COOPERATIVE EXTENSION WORK
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How To Build A Septic Tank

W. H. McPHETERS
Extension Agricultural Engineer

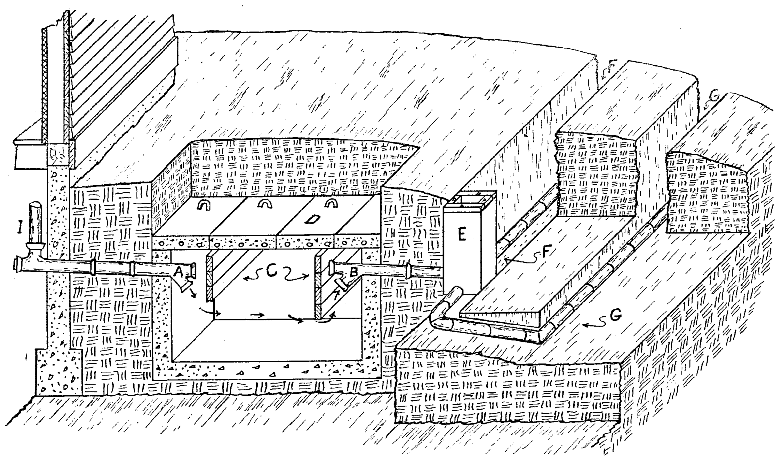

Fig. 1.—Cross Section of Septic Tank and Distribution System.

This view shows path of sewage from house to distribution system.

A. Inlet tile line from house to tank should have a fall of ¼-inch to the foot.
B. Outlet tile line from tank to distributing box should have a total fall of at least four inches.
C. Baffle boards made of any width two-inch plank.
D. Concrete cover slabs. Old horseshoes serve as handles.
E. Distributing box. (See Figs. 6 and 7 for details.)
F. G. Distributing tile lines should have fall of three to four inches per 100 feet. In very sandy soil, 10 to 15 feet of tile is needed per person increasing to as much as 50 feet per person for the tight hardpan soils.

I. Sewer line in house.

HOW TO BUILD A SEPTIC TANK

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The purpose of the septic tank is to take care of the sewage from the home in a convenient and sanitary manner. Water for the home when obtained from a well or spring is safeguarded by use of a properly constructed septic tank and disposal system. If a cesspool is used the underground water supply is subject to contamination from the filth that soaks from the cesspool to the understrata of soil. Wells at a considerable distance from a cesspool are frequently contaminated by it.

There is really no excuse for using a cesspool; it costs nearly as much as a septic tank and is not satisfactory except in very loose, sandy or gravelly soil. And this is the type of soil that allows the filth to soak deep into the ground and pollute the lower strata of underground water.

HOW THE SEPTIC TANK WORKS

A septic tank is nothing more than a water-tight box placed under the ground below frost (Fig. 1). All the sewage from the house is emptied into it. In the tank the sewage is acted upon by a type of bacteria (anaerobic) that requires no air for existence. These bacteria break up all vegetable solids into liquids and gases. The mineral solids drop to the bottom as sludge. The liquid that leaves the tank through the outlet tile B (Fig. 1) should be clear and practically odorless. The gases escape from the tank through the air vent in the outlet tile B and are absorbed by the soil in the tile distribution system.

The sewage is not purified in the tank. It is simply broken up or decomposed and clarified. The purification takes place in the tile distribution system which is discussed under the heading "Distributing System."

There is no chemical used in the septic tank. In fact chemicals should be avoided. It is not advisable to use much of a cleansing chemical or strong lye. It is also not advisable to empty the strong hot suds from the laundry tub into the tank. However, some people do. All other waste from the home, including the rinse water from the laundry, water from the kitchen sink, etc., may safely be put into the tank.

TYPES OF TANKS

Septic tanks may have single, double or triple compartments. There is no particular advantage in having more than one compartment except where the automatic siphon is used. In a tank composed of several compartments, the compartments are small and the one where the sewage enters has to be cleaned frequently. The single compartment tank is the simplest, and the mineral sludge has a large area to spread over thereby prolonging the period before a clean-out. The single compartment is slightly more efficient when the length is about twice the width. Therefore, it is better to have it a long rectangular shape rather than square or round. The baffle boards shown in Fig. 1 are for the purpose of preventing the scum on the surface from being disturbed and to prevent currents from carrying raw sewage to the outlet.

