire protection, etc., and if it is not good for all of these uses it is not a good commercial water. It may be all right for cooking and drinking yet unfit for manufacturing, or vice versa. It is difficult to get a water perfect in all respects but good water of an average quality can generally be obtained in sufficient quantity for any small place at no great expense. If it is polluted or impure it must be purified if it is found to be impossible to get a better supply by going a little farther.

Greater attention is now paid to the purity of the water supply than it was a few years ago in the United States. Good sources of supply are less difficult to procure and some artificial purification is rendered necessary, for people today will not take

readily the water their grandfathers would have been satisfied with. There are two systems of filtering in vogue, the first called slow sand filtration, and by some the English system. The other, rapid filtration or the American system of mechanical filtration. In the slow sand filtration system the water is led into filter beds where it percolates slowly through the filtering medium. On the surface of the sand a kind of slime, composed of finely divided clay is formed. A felted slimy mass of algae, and various bacilli, accumulates in this cultivation bed of clay and here the main purification of the water takes place. It is therefore necessary, for the proper working of the sand filter, that this jelly layer be formed, when the process of purification goes on by the action of the nitrifying organisms until the filter becomes clogged by the suspended impurities and the flow of water gets scanty. It is then cleansed and put in shape for further use by skimming off the surface layer and putting on a fresh coating of sand. The water is turned in again and allowed to waste until a new jelly has formed when the effluent is turned into the city mains. In some places a lot of the old sand is put back with the new in order to hasten the formation of the jelly. Great numbers of filter beds are required as the work is done intermittently in order that the beds may be kept in the highest possible state of efficiency. The system of slow sand filtration is therefore expensive and is better suited to very large cities than to smaller places.

The mechanical system of filtration is an Ameri-

can invention and consists of tanks containing finely pulverized quartz as a filtering medium. A chemical coagulent is added to the water in small quantities to form the jelly and it is not therefore necessary to wait so long for the filter to get into action. When it requres cleaning the flow of water is reversed in the filter and by machinery the sand is stirred up until the water running out is clear. The water is set running the right way again, the coagulent added, and in a short time the filter is working at its full capacity. For a small town it is better than the slow sand filtration method and it may be better in larger places but more experiments will have to be made before a positive opinion can be given.

The primary idea of a filter was a strainer where the suspended matter was taken out. When the matter was thoroughly understood it was found there was a bacterial action also and the ordinary household filter instead of being a protection was an absolute danger, for it cultivated colonies of dangerous bacilli. A household filter in which the filtering medium is a baked clay or porcelain is the only kind to use. Dealers often say the way to clean them is to take out the porcelain once a week and wash it. Such advice is dangerous. The only way to clean it is to boil it by placing in cold water after washing and putting in a pot on the fire and allowing the water to come to a boil and boil briskly until the porcelain is hot. Then let it cool slowly. If the porcelain is cracked get a new one.

Lake water is a doubtful source of supply.

Ground well water is sometimes safe to use and generally unsafe. The well in the thickly settled

Cut loaned by the KEYSTONE DRILLER CO., Beaver Falls, Pa.

community is generally dangerous and the open well cannot be condemned in too strong terms. If a well is used it should be closed and the water pumped from it for ordinary use.

Driven wells are frequently used as a source of supply for a town and they are a good source if the quality of water is all right. For this reason when deciding to adopt the driven well system a careful examination should be made chemically and biologically of the water and an examination made as to the possible sources of supply of the sand and gravel bed into which the wells are driven. A large cistern may be constructed and several wells driven in the bottom of it and the water pumped from the cistern or the wells may be driven in a regular series and connected with a main pipe from which the water will be pumped.

When the quantity required is not great the best system is by pumps with a standpipe or tank containing at least twenty-four hours supply. The tank furnishes the pressure except in case of fire when it is better to disconnect it and let the pump force the water directly into the supply main. Ordinarily the pumps need only be used to keep the tank filled and there should be some sort of electrical indicator in the pump house so the engineer need not pump too much and cause the tanks to overflow.

With a town of over 3,000 inhabitants a direct pumping system may be preferable, with several stand pipes in different parts of town, if it is very hilly or broken. The stand pipes will be supplied by the force main and each supply its own district. There should be stand pipes or tanks to supply districts ordinarily supplied by direct pumping, in case of the pump being required to work in other districts when a fire breaks out and more pressure is needed. Each district can thus be as independent as though in different cities.

With a large city a gravity system may be less expensive than a pumping system but it will require careful figuring in any event. With a gravity system reservoirs are generally used instead of tanks and stand pipes. It is useful to remember that when surface water from streams and lakes is stored in reservoirs that the reservoirs must never be covered but should always be exposed to the light and air. When water from wells and underground sources is stored in reservoirs it

must be covered to exclude all light. This to prevent the growth of algae.

Artesian wells are good enough in their way when no other source of supply is available, but it is seldom that a well can be obtained of sufficient flow to supply even a small place. A town considering the proposition of obtaining water from artesian wells must proceed slowly and carefully in order that after the hole is bored and the pipes laid, the volume of water to depend upon will justify the expenditure of the money spent to secure it.

Salt water is used in sea side cities to sprinkle streets and has been found to be very much superior to fresh water for the purpose. It has been found of doubtful benefit in extinguishing fires as a building well soaked with it never dries thoroughly.

A pumping plant should generally be in duplicate so in case of breakdowns there will be no stoppage of the supply. This is not so important where the plant does not have to work more than a few hours each day or for a day or so in the week. For small towns and generally throughout the west where fuel is scarce the gas or oil engine connected to a power pump is coming rapidly into favor The writer has recommended their use and believes they are the best thing in many cases for the service. They are useful in larger places also where there may be isolated districts to serve of limited area. In such places a separate pumping station with elevated tank can be placed and the water pumped from the main to this tank, which communicates with the pipe system in the small district as an

independent supply. Again they may be used in towns where the water company has a contract to furnish a certain high pressure in case of fire and the pumps do not work constantly. The pumps may supply tanks or stand pipes at a sufficient elevation to furnish a good pressure for domestic use and the smaller gas or oil engine may pump from these tanks sufficient to fill a smaller tank at a higher elevation which can be connected with the main system of pipes in case of fire, a check valve preventing the backing of the water into the lower tank. As this tank for fire purposes may not be used once in six months and might contain water enough to last a half dozen fire streams an hour or two a small engine will do the work at a minimum of attention and expense.

QUANTITY OF WATER

It is not safe to figure on less than 30 gallons per capita per day, and the amount in a manufacturing town may reach sixty to eighty gallons per day per capita. Estimates based on the total population. Some American cities use much more. A leading authority has carefully investigated the use of water in American cities and his conclusions are that sixty per cent of the water pumped is wasted. By metering carefully the water pumped and by careful investigation of the use of water it has been found that the above large percentage is not accounted for. In Europe where

there is more careful and judicious oversight it is stated that fully ninety per cent of the water is accounted for.

The waste exists all through the system by reason of careless work in putting the pipes in place and also by reason of the faulty work in making house connections. The writer has seen plumbers connecting houses when the main was of thin wrought iron and there being a leak under the saddle they beat around it with their hammers until the flow stopped—not adding anything to the excellence of the nearest joint in the main which may have been defective at first. The waste also exists in the interior plumbing of the house and when a water works system is installed in a town there should be a first class ordinance passed to regulate this work and all cocks and faucets should be of a certain standard of excellence. But a very large part of the waste exists by reason of the householder being careless because he pays so much a month no matter how much he uses.

The only remedy is the introduction of meters. An immediate saving in running expenses is noticed. There is a reduction in revenue of course but the resultant is a saving of cost and a consequent increase in actual profits. The careful economical citizen does his best to reduce his water bill and after he becomes accustomed to the meter finds that he does not have to skimp, as the minimum meter charge allows him plenty of water for every ordinary purpose. Wherever the meter system has been introduced it has been favorably

received and its use extended. There has existed oftentimes a prejudice in the mind of the consumer against a meter for fear it will register in favor of the company but a little reflection will show him that as it wears much water must pass through it without being registered, so if the new meter registers in his favor it will be apt to do so as it grows older. In some places a tank is placed in the water company's office which contains exactly ten cubic feet of water at ordinary temperature. A house meter is attached to the supply pipe and water measured into the tank before the eyes of the consumer and he can read the result himself. With a meter geared to 99 per cent there is no fear of the test not satisfying him and he can go with the man and see that same meter installed in front of his house on the supply pipe.

A recent report by the board of water commissioners of Hartford, Connecticut, says "meters act as mechanical inspectors of plumbing and as such are less objectionable to consumers than individual inspectors as well as being more effectual and reliable."

It is possible to obtain in almost every city reliable house meters at moderate prices and their general introduction will reduce the cost of living and do away with enormous waste.

GENERAL USE

Good fire hose will cost at least 80 cts. a lineal foot. The life of fire hose is not long and when it is observed how rapidly effective pressure is lost by long streams no argument is required to show that large mains are an advantage in a water works system. The following table is instructive:

FIRE STREAMS.

Pressures required at nozzle and at pump, with quantity and pressure of water necessary to throw water various distances through different sized nozzles, using 2 1-2 inch rubber hose and smooth nozzles. G. A. ELLIS, C. E.

SIZE OF NOZZLES.	1 INCH.				1⅛ INCH.				1¼ INCH.				1⅜ INCH.			
Pressure at nozzle.....	40	60	80	100	40	60	80	100	40	60	80	100	40	60	80	100
*Pressure at pump or hydr'nt																
100 ft. 2 1-2 in. rubber hose	48	73	97	121	54	81	108	135	61	92	123	154	71	107	144	180
Gallons per minute.....	155	189	219	245	196	240	277	310	242	297	342	383	293	358	413	462
Horizontal distance thrown..	109	142	168	186	113	148	175	193	118	156	186	207	124	166	200	224
Vertical distance thrown.....	79	108	131	148	81	112	135	157	82	115	142	164	85	118	146	169

*For greater lengths of 2 1-2 hose the increased friction can readily be obtained by noting the differences between the above given "pressure at nozzle" and "pressure at pump or hydrant with 100 feet of hose." For instance, if it requires at hydrant or pump 8 pounds more pressure than it does at nozzle to overcome the friction when pumping through 100 feet of 2 1-2 inch hose (using 1-inch nozzle, with 40 pounds pressure at said nozzle); then it requires 16 pounds pressure to overcome the friction in forcing through 200 feet of same size hose.

Insurance rates are governed by the efficiency of the plant in any town and a good showing of large mains has its effect. If a volume of water flowing through a two inch pipe had to flow in the same time through a one inch pipe the velocity would be increased four times but the friction sixteen times. No mains should be less than six inches in a town and eight inches is much better if the cost can be afforded. The writer realizes how difficult it is for many small places with a limited bonding power to put in large mains and therefore cannot urge the putting in of larger than six or

eight inch pipes. It is sensible and economical however to have as much large diameter pipe as possible and to have very little three and four inch pipe.

It is a badly designed water works which has not a double circulation. Pipes should be run down cross streets often to connect pipes on parallel streets and whenever a pipe stops it should stop at a street and from the end a pipe should go through the cross street and connect the parallel pipe line. This helps protect the purity of the water by the avoidance of dead ends, lessens the evil effects of water ram, permits a better flow to points where needed in times of extraordinary draught and allows repairs to be made in districts of limited area without inconveniencing many patrons.

Nothing shows the amateur hand so quickly in a water works system as the presence of dead ends and the absence of a proper number of gates and valves. The proper number of gates and valves is not a difficult thing to determine. There should be a gate on every lead of pipe at all intersections so that at a street crossing where four pipes come together there should be four gates, one at each property line. There should be a gate on every hydrant lead so the dydrants can be repaired without interfering with the working of the system. With a double circulation and plenty of gates, water can be turned off in one block at any time by the closing of two gates and repairs made anywhere in that block, the only inconvenience suffered being by those who are in the small district served by that

pipe. This saves time and money. The writer has lived in a town where there are so few gates (and no gates on the hydrants), that whenever a hydrant breaks a notice is posted and also put in the papers that water will be turned off at ten o'clock p. m., in the system to permit the hydrant to be repaired. At ten o'clock promptly the water is turned off and the eighteen hydrants in the system all opened and the gutters flow until the pipes are empty so the repairs can be made. As the hydrants, as well as other parts of the system, need frequent repairs the expense is much greater in the course of a year than the cost of an adequate number of gates. Even if the company did not want to put in a gate at every street intersection and at every hydrant a few gates sub-dividing the town into districts would help, as during the time the repairs are being made all the pipes are empty and if a fire were to break out the result would be disastrous. Such a state of affairs is bad for the town also as any citizen might have good cause for action against the municipality if he suffered damage, and it could be shown that the council was neglectful in not insisting upon the water company living up to its contract and giving proper fire protection.

