CHAPTER XIV.

SEWER MAINTENANCE.

Art. 78. Requirements of Proper Maintenance.

The requirements for keeping a sewerage system in good running order can be concisely stated as—preventing and removing deposits, and maintaining ample and safe ventilation.

As previously stated, the main dependence for preventing deposits is flushing. If a deposit remains for any time it is apt to continually increase and become more difficult of removal, and deposits should therefore be removed as soon as possible after forming. This the automatic flush-tank is supposed to do for 800 to 1000 feet below it, but any forming below this limit will probably need to be removed by hand-flushing from a manhole or by the use of special appliances. If deposits continually form in any one place and are not apparently occasioned by articles which should not be introduced into the sewer it may be advisable to place a flush-tank at the head of where such deposits form, at one side of the sewer, but connected with it at a manhole or by a Y branch. If obstructions are frequently formed at any one place by the introduction of improper matters, such as ashes, bones, etc., the source of these should be ascertained and the parties responsible therefor punished.

It should not be taken for granted that a sewer is working properly, but the system should be inspected once a week or
at least once a fortnight. This may require merely a look into each flush-tank to see that it works properly, into each inlet or catch-basin to see that it is clean and the grating unobstructed, and into each manhole (the dirt-pan being at the same time removed and emptied) to see that the sewage is flowing with sufficient velocity and is apparently not dammed back by any deposit below. But during the first few months of his service the inspector should enter each manhole and look through the sewer at each inspection until he becomes familiar with its condition of depth and velocity of flow when in good order. If there are any considerable odors observed about any appurtenance the cause should be discovered and removed. This will usually be a large deposit or imperfect ventilation, except in the case of catch-basins, where it probably means improper or infrequent cleaning.

The catch-basins should be cleaned after every rainfall. There is danger of putrefaction and objectionable odor from these if this is not done within two or three days after each rain, but this is almost impracticable in large cities, where there are one or two on every corner, without the use of an enormous number of men and carts, since each cart with three men will clean but five to fifteen catch-basins a day. As an example of what is usually done in this line, a large city in New England, which is considered to have an excellent Department of Public Works, during the whole of one year cleaned its 1100 catch-basins an average of 1.84 times each. It seems almost impossible that these catch-basins could hold the heavier matter washed from the streets during six or seven months (or if so the small amount contributed by each storm would have done little harm in the sewer), and the inference is that a large part of this was not held, but was washed into the sewer; also that the catch-basins were in an unsanitary condition a large part of the time. When so treated they might better be replaced with plain inlets.
A record should be kept of all sewer-inspections, each line of sewer and each appurtenance having a record of its own showing when it was inspected, its condition, when cleaned, what repairs were made to it, with their nature and cost; of the frequency of flushing or of the discharge of each automatic flush-tank; of the location and date of making each house-connection, with all details as to route, size, and grade of connection-pipe, cost, by whom ordered, by whom put in (if by private contractor).

The house-drainage is usually supposed to be, but seldom is, looked after by the owner. It is exceedingly desirable to have a sanitary inspection made of every house by a city inspector at intervals of not more than 12 months; but such a plan would hardly be favored by most American communities, but would be looked upon as an impertinence. It is the city’s duty, however, to insist upon all owners and tenants observing the sanitary regulations as to construction and use of house-drainage systems.

Extensions of the system should of course be made with as much care as were the original sewers, and no alterations made in the original plans without a careful consideration of their effect upon the system as a whole.

ART. 79. FLUSHING.