The single compartment tank generally costs less. The automatic siphon tank is efficient and requires less attention than those without the siphon. It costs several times as much, however, and gives no better results, unless the tank without the siphon is neglected.

SIZE OF TANKS

The size of the septic tank is very important. The minimum capacity should be about 75 gallons or 10 cubic feet per person and a greater capacity is preferred.

The capacity of the tank is the volume of the tank below the outlet pipe. Thus a tank three feet wide, six feet long, and four and a half feet deep has a volume of $3 \times 6 \times 3\frac{1}{2} = 63$ cubic feet=472 gallons. The liquid is only three and a half feet deep in the tank as it is necessary to have a compartment above the liquid for the gases to collect.

The following table gives the proper sizes for septic tanks:

TABLE I.—Dimensions and Capacities for Septic Tanks

Number Persons	INSIDE DIMENSIONS IN FEET			Gallons Capacity	Cubic Foot Capacity
	Length	Width	Depth		
6 or less	6	3	4½	472	63
7 or 8	7	3	4½	551	73
8 or 9	8	3	4½	630	84
10 or 11	8	3½	4½	735	98
12 or 13	9	4	4½	945	126
14 or 15	10	4	4½	1050	140

The approximate number of persons that may be served is found by dividing by 10 the figures in the column "Cubic Foot Capacity."

COMMERCIAL TANKS

Commercial tanks of metal, concrete, and glazed tile of various kinds are available on the market. Many of them are good. One of the main things to consider is getting one that is large enough, at least 75 gallons per person. Figure the capacity, as the ratings given may not be on this basis. If the tank is too small the septic action will not be complete, bad odors may result, and the tank will have to be cleaned more frequently. In figuring the capacity use the distance from the under side of the outlet tile to the bottom of the tank as the depth. (See paragraph on size of tanks.)

THE HOME MADE SEPTIC TANK

Where rock and sand are plentiful, it is possible to build a septic tank for very little cash outlay. This bulletin takes up in detail the method of constructing a home made concrete septic tank. All the drawings and the bill of material are for a septic tank for a family of six persons or less. It is not desirable to build one smaller, for the cost is nearly as great. If a larger one is desired, get the dimensions from the table of tank sizes. The cost will be very little more for a larger tank.

LOCATING THE TANK

The septic tank may be located anywhere near the house, as close as eight or ten feet if desired. It is generally advisable to locate it just out from the bathroom, so that the inlet pipe will be free from bends if possible. The inlet tile line should have a fall of one-quarter inch to the foot. The location of the distribution system (Fig. 1) should be on ground that is little lower than that on which the tank is located, if possible, so that the tile line G and F (Fig. 1) will not be over 16 inches deep. Both tile lines A and B should have water-tight joints. Either of these lines may cross under a driveway if necessary. The tile lines G and F, in the distribution system, are laid with loose joints so that the liquid can soak out at the joints into the upper layer of soil. (See Fig. 7.) They should be located at least 50 feet from the well. They may be located so as to subirrigate the flower garden or even the vegetable garden. It is not advisable to irrigate root crops such as radishes, that are to be eaten raw, but it is safe to irrigate plants that bear fruit above ground.

DIGGING THE HOLE

After deciding where the tank is to be located make a frame of 1″x4″ boards, the inside dimensions to be the size of the hole. For a tank to serve a family of six people the dimensions should be four feet by seven feet three inches. (See Fig. 3.) The corners should be square. Put the frame where the hole is to be dug to serve as a guide. Dig the hole, using a plum line to keep the side walls perpendicular. The walls should be kept as smooth as possible for they are to serve as outside forms for the concrete. It is necessary that they be perpendicular because the form is to hang in the hole. If the walls are not perpendicular one side of the form may hang quite a distance from the wall while the other side nearly touches it. Ordinarily the hole is dug six to seven feet deep, depending on the lay of the land. It should be deep enough so that about 12 inches or more of soil can be put on top of the tank.

HOW TO MAKE THE FORM

Figs. 2 and 5 show how the form is made. The following bill of material is needed for a tank six feet long, three feet wide, and four and a half feet deep. This is the proper size tank for a family of six or less persons. (See table of tank sizes.)

