

College Bulletin Number 100. Issued Monthly. Extension Series II, No. 8

Entered as second-class matter November 27, 1909, at the postoffice at Corvallis,
Oregon, under the Act of July 16, 1894.

OREGON AGRICULTURAL COLLEGE
EXTENSION DIVISION

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Septic Tanks
AND
Absorption Systems

BY

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The Bulletins of the Oregon Agricultural College are free to all residents of
Oregon who request them.

PREFATORY NOTE.

This bulletin has been issued in response to numerous requests for instructions for building septic tanks. It is intended as a guide for those who do not possess a technical knowledge of the subject. The engineering features have been prepared by Professor T. A. H. Teeter, of the Department of Civil Engineering, and the discussion of the bacteriological problems involved has been contributed by Professor T. D. Beckwith, head of the Department of Bacteriology.

RALPH D. HETZEL.

Septic Tanks and Absorption Systems

It is not our purpose to present an elaborate system of sewage disposal, but to offer a design which will be efficient with the least expense possible. Efficiency, rather than cheapness, should be the prime object.

The best engineers and sanitarians favor tanks of two or more chambers. For the ordinary residence, however, two chambers are sufficient, the first an airtight scum chamber to encourage the action of anaerobic bacteria, and the second a ventilated chamber to allow the action of aerobic bacteria after the completion of the anaerobic changes.

Location. The septic tank, if made watertight, can be located anywhere outside the cellar wall, without danger of disease or bad odors, but in a flat country should be placed as close to the traps as possible in order to get the required fall to carry the sewage to it. On small lots in flat country it is impossible to get cellar drainage into the septic tank and at the same time to obtain the proper fall for the outlet pipe.

The top of the septic tank should be placed 12 to 15 inches below the ground surface, to escape action of frost in cold climates, and also in order that it may be out of sight.

The Sewer Connection or Inlet Pipe. The sewer from the house should consist of a 4- to 6-inch vitrified sewer pipe with a trap near the house end to form a water seal in order to guard against the escape of sewer gas into the house. The joints of this pipe should be carefully cemented with Portland cement to prevent leakage into the surrounding soil. The inlet pipe should enter the first or airtight chamber of the septic tank, turn down and extend from 12 to 24 inches below the surface as shown at (a) figure 1, so that the sudden discharges of sewage from the flush closets will not disturb the surface scum which forms on the sewage.

The Grease Trap. The grease from kitchen and dairy sinks will not be destroyed by the septic tank processes, and should not be allowed to discharge into the tank.

To stop accumulation of grease in the septic tank the kitchen and dairy sinks should discharge into a grease trap such as shown in Figure 2. The construction of the trap is as follows.

Two holes are cut on opposite sides of a 24-inch sewer pipe to serve as inlet and outlet to the trap. This pipe is placed end to end, above a second 24-inch pipe, set vertically in the ground, as shown in Figure 2, and the joints made watertight with a rich portland cement mortar.

A concrete bottom is placed in the trap and the inlet and outlet pipes cemented in place as shown. The outlet pipe may be constructed of 4-inch vitrified sewer tiles and bends. The following is a bill of material needed to make such a trap.