It is well when water has to be pumped for supply that economy in operation be carefully looked into. For example it is well to have the pressure for fire purposes as near one hundred pounds to the square inch as possible. For domestic use thirty-five to forty pounds will be ample. There is a water works system in the writer's mind which can be

used as an example to show how a saving might have been effected in operation during the eight or nine years it has been in operation. The contract with the city required a pressure of ninety-five pounds at the hydrants in event of fire and to secure this the company constructed a reservoir one hundred feet in diameter and sixteen feet deep at an elevation of two hundred and twenty feet above the lowest part of the town. All the water used has been pumped to that height. When first put in operation very little pumping was required. Now the pumps work every day and nearly all day long. It is proposed to construct another reservoir at half the height for the use of the lower portion of the town and leave the upper one for the higher level. Thus the pressure will be uniform all over town but the lower portion only will have the fire pressure, as arrangements are to be made to get the pressure from the upper reservoir in case of fire.

If the lower reservoir had been constructed at first there would have been a wonderful saving in operating expenses for eight years past. As the pumps were not working all the time and it took some time to get up steam and direct pumping into the main in case of fire would have been unsatisfactory, a small tank could have been placed at the higher elevation, for use in case of fire, with check valve to prevent a backing into the lower reservoir when the high pressure was used. The calculation for the size of the tank would have been easy. Referring to the table of fire streams it will be seen that a 2½ inch stream with a 1 inch nozzle and

80 pounds pressure at the nozzle will deliver 219 gallons per minute. Four such streams will deliver 876 gallons per minute and if the fire lasted two hours there would have been used 105,120 gallons of water. It is highly improbable that any fire in that town would have lasted two hours, and as the system is arranged it would have been impossible to have thrown four streams on any fire at one time, the hydrants being too far apart and the system being poorly arranged as respects circulation. There have been very few fires in the town.

Now the supply of the upper level is being considered, fire protection can be assured by direct pumping or by the construction of an upper tank at an elevation to give 95 pounds pressure there and the town can have two independent systems, each with about 45 pounds domestic pressure, and the lower, or business, level assured of a possible fire pressure of from 95 to 140 pounds, and the upper level assured of a fire pressure of 95 pounds. But the waste of money involved in pumping water 110 feet higher than was necessary for eight to nine years can never be returned. It is an absolute loss.

The question of material for pipes need only be briefly touched upon. Cast iron has been for years the standard material for piping systems and with many engineers is yet a favorite. In small cities the writer confesses to a preference for wrought iron. Cast iron pipe represents rather too much dead weight compared with their strength, as the best method of obtaining long service before destruction by rust is to make them thick. This to towns

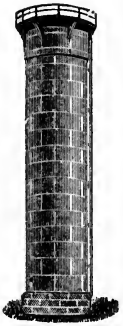
where freight is an item is an insuperable objection to their use. It is very hard to prevent incrustation in cast iron pipes and being to a certain extent brittle they are in greater danger of breakage from "water ram" than wrought iron pipe. Cast iron pipe is usually in 12 foot lengths, measuring from mouth to mouth of the bells.

Wrought iron pipe needs protective coatings more than cast iron to protect it from corrosion. It retains these protective coatings badly unless they are very carefully made and applied and then the life is as great as that of any pipe. It possesses greater strength in proportion to its weight than cast iron and a difference in cost in its favor is generally owing to freight rates. It is not troubled with incrustation to the extent that cast iron is and coming in longer sections than cast iron requires fewer joints, less lead and packing, less labor in laying and is cheaper to maintain. Lock joint, seamless, wrought iron pipe is superior to lap and riveted pipe owing to the interior smoothness enabling an even flow to be maintained.

Wooden pipe is advertised considerably. When made of California redwood staves and banded with iron it is a desirable pipe in diameters greater than 12 inches. It is lasting and can be made to withstand any pressure. There are pipes made of wood constructed by boring a hole through a log of small diameter and wrapping spirally with iron bands, which have sometimes proven satisfactory and sometimes have not. The writer has investigated this pipe and believes that if it were made of

pieces taken from large sections cut from near the heart of big trees and then wrapped spirally with strap iron and asphalted, it would be preferable to the pipe usually seen, which is made by boring a hole through a small sapling. The life of the pipe then depends upon the condition of the tree from which made. The hole may use up all or nearly all of the heart wood and leave the soft outside wood to withstand the effects of moisture.

Sewer pipe of vitrified clay is used in many places as a conduit where it has been found possible to lay



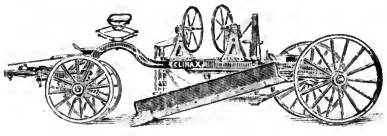
STANDPIPE.

Cut loaned by Springfield Boiler and Manufacturing Company, Springfield, Ill.

it on an even grade and therefore it does not have to work under pressure. It has been used in a very few places under slight pressure. The writer believes it has not always proven satisfactory in actual use. Where used it has been in situations in which a ditch or wooden flume might ordinarily be used in preference to metal pipe, owing to expense, and is advantageous in being a closed conduit.

Rates can only be fixed by taking into account all

items of expense entering into the supplying of water. Rates based on a comparison with neighboring cities often work an injustice. Every city should own its own waterworks but politics should be kept out of the administration. On this subject (Municipal Ownership) the reader is referred to Chapter VI. Under municipal ownership water can be furnished at low cost, or at a profit or at a fearful expense, so much so that the people might be better off with a system under private ownership.



CHAPTER IV.

STREET LIGHTING AND FIRE DEPARTMENT

The cost of street lighting does not seem to vary by any known rule. Investigation shows such wide differences in the same locality that sometimes hints of collusion between councilmen and officials of the light company may be warranted. The policy of the private company is of course to "charge all the traffic will bear," and as rates are often fixed by simple comparison of rates in near-by cities there is danger of innocent and unsuspecting men of honest intention being hoodwinked by showings from places where the administration of affairs is not so fair and honest as in their town. Yet there is also the danger of the lighting company being unintentionally wronged by a comparison unjust and too one-sided. But if the rates are fixed too low the company goes into the courts and shows its books whereupon the judge is liable to fix the rates. Owing to this some cities have a pleasant little way of fixing the rates at the point which is one notch higher than the litigation point and thereby secure a low priced service—which is apt to be very costly in reality, considering service and breakages, or pretended breakages, or by the fixing of a schedule by the company which does not inure to the benefit of the city. No just comparison can be made without

a full knowledge as to the number of hours of burning. A contract between the light company and the city should be specific and in detail and should be submitted to some man who has a knowledge of the business and the technical terms used, before it is signed. Claims of a lessening of cost under municipal ownership are not always borne out on investigation, as municipal book-keeping leaves much to be desired. Many men do not seem to consider that municipal works are as liable to deterioation by time as private works and therefore do not write off depreciation every year.

The invariable fault is to fall back on taxation to make up deficits, pay bonds, etc. While this is perhaps correct the amounts the taxpayers have to pay on account of the bonds and other expenses incurred by reason of municipal ownership should show on the books of the plant as items of expense.

The cost of lighting with arc lights varies from $55 to $136 per year and the schedules and average hours of burning vary as much more. But it may be stated that in a detailed examination of the schedules it does not show that the hours vary as the cost exactly.

For a small town kerosene lamps on posts have been used with only fair satisfaction, until a gas plant or electric plant has been put in. But it is not necessary to wait for a general plant to be put in as there are several makes of incandescent mantle gasolene lamps in the market which give excellent satisfaction. The burner has to be heated before the gas is lighted and some have a small sepa-

rate alcohol lamp for the purpose while others have an attachment on the burner. The lamps are made in several styles for street use and many prefer them to gas or electric light.

From one of the circulars of a firm making gasolene incandescent mantle lamps the writer has taken a table showing the comparative cost of lighting a room 20x60 feet floor area and with ceiling of ordinary height. It is given below and has not been changed in any way. A few remarks might be made in this connection however as to the statement of cost so the reader can figure the matter out himself. A 16 candle power electric lamp is considered sufficient in most cases for a floor area of 100 square feet, therefore it is possible the cost of the electric light service might be less than the figures given. Three-fourths of a cent per hour is a usual charge.

A 16 candle power gas jet is more like to consume 6 feet per hour although the usual flow of an ordinary burner is 5 feet. One dollar per 1000 feet of gas is cheap gas. The information as to cost of carbide for acetylene gas gives no information to the non-technical reader. In the city of Wabash, Ind., the cost of a 16 candle power acetylene jet is ⅓ cent per hour with discounts off of from 10 per cent to 30 per cent for consumption of from 600 to 2000 hours. The cost of the oil lamp with central draught the writer believes to be a trifle low and he cannot vouch in any manner for the figures relating to the incandescent gasolene lamp except to state that he knows where electric lights have been taken

out and these lamps used instead with better satisfaction and a remarkable saving in expense. The number of hours had best be investigated also in the table as the writer has not looked into it in any way except as to the cost explained above. It is always best to examine closely all tables and statements made in catalogues, as errors sometimes creep in.

COMPARATIVE COST

FOR LIGHTING A ROOM 20x60 ONE HUNDRED HOURS PER MONTH FOR ONE YEAR.

Eighteen incandescent electric lamps, 16 candle power, 288 candle power, 21,600 hours at ¾ cent per hour, cost	$162 00
Eighteen gas jets, 16 candle power each, 288 candle power, 5 feet per hour, per jet at $1 per 1,000 feet, cost	108 00
Twelve Acetylene gas jets, 20 candle power each, 240 candle power, carbide at $90 per ton, cost	100 00
Three central draft oil lamps, 75 candle power each, 225 candle power, one gallon of oil per burner, 10 hours, at 6 cents, cost	21 60
Three incandescent gas lights. 100 candle power each, 300 candle power, one gallon of gasolene per burner, 60 hours, 6 cents, cost	3 60

In relation to the placing of lights a report made in St. Louis last year by the board of public improvements was against the use of electric lights in the residence districts and in favor of incandescent mantle gas lamps (not gasolene but city gas). The cost was found to be practically the same. In the business district a large volume of light, which will in some measure illuminate the buildings as well as the streets is needed, while in the residence districts an even distribution of light by small units is found to be wanted. Small units of light have an economical advantage for lighting long blocks with few street intersections. Incandescent electric lamps in

the residence districts are objectionable on account of the wiring strung along overhead and across intersecting streets, and electric arc lights in residence districts are an annoyance to the residents of the immediate vicinity. Trees in a residence district also interfere with a proper distribution of light from an electric lamp.

In many European cities the number of gas jets in out of the way courts, narrow squalid streets and other places where in the United States it is thought a waste of good money to put lights, always attracts the attention of the traveller. Upon inquiring the reason he is told that one gas jet is equal to a policeman and very much cheaper, as a preventative of crime. In some cities of the United States it has been found that a bright light at each end of a block does more toward clearing a neighborhood of the unfortunate creatures of the half world than a nightly raid of the police.

FIRE DEPARTMENT

The following brief suggestions are given as the result of some little personal experience with a volunteer fire department in a small town and after inquiry into the experiences of many other small cities.

The first requisite is a good alarm system and there is only one standard for large places. It is too costly, however, for the small town and for such places the writer has found the simple magneto telephone to be as efficient as anything and very

cheap. The operation of such a system is as follows: The city is divided into districts, seldom exceeding six on account of the number of rings required, and each district has a number. As many telephones as the city can afford to pay for are put in locked boxes on poles with a notice painted on the box telling where the key may be found. In many of the saloons, stores, hotels and other public places and in the residences of the members of the fire department may be placed telephones or simply alarm bells. When any person notices a fire it is only necessary to go to the nearest telephone box, open it and proceed to ring the number of rings which will indicate the district in which the fire is discovered. The alarm should be rung, say three times, and then the aurophone put to the ear so inquiries may be answered. They will come in at once from every telephone on the line and one answer is made to all, giving the exact locality of the fire by the house owner's name, or number and street.

The companies are supposed to have sufficient organization for every member to know exactly where to report. The chief should at once repair to the fire and the various captains and other designated officers to the places where the hose carts and ladder trucks and engines are housed. Some members who have apparatus at their residences or places of business proceed to the fire, while others whose duty it is will stop to rouse certain individuals who have no alarms. It takes only a short time to arouse the men whose duty it is to extinguish fires

and the peace of the whole community is seldom disturbed unless the conflagration is a large one; and then a general alarm can be turned in by the ringing of church and school bell with the usual accompaniment of shouting men and barking dogs.

In places where the marshal or street commissioner is ex-officio fire chief and there is no organization, or only a quasi one wherein every political heeler is put to work with a hose and puts in his bill for $2 at the next council meeting, it hardly pays to attempt to put in a good alarm system, or improve upon the plan in existence. But where a good volunteer department is encouraged the results are very good as insurance rates are lessened and the city soon takes a pride in its well organized and drilled fire department. The forming of several companies tends to a beneficial rivalry.

The first step in the preparation for fire fighting will consist in the council requiring every house to contain at least two buckets for fire purposes only, properly painted and marked, set on shelves and kept full of water, together with an ax and 25 feet of rope with a heavy hook on one end and a knot every foot apart. There should be also on every floor at a convenient point not less than three hand grenades or a small chemical fire extinguisher.