4 pieces of 2″x4″— 8′ long—For the four corner posts.
2 pieces of 2″x4″—10′ long—For the four side brace supports (b, Fig. 2).
1 piece of 2″x4″—10′ long—For the two end brace supports (d, Fig. 2 and the long brace, Fig. 5).
1 piece of 2″x4″—10′ long—For the four cross braces (Fig. 5).
2 pieces of 1″x4″—10′ long—For the four end pieces (c, Fig. 2) to nail sides to.
1 piece of 1″x4″—14′ long—For the two cross arms to hold the form in place.
12 pieces of 1″x8″—12′ long—Shiplap to make sides and ends. Any one-inch lumber may be used instead of the shiplap.
1 piece of 1″x6″— 6′ long—To make bevelled cleats.
2 pieces of 1″x4″—14′ long—To make frame for digging hole.
1 piece of 1″x4″— 6′ long—To use as tamping stick.
12 pieces of 3/8″ reinforcing rod, 3 feet 10 inches long for reinforcing lid. Three for each slab. (Fig. 5).
Two 4-inch Sewer Y's, one for the inlet and one for the outlet.
Sufficient number of feet of 4-inch sewer tile to go from house to tank and from the tank to the distributing box.
About 100 feet of 4-inch drain tile for distribution system.
1 pound 16-penny common nails (to nail corners together).
3 pounds 6-penny common nails.
8 old horseshoes for handles for lid (Fig. 5.) They are convenient but not absolutely necessary.
Many times it is possible to use all or part old lumber.

About 17 to 19 sacks of cement and two and a half cubic yards of sand will be needed. A load of small rocks about the size of one's fist may be used to advantage.

Making the Sides. Shiplap or matched boards are excellent for this purpose but any width one-inch boards are satisfactory. The total height of the side is about four and a half feet, but if it happens to be a little more than four and a half feet when using a certain number of boards, just leave it, rather than rip a board to make it exact. These boards are cut six feet long with bevelled ends, the length measured on the long side. They are nailed at each end to a 1″x4″ board (c, Fig. 2) which is also bevelled by use of an axe or drawknife. When the bevelled edges are placed as shown in Fig. 2 they form a bevelled end that can be easily removed from the concrete. This bevel is about 45 degrees. It is easier to saw the bevelled

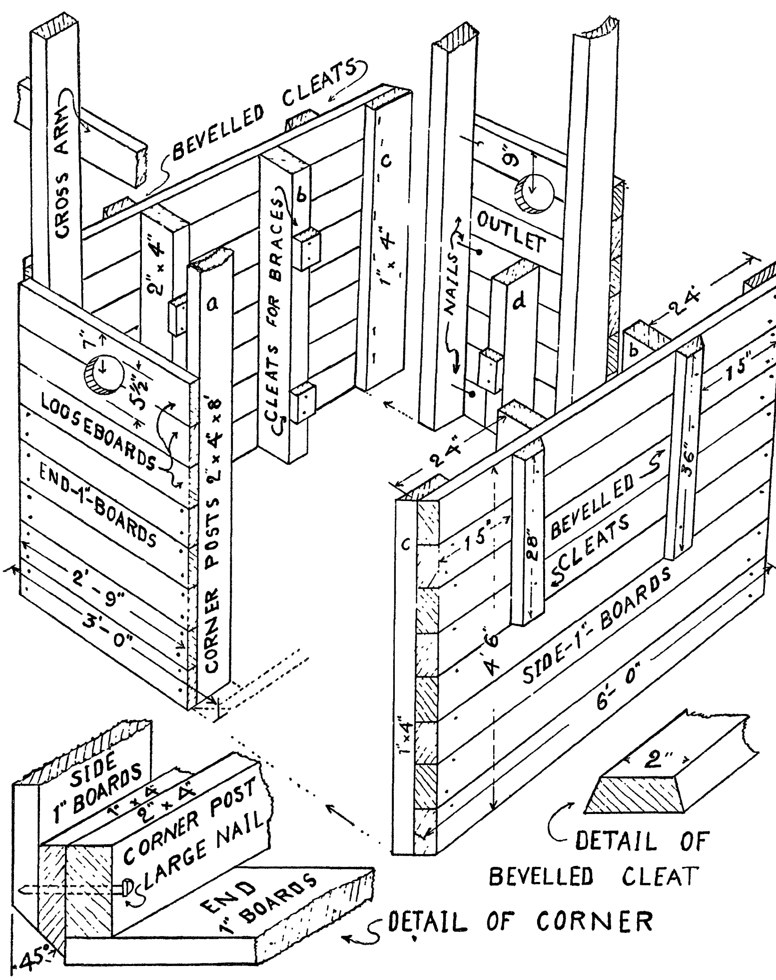


Fig. 2.—Perspective drawing showing how the form is made. The dimensions on this drawing are for a tank the proper capacity for six persons.

ends when sawing the boards than to saw the bevel after the side is nailed together. Two pieces of 2"x4" (b, Fig. 2) are nailed across the side, 24 inches from the ends, for the braces to fit against, to give stiffness to the side. On the outside of each side two bevelled cleats are nailed, one near the inlet to be 28 inches long and the other near the outlet to be 36 inches long.