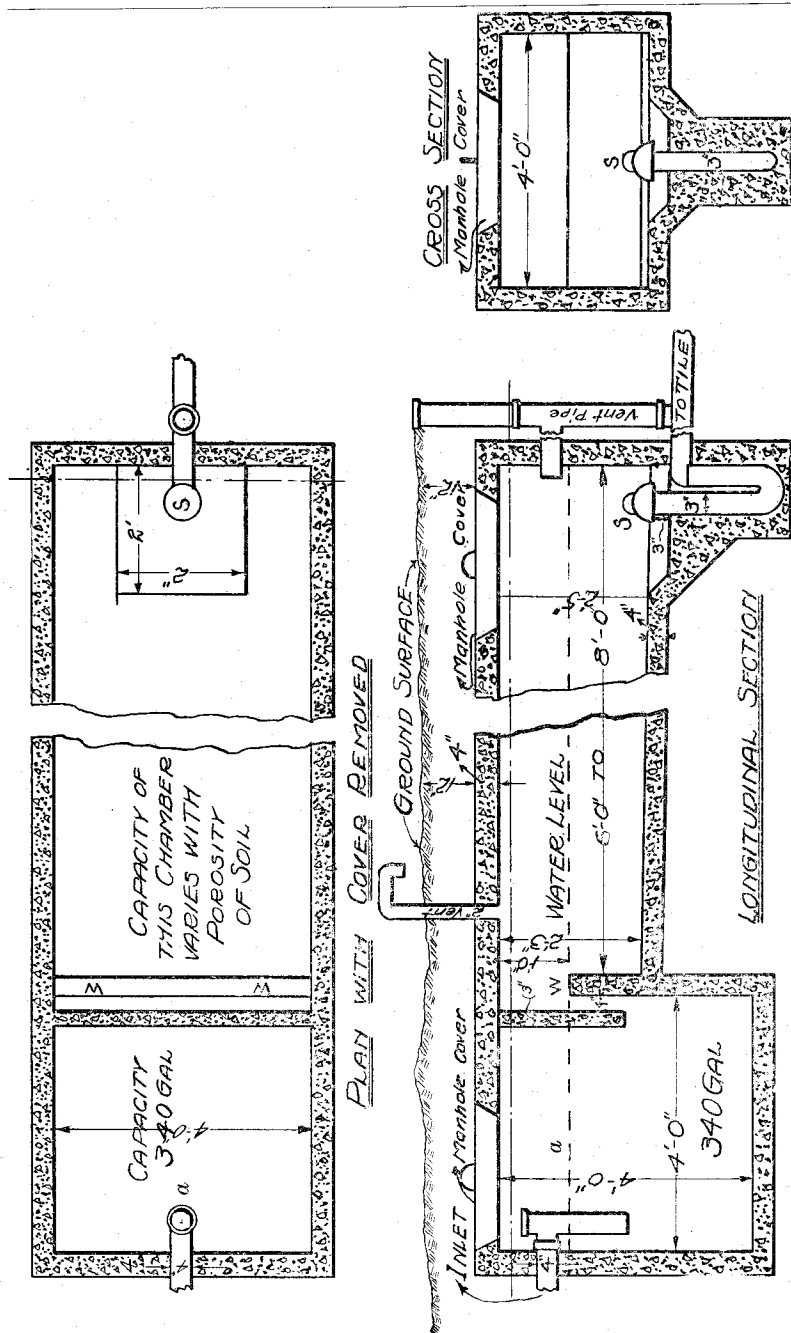


FIGURE 1

Two 24-inch vitrified sewer pipe.....	\$5.00
Two 4-inch vitrified sewer pipe.....	.40
One 4-inch "T" pipe.....	.40
Two 4-inch vitrified quarter bends or elbows.....	.60
Cement to construct bottom and cover for trap.....	.30
Total	\$6.70

The cover may be moulded in place if the top of the tile is covered with paper to prevent the cover from sticking after it is cast, or the cover may be made of 2-inch planks sawed to fit the bell of the pipe. A loop of iron should be cast in the cover to be used as a handle.

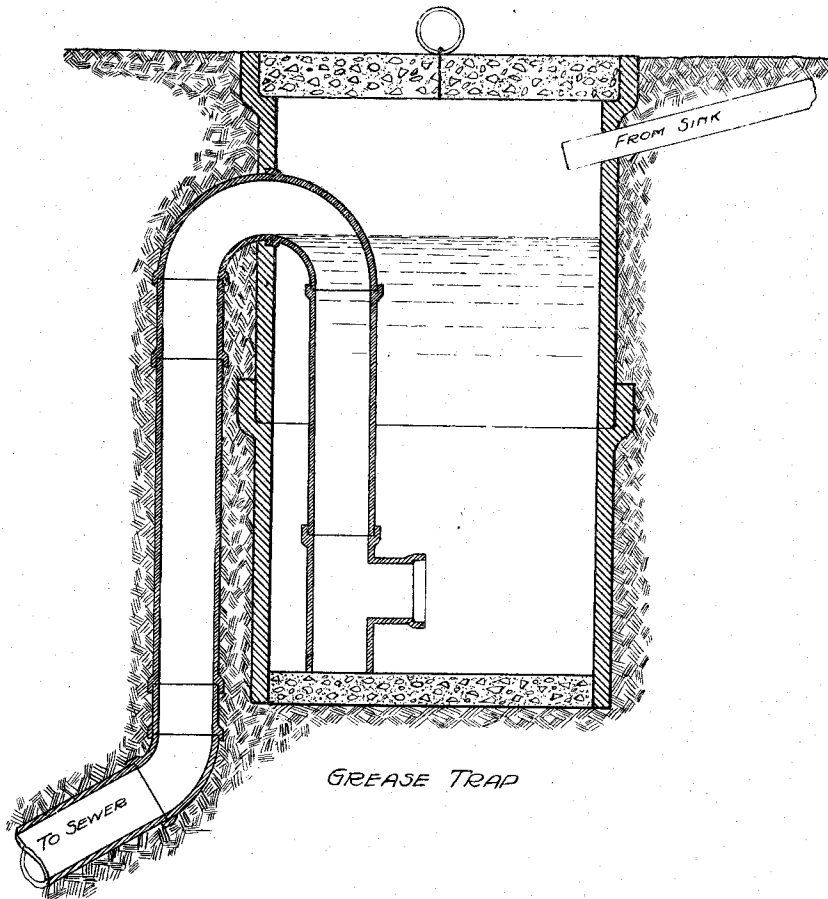


FIGURE 2

Size of Septic Tank. The size of the scum chamber should be such as to contain the sewage flow for a period of not less than 18 hours, nor more than 36 hours, or an average flow of about 24 hours, in order that the putrefactive processes may have been carried to the proper stage when the sewage is discharged into the second chamber.

Assuming the average family to consist of five persons, with a daily water consumption of 67 gallons per person, the necessary capacity will be $337\frac{1}{2}$ gallons or 45 cubic feet. Or, assuming six persons with a water consumption of 50 gallons, we would get about 40 cubic feet. A convenient size for a scum chamber of this capacity should then be about 4 feet by 4 feet by 3 feet deep below the water line, or 4 feet by 4 feet by 4 feet deep below cover, allowing 12 inches between the top of the liquid and the cover. The second, or discharge chamber, should be of the same width and about the same capacity, but shallower and longer.

The table on the following page gives capacity of rectangular tanks of various sizes.