The next step is the organization of volunteer companies and their drilling. The first lesson in drilling is to learn how to pass buckets and handle the axes, knotted ropes and fire grenades. There should be one drill each week if possible and two or three times a year a competitive drill in all the glory

of red shirts and leather hats. Each company should have two or three Pompier ladders and two or three chemical fire extinguishers to be strapped on the back. The men who handle the ladders and "spark chasers" as the chemical extinguishers are sometimes called, should be provided with heavy leather belts, having on them snap hooks. With these light useful ladders and the extinguishers many fires can be prevented from becoming dangerous conflagrations in a short time. The drills consist in climbing over houses and running up store fronts from story to story with the ladders and at some windows hanging on by means of the snap hook and directing an imaginary stream from the extinguisher or a hose into the room. There should also be drills with bonfires in order to train men in the use of buckets and chemical extinguishers, and the use of the hook and ladder apparatus.

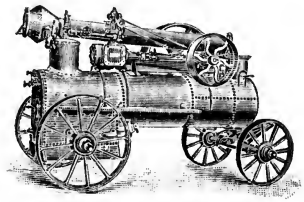
If the town has a water works system with a good pressure there should be frequent practice with the hose and hydrants. Good village hose carts equipped with axes, crowbars and drag ropes can be purchased at prices ranging from $100 upwards. Fire hose can be obtained at prices ranging from 60 cents to $1 per foot. If the place has no waterworks system with good pressure some form of village fire engine may be used to suck water from the pipes, or if there is no waterworks system in the town then the engine may be used to draw water from private wells or cisterns, and public cisterns may be built at the intersections of main streets, calculated to hold water enough to last a good fire an hour or so

with three or four hose streams playing constantly.

Village engines can be purchased at prices ranging from $185 to $1000 or $2000 with room on brakes for from two to 20 men. This form of engine has not by any means gone entirely out of date and is doing efficient service in many small places. It is an elegant contrivance for keeping up interest in volunteer departments and when frequent tournaments can be arranged with neighboring towns the engine becomes an object of adoration to the men of the company possessing it. A good companion, and not always a competitor of the village engine, is the one or two tank chemical engine mounted for hauling with drag rope and costing from $300 up.

The equipment of alarm system and fire fighting apparatus alone will not make an efficient department. It requires the frequent drill and thorough training and the keen rivalry between companies. In short, upon the personnel of the fire department depends the value of the apparatus of the town. The companies must be encouraged. It is well for a general meeting place to be provided at public expense for the members where a caretaker provided by the city keeps the rooms in a clean condition. Here there should be kept the latest periodicals and an outfit such as every good athletic club possesses. There should be no dues for members of the fire department and there should be an abatement of poll tax and some other little vexatious things the ordinary citizen is subject to. No money should be paid anyone by the city for service at fires but worthy and needy members of the companies can be

engaged as watchmen over ruined premises when required after a fire, to clean the apparatus and keep the general quarters in order. Merchants in many small towns will assist the council in keeping good volunteer companies and the interest manifested by the young men in such things will soon become felt in other civic affairs. Many places too small for a military company have volunteer fire companies which supply the need the military company supplies for exercise and companionship among men of congenial dispositions. Sometimes such organizations go into politics "but that is another story" as no body of men is entirely free from the desire to control local politics when strong enough.



CHAPTER V.

PLANS AND SURVEYS

Many of our towns have been settled so long and there has been so little care exercised in preserving monuments that the original stakes have disappeared and a "happy go lucky" way of establishing lines for fences and buildings has crept in which leads to trouble between neighbors. Sometimes the trouble flares out and the whole town is stirred from center to circumference over the matter and the merits and demerits of various surveyors discussed with acrimony. It is apt to get to such a pass that it is impossible to relocate the original lines with certainty. The longer such a state of affairs continues the worse the confusion and the prospect of costly law suits are promising at some future time when land has increased considerably in value.

The causes for such a state of affairs are many. Sometimes the original survey was faulty. This is often the case, for the original survey was made when land was cheap, with imperfect instruments and by careless methods; sometimes by men illy trained. When the original stakes disappeared surveyors coming after who were called upon to survey a lot had to start from some fence corner or building claimed to be correct by some and the correctness of which was denied by others. If these surveyors had been commissioned to survey the whole

town and their records kept carefully the troubles would not be so great. But the surveys were isolated ones made at a cost satisfactory to the lot owner and the price seldom large enough to enable a man to do all the work that was really necessary to do a correct job. When the owners between the later re-surveys finally get pinched there is trouble.

When the need of some proper definition of boundaries is realized and a complete re-survey decided upon, it should be made by a competent engineer who has had previous experience in that class of work and who has some legal knowledge. For his work must be done so if courts and juries follow over the lines they will say it has been as well done as it possibly could be. It is a risky thing to disturb long established possessions and only the most conscientious and careful work will do.

An axiom in settling disputes over lines is that monuments govern distances and distances govern bearings. Such decisions were given in former days when compass lines were so often run and there was known to be errors in that class of work. The setting of a monument was something any man could do and it was supposed almost any one could measure a line as he wished, but the turning of angles was a matter requiring skill and in matters of skill men often make mistakes. It is now conceded however that with the modern methods of laying out work the measuring of a line is a more skillful matter than the turning and reading of an angle and later decisions give the proper weight to both operations. Although there has been a change in that

respect there has been none respecting monuments and they must govern above everything—unless positive proof can be given that they have been altered or changed in location. Of several calls in a description the certain govern the uncertain, even to the rejection of the uncertain. When a town has been laid off without any permanent monuments and the original stakes have rotted and disappeared the surveyor who comes in and tries to lay off that town mathmatically without paying proper attention to long established possession is foolish. Each block has to be treated by itself and the surveyor must recognize what he terms inaccuracies. The city of course is entitled to the full street width but it is doubtful if any buildings can be removed from the street if they are not an obstruction. They can be permitted to remain until they become a nuisance or until rebuilt, when the city can assert its claim to the portion of street they occupied.

A resurvey made under such circumstances often gives crooked streets of varying width where the original plat showed a straight street of even width but if none of the points can be positively identified then it is impossible to lay the place off as it was claimed to be first laid off. The only way to prevent a recurrence of expense and trouble is to finally and definitely fix the lines by permanent monuments, well identified, and record the maps. If the town has been monumented and the buildings have been put up without surveys there is no doubt that they must come to the right lines as the monuments govern, and if in existence at the time the buildings

were erected there could be no excuse for not building exactly on the proper lines. Because the original owner was too stingy to employ a surveyor he should not be allowed to unsettle the lines of a whole neighborhood.

Every town should have a city base, or plane of reference, from which tc calculate all elevations. This is for the purpose of permanently establishing official elevations and grades of streets and sewers. The elevation above sea level, or the mean of lower low tides, is a good plane of reference if government bench marks are near; or low water mark in the stream into which the sewerage is discharged may be taken. The plane of reference may be termed zero and elevations referred to as so many feet above or below it. Frequent bench marks should be established throughout the city, referring to the city base so that long lines of levels can be avoided in doing work. Careful records should be kept of such things.

All subdivisions of land within the town limits should be subject to the approval of the council before the plats are filed. The council should prescribe the maximum and minimum grades, the direction of the lines and the width of the streets. When the owner submits his plats for the approval of the council they should show proper connections with adjacent city monuments and show monuments at all street intersections and changes of direction. The elevation of all corners above city base should be also shown in red ink.

SPECIFICATIONS AND CONTRACTS

It is unwise to attempt to do any work without plans and specifications being prepared in advance with estimates of cost. Complete specifications are plain descriptions with the necessary drawings, in detail of the work to be done, and should form a part of the contract. As a rule it is better to do all public work by contract than day labor. It will be found most satisfactory in the end, although a very few places have found it otherwise.

It is not economical for the municipality to furnish paving and other material and contract simply for labor, as the inspectors are apt to be lenient in passing imperfect material in order to save loss. The only way is to have the contractor furnish everything under rigid inspection before being put in place.

The council should not attempt to dictate to the contractor whom to employ and whom not to employ. It is well to give home labor the preference but if the contractor is compelled to employ only local labor the cost of the work is increased. The men thus encouraged become very independent and the contractor finds good men scarce and hard to deal with when protected thus. It is not just nor honest to the taxpayers to put such restrictions in any contract.

For economical work there must be good, clear specifications, honest advertising and letting of contracts, with competent supervision and severe penalties for non-performance and shirking of work.

PLANS

When plans for public water supply or lighting or sewerage are wanted there are two methods only which can be considered, one of which must be adopted.

The first method, which is undoubtedly the best, is to select a competent engineer and have him prepare the plans. Pay him a fair price for his work and give him every facility in its prosecution. This is a proceeding in accordance with the old saying: "Every man to his trade."

The plans when completed must of course be accepted or rejected by the council. A consulting engineer can be selected to report upon them or the council can act without a consulting engineer, other than the one who has been employed to prepare the plans. But if no other engineer is employed then the council should not attempt to criticise any of the technical or scientific features of the plans as that is a criticism of a man's ability by men of no ability in that particular line of work. Questions of expediency alone must govern in the rejection or acceptance of plans.

The great objection to the above method is that many men assume the title of "expert" who have no right to do so. Some incompetent man is sometimes selected out of gratitude for past favors received, or prospective favors to be granted, or out of friendship to some one in authority. To avoid such a selection the expedient is sometimes tried of advertising in an engineering paper of wide circulation for an engineer. The advertisement should state the size of the town, both as regards area and

population, the work required, and ask for engineers to send in sealed envelopes a statement of their experience in such work, a photograph of themselves, a list of good references and a statement of how much they will charge to do the work. This method generally results in a satisfactory way if there is no good engineer in the immediate neighborhood to undertake the work. The man who offers to do the work for the lowest price is not always the best man to employ and it is generally the case that some local engineer can tell readily among the men who present themselves for the work, those most prominent in the profession for the class of work advertised. It is well to state in the advertisement that applications will not be considered from those who come in person or write personal letters to the councilmen in advance of the date set for opening the sealed letters.

The second method spoken of is to have competitive plans prepared. In the former edition of this work the writer went somewhat into detail on the manner of preparing for a competition of plans. It is a practice, however, to be discouraged and one which no town should attempt. The business generally results unsatisfactorily to all concerned and the best plan is not often selected.

In examining plans which have been prepared on an order of the council there is oftentimes manifested a disinclination to employ engineers. This is notable in the western states. To examine sewerage plans a committee of plumbers, architects and physicians will be appointed, with perhaps a con-

tractor or two, while to examine plans for water supply, stationary engineers, machinists and contractors are favored. The much vaunted "sense" of the business man is relied upon, yet this same business man calls in physicians when ill, lawyers when sued and a carpenter and mason when he wants to build a house. To employ the physician and lawyer to build his house or consult the carpenter when ill and have the mason prepare a plaster for a sore chest, would be extremely bad form and not economical. The inferences are obvious.

THE VALUE OF TECHNICAL ADVICE

In an editorial in the Engineering News of July 11, 1895 the following extract appeared: "The fact that a competent engineer can make a little money go much farther than it would go without his advice and aid is one which the general public is slow to comprehend. The average man congratulates himself upon the dollars he saves by dispensing with an engineer's services, and knows nothing of the dollars lost in exhorbitant prices, or in work poorly executed."

The average man has to build at least one house in his lifetime. If he is sensible enough to have an architect to stand between him and the contractor he is generally fortunate in his work. When he attempts to do without an architect and accepts the plan of some builder to whom he awards the contract he is in a pitiful plight. When he buys a

book of ready made plans and attempts to do the work without any architect at all he delivers himself bodily into the hands of the contractor who erects the house, and generally pays a high price for a poor job. Speaking of men in such connection a recent article in the American Contractor says: "I have constructed more than a hundred buildings," remarked a prominent builder, "more than half of them on my own account, and think I understand the art of building, but I would as soon think of myself making the hardware by hand as proceeding without an architect, even when I am following plans which I have already used, as is sometimes the case. In an architect I have a responsible agent who avoids mistakes and is accountable when they occur. Occupying the position he does he can secure the lowest bids, and acting in a fiduciary way, must ignore the claims of personal friends, which a builder is often unable to do. I have tried the other plan enough to demonstrate its absolute fallacy. A competent and reliable architect will save the builder several times the amount of the charges he makes."

When a city attempts to have work done by men who have no previous training in the work the result is a failure. Yet it is often attempted. Many times a surveyor of little ability as a surveyor and no knowledge of engineering is appointed as a city engineer and allowed to work his own sweet will in matters calling for the highest possible engineering skill and advice, when it should be known that a surveyor bears the same relation to an engineer that

a pharmacist does to a physician. It is well to have a local man to do the ordinary work of setting out lines and making surveys but if he is not trained for the higher engineering work it is better to call in a man, who has made such matters a special study, to consult with him and the council.