When automatic flush-tanks are used they should be inspected at intervals to insure their regular discharging. The most common failing with siphon-tanks is the trickling over of the water into the sewer as fast as it enters the tank after it has once reached the level of the top of the bend. Under this condition the siphon will never flush. This trickling may be due to faulty designing, but is usually caused by a leaking joint or blow-hole in the iron siphon at some point, which must be corrected. The frequency of discharge is regulated
by the cock admitting the water. This can be adjusted only by actual trial with each tank. It is a good plan to have one or more registering reservoir-gauges for use in the flush-tanks which will indicate the times of discharge. A simple one, but sufficient for this purpose, can be made with a clock-works actuating a cylinder on which the height of water is constantly registered by a pen whose motion is caused by the rise and fall of a float, a cord carrying the pen and one from the float both passing over connected wheels of such relative diameters that the path of the pen is but 4 or 5 inches long. Such an apparatus left for a day or two in a flush-tank will serve in place of frequent visits to it, and can be moved from one to another as each is adjusted to the desired frequency of discharge. The waste of water caused by flushing oftener than once in eighteen to twenty-four hours is not justified by any proportionate advantages.

Reference has already been made (Art. 42) to flushing directly from 2- or 4-inch branches led from the water-main into the flush-tank. In using these the valve is ordinarily opened to its full extent, or so much as is necessary to maintain the height of water in the flush-tank as great as is safe for the tank or sewer. It may be left open until such time as the water flowing through the manholes below is perfectly clean. It will be necessary to use the most solid construction in the flush-tank to resist the considerable force with which the water leaves the water-pipe.

Instead of connecting the flush-tank with the water-main by a large pipe a small one is sometimes used, and the tank filled from this after closing the sewer end, which is then opened and the contained water allowed to flush the sewer. This method takes much longer than the previous one and is consequently more expensive. In some cases the flush-tank is filled by hose from the nearest fire-hydrant.

In some cities the water is conveyed to the flush-tanks in
carts, and either the tanks filled from these and discharged by
hand as above, or from the bottom of the cart a large pipe or
canvas hose is lowered into the flush-tank and connected with
the end of the sewer, into which the water is discharged under
a head equal to the elevation of the cart above the sewer.
In New Haven, Conn., such a cart is used holding 700 gal-
ions, in connection with which an ovoid ball is passed down
the sewer to assist in the cleansing, its distance from the
flush-tank being regulated by an attached cord which passes
up through the sewer and flushing-pipe to the surface. These
carts are ordinarily used at manholes along the line of the
sewer rather than at flush-tanks proper.

Flushing, as has been stated, is seldom effective for more
than 800 to 1000 feet below the point of entrance of the
flushing-water. Hence, when automatic tanks are not used
at the head of every section of such length which requires
flushing, this is performed at manholes wherever necessary.
For this purpose outside water may be introduced by carts,
as just described; or all the openings in a manhole may be
stopped and the manhole filled by hose, when the plug to the
down-stream opening is removed and the sewer below flushed; or only this opening is closed, and the sewage is
permitted to back up in the sewer above, when the plug is re-
moved and the sewage performs the flushing. The last method
is not particularly satisfactory with pipe sewers in most
instances, since the head obtainable is usually very small and
the velocity of flush consequently the same, and if the house-
connection pipes are on a flat grade the sewage may back up
these to an undesirable height. Deposits also may form while
the sewage is accumulating, which will not be removed by the
flush if near the upper end of the dammed sewage, and the
time required for a sufficient volume of sewage to collect will
often be considerable and increases directly as the necessity
for frequent flushing in each case.
The plugs used for stopping pipe and small brick sewers may have any of a variety of forms. One design is a simple conical cork-shaped piece of wood with heavy rubber so fastened around it as to come between it and the inside of the sewer when the plug is pushed into place and make a watertight joint. Another consists of a solid centre of plank, around the edge of which is placed a pneumatic tube similar to a bicycle-tire, which is inserted just inside the sewer and the tire inflated by a bicycle-pump. These have ropes attached by which to draw them out of the sewer when the manhole or flush-tank is full, the air being first released from the tube of the one last described.

Another plan, that of bracing a loose frame or hinged gate against the end of the sewer in a manhole, is hardly applicable to properly constructed systems, where the manhole-channel and sewer are continuous, but may be used in a flush-tank designed for the purpose. The cover, whether loose or hinged, may be held in place by a brace hinged at the middle and extending from the cover across the flush-tank to the opposite wall. A rope is attached to the hinge of the brace and by pulling this when the tank is full the brace folds up and releases the cover.