Baffles. The inlet pipe enters the tank and discharges downward at a point 12 to 24 inches below the surface to prevent surface disturbance, which might break the scum. The discharge from the scum chamber to the siphon or dosing chamber takes place over the top of the partition wall or wier, W-Figure 1. To prevent the scum from floating off into the second chamber a baffle wall must be provided. The scum which forms on the surface of the sewage in the first chamber is essential to the proper action of the tank. This baffle wall is placed about 4 inches in front of the partition wall and down to a point 12 to 24 inches below the surface, as in the case of the inlet pipe. The space between the bottom of the baffle and the top of the partition wall or wier is normally full of sewage, making the first chamber airtight.

Size of Second or Dosing Chamber. The sewage from the scum chamber should discharge over a wier, (w) into the siphon or dosing chamber, as shown in Figure 1. The size of this second chamber depends on the character of the soil in which the absorption system is laid, and may be from three-quarters to three times the size of the scum tank. A dosing chamber three-quarters the size of the scum chamber is usually large enough. But if the percolation is slow, due to the fine character of the soil, the dosing tank should be larger. The tank should ordinarily discharge automatically not oftener than once in 24 hours. If desirable, the siphon chamber can be increased in length so as to increase the period between discharges, and give more time for absorption.

To enable the outlet pipe to have the required amount of fall where the ground is flat, the second chamber should be made as shallow as possible, as in Figure 1.

Necessity of Compartments. It is a fact which must be recognized by the users and constructors of septic tanks that the efficiency of the tank depends on the presence and activities of the proper kinds of bacteria. The tank becomes nothing more nor less than a large culture chamber for the growth of the proper kinds of bacteria, and upon them solely depends the work of purification of sewage entering the tank. Roughly, it may be stated that the types of bacteria in a septic tank

CAPACITY OF RECTANGULAR TANKS.

To obtain values from this table choose the greater dimension as the length and the smaller as the width. Find the number of gallons under the proper length at the top of the column and opposite the width at the right. Multiply this number by the **depth of tank in feet**.

Width of Tank	Length of Tank in Feet										
	2	3	4	5	6	7	8	9	10	11	12
2.0	29.92	44.88	59.84	74.81	89.77	104.73	119.69	134.65	149.61	164.57	179.53
2.5	56.10	74.80	93.51	112.21	130.91	149.61	168.31	187.00	205.71	224.41
3.0	67.32	89.77	112.21	134.65	157.09	179.53	202.97	224.41	246.86	269.30
3.5	104.73	130.91	157.09	183.27	209.45	235.65	261.82	288.00	314.18
4.0	119.69	149.61	179.53	209.45	239.37	269.30	299.22	329.14	359.06
4.5	168.31	201.97	235.63	269.30	302.96	336.62	370.28	408.94
5.0	187.01	224.41	261.82	299.22	336.62	374.03	411.43	448.83
5.5	246.86	288.00	329.14	370.28	411.43	452.57	493.71
6.0	269.30	314.18	359.06	403.94	448.83	493.71	538.59

(Given in gallons for each foot of depth), 1 cubic foot is equal to 7.48 gallons.

are two; first, those which thrive without the presence of free oxygen or air and which therefore demand that the portion of the tank in which they grow must be as nearly airtight as practicable; and, second, those which require oxygen to thrive, and which therefore do their work best in the presence of as much air as possible. The second compartment, where the bacterial action is completed, should therefore be so constructed that air may have free entrance and circulation.

A great variety of material finds its way into a septic tank by way of sewage. This material consists of various kinds of albumens, such as are found in fecal matter, house slops, paper, bits of cloth and carpet sweepings, and a certain amount of greasy matter which gets by the grease trap, together with many other substances. Much of this material is suspended in the liquid. Upon its admittance to the tank, it is attacked by the bacteria which should be growing in the tank, and the greater portion of the solid material is liquified. In order to bring about the changes which are noted in the above paragraph, it becomes very necessary that the tank be composed of two compartments, and that there be no possibility of admittance of air through the trap or otherwise from the second chamber back into the first. Many of our so-called septic tanks in the State of Oregon have merely one chamber, although sometimes there is a partial dividing wall between them. **Such a tank is nothing more nor less than a cess-pool**, and is a menace to health because of the false feeling of security which it gives to the users. This liquification which takes place in the first tank cannot be brought about if air is in the tank. As the solid matter is liquified, a certain amount of gas is given off which comes to the top, and the small bubbles rising bring with them bits of undissolved material which form a scum on the surface of the tank. The presence of this scum is absolutely necessary for proper results in the purification of the sewage, and in order that this scum may not be broken and settle to the bottom, the inlet pipe, as has been described elsewhere, must dip below the surface. Thus there will be no undue agitation of the surface film, which sometimes becomes two or three inches thick. A certain small portion of the solid matter will not be attacked by the bacteria living in the airtight chamber, however, and after a time this part will settle to the bottom, making a layer of mud which is sometimes called "sludge." It will be found necessary to clean out this sludge, which may become five or six inches deep in a year's accumulation. The germs living in the airtight chamber, which are technically anaerobic bacteria, will do their work, if thriving properly, within twenty-four hours' time. This first chamber should, therefore, have a capacity equal to twenty-four hours of sewage flow. The effluent from this tank will have an unpleasant color and odor, and probably will be quite turbid in appearance. In the later state of purification, it is attacked by the bacteria which thrive in the presence of air and therefore must be allowed to pass over into chamber No. 2, where the proper germs will in time be found to thrive. On leaving this second chamber, then, the sewage will be fairly clear as to appearance and corresponding deodorization will have taken place. As has been stated elsewhere, this change takes place rather more rapidly than that in tank No. 1, and therefore it is necessary to have the volume

of this compartment only approximately two-thirds to three-fourths that of the first.