Sometimes in the evaluation of a plant the city proposes purchasing, men are selected to examine the plant because they are "practical" and an engineer, forsooth is "theoretical". In common language theory means hypothesis, but in scientific circles theory is one thing and hypothesis is another. A theoretical man among scientific men is one who has had a good scientific training and a theory is simply a statement in technical language of the result of a long continued series of accurate observations. It is the statement of an observed law in a manner which will enable a man to predict confidently how a certain event may terminate. But in common language the word "theory" is so often used when "hypothesis" or "hypothetical" may be really meant, that a man claiming to be well posted theoretically is at once set down as a fool. All that is necessary for a man to take high rank as a practical man in some communities is to parade himself as a man who has used his eyes and ears to observe things and has never wasted time reading books on the subjects he discusses, for he somehow thinks that neither the writer nor the reader of scientific books as good sense. It sometimes happens that the patient and useful work of a really conscientious engineer in a community is en-

tirely undone by a pretentious and ignorant man who boasts of his "theoretical" ignorance and prates about his "practical" (?) knowledge in the columns of the local paper. He somehow cannot get through his head an idea that the engineer who adds to his book knowledge an experience of many years in the practice of his profession may be a practical man. It must be borne in mind that after an engineer leaves school he seldom has occasion to consult a work on mathematics or abstract science unless he has a bent in that direction. His reading along engineering lines is in weekly or monthly periodicals filled with descriptions of work executed by other engineers and in the reading of books of the same nature, but each of which treats of a special subject. He must really be a practical man if he adds to his own experience a knowledge of the experience of others. His theoretical training enables him to sift the false from the true unerringly. The untrained man is generally more theoretical (i. e. jumps at conclusions with little reason) than the trained man.

THE COST OF TECHNICAL ADVICE

Technical advice of value costs nothing. That is, there is a real saving by having such advice and wrong to add it to the expense account of a piece of work. It must be borne in mind that while there may be pools in bidding on work, at the same time there may be variations enough in the plans of the bidders to account for the dif-

ferences in price, and if the council has not ascertained the conditions so well before calling for bids that everything is provided for and nothing left to luck, the element of uncertainty must be covered by a large price which may or may not be all profit. When the contractor prepares his own plans he is entirely responsible and the city pays him a big price for insurance. With the engineer in the responsible position the contractor has only to do exactly as the engineer directs and he is sure of his money. All reputable contractors prefer to have good men in charge of work, notwithstanding the general opinion to the contrary.

Cities and individuals have often to call in consulting engineers to look over work being done by an engineer in their employ or to give opinions on plans prepared by some engineer whom they have employed or will employ to carry out the work. The consulting engineer is then put in the position of a critic and his expressed opinion may have the effect of throwing a man out of work and perhaps ruin his reputation. This is a serious position for a man to occupy and it is well to bear in mind that no reputable engineer will thus pass judgment upon the work of another unless that engineer is first told of his employment and expresses himself as agreeable to having the consulting engineer called in. If he leaves his work before the consulting engineer is employed that is an entirely different matter. But even in that case no reputable engineer will render a report upon another man's work until he has given that man an opportunity for a hearing, as

the first man has had perhaps months to study the matter and the consulting engineer has of course to pass judgment after less time given to study of the problems involved. If parties employing engineers find a man willing to violate such a plain rule of common courtesy they should avoid him.

What to pay an engineer is a question difficult for most men to determine. If they advertise for an engineer the prices vary greatly and if they start to hunt for an engineer they will find the same differences to exist. Among men of standing, however, there is something near uniformity in the charges made for professional services, and the same is true of engineers who wish to stand well in their profession and who take a pride in their work. There has to be a distinction made in the character of work done. For consultation on matters requiring special training, skill and study, and for advice in settling disputes a charge of $25 per day together with all expenses is a minimum. When plans have been prepared and work is being done, if the engineer is retained in a supervisory capacity, his charge then is generally $15 per day and all expenses for each day he is actually on the ground. For example, a town may call in a man first to consult with them in the matter of a sewer system and he charges $25 per day for the time he has spent on that trip. The local engineer prepares the plans and they are submitted to the consulting engineer, "expert" some term him, and he goes thoroughly over them suggesting changes and making a final report, and his charge per diem is the same. The work is pro-

ceeded with and the local engineer put in charge, but with the privilege of calling in the consulting engineer as often as he feels his presence necessary. For this latter work the charge is $15 per day.

In the case of ordinary surveys a sliding schedule is generally arranged. This is for work which the engineer may do personally or may trust to an assistant, but being himself responsible for its right performance. The charge then is usually $10 per day for six days work, $8 per day for the next six days work and $6 per day for every day after. For office work in connection the charge is usually $8 per day for six days, $7 per day for the second six days and $6 per day for every day after that. This of course in addition to traveling expenses and all expenses incurred during absence from home.

The most satisfactory way of paying for engineering services other than consultation, is by a percentage upon the contract cost somewhat as follows: For preliminary plans and estimates without surveys, one-half of one per cent of the cost. With surveys it may go from 1 to 5 per cent. For complete plans and specifications in addition to above, 1 per cent. For supervision (which does not include the setting of grade and line stakes) 1 per cent in addition to above. With the setting of stakes (the engineer paying his own helpers) 2 per cent. Or all of the above (except the first surveys) three and one-half per cent where the employer pays for the inspector on the work and the engineer is expected to go on the work as often as is necessary to thoroughly supervise the carrying out of the specifi-

cations. If the engineer is expected to pay for the inspector the charge will be 5 per cent for everything except the original surveys. Sometimes the original surveys are of so little moment that nothing extra is charged for them. The ground must be studied, however, before any estimate can be given on that point.

Under the percentage system the pay is due as each step of the work is completed; and the percentages before the contract is let, or if the proposed work is abandoned before a contract is let, are due and payable upon the estimated cost.

In reports taken from many cities of the United States the engineering, including surveys and office work, varies from 5 to 10 per cent of the cost of the work and in railroads the engineering is generally estimated at about 5 to 7 per cent. In many cases, however, there is made a difference between the engineering and superintendence, the engineering consisting simply in the preparation of the plans and the setting out of the work, the carrying out being charged to superintendence. Yet in other places the whole is charged to the engineering account.

HOW TO DO THE WORK

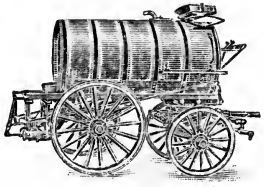
A remark was heard by the writer one day in a city of some size where some street work was in progress. An official of a small town near by was watching the work and talking with the contractor. It developed that as he had some business requiring his presence in the city his brother councilmen had asked him to gain some information

about such work and report to them. He said in part: "We are very anxious to get work like this done in our town but there is no contractor there who can do it. If you would come up there and do us this kind of a job we will be glad to talk with you."

He, like many others, believed the whole job to be the work of the contractor. The people of that place wanted work done and never considered that it was necessary to have carefully prepared plans and specifications and responsible oversight. One and all the various builders and teamsters in that town had declined to undertake a job of macadamizing because they were not familiar with such work. They were ready to build cross-walks and haul gravel but to carry a careful piece of work through in its entirety they were shy. The work was not done because the council did not know exactly what was needed and the contractors were as badly off. Acting upon the advice of the contractor whom he talked with, this particular councilman went home and made a report to the others.

The town surveyor was asked as to his experience in such work and frankly confessed that while "it is easy to read books and get posted on such things" he had not had any experience in such work but mentioned a man who had. The man was sent for. A careful set of specifications was prepared with full drawings in detail, and the town surveyor was given some instruction in matters of which he said he was ignorant. Bids were advertised for and to the surprise of the council there were quite a num-

ber of their local men represented. One of them got the job and the engineer who prepared the plans was called in several times during its progress to advise with the contractor and the town surveyor. After the completion of that piece of work the latter found himself able to prepare plans and specifications for other work of a similar nature, and the council had learned a great deal. Not the least of which was that any kind of work that a man wants done can be done provided the contractor has laid out fully for him every detail and has someone over him who is responsible and competent. The contractor does not need necessarily to be experienced in such work to do it right—although he is more apt to make money as his experience increases.



CHAPTER VI.

MUNICIPAL OWNERSHIP

The items of cost in any enterprise may be generally stated as follows:

1—Interest on the investment, which includes interest on the bonded indebtedness and also on all capital expended for construction over and above the bonded indebtedness.

2—The annual payment into the bonded indebtedness sinking fund.

3—Payment into a fund for periodical renewals, or the annual reduction in value by reason of depreciation of the plant through time.

4—Operating expenses and administration.

5—Extensions and improvements of the system, and a payment into a fund for anticipated future extensions or additions.

6—The profit on the investment.

The first and last items are sometimes so closely connected that they are synonomous, but the investment is not gilt.edged then unless the stock is watered. As men organize quasi-public corporations for the profit there may be in them, the idea of municipal ownership of all public utilities is alluring for it is imagined the people will save to themselves the profits usually made.

Under the head of operating expenses it is sometimes customary to place the item of taxation and

sometimes it is customary to remove taxation and insurance from the item of operating expenses and place them by themselves as a separate item of expense. It is urged that under public control the only items of cost are as follows:

1—Administration.

2—Labor, supplies, etc.

3—Renewals and extensions.

4—Maintenanee.

Profits, taxes and interest are saved, therefore the consumer gets his goods at bare cost or perhaps a small profit may be made to help defray the cost of other non-productive properties.

Advocates of wholesale municipal ownership are no doubt honest in their intentions and beliefs, but deficient in perception of economic facts. Anything tending to an increase in salaried positions, especially positions not requiring any wonderful amount of ability but where faithfulness and honesty should govern, tends to increased expenditures and increased danger of political control or "bossism". With an enlargement in scope of the civil service idea and the elimination of national party politics from municipal affairs, it is possible our municipalities may safely and economically engage in various lines of business, but not otherwise.

In America Professor Bryce says we have made a conspicuous failure in our, so-called, system of municipal government. The excuse that our cities have grown too fast is not a valid one. The reader is referred to Albert Shaw's "Municipal Government in Great Britian" and "Municipal Government

in Continental Europe" for information as to the relative growth of American and European cities in the last thirty-five or forty years. The American familiar with the "boom" growth of his own cities will gasp with astonishment when he compares some of the most prominent American cities with the places in Europe he has been accustomed to think slow.

The excuse that our failures are on account of universal suffrage, while in England where municipal government has nearly attained perfection the suffrage is restricted, is not a valid excuse. Birmingham in 1891 had a population of 430,000 and Boston a population of 448,000, a difference in the favor of Boston of 18,000. Birmingham had 88,186 registered votes while Boston had 73,000 a difference in favor of Birmingham of 15,186 so that Birmingham with 18,000 less population and with strictly enforced laws respecting the right of suffrage had 15,186 more registered voters than Boston, where every man could vote if he felt like it. Where the vote is a privilege it is valued. Where it is an inherent right there is a class of indifferent men who hold the balance of power—and unfortunately, when these men are aroused it is seen they express at the polls the best public sentiment. They should be kept in an interested state of mind.

Joseph Chamberlain in a Manchester speech a few years ago said the reason for failure in municipal government in the United States was that the highest officials were underpaid and their terms of office were short with no guarantee of permanence in

office no matter how good their record, while their subordinates received higher pay than they could get in outside employment and had to use every possible political device to hold their positions. He said, in short, that our American cities are controlled by the clerks of departments and the workmen on the streets instead of by the better and more intelligent class of office holders, who were ofttimes incompetent because they held their office by election and accepted for short terms smaller salaries than an able man in their profession could make in private practice.

Such a state of affairs must be changed. In England there are men in office who have held office continually for 40 and 50 years and there are men on the councils who have been there nearly all their lives. Attorneys, clerks engineers and such men are appointed in those countries for life or good behavior and the pay they get is very large to an American. Their assistants and subordinates are appointed after rigid practical examinations and their pay is regulated by the salaries paid in business houses for similar service. The "boss" is unknown. National politics play no part in municipal affairs. The interests of the city alone are concerned. That is the reason municipal ownership has been so successful in England and it explains why it has not always been a great success in America.

Municipal ownership is not in such a country in a state of theory (hypothesis) and experiment. It should not be here and it is a question if it ever was

in such a state. Rome 2,000 years ago possessed vast waterworks and baths and a lighting system all under municipal ownership and control. All the cities of the ancient world owned their own waterworks systems. Yet the question is argued today in American cities as if it was something new and untried. Conducted in a perfectly businesslike way, with marked efficiency the only rule for appointment and promotion, it is something comparatively new here.

The only argument of the writer against municipal ownership is that it is not right until the affairs can be conducted in a businesslike manner as in private corporations. In private corporations an employe's value is rated by his earning capacity. His efficiency for the work in hand is somewhere nearly proportioned to the work expected of him. In a municipality it too often happens that a man's fitness for the position he holds is apt to be guaged by his usefulness at election time. Patronage, more than efficiency, governs his appointment. Therefore it is that public enterprises are so seldom economically managed. While the elected officers may be perfectly honest in their intentions, and do their own work to the best of their ability, with little desire to perpetuate themselves in office, their appointees are either busy feathering their own nests before next election day, or laying wires to hold on to their jobs, and the best way to hold on to such a job is not always to attend faithfully to the work paid for.