In large sewers it is generally impracticable and unnecessary to dam back the sewage higher than, or even as high as, the crown of the sewer, and a dam one half or two thirds the height of the sewer is sufficient. This may be made similar to those already described, but not filling the entire bore of the sewer. Or a "pocket dam" may be used. This consists of a bag of tarred canvas having rings around its mouth and a rope passing through these long enough to reach from the sewer to the surface. Another rope is fastened to the bottom of the bag. This bag is filled with water and placed in the sewer-invert, being held upright by the rope through the rings, and serves as a dam to the sewage. When
this has raised sufficiently this rope is released, the bag collapses and is removed by the rope attached to its bottom.

In very large sewers flushing, if practised at all, must generally be done with sewage, on account of the enormous quantity of water required for this purpose. But this practice is not recommended where sufficient water can be obtained. In the case of storm or combined sewers advantage should be taken of light rains by damming up the run-off from them in the sewers and flushing with this comparatively clean water. Heavy storms of course need no assistance in their flushing effect.

To ascertain the height to which water in a large sewer has risen in flushing (or at any other time, as during storms) an ingenious method, employed at Omaha, Neb., is to drive into the wall, 2 inches apart vertically, small iron rods with the ends turned up, on each of which rests a cork with a hole in its bottom, which can be readily floated off when reached by the water. Upright whitewashed sticks placed in the vertical diameter of the sewer have been used for the same purpose, but not with perfect success. Probably the best appliance is the Frieze self-registering depth-of-water gauge, in which a continuous record of sewage depth is kept upon a cylinder revolved by clockwork, the pen being carried by a vertical arm attached to another arm, one end of which is hinged and the other carries a float which floats upon the surface of the sewage.

Of the various methods of flushing small sewers, a properly regulated automatic tank is probably the least expensive; and permanent water pipes leading to man-holes require somewhat less time than the use of hose or water carts.

In 1907, of 138 cities of more than 30,000 population, 30 used automatic flush tanks alone, 78 used fire hydrants or some other method of supplying water by fire hose, and 27 used both
methods. New Haven was the only one reporting the use of portable tanks; and only one of these reported the use of flushing valves.

Cleaning sewers in New Haven by the water-cart above described cost $3 to $4 per mile cleaned. One argument in favor of hand-flushing is that it renders more probable frequent inspection of the system, which will be made at the time of flushing; but on the other hand pressure of other duties or carelessness may cause longer intervals between flushings than is desirable. As a general rule automatic tanks should be used on pipe sewers where there is not retained by the city a constant force of laborers for maintenance of sewers and streets and similar purposes. In the case of large brick sewers it is probably best to resort to one of the methods of hand-flushing. For pipe-sewer dead-ends in cities with a maintenance force automatic appliances are desirable, but are in many instances not used. When any flushing is done elsewhere than at dead-ends hand-flushing is generally resorted to.

Art. 80. Cleaning.

The purpose of flushing is to prevent deposits, or rather to prevent the accumulation and solidifying of deposits. But from the insufficiency or infrequency of flushing this object is sometimes not attained; or obstinate obstructions may be formed by sticks, stones, or other matter which flushing is not adequate to remove, and these must be removed by hand or some other method. Catch-basins must be cleaned by hand, and this should be done frequently. The manhole dirt-buckets, also, should be cleaned at intervals. These last are merely removed from the manholes and dumped into a cart or wheelbarrow.