Many so-called authorities make statements to the effect that one may expect sewage to be purified almost entirely by a septic tank. This is erroneous, for it should be understood that a septic tank which purifies over 70% is very exceptional, and that generally only from 60% to 65% purification may be expected. This amount of purification, however, warrants the construction of a tank whenever such is physically and financially possible and necessary.

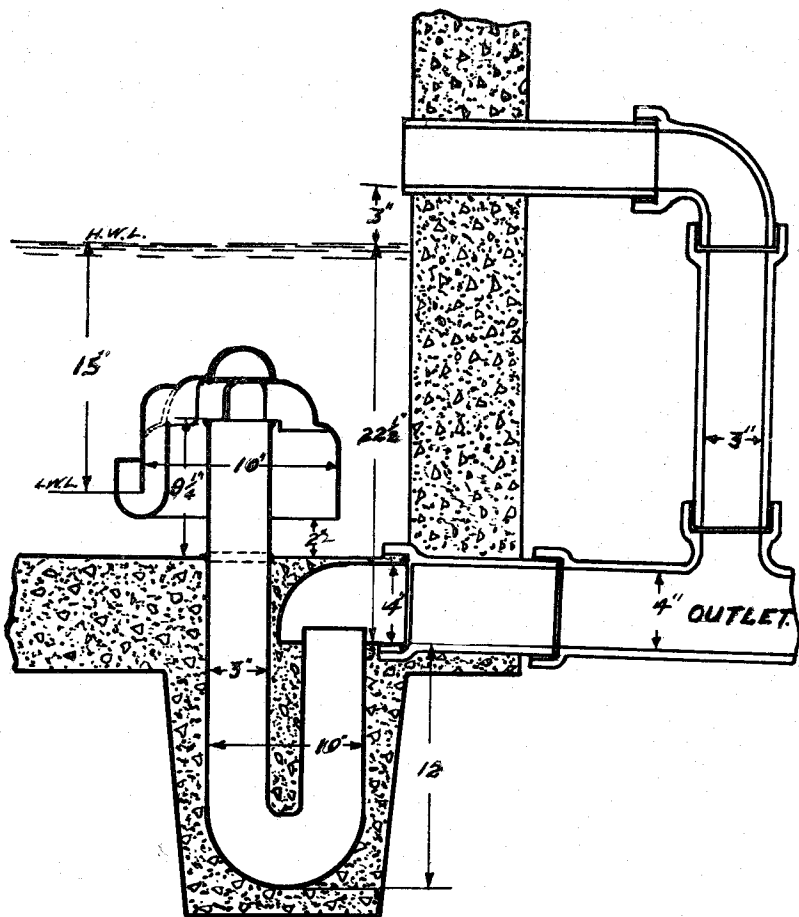


FIGURE 3

Siphon and Siphon Chamber. In order to spread the sewage uniformly over the entire absorption area, it is absolutely essential that a quantity of effluent sufficient nearly to fill the whole system of absorption tiles be released suddenly into the absorption system. If sewage is allowed to flow from the septic tank in a small continuous stream, the absorption area nearest the septic tank may become waterlogged, while the absorption area farthest away will receive none of the effluent. To insure regular and automatic discharge of the effluent, a siphon should be installed at S, Figure 1.

The operation of the siphon is as follows: The trap at the lowest portion of the bend of the siphon is first sealed with water. As the sewage rises in the siphon chamber, the air under the bell is compressed and the water driven down in the long leg of the siphon. Finally a bubble of air escapes around the bend or "dip" of the siphon and carries with it some water. As soon as the air escapes from the long leg the water rushes in and starts the siphon working. The liquid is drawn from the tank until the seal is broken by the slow admission

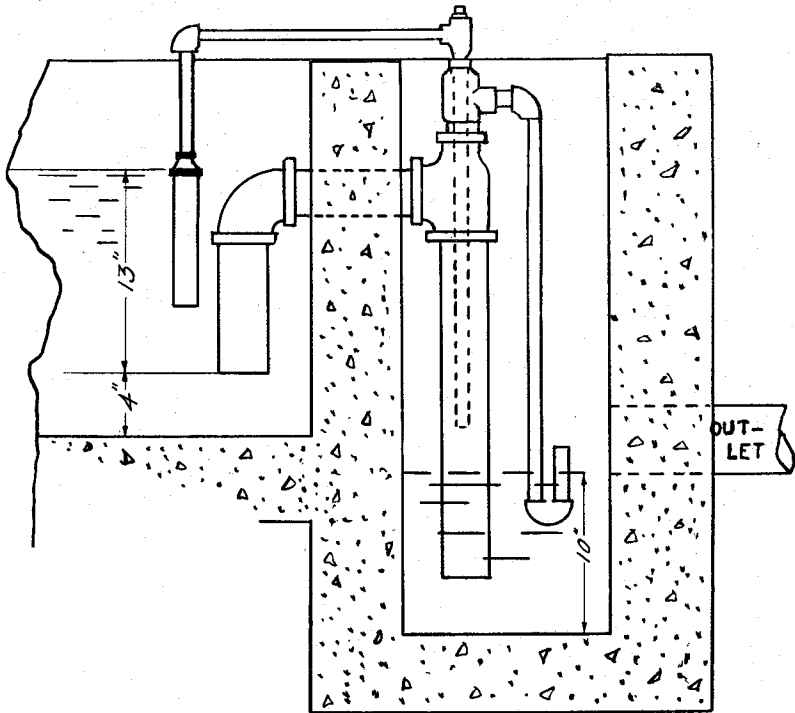


FIGURE 4

of air through a vent in the lower part of the bell. Enough water remains in the siphon to seal it and the process is repeated automatically. The size of the chamber should be such as to permit refilling about once in 24 hours.