Opponents of municipal ownership are convinced

that wise laws well enforced will serve everything and leave the time of the council to the matters of real public interest. But an exception is generally made in favor of the waterworks system being under municipal ownership simply because of the thorough control which the people then have over fire protection, the protection of health and extensions when needed into growing districts. The hope of saving should not influence in the public ownership of waterworks for sometimes municipal ownership of waterworks is so expensive a luxury that although taxes, interest and profits are not considered in the items of expense attendant upon operation, the people are extremely likely to pay more for their water than the private company charges.

In general the items of expense entering into the operation of a municipal plant will be the same as those entering into the operation of a private plant. However, it is not best to fig ure on any profit for the business is a co-operative enterprise and the product should be sold at cost. Taxes cannot be figured in on a public plant but insurance must be. The interest and sinking fund on the bonds should be charged as an item of expense but no interest charged on the investment after the bonds are paid up. The money is permanently invested. It is not right either to figure into the cost of operation a fund to provide for future extensions. These will be met by the future residents when needed. As the noted Irish member of parliament said, "Do not be so careful to take care of posterity. It has done nothing for

us and our grandfathers let us paddle our own canoe." Every thinking man realizes that it is not well to tax ourselves in this generation for the whole cost of an enterprise which will benefit the next generation as well.

It is proposed also that all annual extension work should be borne by general taxation for there is a good return to the city at large and the amount needed is difficult to estimate in figuring up expenses of operation for the succeeding year, in order to fix charges.

So then we have to consider as legitimate cost of running a municipal plant the interest and sinking fund to pay off the bonded indebtedness, the writing off each year of the depreciation, the making of repairs, the maintenance of the whole system and the cost of fuel, labor, administration, insurance, etc.

The revenue from the works should be from two sources; general taxation and private consumption. The consumers of the product should not pay the entire expenses for they are the progressive element whose property has been improved. The owners of unimproved property should pay a part of the cost. Every enterprise of a public nature in the town increases the value of all property and the unimproved property increases in value in a greater ratio than improved property. So if it is a lighting plant the city should pay for its own lights from general taxation and in case of a waterworks plant, for the water it uses or has a right to use.

This is the true theory at the bottom of hydrant rental and payment for water for public use when

dealing with a private company. It is not right to make a contract at a flat rate with a water company for hydrants for a term of years. The council should annually get all the information regarding cost of the company's plant, cost of operation and the revenue for the year past. Then fix the rates on an equitable basis for the consumers of water and guarantee to the water company a proper return on its investment by making up the deficiency by the payment of an annual sum on account of general benefit, fire protection and public use. In return for this require the water company to put in hydrants whenever and wherever ordered by the city, the sum of money paid by the city being independent of the number of hydrants. The city should own the hydrants and pay for their erection, connection with the water mains and maintenance. It is a grave mistake to pay a certain sum per month or year for each hydrant as it operates to keep many districts out of the reach of fire protection because of the increased cost of extra hydrants. Yet the people in these districts have their share of the taxes to pay for fire protection, general benefits and public use of water.

THE VALUE OF AN OLD PLANT

There comes a time in the history of almost every place when the idea of purchasing an existing plant has to be considered. At such a time the wisest course is to send for an outside competent man to make an estimate of the proper price to be paid.

There are three values to an old plant of a private

company: First—The value to the company as an investment. Second—The value of the plant by reason of the material in it. Third—The value of the plant to the community. This third value may be nearly what the company places as the income producing value, and again, it may be far lower than the actual value of the material in the plant. The value to the community depends upon the efficiency of the plant. If it has been well designed and cared for and all extensions made have been under the direction and with the approval of the council, or board of public works, then the people may pay the price the company asks. Otherwise there is a serious economic loss possible by reason of the duplication of an already efficient machine. But if the plant has not been well designed and the extensions show that a niggardly policy has been pursued and there is evident a lack of judgment in the management of many of the small though important details it is possible the people have no system to purchase; it is simply a plant and a poor one. It may happen the plant can be taken at a proper valuation and remodeled to do all the work required of it at a less cost than an entirely new plant would cost. All these are matters to be determined at the time of examination.

The person employed to examine the plant has first to determine, as near as can be, the original cost. To this he must add the cost of all extensions. He must ascertain the exact indebtedness of the company and the state of the indebtedness. The yearly interest charge and cost of operation.

The revenue from private consumers and the revenue from the city. The life of the franchise and the length of life left in all existing contracts, if any. And generally the value of the plant to the community, the general features of design, the present condition and cost of making it adequate to serve the town if purchased. The value of the material should also appear but it is not of such importance as the other items, for the deterioration must be naturally an estimate for much of the plant.

With such information before them the people can act intelligently when it comes to voting on bonds. The embarrassing features of a purchase by the city are the value to place on any existing long term contracts the city may have with the company, and whether the city should pay anything for the franchise right, which has been obtained from the city. These questions require expert advice.

AN ARGUMENT AGAINST MUNICIPAL OWNERSHIP

Mr. A. S. Baldwin, writing in the Merchants' Association Review (San Francisco) in April, 1900, argues against the purchase by the city of the Spring Valley waterworks plant and favors public control as opposed to public ownership. The gist of the argument is that with municipal control instead of municipal ownership the city has no responsibility, no debt and no liability of any kind. With the limitation that the rates fixed annually will allow the company a fair and just return upon its invest-

ment, the city under the general state law fixes the water rates to be charged. Municipal control also means that the city derives a revenue from the taxes paid by the private corporation. So far his argument is good. But he goes farther:

"Private ownership means that the corporation borrows, but never pays anything except interest on the debt. It issues bonds or sells more stock whenever money for permanent improvements is required. It renews its loans by another bond issue. It borrows for land purchases and new construction. The taxpayers and consumers buy from the private corporation water and pay enough to enable the company to pay taxes, operating expenses and interest only on its obligations. The private company owes always. Its stockholders and bondholders are its mortgagees. The individuality of its creditors changes but the debt is always there. Its debt is a flat loan constantly renewed. Not so with the city. It borrows and must pay. The debts must all be liquidated within 40 years. It is an installment loan. There is the annual installment of principal, also the interest on what is due, and also new construction, extension of pipe-lines; also water rights, additions to pumping plants, land purchases, repairs, salaries and general expenses, all to be provided for either out of income or taxes. Hence the difference between the amount to be raised annually by the city and that required under private ownership." etc. etc.

The one fault with the above argument is that the private company works under and by virtue of a franchise granted by the city and is at the mercy of the city when the franchise expires. Hence the entire cost of construction and the value of the investment must be earned by the company and the

money returned to the stockholders and bondholders which they have invested, plus good interest and a snug profit. The time in which the franchise expires may be only 20 or 25 years and the people may have 40 years in which to pay the city bonds. Or the people can refund every ten or 20 years and keep the debt hanging along. This is not economical but at the same time the payments can be smaller and borne by several generations whereas the private company must get all its investment back before the term of the franchise is ended.

The tax rates in badly governed cities and also in cities owning all sorts of public utilities are high. Care must be taken that in owning public utilities the bonded indebtedness and the consequent tax rates do not become too much of a burden. In shifting from indirect to direct taxation there is not always economy. It may be that the opponents of municipal ownership on general principles may be correct and that wise laws well and intelligently enforced are better than municipal ownership.

BONDS

Municipal securities are in general considered a desirable investment although the buyer is put upon inquiry as to the validity of the issue. Being issued under statute every statutory provision must be carefully observed, or the issue will be void. As a rule it is well for a small place considering a bond issue to secure the advice of the best attorney in the place, or if he is not a man of good experience then secure the service

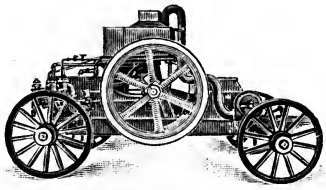
of some attorney recommended by a representative broker or dealer in municipal securities. There are attorneys in many cities whose practice is almost exclusively devoted to such work.

To quote, a well known financial and corporation attorney in an an interview in The American Banker,: "Brokers are careful in these matters. In fact I know of no first class brokerage house which will issue such securities, unless, besides the certificate of a local attorney that tbe obligation is properly issued, they have an opinion from special corporation lawyers confirming that view of the case."

The insufficiency of the security does not operate against the sale of bonds so much as ill advised action in their issue. Such operations are often undertaken hastily and without due care. Records are scanty and a lack of detail and knowledge shown which affects seriously their security and hampers their sale. Bonds are sold at a prenium, at par and below par. To secure their sale at par or at a prenium, all action taken must be deliberate and well considered, due attention paid to the ruling market rates of interest and the records full. It is better to have the records prolix than injured by want of particulars. A mistake in a bond issue has three effects. It results in increased expense; it causes all securities of the place to be looked at suspiciously, and it holds the officials up to ridicule. Mud slinging abuse or wrongful criticism can be stood but once a target for ridicule and a man loses much influence.

MUNICIPAL CONTROL

Upon the subject of municipal control volumes could be written. It is best for any small place having applications for franchises for street car lines, telephones, electric lighting, gas lighting, etc. to employ some competent person to prepare the terms on which the franchise will be granted and then advertise the frnachise under these terms for sale to the highest bidder. The innumerable details can hardly be touched upon here, and new features become known daily.



CHAPTER VII.

THE CITY ENGINEER

This chapter is written for the city engineer of a small town who may have had little or no experience in municipal work before his appointment or election to that position. The writer has served as city engineer in a town the population of which was variously estimated as being from 1200 to 2000, and afterwards in another place where the population was 3000 to 5000, according to whom one talked, and therefore hopes he can give hints of value. He has also been in a number of places ranging in size from 500 to 300,000 inhabitants on professional business and has come in contact with many engineers trying to keep up their work and with methods widely varying.

One of the first things the engineer should do is to subscribe to some first class engineering periodical. To several if he can. Municipal Engineering, Indianapolis, Ind., is a monthly publication the subscription price of which is $2.00 per year. The name indicates the field it covers. While a valuable paper it attempts a great deal on the popular side of the subject and is a favorite among non-technical readers. Every councilman would be benefitted by subscribing to it.

The Engineering News and the Engineering Record of New York City, both weeklies and $5.00 per year, are too well known and too highly regarded

by the profession to need any special recommendation here. The Engineering News attempts to cover a much wider field than the Engineering Record and succeeds admirably. The Engineering Record is particularly good in descriptions of contractors' plant and machinery and erection, and in its descriptions of sewerage and sanitary work.

The Journal of the Association of Engineering Societies is published in Philadelphia under the care of John C. Trautwine, jr. and is a monthly, $3.00 per year. Many of the local engineering societies of the United States have formed an Association for the purpose of having their proceedings and special papers printed at a minimum of cost and in order to bring all the engineers of the country more closely together. The Journal contains selected papers read before the various societies and these papers are valuable contributions to technical literature.

The Engineering Magazine, New York City, $3.00 per year, is a monthly and very valuable for its abstracted articles on various branches of engineering work and the extremely valuable index to current technical literature.

In his library it is of course assumed that every engineer has a copy of Trautwine's Civil Engineer's pocket book. Then add on the subject of pavements Judson on "City Roads and Pavements" $1.00, or in flexible board covers, 75 cents. The next book should be Merriman's "Elements of Sanitary Engineering" $2.00. It takes up the subjects of pavements, sewerage, water supply, street sweeping and garbage collection in text book form. It is an

excellent introduction to the science of municipal engineering. Baumeister's "Cleaning and Sewerage of Cities," $2.00, is an excellent work covering much the same ground and translated from the German. The city engineer should have both. On water supply the best work to start with is Goodell on "Water Works for Small Cities and Towns" $2.00 and Billings' "Some details of Water Works Construction" $2.00. To follow these works, if a project is on hand to sewer the place or design a water works system and the engineer is diffident, get Folwell on Sewerage, $3.00, or "Water Supply" $4.00. These two books give a vast amount of practical information. Fanning on Water Supply $5.00, is the standard. Staley and Pierson on "The Separate System of Sewerage," $3.00, is an excellent work dealing with only one system of sewerage. It touches upon house drainage however and methods of payment for work. Waring on "Drainage of Cities and Lands," $6.00 is an excellent work also, but deals with only one system of sewerage.

No city engineer can afford to do without Johnson on "Engineering Contracts and Specifications" $3.00. It is presumed that the engineer is up to date in methods of surveying. Johnson, "Gillespie's Higher Surveying," revised by Staley, Raymonds "Plane Surveying" and Carhart's "Plane Surveying" all contain much to interest a municipal engineer. Raymond's is a most excellent work for the engineer in private practice, $3.00.