They are 15 inches from the ends (Fig. 2). They are made by ripping the 1″x6″ board in the middle and then bevelling the edges with an axe or drawknife. When the form is taken out after the concrete has hardened these cleats pull out leaving notches in the wall to hold the baffle boards in place. The six-penny common nails come through the 1″x4″ end-board and should be cleated. Cleat them with the grain of the wood and be sure they are completely imbedded because the surface must be smooth so that the corner 2″x4″ will slip on them when removed after the concrete has been placed.

Making the End. The ends are made by sawing one-inch lumber two feet nine inches long and nailing on the edges of the 2″x4″ corner posts (Fig. 2). They should be just flush with the 2″x4″ so that it will slip past the side when removing. Be careful to nail the boards on so that the ends form a rectangle. The hole for the inlet pipe is five and a half inches in diameter and is located midway between the two corner posts. The center of this hole is seven inches from the top edge of the end. The outlet hole is also five and a half inches in diameter but is located nine inches below the top edge, making the outlet two inches lower than the inlet. These holes may be made with a keyhole saw or they may be made by sawing several notches and splitting out. They do not need to be smooth and true.

The top three boards, if six or eight inches wide, are left loose on each end so that when the end form is removed these boards around the inlet and outlet pipes remain against the concrete and can be taken out without splitting them to pieces. (See the discussion on the removal of forms.)

The form when first made is in four pieces, the two ends and the two sides. It is put together by setting up a side and end and driving three 16-penny common nails from the inside into the 2″x4″ corner post, one near the top, one near the bottom and one near the middle. *They should not be driven completely in.* However, the side should be driven tight against the corner post by holding a heavy hammer or rock against it. Leave them so that a claw hammer or nail puller can get hold of the head. If they are driven completely in it will be impossible to take the form out without splitting the corner posts. (See Figs. 2, 3 and 5.)

PLACING THE FORMS IN THE HOLE

The form should be greased with linseed or lubricating oil. The bottom of the hole should be about level and the sides as smooth as possible. Put four bricks or blocks, full four inches thick, in the bottom of the hole, one near each corner. Have one man in the hole and four men to lift the form by the ends of the cross-arms and lower it into the hole. The man in the hole places one of the four-inch blocks under each corner. Knock the cross-arms off letting the form rest on the four bricks. Shift the form until the space between the form and the wall is about the same all around. With a carpenter's level, level the sides and ends of the form by putting small pieces of wood on top of some of the blocks if necessary. After the form is level renail the cross-arms on. Press them tight against the frame on the ground before nailing, so that when the blocks are removed from under the corner the form will hang true in place. (See Fig. 3.) Now remove the blocks, for there