The siphon should be set with a clear space of 3 to 4 inches under the bell to allow free admission of the liquid to the siphon.

Siphons in sizes adapted to small septic tanks may be had for about \$12 to \$15. Figures 3, 4, and 5 illustrate a few of the standard makes of siphons. Automatic siphons are manufactured by the Pacific Flush Tank Co., Chicago, Ill.; F. Stary & Sons, Cedar Rapids, Ia.; and The

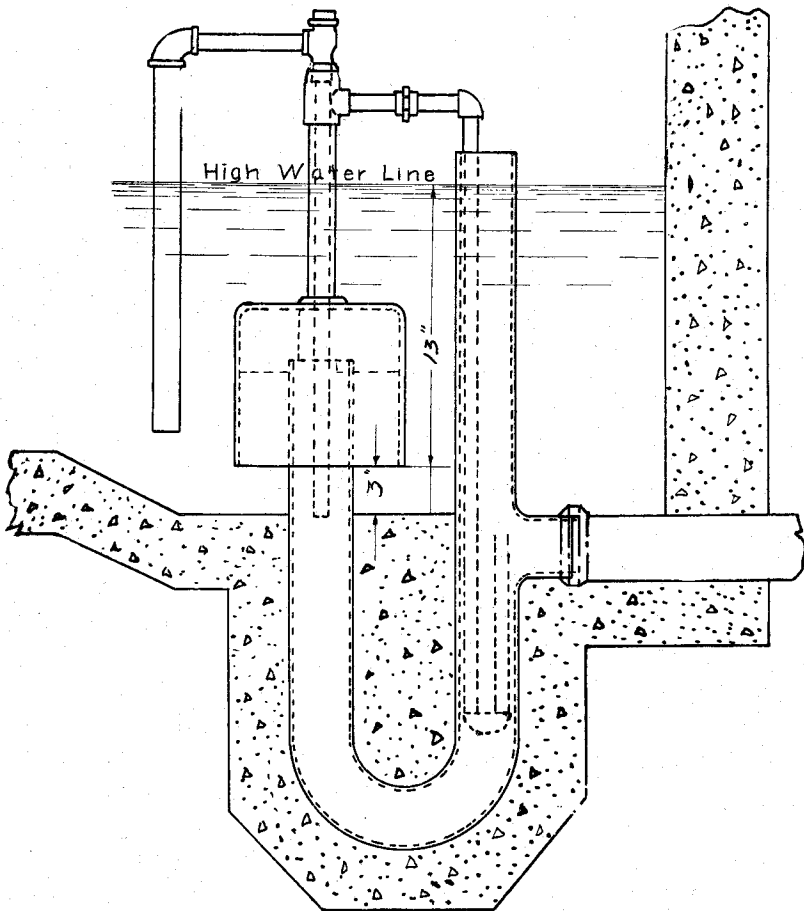


FIGURE 5

Merritt Hydraulic Company, Philadelphia. Names of local representatives of these firms may be obtained by writing to the firms at the above addresses.

The Disposal System. The siphon should discharge into a line of 4-inch vitrified pipe connecting the tank with the disposal or absorption system, which should be located at a safe distance from house and well. See Figure 6.

The absorption system should consist of 4-inch unglazed red farm tile, laid with $\frac{1}{4}$ -inch joints at a depth of 12 to 15 inches below the ground surface. The joints should be covered with pieces of broken tile to keep the dirt out. The fall should be not more than 2 inches per 100 feet. If the slope is steeper, the effluent will run to the lower end. It is customary to allow one foot of tile in sandy soil and two feet of tile in clay or impervious soils, for every gallon of sewage discharged daily by the tank. The total capacity of the tile, however, should equal at least 75% of the discharge tank from which the sewage comes.

The tiles may be laid in parallel trenches, spaced 5 to 15 feet apart, leading from the main outlet pipe. These trenches should be partly filled with coarse gravel and sand to the top of the tile to allow freer access of air to the sewage.

In case the soil is impervious or poorly drained, tile under-drains should be laid midway between the absorption tile and a foot or two below them to prevent waterlogging of the soil. The capacity of the absorption system can be increased by the cultivation of vegetation, such as grasses or lawns on the absorption field.

It must be borne in mind that the irrigation system needs a rest of nearly 24 hours each day and therefore the flush should take place quickly and completely. Where it is necessary to arrange the disposal system on a hillside, the main tile line leading to the branches will probably have such a fall that the water will flow entirely too fast. This difficulty can be overcome by stepping the main tile line by means of special drops, as shown in Figure 7. Figure 6 illustrates a general plan of a disposal system. Certain companies claim to have patents on the septic tank and underground disposal system. While many people build their own tanks they do so at the risk of claims for infringement by these companies.