The writer has not given the above as an advertisement and has not consulted any publishers in

preparing the above list. It does not purport to be a complete library but simply to be the nucleus of a library and lists the books he has found useful in his own work—given in the order of their possible value to the city engineer. To increase the list properly, would exhaust the catalogues of the technical book publishers. On the subject of the purification of water Rideal's "Water and its Purification" is a good work, as it covers the field well. $1.60; Sidney Barwise "Sewerage Disposal" $2.00 is a new work and very comprehensive. They are both English works. Dr. Rideal on "Bacterial Treatment of Sewerage" $3.50, is good. In Van Nostrand's "Science Series" are many valuable little works at reasonable price, 50 cents each. Some can hardly be spoken of too highly. Almost any book dealer can procure the above works at the prices given and all of the periodicals named have book departments and will procure any book published.

No engineer can afford to throw away a catalogue or price list nor any fragmentary bit of technical literature. The day is sure to come when he will want it, and want it bad. To preserve this matter a card index is first needed. The writer uses one he made with a cigar box to hold it. The box is 3¾ inches high, 4¾ inches wide and 9 inches long (inside measurement.) He had the local newspaper office deliver to him 500 cards each 3¾ x 4¾ inches on white cardboard. He had made also 122 cards of heavier colored board. These cards however were 4¾ x 4¾ inches in size. They were trimmed so that each had a projection an inch and

a half wide and three quarters of an inch high above the general level of the cards in the box. One projection was at the extreme left of the card, the projection on the next card was a little to the right, the next farther to the right, etc. until the width of the box was reached with five cards. Each projection was then lettered by placing first the letters of the alphabet on each projection in their order and then going over the cards again and placing after each letter a vowel on one of the projections so that on looking at the box one sees on the colored projections above the general level, Aa, Ae, Ai, Ao, Au. Next to A comes B, etc. The colored cards are placed in a box with a white card between each and behind the whole lot are the remainder of the white cards to be called into service when needed. Articles are indexed by cross indexing and cross referencing plentifully, using only one side of the white cards, so it is not difficult to refer to any article wanted on short notice. The first vowel governs the space to be used after the main letter in the word to be indexed. Such an index is valuable for indexing maps and notes as well as fragmentary printed matter.

To contain the catalogues and fragmentary literature it is not difficult to purchase pamphlet filing cases in stationery stores. But they may also be made by a man who is compelled to economise. Out of thick cardboard, or pasteboard make cases three inches wide and seven inches high. They should be ten inches long on the bottom and seven inches long on top, only one end closed. Shelves can be made to contain them and a ring should be placed

on the end to draw them out when needed. If the shelves are placed close together and the boxes fitted to them there is little annoyance from dust. The cases are to be numbered and no attempt made at classification in the cases. Each pamphlet or piece of paper simply needs to be marked with the number of a case and put in as it is received, after indexing it. The pamphlet library becomes a regular encyclopedia after a while. It is invaluable to every progressive man, or to all men who wish to be progressive and up to date. The writer does not approve of weeding out each year or two as some recommend. It is a difficult task and much time is wasted. Let the matter accumulate and executors can do the weeding out, which will likely be by a bonfire in the back yard, of the whole collection. When a card in the index becomes full on one side it is not always best to start in on the other. Commence with another card. Each subdivision will then grow according as the letter is used. Each white card would have pencilled on it the main letter and vowel also. As this card index has no card holder nor rod the engineer using it had best go through it once in a while to see that he has not put any of the cards back in the wrong places.

Such pamphlet filing cases as are described will take a catalogue or magazine of standard size. Special clippings can be pasted to sheets of cardboard or there can be filing cases made to contain long envelopes. Each envelope can have written on the outside the full title of all articles folded in it and these articles can de indexed simply by the case

containing the envelope. It is to be regetted that so many manufacturers persist in getting out catalogues of unwieldy size. Many are excellent works of art and too much expense entirely is gone to in their production. The money spent on half tones is not wasted but the money spent on heavy paper with a glazy smooth surface is thrown away especially if it is in a comparatively thin book having pages from twelve to eighteen inches square which will persist in doubling back and falling all over. The effort to hold one of those pages out while sitting back in an office chair often tires a man exceedingly. A Councilman said to the writer once while looking at the catalogue of a road machine, "I am prejudiced against that firm simply because they think I have got good enough eyes to try and follow a line of print two feet long and break my ——arm trying to hold up the——page. They could put all those cuts on a page less than half that size if they did not try to group them all on one page or they could make a pretty little book with that printed matter and have all those nice half tone engravings scattered through like a regular Harpers Magazine. It looks to me as if some printer had buncoed them." Five by seven inches and 7 x 9 inches are good sizes and a man feels especially grateful to a firm which can get a catalogue out in a size which will go in a coat pocket, for if it contains matter which interests him he can carry it around and take a peep at it once in a while until he has gotton the good of it. When it comes to preserva-

tion the big fellow is apt to be cut up or thrown away and thus not preserved at all.

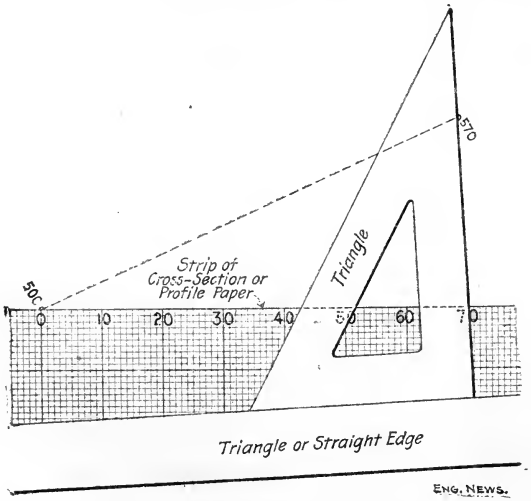
The somewhat common fault in the office of the city engineer or town surveyor in a small place is a lack of records of work done. He very seldom gets a salary and oftentimes his pay is small and his bills paid grudgingly. Nevertheless he should keep complete records of all the work done during his incumbency and he is no less than a thief if he walks out of office and retains notes which would be useful to his successor in office and to the city.

It is a too common practice for the city engineer to retain his notes when he goes out of office. All surveyors and engineers should return to their employers plats with enough data on them for any competent man to retrace the lines and the city engineer should, in addition leave behind in the archives of his office a record of the plats. He should also leave behind him full copies of plans and specifications for work executed during his incumbency.

The first thing which should be done would be to get from the office of the Recorder copies of all plats of the city which have been recorded and also copies of all the field notes. A map on a scale of about 200 feet to an inch should be made and notes made of points where it has been difficult to make things "gibe." Then as surveys are made and information secured the new facts gained can be put in convenient shape for reference and red ink notes made on the plat to indicate where the information may be had which will elucidate the points.

There should be also a plat on a scale of about 400 feet to an inch which should show only the outlines of the blocks and not give any dimensions—except by scaling. Upon this map should be platted all elevations so that finally when the work of leveling has been carried far enough contours can be drawn on it and the information necessary for a study of the drainage and sewerage of the place may be in a convenient form. Such a map is invaluable. The contour interval can be whatever the engineer chooses to select. In some places one foot may be necessary or advisable, while in other places twenty feet would serve. The contour interval should be determined by the ground and the importance of the study of any particular locality.

For interpolating contours the writer has used for years a method described by him the Engineering



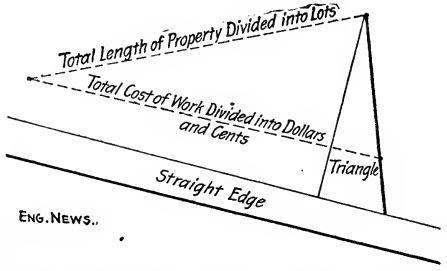
News of May 10th. 1900 and a cut of which he is enabled to produce here by the courtesy of the

editor. A dotted line is drawn connecting the two points of which the elevation is known and which have been plotted in their relative positions on the map. A piece of cross section, or profile paper, marked as shown, is laid at any angle and one end is at one of the points. The end at the point is at the elevation of that point marked on the cross section paper. A triangle connects the other point and the similar elevation marked on the strip of paper. The triangle is moved along another triangle or straight edge and at each contour interval decided upon a dot is marked on the line connecting the two plotted points.

In the issue of June 21st. 1900 of the same paper Mr. H. F. Bascom, C. E. described a method original with himself which is superior. He lays a strip of cross section or profile paper along a line connecting the two points. This piece of paper has no figures marked on it. He then puts on top a graduated strip at an angle, precisely as shown above, but instead of a triangle being used to put in the points he swings the graduated strip around until the graduation on it corresponding to the elevation of the second point intersects with a line on the plain piece of ruled paper touching that point. He then follows along a ruled line from each graduation and where the edge of this plain paper marks an imaginary line connecting the two points of elevation he puts a dot. When the pieces of paper are removed he connects these dots with others of equal elevation between other points, in order to draw in the contours.

For a ready method of covering a large area of ground preparatory to a study for sewerage or drainage or street grades, nothing can compare with the stadia method. The writer prepared in 1893 an article on the subject for the catalogue of J. C. Sala and in that article gave a method of preparing a diagram for reducing the rod readings to horizontal distances and also a diagram for getting the difference in elevation between two points.

Mess. Wiley & Son, New York City, sell for 50 cents a diagram designed by Professor Johnson. It is excellent and can be thoroughly recommended. It is accurate and well adapted for office use, its size (17 x 22 inches) preventing its being taken into the field. The writer uses, to take to the field and for all side shot reductions the Cox Computer. This is about eight inches square and has a circular computing scale. The Cox Stadia Computer is sold by Mess. W. & L. E. Gurley of Troy, N. Y. for 75



cents. There are slide rules of foreign manufacture on the market but the best stadia slide rule the writer has seen is the Colby slide rule which is high priced.

While on the subject of diagrams attention may be called to the following diagram, on the principle

of similar triangles for assessing the cost of improvements along the frontage of property.

To resume the subject of records. For information of a permanent nature relating to property lines and field notes the best plats are on a scale of 100 feet to an inch. These plats should show nothing but lines and elevations finally determined and should be in such detail that any competent surveyor can retrace the lines. It is best to prepare a plat on a convenient size sheet and add to it little by little until the sheet is full and nothing in that neighborhood remains to be determined. Then have it officially adopted by the Council and placed on record. Monuments should be either of granite or concrete four inches square and three feet long, set at the intersection of the center lines. The top should be a few inches below the street surface and it is well to have the top serve as a bench mark for levels as well. A good temporary monument is made of a two inch iron pipe two feet long, driven into the ground, filled with wood and having its center determined by a nail driven in the top. On out of the way roads and lanes where no improvements have been made a good monument is made by taking a post hole digger and putting down a hole two or three feet deep. In the middle of this hole drive a stick one inch square, exactly centered. Fill the space around with a lime paste. Such a monument is cheap and lasting. It was first used by George C. Power, City Engineer of San Buenaventura, Cal.

When a street is improved the monuments should

be carefully referenced and replaced. It is a good plan when a concrete curb or cement sidewalk is built, to place in the cement a few nails from which to make further surveys and thus avoid the nuisance of tearing up the street surface and also because it is generally easier to work along the edge of the curb than in the middle of the street.

One more set of plats is required. These are for the special study of certain blocks and lots which may bother a surveyor to adjust and may be on any scale from ten feet to an inch to 50 feet and show all the work in detail. In fact the writer has been in the habit of preserving nearly all his calculations as well on these sheets. The plat itself may occupy a small portion of the sheet and all the calculations may be placed there with it.

It is not supposed the engineer should stand all the expense himself of this work. It should require but little argument to show the members of the Council how important such work is and sometimes they will consent to help him out. Many Councils however will refuse to pay one cent and some men think the fixing and recording of lines had better be left to other future Councils. They are afraid of trouble during their incumbency. When lines are being surveyed which are likely to embroil the engineer and Council in controversies the surveyor had best have at hand "A Manual of Land Surveying giving the Law and Practice" $3.00, by Hodgman where he will find digests of several hundred court decisions and comments of value. With such a work at his elbow it is not likely court decisions

will be against any of his work. "Engineering and Architectural Jurisprudence" by John Cassan Wait, M. Am. Soc. C. E. and an attorney of note, is a work no engineer can well afford to be without if he has much construction work in hand. "Architect, Owner and Builder before the Law" by Clarke is another work principally valuable however to those in charge of building construction. The first work costs $6.00 and the second $4.00.

For recording notes in books the writer used as a starter, books 5½ by 8½ inches in size containing 100 pages. They can be obtained from any stationer without any vertical ruling on the pages for $3 00 per dozen. One should be marked "Street and Lot Surveys" and in it be placed a diagram of all lots surveyed and a copy of this diagram be given to the owner, having on the lower corner a statement as to the book and page in which it is recorded and the date of record. A diagram of particular points fixed in street lines can also be put in this book together with field notes of street and lot surveys.