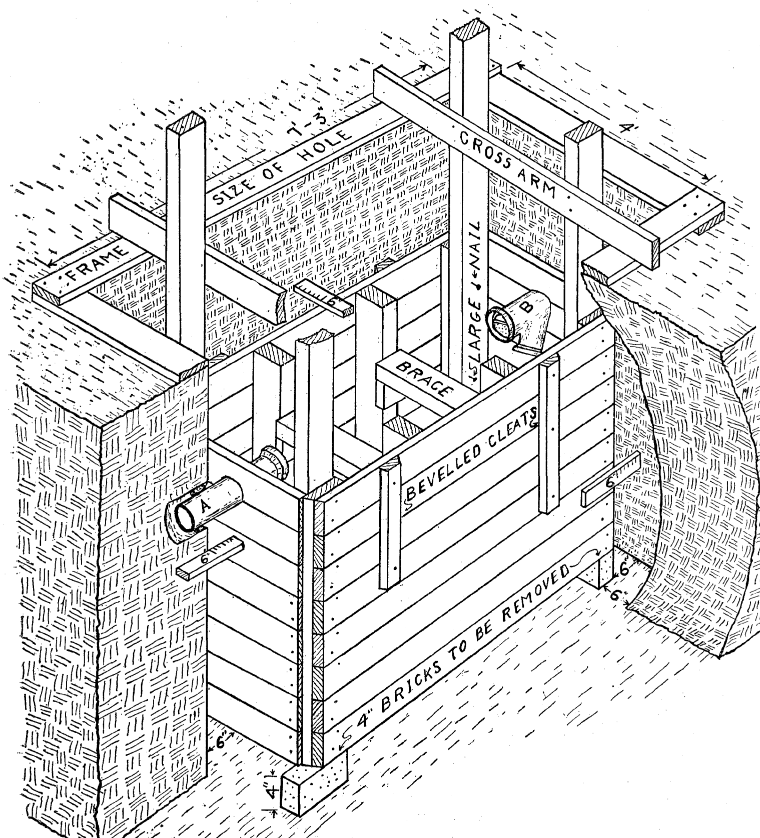


Fig. 3.—This drawing shows the form set in the hole ready for the concrete. The bricks under the corners should be removed before putting in the concrete. The top three end boards are not nailed. (See Fig. 2.)

will be a leak in the tank if they are left in the concrete. Next place the loose boards on the ends in their proper place and mark on the end walls opposite the holes. With a trowel or bar, dig a hole about a foot deep back into the bank so that the end of the tile can project into it. (See Figs. 3 and 5.) The tile can be stuck through the hole in the form and project into the hole in the wall and be held in place by wedging small rocks between the tile and the edge of the hole.

PLACING THE CONCRETE

A septic tank should be made of water-tight concrete. This is made of a mixture of about one part cement to two parts sand and three parts crushed rock or gravel. Do not use more than six gallons of water to a sack of cement. If the mixture is too dry, change the amount of sand and rock, not the water or cement. Where bank run sand and gravel is used, try a batch and find out how much is needed to go with one sack of cement when five and a half gallons of water are used. The mixture should be of a thick jellylike consistency. By all means do not have it sloppy. Place the concrete between the form and the earth with shovels. Put it in uniformly, that is keep all four walls about the same height by carrying them up in layers. If too much concrete is dumped on one side the form will be shoved over making one wall thick and the other thin.

The concrete will run under the form into the bottom for a while. When the wall is about a foot and a half high the concrete will cease to run out. As soon as this condition is reached put a batch or two of concrete in the bottom and finish it. Be

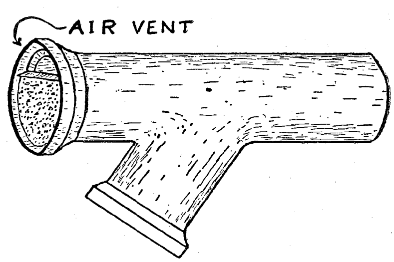


Fig. 4.—Detail Drawing of the Four-inch Sewer Y Outlet Tile. The inlet tile is fixed in the same manner except that the entire end is covered with concrete instead of leaving the air vent. Cut two discs of tin or heavy tar paper just large enough to drop into the large end of the tile and rest on the flange. Set the tiles upright and place these discs in the ends. Bend up a portion of the tin disc, as shown in the figure, to form the air vent for the outlet tile. The entire end of the inlet tile is to be covered with concrete. Put about a half inch of concrete on top of this disc. These tiles should be fixed a few hours before they are to be used.

sure the concrete does not come above the bottom of the form. If it does the form will give trouble in removing. The easiest way to be sure that the concrete does not come above the boards is to get into the tank after finishing the concrete work and see that the end of the trowel will slip between the floor and the form.

Someone should be kept busy with a tamping stick, for it is impossible to make water-tight concrete unless it is well tamped. It is possible to use a lot of small clean rock about the size of one's fist by dropping them into the concrete and tamping them in. Do not drop them close enough to touch each other or the inner wall.

The outlet and inlet tile should be fixed as shown in Fig. 4 and need not be put in place until the concrete is up nearly to where they are to be placed, as they will be considerably in the way. When the concrete is nearly up to the top of the end-boards that are nailed, add the loose boards and place the tile in properly. See that the one with the air vent is used for the outlet. Then continue concreting until the top of the form is reached. Strike it off even with the top of the form.