Construction of the Septic Tank.

Material: Septic tanks have been constructed of wood, stone, steel, brick and concrete. Concrete is **preferable** on account of ease of construction and durability.

In handling the cement the following precautions must be carefully observed to insure success:

1. The cement must be stored in a dry place.
2. Sand must be clean, coarse, free from loam, clay, vegetable matter or dust.
3. Concrete must be placed in position within 20 minutes after mixing. It should be placed at once.
4. Concrete should be kept damp and shaded for four or five days after placing, to prevent cracks.
5. Concrete should never be allowed to freeze.

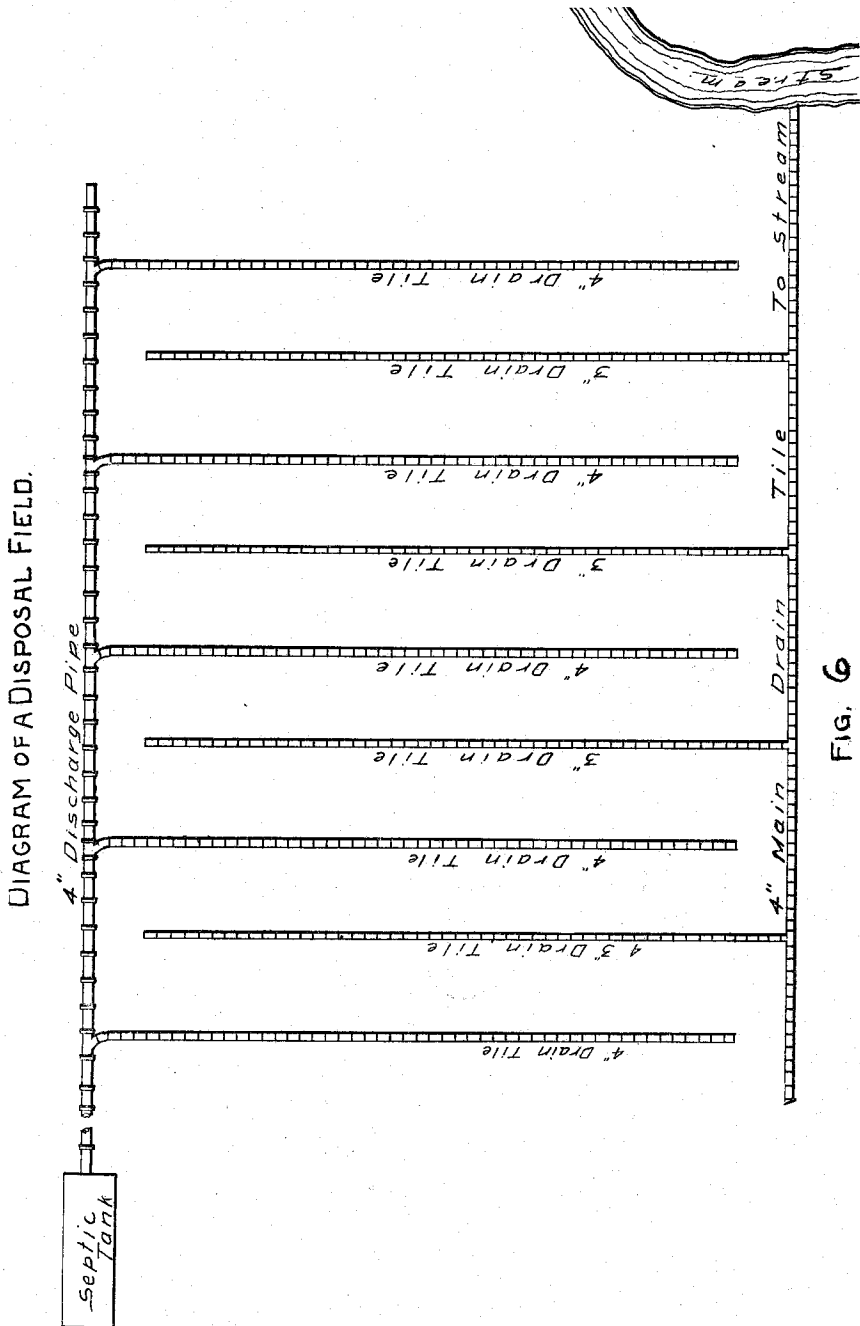


FIG. 6

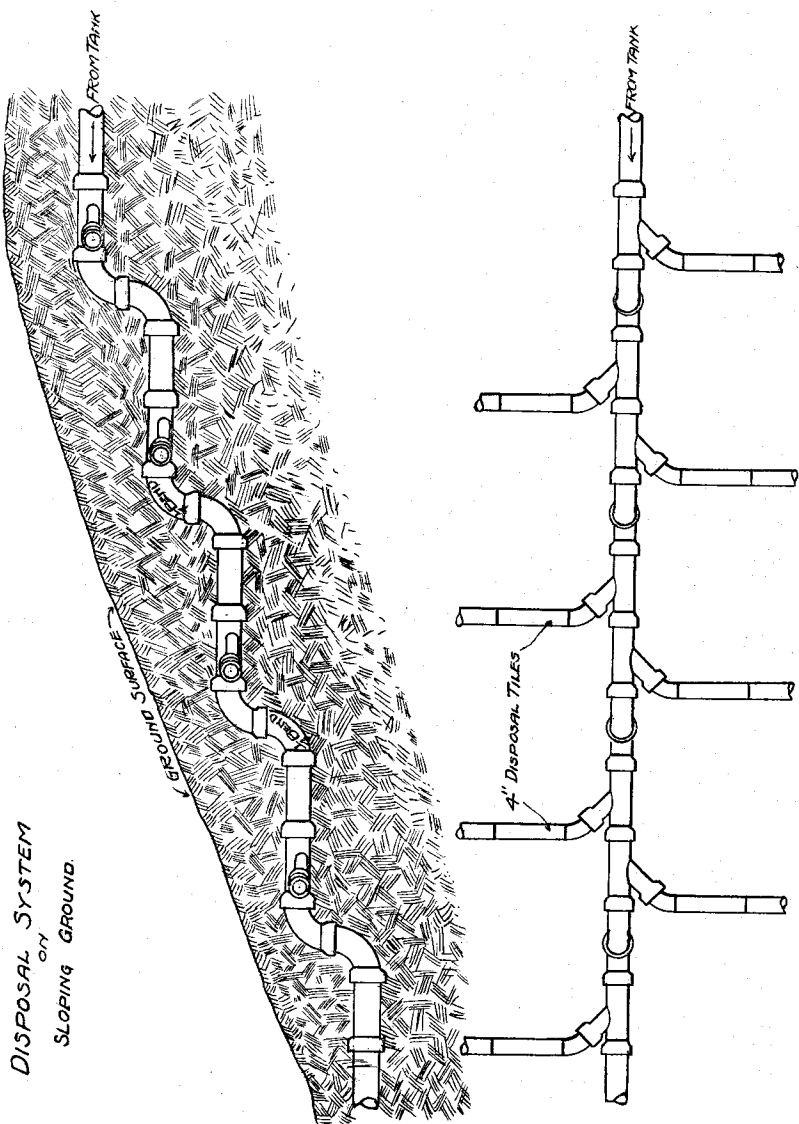


Fig 7.

6. Do not separate the materials in placing.

To avoid separation of the material, place the concrete in layers 6 to 12 inches thick, and then puddle or tamp it with a spade after adding each layer.

The concrete for the walls should be wet enough to appear "mushy." A spade or old saw should be run up and down between the concrete and the wooden forms to crowd the stones back and allow mortar to run in next to the form to get a smooth surface. The concrete should be mixed on a watertight mixing board, about 6 feet by 8 feet. The cement and sand should be mixed together dry, in proportion of one part cement to two sand by volume. Then four parts of broken stone or coarse gravel should be added next, and the whole mixed dry. Finally the water should be added and mixed until the concrete is wet throughout.

The Pit. Dig the pit exactly to the dimensions of the outside of the walls of the tank, which will be the inside dimensions plus the thickness of the walls. The vertical walls of the pit will constitute the outside forms for the concrete. The pit should be deep enough to permit a fill of 9 to 12 inches of earth on top of the tank. In the outlet end of the siphon chamber a hole should be dug in the bottom of the pit deep enough to allow concrete to be cast all around the siphon bend. See Figures 1, 3, 5, and 6.