A second book can be marked "Monuments and Bench Marks" and contain diagrams, not drawn to scale, of monument and bench mark references, with particular information relating to such matters. A third can contain notes of sewer locations, etc. Whenever any plats are referred to in the books they should be carefully designated and on the plats should be notes calling attention to the matter in the books, giving the letter of the book and the page. All this matter should be carelully indexed

alphabetically in an index book hung on the office wall.

For information about levels and profiles a plat and profile book called "Dunham's Plat and Profile Book" is as good as anything the writer has found. It has convenient size pages and can be easily carried in the pocket. On the odd numbered page is simply a border and on the enclosed space can be written notes and placed diagrams to assist in understanding the matter on the opposite profile page. On the ordinary scale the page can be arranged to hold a profile of 3000 feet of street but of course the scale can be varied to suit the circumstances. The writer has used a page for blocks of all lengths altering of course the ratio of the vertical and horizontal scales on each page. These books contain pages for 36 profiles and cost $1.00 each. Formerly they were printed on a better quality of paper than at present and the lines of the plate were light. The covers were of leather but now they are an imitation leather and the paper used is not so smooth and the plate prints dark heavy lines. There is room for an improvement by having the books made in the former better style or else give the engineer the benefit in the decrease in the cost of production by lowering the price, which has not been altered.

FILING OF PLATS

The engineer will never be able to get rid of drawings which can only be preserved in roll form. There are too many things to be placed on large sheets of paper. But an endeavor should be made to keep as much information as possible on sheets.

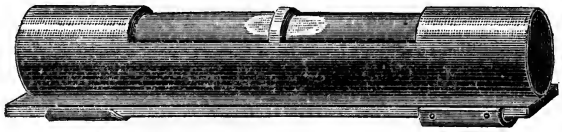
Four sizes of drawings can be used. "A" sheets are 9x12 inches. "B" sheets are 12x18 inches. "C" sheets are 18x24 and "D" sheets are 24x36 inches. Sheets between these sizes are kept with next larger size. It will be seen that the above permits of the best possible use of rolls of paper 36 inches wide.

The sheets should be carefully indexed by card index and each should be numbered. It is best to number the drawings in the order made, regardless of size, and index by title of drawing, letter and number. A portfolio can be made to contain them or can be purchased at low cost. The portfolios can be hung on the office walls, or, if the engineer is wealthy enough, can be kept in a cabinet with shallow drawers, made especially for the drawings. Maps, details and all kinds of drawings can thus be preserved.

MEASUREMENTS

In measuring lines too great care cannot be exercised. Steel tapes graduated to hundredths of a foot are the best to use and it would be well to send them to Washington, D. C. to be tested by the government, before using them. It takes only a short time to accustom men to using a spring balance on the end of a tape. A common spring balance can be purchased in nearly any hardware store for thirty-five cents which serves excellently. It is about nine inches long and an inch in diameter. The writer uses also a tape level (on which he obtained a patent in 1892) in nearly all his work. It

is attached to the tape by clamp springs so placed on the bottom that a simple "twist of the wrist" attaches the level to the tape. Some engineers prefer a level on each end but one is sufficient. The level is placed about one foot away from the end and the tape pulled to the proper tension and then raised or lowered until the bubble indicates that the ends are



at the same height. After this it is not necessary to pay any more attention to the bubble for a man can keep the level thus ascertained, easily enough. A hundred foot tape requires about a sixteen pound pull. The bubble should be in the middle of the tube for short distances of about twenty-five feet or less and move towards the hand for greater distances (for allowable sag) until on a tape one hundred feet long, with sixteen pound pull it is almost at the end of the open space.

For measuring on streets with good stiff grades and where the tape has to be used in short lengths the best method is to use a fifty foot tape and measure on the slope, putting twenty penny nails at the end of each measurement, i. e. at each fifty feet. The tape should be hauled taut each time. Then run levels over the road and read the rod carefully at each nail. The distances can be reduced to the horizontal by using tables of squares and there will be no danger of the work not afterwards checking

out. This is a good method for running out a base line for initial surveys and for triangulation for stadia work, only using instead of the nails, stakes, one inch square chamfered on top and with a small tack at the end of each measurement. A further advantage in this is that a profile of the street can also be obtained at the time of the measurement. The stations will be irregular but after the profile is platted it will cut little figure.

STANDARD TAPES

Sometimes, but very seldom, it happens that a city laid out years ago was carefully surveyed and monumented. But there is a difference in the measurements with measuring done at a later date and the difference is constant and in one direction. It is not an error but if good judgment is not used there will be errors introduced by reason of this difference. All the lines should be gone over carefully between monuments with a standard tape and the difference ascertained. Then the city should have several tapes made which will be correct only when applied to work between the monuments but of course will differ from a standard tape by the amount of the constant difference found. An ordinance should be passed forbidding the erection of a building or fence in the city until the applicant for the permit has had the lot measured and no one should be permitted to do the measuring but a licensed city surveyor or an employe of the city engineer's office, and it should be done with one of the tapes made for that purpose.

MARKING OF SURVEY POINTS

In macadamized streets the best material for points, to be used again, are twenty penny wire nails, the heads driven about one inch below the surface and referenced by measurement to sidewalks, curbs, fences or buildings. In unpaved streets wooden stakes one or two inches square with bevelled heads driven one inch below the surface, will last a long time. This is of course in places where there are no monuments or on parts of streets where it is a long distance to a monument.

The recovery of points is embarrassing sometimes. Marks on buildings and fences are liable to disappear and the engineer can hardly be too particular. He should make several ties, choosing preferably a brick or stone building when he has a choice. For a point in an earth street where surveys are seldom made and reference points are liable to disappear quickly a good method is to make a ring with a fifty foot, or twenty-five foot, tape and on this ring drive half a dozen stakes with their tops flush with the surface. Tacks should mark the exact distance from the point to be preserved. Tie in all these points as well as the center and when it is required afterwards and the direct ties have disappeared it may be found when any two of the tie stakes are found and a measurement from each with the radius of the curve will intersect in the proper place.

The markings of buildings should be systematic. A common way to mark a line measurement is to

drive three nails or tacks in a vertical line. It is understood that the middle tack is the one to measure from. For elevation three or four nails in a horizontai line with one projecting slightly for the level rod to rest upon is a common method. The diagrams in the record books describing these points should be carefully drawn. Transmitted from one city engineer to another and carefully kept up such records are of value. Less will be heard then of the disagreement of surveyors, than is now heard in every small place.

THE RESURVEY OF LOTS

These surveys are generally made for building purposes. A diagram is given the party ordering the survey and such diagram is generally placed upon the letter paper of the surveyor, after being recorded in his book of lot and street surveys. The diagram is not drawn to scale, but shows all adjacent, or encroaching improvements, together with the amount of the encroachment or the distance away of the parts on which the marks have been placed. Where a tack has been placed to mark a line it is indicated by the word "tack" and the distance from that point to the point defining the lot line, is marked in red ink, the diagram being in black. Elevations above or below certain points indicated on the diagram, are shown in blue.

In the resurvey of a lot there are three cases to be considered:

First—There may be a monument at each end of the block.

Second—There may be no monuments but there may be buildings already erected, supposedly by survey.

Third—There may be neither monuments or buildings but the curbs may have been set.

In the first case measure carefully from one monument to the other and distribute the difference, if any is found, proportionately between the monuments, unless it interferes with buildings already erected of permanent material. In such case if there is a surplus and your client can be given his land without taking from others make an adjustment and note it in your records. Your diagram can show your client he is safe and your records can keep your successor from getting astray. It is well to verify the monuments occasionally from others, as they are often disturbed.

When buildings or fences are in it is common to measure from the nearest, assuming it to be correct. It is a loose practice, but if there is nothing to go by it is well to verify from each end of the block the correctness of the location of the fence or building taken as a starting point. When monuments are out or have been disturbed it is customary, and wisest, to treat each block by itself, regardless of others. If the measurement discloses a surplus distribute it proportionately between the points or buildings disclosing it and if there is a deficiency it is generally safest to throw it into the street if not great in amount. The sidewalk can stand it.

When curbs have been set it is customary to set the transit on the curb line and sight along it as far as possible to get a clear sight. As curbs are seldom out more than an inch or so and the sight obtained may be several hundred feet while the depth of the lot seldom exceeds one hundred feet, an error in the side line from an angle turned from the curb will be too small to consider. Most of the lots surveyed in even large cities, lacking regulations over this important part of the surveyors business, are surveyed in this manner and so long as there is no grumbling and every man gets his land, while the city has enough street width there should be no objection, provided careful records are kept.

The curb along the front of the lot gives the line. The curbs at each end of the block are the points from which the distance is measured. The width of the sidewalk having been found at each side line of the block that distance is set off from the curb and stakes driven. The distance between these stakes is then measured and compared with the official distance. Any surplus discovered is distributed as described above. If the distance falls short each stake is moved towards the curb until the distance agrees with the recorded distance, leaving the shortage in the sidewalk. If the former surveyors have measured from each end of the block and the buildings occupy so much space that your client cannot get his land, show him the facts and let the owners fight it out.

The end stakes having been adjusted the line is then measured down the block until a point is

reached in front of the lot where a clear sight can be had to the end. Set in a tack point for the transit and turn the angle. Measure across the width of the sidewalk and set in a stake for the front line. Continue the measurement with care to the depth of the lot (which it is presumed has been ascertained by measuring on the side lines of the block as described for the front.) Set on each stake and turn the angle to set the corner stakes; or mark the adjacent buildings or fences, which is preferable to driving stakes liable to be disturbed during building operations. If is not easy to measure along the lot lines it is customary to measure along the curb line as an offset. Then the marks for the side lines in front can be placed on the curb. With a wooden curb set three nails in the shape of an "L," the nail at the angle and on the upright portion being on the line and the other nail being on the inside of the lot. These three points will be shown on the diagram and the distance marked to the front line of the lot. If the curb is stone or concrete chisel an "L" on top. If the block to be surveyed is between blocks (not necessarily adjacent thereto) having curbs or buildings, it is easy to carry the curb or building lines across these blocks, on all four sides. The comer stakes thus found can be adjusted to conform to the dimensions and angles given on the official plats and the survey proceeded with as above described. It is well after completing the survey to drive at the block corners four by four posts with tops flush with the ground and having a nail set in to indicate the exact corner point. Future surveyors will then be likely

to perpetuate these points by basing their surveys of lots in that block upon them.

If the lot to be surveyed is in a block not near one having curbs or buildings, and where there are no monuments, the surveyor meets with problems he must settle for himself, according to circumstances. He must proceed with all possible care with the best information obtainable and should be chary about discrediting the work of previous surveys and re-surveys until he has actual documentary evidence in his possession which will convince the most ignorant man that his work is right, even if it does not agree with some previous work.

It has been remarked that "surveying is an art and not an exact science." This is especially true in cities and towns where the data is incomplete and yet the land so valuable that every man wants to get possession of every fraction of an inch he is entitled to.

The judgment of the surveyor is frequently taxed and he must reason from an assumed standpoint with correctness. It is strange to say that correct results can be reached by using hypothetically correct starting points, but the problem is simply to give a man his land so he can occupy it. If he gets a piece of land the size he paid for and gets it without interfering with the rights of others and with no danger of future interference who can say the surveyor was wrong in scientifically (?) "fudging" his work, so far as starting points are concerned. The measurements are to be as correct as it is possible for a man to

measure, and the builder has only to do with measurements. Angles he does not regard.

SETTING STAKES FOR WORK

If cuts and fills on street improvement work are considerable there will of course have to be several sets of stakes set.

If the grading is only a foot or two the best way to set the stakes is to measure along the edge of the sidewalks, or along the front of buildings, and put in nails at regular intervals and number them. Measure over and set a nail at each end of the block on the curb line. Set the transit on one end of the block and have a rod held at the other, on these nails set to mark the curb line. A leveling rod, reading to hundredths of a foot, can be held on each nail driven in the fences and buildings and horizontally across the curb line. The engineer reads the rod and at once obtains the distance out from that nail to the curb, which distance he proceeds to record in his book and has his rodman mark in lead pencil, or black crayon on the building or fence above the nail. After getting these distances out he proceeds to take the elevations of each nail and marks in blue above the nail the height it is above the curb or below the nail the depth it is below. A diagram is given to the contractor showing all this information. He needs no more stakes but proceeds to set his curbs first, then excavates for the gutters and roadway, sighting across from curb to curb with properly graduated stakes to get intermediate heights and for crowning the road-

way. The nails are then in position for checking at any time. Stakes are too easily knocked out. In addition however to these permanent marks it is sometimes well to set stakes for subgrade, the top of the stake being at the proper elevation.