The catch-basins are generally cleaned by ordinary
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shovels, the dirt being taken to the surface by a bucket and emptied into a cart. Two men and a cart and horse suffice for this work. In some cities, and especially when the catch-basins are small, the dirt is removed with long- and heavy-handled hoes, the blade of the hoe being at right angles to the handle and about 8 by 10 inches in size. These are used from the surface through the manhole-opening or that left by removing the grating. Catch-basin walls should be thoroughly cleaned with a hose and broom and washed with a solution of chloride of lime or some deodorizer, but this is seldom done. The cost of cleaning a catch-basin will vary probably from 50 cents to $2 each, depending upon their size, the frequency of cleaning, and other special circumstances or conditions; $1.40 seems to be about the average for large cities. Catch-basins at the ends of siphons are difficult to clean, being in most cases at the bottom of a shaft containing many feet of water. Long-handled hoes may be used, or the siphon may be closed and emptied of sewage to permit reaching the catch-basin. An apparatus acting on the principle of the steam-siphon or sand-pump is used with success in the Waltham, Mass., siphon, emptying the catch-basin or sump without the siphon being emptied. The pipe \( B \), Fig. 34, is lowered into the sump and the nozzle is attached to a hose from a hydrant. When the water is turned on the sand and other solid material, mixed with sewage, is sucked up through \( B \) and discharged through \( A \) into the sewer, from which it is prevented from returning by a temporary dam in the end of the sewer.

Small sewers are cleaned by flushing when this is possible, but in many cases other means must be resorted to. The use of "pills" is convenient where there are no stones, sticks,
or other hard materials in the sewer. These are round balls, usually of wood, which are floated through the sewer either in the sewage or, if there is not enough of this, by flushing water. A set of these 2, 3, 4, 5, 7, 9, etc., inches in diameter should be kept on hand. When a sewer is to be cleaned the smallest pill is floated through from one manhole to the next, where it is caught by an assistant; the others are then sent through in the order of their sizes until all have passed through up to the size one inch smaller than the sewer. When any ball reaches a point where the opening is contracted by sediment to less than its diameter the ball, which has floated and rolled along the top of the sewer, dams up the water until it has sufficient head to force its way under the ball and scour out the sediment. The ball rolls slowly ahead, the current washing away the sediment for an inch or two under it. If there is a lamp-hole on the line the ball may bob up into it, and a man should be stationed there with a pole to push the ball down and into the sewer below the lamp-hole. If a stone or stick is among the deposit the ball may be stopped by it, in which case both stone and ball must be removed by another method. The pill cannot be used when the sewer is stopped entirely so that there is no flow through it. No cord should be fastened to any of these round balls, as it is liable to be rolled about them and wedge them in the sewer, catch in obstructions, and generally give trouble. Ovoid balls, however, are sometimes used with cords attached. These do not roll along the top of the sewer, and may need to be weighted to prevent the friction between them and the sewer top interfering with their motion ahead.

In place of the pill, particularly in sewers larger than 12 or 15 inches, a small carriage is sometimes used which travels on wheels through the sewer, its front being of such a shape as to almost fill its bore except for an inch or two at the bottom. Where the sewer is not more than 3 or 4 feet in
diameter the carriage is usually provided with other wheels on top, which are pressed against the sewer-arch by springs. This contrivance is hauled through the sewer by a rope, which has first been introduced into it by floating through the sewer a piece of wood or cork carrying a cord to the end of which the rope is attached. Another rope is fastened to the rear of the carriage to haul it back if it strikes an immovable obstruction. This is a modification, and on a small scale, of the method employed for cleaning the Paris sewers, where a plank form, similar in shape to and but little smaller than the sewer-invert, is carried by a boat or wagon and lowered into the sewer as far as necessary to cause a scouring of the deposit. The boat or car is carried forward by the water backed up behind the scouring-form, which is raised or lowered to the proper position by a workman riding in the conveyance.