Floor. It is well to provide a sump or shallow sunken pit, 24 inches by 24 inches by 3 inches deep, about the siphon bell, as shown in Figure 1.

The siphon should be placed at such a level that the bottom of the bell will be 3 or 4 inches above the finished floor of the sump. The space around the lower part of the siphon loop should be filled with concrete. The floor of the pit should then be covered with 4 to 6 inches of dry concrete, tamped and allowed to set.

The Forms. The forms should be constructed of green lumber finished on both edges and one face to make tight joints. Shiplap is used extensively for these forms. The inside form is made of two large bottomless boxes (A and C, in Figure 8), and one small box (B), to fit the inside dimensions of the two chambers, as shown in Figure 8.

These boxes should be carefully leveled in place, with their sides equidistant from the walls of the pit.

Walls. The space intervening between the walls of the pit and the sides of the boxes should be filled with concrete, and the wall faces "spaded" to work the stones away from the wall surface.

The baffle and partition walls should be cast with those outside. The baffle wall should be reinforced with $\frac{1}{4}$ -inch rods spaced 6 to 8 inches apart, running horizontally through its center.

After the concrete has set for three days, the forms should be removed, the walls and floor wet down and then plastered with one-quarter inch of clear cement mortar to make them watertight. Keep the tank shaded and damp for three days to allow the plaster to set without cracking. At the end of three days the tank is ready for the cover.

Cover. The tank should have a re-enforced concrete cover. It may be made as follows:

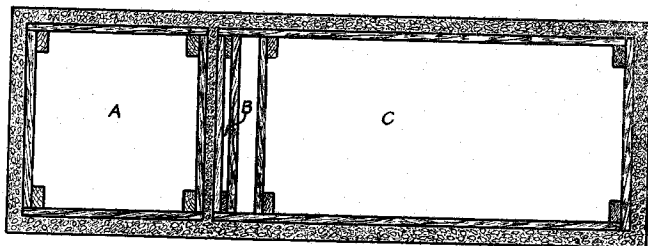
1. Build a floor inside the tank and flush with the top of the walls, as shown in Figure 9. The boards should be laid across the tank rather than longitudinally, as they will then be easier to remove.