For sewers it is well to set stakes twenty-five feet apart on each side of the trench and six inches or a foot away from the edge. The tops of the stakes should be some regular number of feet above the bottom of the trench. This height can be ascertained from the profile so no stake need project above the surface and yet none be more than a foot below. To obtain the grade for the bottom and for the sewer pipe a piece of wood can be laid across the trench resting on the grade stakes and a cord stretched tightly along the middle line of the excavation. With a rod graduated to hundredths of a foot the distances can be measured to any point from this line to the bottom of the trench or to the top of the pipe in place. It is of course important that the cord be tightly stretched and that no sag be in it. It is above the heads of the workmen and out of the way more than cords in the bottom and the stakes on top are preferable for many reasons to stakes in the bottom of the trench. It is understood of course that "circumstances alter cases."

TESTING OF MATERIALS

It is seldom that an engineer is so situated in a small country town that he can test materials so he must use especial care in drawing up his specifications. If he can install simple apparatus for testing the more usual materials he is

well off and the town is fortunate to secure his services.

It is possible for every engineer to test cement with low cost apparatus. He can use apparatus made by himself which will cost in the neighborhood of five dollars or he can put more into it and spend many more dollars until he is able to purchase a standard testing machine. For the majority of cases the cross bending test of cement is excellent and better than the tensile test.

For this the engineer needs to procure some sieves such as assayers use and select a bed of sand in the vicinity to use for cement testing. Get some of the sand and thoroughly cleanse and sift it. Mix it with a quantity of cement in the proportions recommended for briquettes and make ten or twelve bars exactly one inch square and five inches long. Send half of these bars to the professor of civil engineering in the state university together with enough cement to make an equal number of bars with the standard quartz sand usually used, and also to make several briquettes for tensile test with standard quartz sand. These briquettes can be tested and also the bars to obtain the ratio between the tensile and cross bending test. Then the bars made by the engineer should be broken to compare his mixture with the standard mixture. When he gets the results he can proceed to break his own bars and thus have a standard of comparison.

A saddle, or ring, for placing over the bars can be made of quarter inch steel wire in the shape of a stirrup. This is hung across the middle of the bar

with the flat side on top and the bar should be supported with a span of exactly four inches On the ring can be suspended a bucket into which shot can be gently poured until the bar breaks. The bucket and its contents weighed after the break will give the number of pounds necessary to break the bar. So all specifications can be written to provide the best standard for a tensile test but the tests can be made by cross bending and a proper ratio once determined makes it fair. The ratio does not have to be determined by sending samples to the university every time cement is tested.

A good machine for testing cement by the cross bending test can be made by any engineer, or man handy with tools, for less than ten dollars using a butchers beam scale in combination with short levers as a part of the machine. The moulds for the bars are easily made out of hardwood or metal.

A test for soundness of cement is often used when the engineer feels the need of a quicker method than the cross bending or tensile test For this nothing better than the method of Michaelis has been devised. For this take a piece of glass with a perfectly plane surface and place on it a piece of good quality filter paper three inches in diameter. Upon this mould a pat of neat cement mixed with just enough water which will make it "wet" but not thin enough to run. It should be mixed very carefully and thoroughly and much care taken to prevent the leaving in it of any cracks or blow holes or cavities of any sort. When completed the pat should be three inches in diameter and drawn to a fine hair

edge all around and be about half an inch thick in the center. Place around it a ring which will clear it and the top of which will be high enough to clear the top of the pat. Over this place a moist cloth until the pat has set hard then place it in water at the normal temperature of the office and leave it there for twenty-four hours. Then place it in a vessel of water at about the same temperature and bring slowly to a boil. It should take about half an hour to reach the boiling point and the best thing for the purpose is a cheap single wick kerosene stove. The water should be allowed to boil constantly and quietly (simmering) for three hours when the pat should be taken out and allowed to cool gradually, preferably by putting a cover on the can it was boiled in, placing the pat on it, turning out the flame and leaving the pat there until it is cool. Above all things do not attempt to cool it by applying water or any other material. When the pat is cool it should be hard and free from cracks. Sometimes the engineer finds difficulty in making the pats in which case he can mold balls one or two inches in diameter on the filter paper and boil them. This test is considered a good one of the soundness of Portland cement and guarantees its quality. It cannot be used upon a mixture of sand and cement and is valueless for a test of natural cements.

TESTING OF STONE

Sometimes when erecting a structure for a public use the owners of quarries in the neighborhood bring in pieces of cement gravel, clay and such like material which they term stone and wish it used instead of good stone in order to advertise the quarry. Sometimes in fact stone is brought in which is new to the engineer and upon the value of which he hesitates to pass an opinion. Some ready method of testing the possible weathering qualities is needed and for this the author has frequently used the Glauber Salts process. For this test make a saturated solution of Glauber Salts. This solution must be made in cold water or at least in water which is of a temperature less than 70 or 80 degrees Fahrenheit. In this solution should be placed pieces of the stone to be tested, together with pieces of a stone which has been tried in that locality by years of service and found to be good. It is well to have the pieces ground down to the same shape and size but still that is not of such importance so long as the exact surface in square inches is known of each piece. The author first dries the pieces thoroughly in a drying oven and then immerses them in the solution at a temperature of about 70 or 80 degrees and puts the vessel containing them on a stove and allows it to come to a boil. It is permitted to boil slowly for about half an hour when the specimens are taken out and hung in the open air for twenty-four hours. They are then washed gently with water from a wash bottle and again

placed in the solution and boiled. This is continued for seven or eight days when the specimens are placed in fresh water for twenty four hours at a time and the water thrown away and more fresh water used. This long soaking in fresh water which is changed every twenty-four hours is continued for another week making the total length of the tests equal to fourteen or sixteen days. After the soaking in fresh water has effectually removed all dried salt by dissolving it the pieces are placed in a drying oven and dried thoroughly. The difference in weight before and after the conclusion of the tests taken in connection with the surface area of each piece (which should hardly be more than one cubic inch in size) gives the percentage of loss in weight per square inch of surface. This is the most ready means of determination of the value of stone which the author can recommend to men who have little apparatus and infrequent necessity for making such tests. Some men in addition to finding the weathering value of stones by the above process put the stones through a compression test after the process is completed

ENGINEER'S NOTE BOOK

Every engineer has, or should have, a note book in which to jot down his experience with different materials, the solution of difficult questions, memoranda which he will find useful at some future time, etc. Such a note book grows and it is difficult to index it so matters can be easily found. Therefore it is best to use loose sheets. These sheets are best when about the size of the ordinary pad of note paper to be found in every stationary store. They can be put into heavy manilla envelopes about seven by ten inches in size. A number of these envelopes can be used and each one lettered on the side and on one end with the subject which it is supposed to contain exclusively. Sewerage, Water Supply, Pavements, etc. etc. The sheet should have a margin one inch wide at one end and one-half inch wide on the other three edges and both sides can be used. Sometimes the sheets will be ruled writing paper, sometimes plain drawing paper, sometimes cross section paper, sometimes tracing paper and sometimes tracing cloth. Once in a while they may be pages cut from books or articles cut from papers. Sometimes drawings and sometimes sketches, most frequently memoranda or references to pages and volumes of magazines or papers in which useful articles can be found. When an envelope contains about one hundred sheets they should be bound in heavy manilla paper by ordinary clip fasteners and the sheets numbered and the book given a title and number. Then all the mat-

ter in it can be indexed in the card index before described and the book placed in the pamphlet library.

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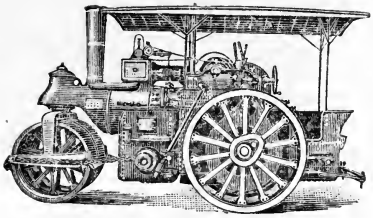

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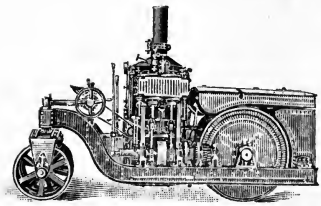

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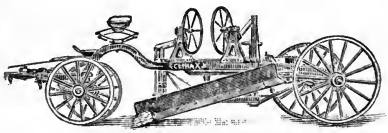

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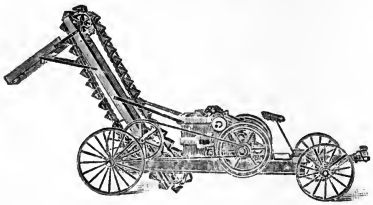

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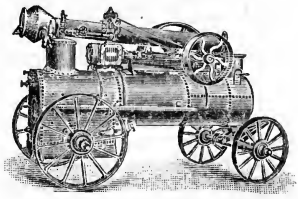

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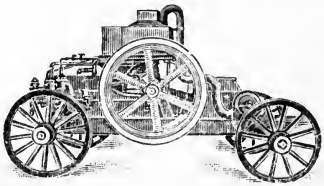

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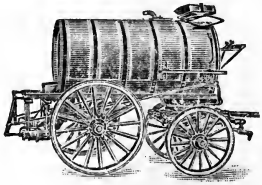

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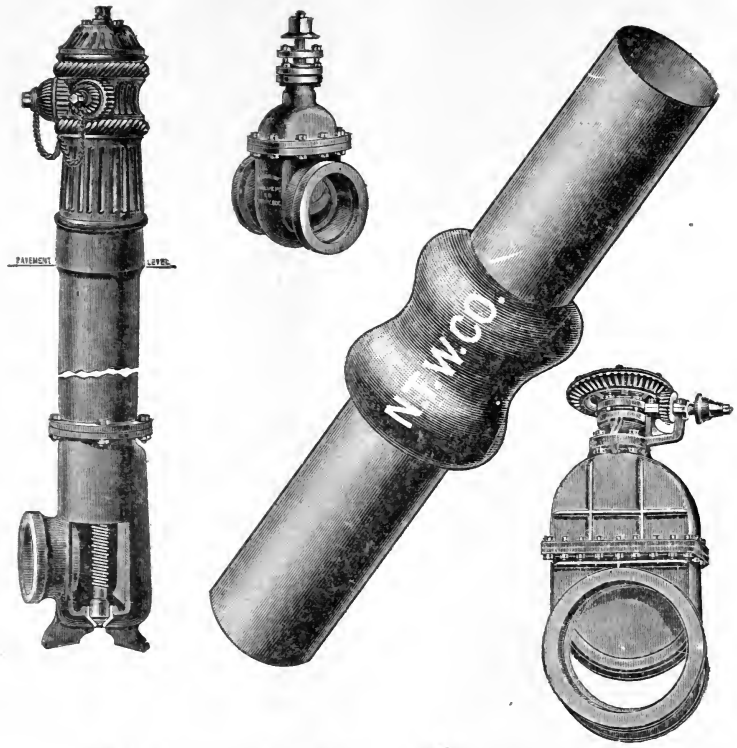

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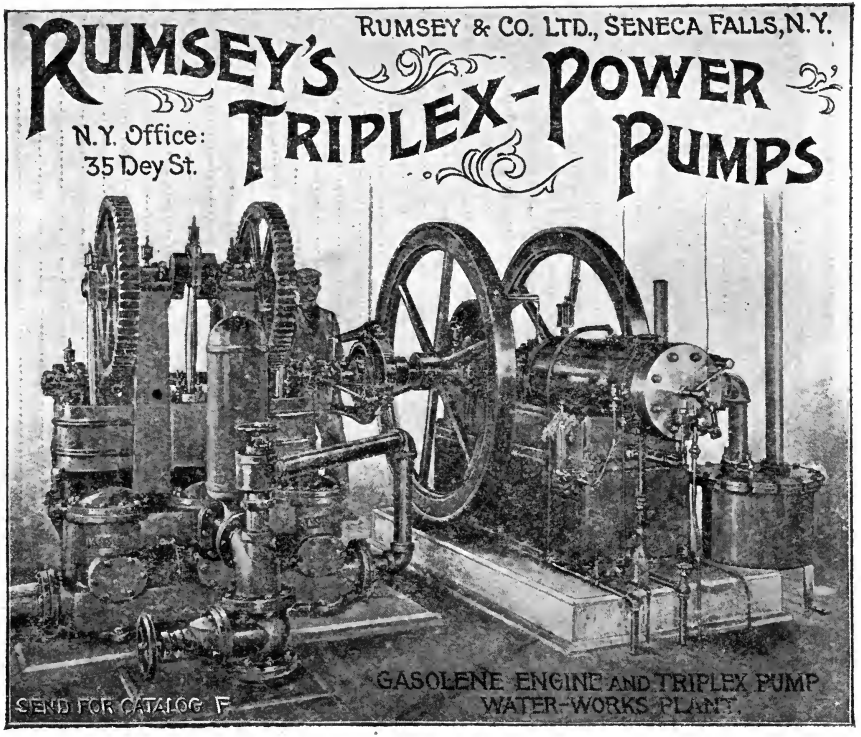

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"At times the client is placed upon the horns of a dilemma and the situation is often very complex. If he calls for bids on contractors' plans, the prices, as well as the plans, will be found to differ so widely as to make a selection of the best for the least expense a very difficult matter. If he have an expert prepare plans and specifications, then all bids are directly comparable, and practice has proved time and time again, that on account of the more direct competition between the bidders, the reduced bids under this method will more than offset the fee of the consulting engineer."