RULES FOR MAKING GOOD CONCRETE

1. Use hard clean rock.
2. Use hard clean sand that is not too fine. Fine sand requires more cement.
3. Mix the ingredients thoroughly.
4. Use as little mixing water as possible to have a workable plastic mixture, not over six gallons to a sack of cement. Every pint of water added in excess kills two pounds of cement.
5. Tamp and spade the concrete in the forms thoroughly.
6. Keep the concrete moist or wet for at least a week while curing; the longer the better, for the setting of concrete is a chemical action which cannot continue if allowed to dry out.
7. Reinforce, with steel rods, all parts of concrete that are subjected to a pull.

MAKING THE LID

Clean off a place at the side of the tank (Fig. 5). Make a frame of 1″x4″ boards, four feet wide inside dimensions. Divide the length into four slabs, 21 inches wide each, by use of cross partitions of 1″x4″ boards. It is well to take a hoe and cut out a little of the soil near the middle of each partition so that the slab will be five inches thick in the middle, tapering towards the ends to four inches.

If handles are desired set old horseshoes into the ground, toe down, near the ends of each slab. Then when the concrete is cast the heels of the shoes will be imbedded in the concrete leaving the toe of the shoe sticking out as a loop. This will aid in putting the slabs on the tank. Fill the form nearly full of concrete, tamping well, then lay the three reinforcing rods in each

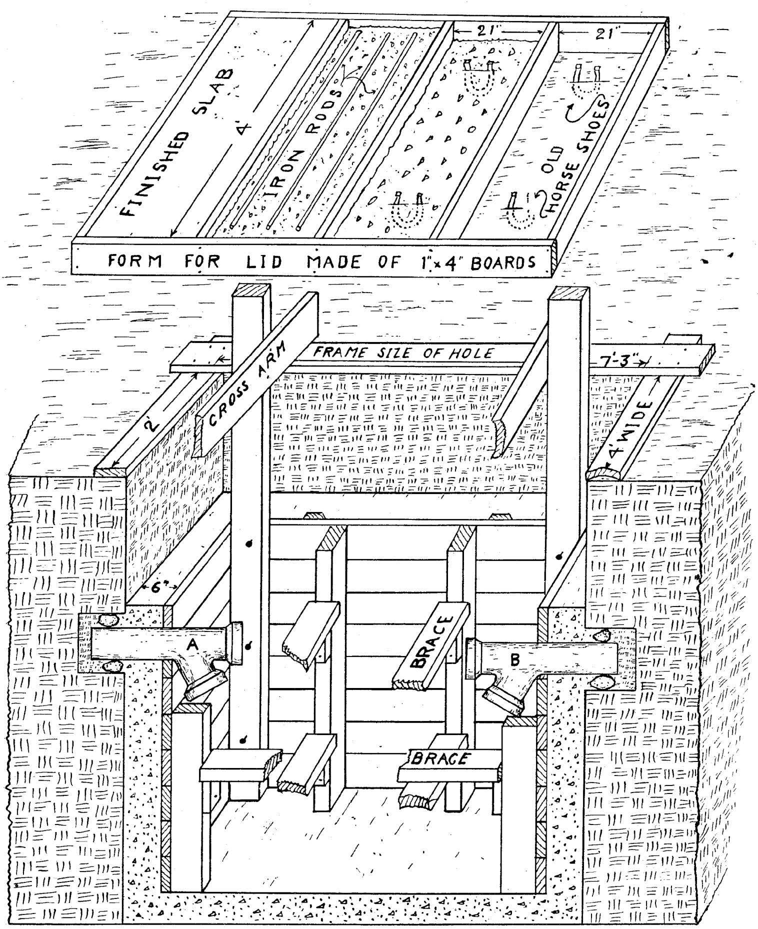


Fig. 5.—A Cross-sectional view showing how the tank appears after the concrete has been put in and before the forms are removed. The method of bracing and the method of holding the inlet and outlet tiles in place are clearly shown. At the top of the picture is shown how the four slabs are made for the cover.

slab as shown in Fig. 5 and fill up with concrete, strike off even and let cure. These rods should be near the top of the slab. Keep concrete slabs moist by use of wet paper until the next day then remove the forms and cover the slabs with dirt and wet down to cure. They should cure about 10 days before being put on the tank. The slabs are placed on the tank upside down, that is, with the upper side next to the concrete walls, the rough side containing the horseshoes being the top. (See Fig. 1.) Before putting the slabs on the tank spread a layer of concrete about one-quarter inch thick on the top of the wall. Let set for about half an hour. Sprinkle a very thin layer of fine dirt over it to keep the lid from sticking. The lid, however, will settle into it and thus make a good joint.