2. Build a bottomless box about 4 inches deep around the outside of the top of the walls. Place a manhole form, such as shown in Figure 9, at each end of the tank, immediately over the inlet and outlet pipes.

3. Place $\frac{3}{8}$ -inch round iron rods about a foot apart lengthwise and crosswise of the tank for re-enforcement about $1\frac{1}{2}$ inches above the bottom of the cover.

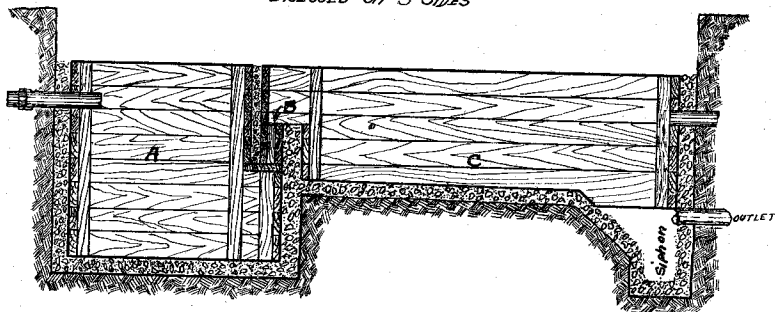
4. Fill in the cover form with concrete, taking care not to displace the re-enforcing rods. After the top has set, the manhole forms may be withdrawn and the covers cast in place by lining the manhole with paper to prevent the new concrete sticking to the old. The manholes should be placed immediately over the inlet and outlet pipes to render the pipes easily accessible for cleaning and repair. The edges of the manhole should be re-enforced with $\frac{3}{8}$ -inch rods, one on each of the four sides, about $1\frac{1}{2}$ inches from the edge of the concrete.

ARRANGEMENT OF FORMS



PLAN.

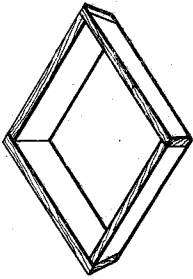
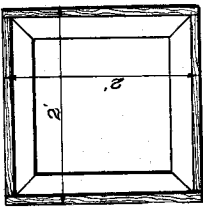
FORMS TO BE CONSTRUCTED OF 2"x4" AND 1"x6"
DRESSED ON 3 SIDES



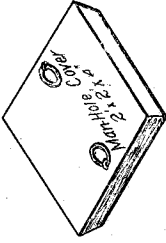
LONGITUDINAL SECTION

FIG. 8.

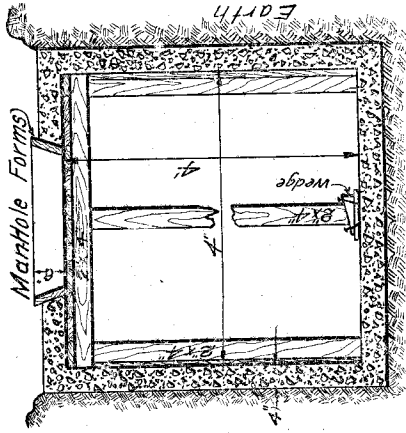
FORMS FOR MANHOLE COVER



MANHOLE LID



FORMS FOR ROOF OF TANK



RING FOR LIFTING COVER

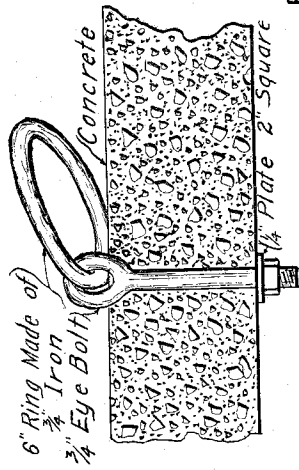


FIG. 9

Cost of Construction. The following is an estimate of the cost of construction of the septic tank shown in Figure 1. The cost will vary somewhat with the locality, and with the ease with which material can be procured.

Cement, 5 barrels (20 sacks).....	\$15.00
Sand, 2 yards.....	2.50
Gravel, 3 yards.....	3.00
Lumber for forms.....	3.00
Steel for re-enforcement.....	.50
Sewer pipes and fittings.....	3.00
Siphon	15.00
<hr/>	
Total material for tank.....	\$43.00
Labor	20.00
Absorption tiles, 325 feet.....	8.00
<hr/>	
Total	\$71.00

Much of this expense can be saved on the farm where lumber, labor, and gravel are already available. In case the cost is prohibitive, the siphon can be replaced by a plug, with a long handle extending through the top of the tank, which can be withdrawn by hand once each day.

Special Notice for Cleaning. Particular attention must be called to the fact that when the septic tank is cleaned, as it should be approximately once a year, it is best merely to take out the heavy material or sludge and possibly to rinse off slightly the walls. Under no conditions must a germicide, such as chloride of lime or carbolic acid, be used in this cleaning process. These compounds, and others of the same nature, kill the bacteria which are absolutely necessary if the tank is to do its proper work; if they are killed the tank will be found to be of little value until sufficient time has elapsed for these bacteria to grow again. In connection with the above statement, it will become apparent that a tank which has just been constructed will not be found to be as efficient as one which has been in use for some months, because the bacteria will not be present in maximum quantities in the new tank. Their intensity of activity also increases after a time.