These methods all depend upon the scouring action of the water and presuppose a passage through the sewer. Other contrivances for cleaning a small sewer under such circum-

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**Fig. 35.—Disk for Cleaning Sewers.**

stances are based upon the use of main strength to haul the material out. Probably the simplest is in the shape of a heavy plank disk to which a rope is attached by three short light chains fastened to as many bolts through the disk. One of these chains is attached at each side and one at the bottom of the disk, and their relative lengths are so arranged that when all are taut the top of the disk will incline a little away from the rope. Upon the other side of the disk, at its top, is fastened another rope. By the latter it is pulled a short distance into the sewer, lying flat; the other rope is then pulled, when the disk rises into an upright position and scrapes
along the deposit in front of it. It is well not to draw this too far into the sewer at once, but to clean only a few feet at each trip. The dirt can be scraped to a manhole and there removed by buckets. It is awkward pulling in a manhole bottom, and it is well to arrange a pulley in a frame, around which the rope passes, as also around another pulley at the top to permit of a horizontal pull. The lower frame may consist of two $4 \times 6$ or $4 \times 8$ timbers fastened to each other parallel and a short distance apart, between which the pulley turns in journals fastened to their under sides, these timbers being braced against the inside arch of the sewer and the pulley being in the centre of the manhole (see Fig. 36). This method can be used where the material is too heavy to be scoured out by pills or similar contrivances, and also as a substitute for these.

In some cases the sewer will be found entirely stopped, so that no cord can be got through it, and an opening must be forced through. A rod of some kind is used for this purpose. Since none longer than 5 feet can be got into the sewer through the manhole (unless it be too flexible for efficient service) rods of this length made to joint together are gen-

![Fig. 36.—Method of Using Cleaning-disk.](image)

erally used. These are sometimes lengths of gas-pipe with screw-couplings, but wooden rods 3 to 5 feet long, with a peculiar
hook or other patent coupling, are furnished by two or three firms. These are forced through the obstruction by working them back and forth or even by driving with a hammer. When an opening is once made it is well to leave the rod in it and work it a little back and forth as the sewage flows through until the hole is too large to be in danger of immediately stopping again, when a pill or cord may be floated through and the cleaning completed by one of the above methods.

A small sewer or sub-drain may also be cleaned by the use of hose, as explained in Art. 73.

In some cases the obstruction may be so obstinate as to necessitate the digging up of the sewer. Before doing this its exact location should be ascertained by pushing a rod to it through the sewer and measuring its length, or by the use of mirrors, as previously described.

For cleaning house-connections, sub-drains, and other small pipe which cannot be readily reached, garden hose is excellent, sufficient water being turned through it to make it stiff enough to be pushed through the pipe; or rods may be used, as just described. Instead of a rod the city of Waltham, Mass., has used for these cases a length of steam-hose filled with sand, a wooden plug being fastened in the end of it. This is flexible, but stiff enough for use in a pipe only 3 to 5 inches in diameter.

Even pipe sewers of 18 inches diameter and up can be entered for inspection and cleaning by hand. It is reported that in Waltham a Hungarian crawled through 850 feet of 15-inch pipe running 2½ to 4 inches deep with sewage, there being in at least one place not over 9 inches of clear space above the deposits and sewage. The author has seen a contractor crawl through 200 feet of 18-inch sewer, and it is nothing unusual for a man to pass through almost any length of 24-inch pipe. A large stone or a stick wedged across the
sewer can frequently be removed in this way and the necessity for digging up the pipe avoided.

If the sewer is found to be broken in any place there is generally but one thing to do, to dig down to and replace it. A sewer which is only cracked or is leaking badly has been repaired by inserting inside of it a line of screw-joint pipe as large as can be slipped into it, and sealing the space between the two at the ends with cement. The substitution of new pipe would probably be cheaper in most cases, however.

When small pipe is only coated or contains but little deposit it is sometimes cleaned by the use of a wire brush, just the size of the sewer, fixed upon the end of a rod similar to those already described. Small sticks, jute, etc., can be cut by tree-pruning shears. Cloth or similar matter can be withdrawn by a contrivance like a large corkscrew on the end of the rod.

The cleaning of sewers large enough to permit a man to work in them needs no special discussion. If they are large enough the dirt may be carried to the manhole in a low car running on the sewer bottom. In smaller sewers it may be shovelled or hoed into a pile at each of two manholes from a point midway between them and removed in buckets.

An inverted siphon may be cleaned as an ordinary sewer, after the sewage flow has been diverted to the other siphon-pipe or dammed up and the sewage contained in it pumped out.