Plaster a very thin layer of this concrete on top of the cracks between the slabs to keep dirt from falling into the tank. This concrete should be made of about one part cement to five or six parts of sand, as it will need to be broken off when cleaning the tank every 10 to 15 years.

Before putting the lid on put in the baffle boards. (See Fig. 1.) Any width two-inch planks will be satisfactory. They should drop easily into the notches in the side of the tank. In fact they should be soaked in water previously so they will not swell and crack the walls. They should lack two to three inches of coming to the top of the tank so that gases will be free to pass to the air vent in the outlet tile.

REMOVING THE FORMS

In warm weather the forms may and really should be removed after 24 hours curing, but in cold weather they should be left on for several days. To remove the forms take all braces out, knock the cross-arms off, and pull the large nails out of the corner posts. Then push the ends in by pushing on the corner posts. The lower part of the end may have to be pushed out with a 2″x4″. The three loose top boards will remain in place, as they are held by the inlet and outlet tiles. They are removed after the ends are taken out. After the ends are out, the sides will pry loose easily and can be lifted out. If the form is to be used again, grease it and store it away. It is possible to use a form for six or eight tanks.

As soon as the form is removed paint the concrete walls with a coat of cement and water mixed to a thick creamy paint. Keep moist while curing.

HOW TO INSTALL THE DISTRIBUTING SYSTEM

The distributing system is where the purification of the sewage takes place. The liquid leaving the tank, although clear, is not pure. It leaves the tank and passes through a distributing box to the tile system. There are two lines of drain tile leaving the box. A wooden valve is placed in the box so as to divert all the liquid into one tile system while the other system is drying or being aerated. The valve needs to be changed every week or so, the length of time depending on the type of

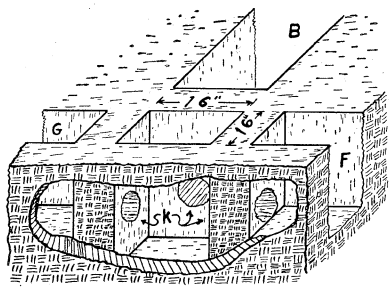
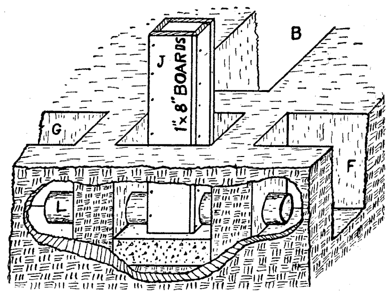
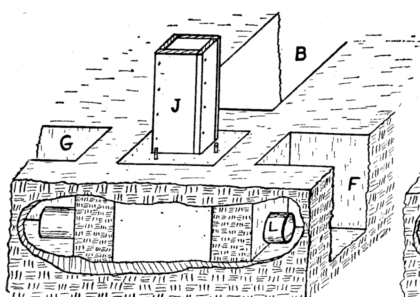


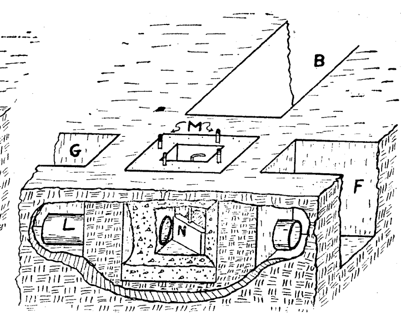
Fig. 6a.—The hole dug ready for the form.



6b.—The hole with the form and tile in place ready for the concrete.



6c.—The hole with the form and and concrete all in place.



6d.—The finished box with the form removed, and valve in place.

Fig. 6.—Shows the four steps in making the distributing box.

B—The ditch for the tile line from the septic tank to the distributing box.
F and G—The two ditches for distributing tile lines.
K—Holes punched through from the hole to the ditches for the tile.
L—Tile in place.
J—Inside form made of 1″x8″ boards.
M—Bolts to fasten the 2″x4″ frame. The lid will be hinged to this frame.
N—Wooden gate valve to divert liquid to the distribution system made of a piece of 2″x6″ plank. (See Fig. 7.)

soil. In heavy clay soil it may need to be changed once a week and in lighter soils not so often. In extremely coarse sandy soil the valve may be left out entirely. This however is not often advisable. The length of these two lines depends on the number of people using the tank and the type of soil. For very sandy soil use 10 to 15 feet of tile per person, the number of feet increasing with the tightness of the soil up to as much as 50 feet per person. It is well to make each of the two lines about 50 feet long. If found insufficient more may be added later. The soil bacteria (aerobic, or air-loving bacteria) cannot thrive in wet, sour soil so it is necessary to use the two tile systems, letting one dry out while the other is being used. With the automatic siphon system all the liquid is discharged from one compartment at once and the soil allowed a period for aeration, while the compartment is being refilled. This, however, is no better, if it is as good, as a longer period of wetting and drying, by use of the distributing box just discussed.

An installation of the system is shown in Fig. 1. The liquid leaves the tank, enters the box and then the tile system. The tile in the system should be about 16 inches deep. Four-inch drain tile is laid with loose joints, the joints being about one-eighth of an inch apart. Cover over the top side with tar paper. *Do not wrap the paper around the joints.* (See Fig. 7.) The tile should have a slight fall, not over three to four inches to 100 feet. If too much fall is given most of the liquid will run to the lower end and make a muddy place. It should soak out at the joints all along the line and be absorbed by the soil. In order that the depth of the ditch be nearly constant it is nec-

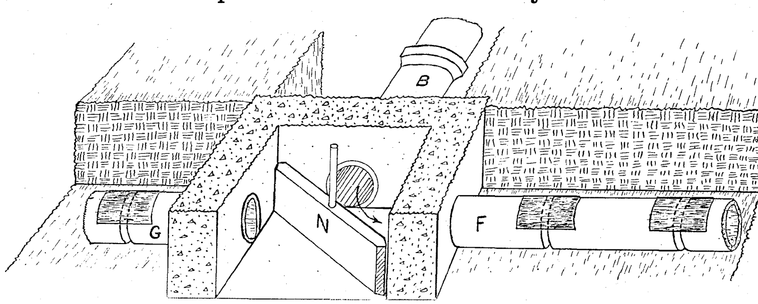


Fig. 7.—Detail drawing of the distributing box. This view shows how the valve is made and used to deflect incoming liquid first to one distributing tile line, then to the other. The tile line B, from the tank to the box, is made of four-inch sewer tile with cemented joints. G and F show the two distributing tile lines. They are four-inch drain tile laid with loose joints about 1/8 inch apart and the top half of the joint is covered with tar paper.

essary to lay the tile across the slope rather than up and down it. (See Fig. 1.) Of course if the land is flat it may be laid wherever desired.

The two lines of tile should be laid about six to eight feet apart. In case the soil will not soak up the liquid it may be necessary to lay a drain tile between them a little deeper, running it out at the lower end. If there is insufficient fall, where the land is nearly level, it may be necessary to run it into a small shallow well or sump. This third tile acts as a drainage system only. Sometimes it is advisable to put a layer of cinders or fine gravel under the tile to increase the absorption surface, but as a rule this is not necessary.

Making the Distributing Box. The four steps of a convenient way of making the distributing box are shown in Fig. 6. The hole for the box is dug 16 inches square where the box is to be placed, (Fig 6a). The bottom of this hole should be about eight inches deeper than the outlet of the tank. Then dig the ditch from the tank to within about a foot of this hole. In like manner dig the two ditches (F and G, Figs. 6 and 1) to within a foot of the hole. Cut holes through from the box to each ditch.

Pour about four inches of concrete in the bottom of the hole and level off for the bottom. Now push the tile through each hole from the ditches. Make a box of 1″x8″ board about three feet long, set it on the concrete bottom and push the three tile up against it. All three tile should be on the same level (Fig. 6b). Make a rather dry mixture of concrete, one part cement to four parts sand, and tamp around the wooden box. Shake the box up and down slightly every little while to break contact with the concrete and box so that it can be pulled out entirely in about ten minutes. If left too long it cannot be pulled out.

The concrete should extend a few inches above ground. The wooden box should be greased so as to slip out easily. Small bolts should be placed in the top of the concrete walls so that a 2″x4″ frame may be fastened on for the lid to hinge to.

The valve is made of a piece of 2″x6″ as shown in Figs. 6d and 7. All that is necessary to change the valve is to raise the lid, lift the valve out and drop it into the opposite two corners.