UNIVERSITY OF IDAHO

AGRICULTURAL EXPERIMENT STATION

Departments of Agricultural Engineering and Bacteriology

The Farm Septic Tank

By

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BULLETIN NO. 128 **JANUARY, 1922**

Published by the University of Idaho, Moscow, Idaho.

UNIVERSITY OF IDAHO AGRICULTURAL EXPERIMENT STATION

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*In cooperation with U. S. Department of Agriculture.

THE FARM SEPTIC TANK

*J. C. WOOLEY
and
W. M. GIBBS

INTRODUCTION

The first and most important step in modernizing the farm home is the installation of an adequate sewage system. The advantages of such a system are numerous. The improved sanitary condition as a result of the final removal of the open privy vault, with its odors and swarms of disease laden flies which are a constant menace to health, is worth many times the cost of its installation. (This sanitary assurance is of far greater value to the house-hold than is the added comfort and convenience.)

The two common methods of disposing of farm sewage are the septic tank and the cess-pool. The septic tank depends upon bacterial action for the destruction and purifying of the sewage, while in the cess-pool complete decomposition does not take place. The septic tank is far more satisfactory, and is no more expensive than the cess-pool, provided the latter is located a sufficient distance from the house. The septic tank may be adapted to any locality and its efficiency is well established. It produces no odors and the out flowing stream is sufficiently sanitary that it may be discharged into an open field.

The purpose of this bulletin is to describe in a general way the bacterial action in the septic tank, and to give in detail the method of its construction and operation.

BACTERIOLOGY OF THE SEPTIC TANK

Bacteria in General

Bacteria, or germs, are minute living plants, not animals, so small that ten thousand placed end to end would reach about one inch. They multiply by merely breaking in two, thus making two where there was but one, and as each of these again divides we have four, etc., until countless numbers are present. This process of multiplication takes place so rapidly that there may be thousands of bacteria created from one within a few hours. The amount of misconception which prevails in regard to bacteria is most astonishing. When the majority of people think of germs they think only of those which produce disease. It is true that disease-

*The drawings and bills of material for the farm septic tank were made by J. C. Wooley, former agricultural engineer of the Agricultural Experiment Station. The detailed instructions for location and construction were prepared by R. B. Gray who succeeded J. C. Wooley in 1920.

producing bacteria play an important role in life and will always be the major study because they deal with human life, yet those bacteria which produce disease are relatively few in number and of minor importance as compared to those which are beneficial. Bacteria are everywhere. A teaspoonful of any soil contains about fifty million of various kinds, our hands and faces are covered with them, we have them in our mouths and eyes, our intestines contain millions of them, yet we remain unharmed. Without bacteria nothing could decay and we would soon have the earth covered with undecayed matter of all kinds. These friendly little workers are ever present and ever tendering us the great service of feeding upon waste and returning all waste materials to the soil in simple form to be used once more by the growing plants. They decompose the material which goes into the septic tank and break it up into simple compounds which are returned to the soil as food for plants.

Changes Taking Place in Septic Tank

The sewage entering the septic tank is composed of waste material of very diversified origin and chemical nature. It is seldom of the same composition on two successive days, yet the bacteria readily attack it and change it to harmless material which is not even attractive to flies. The material entering the tank in the form of human excreta contains proteins, fats, oils, salts, and other compounds of a very complex nature. Considerable fats from other sources may also enter the tank. Paper, a product made from wood, is always deposited in the tank.

When the septic tank is completed, it is first filled with water until the overflow pipe is covered. It is then ready for use. Waste materials from the home are flushed into it and the bacteria begin their activities. The fats rise to the surface and in a few days a scum is formed. Once this film is formed it should not be broken because it aids materially in the action within the tank. Within a few weeks this scum will increase until it has the appearance of a dirty mass with a brittle surface, covering the water in the tank. Some bacteria require air in order to carry out their activities, others do not. The kind which serve in the septic tank do not require air and, in fact, are more efficient in its absence. This scum on the surface aids in keeping out the air.

Proteins are composed largely of carbon, hydrogen, oxygen and nitrogen, which, when combined in proper proportion, give a highly complex compound insoluble in water. Meat consists largely of protein. These proteins find their way into the tank and serve as food for the bacteria. In a very short time the protein is decomposed, the carbon unites with some of the oxygen and forms carbon dioxide which leaves the tank in the effluent. The nitrogen combines with the hydrogen to form ammonia which dissolves in the water in the tank, or reacts with other compounds present to form harmless salts which pass out in the effluent. Some proteins also contain a small amount of sulphur. This sulphur joins the hydrogen and forms a gas known as hydrogen sulphide. This gas has a very disagreeable odor and here again the fatty scum on the surface renders a service by confining this gas. The gas does not remain long but soon joins iron or other metals which have come into the tank and forms iron and other metallic sulphides. These sulphides are not soluble in water so fall to the bottom of the tank as a black, inert, finely divided residue. This residue should be pumped out from time to time as occasion demands, usually each three or four years. Thus our complex insoluble protein is completely destroyed in the tank and little or no trace remains.

The paper that goes into the tank contains largely carbon, hydrogen and oxygen. This combination is known as cellulose and is more slowly decomposed by the bacteria than the proteins but eventually it is destroyed. The carbon and hydrogen combine to form methane, or mash gas, hydrogen gas, carbon dioxide gas, and water. All these substances are colorless and harmless and the paper seems to merely dissolve. Excessive amounts of paper should not be flushed into the tank.

The scum on the surface of the tank contains a high percentage of fat. This scum may become six inches or more in thickness. The fat is slowly converted into soapy-like material which gradually goes into solution and leaves the tank in the effluent.

The carbohydrates which arrive in the tank are easily decomposed. They contain usually carbon, hydrogen and oxygen. Common sugar is an example. They are readily attacked by the bacteria and changed to carbon dioxide and weak acids. The weak acids do not hinder action in the tank because they quickly combine with salts and form inert material easily soluble in water, or they undergo further decomposition to simpler compounds, such as carbon dioxide and water.

All these materials driven into the septic tank are easily cared for by the bacteria and changed to simple harmless materials. They enter as a dirty, greasy mixture and leave in a simple and sanitary form. The tank may be placed as near the house as desired because there is no odor from it. The out flowing stream, or *effluent,* may be run into an open field because it contains only completely decomposed substances and is not insanitary.

Excessive amounts of strong soapsuds or washing powder, bleaching powder, and chemical cleaning compounds, should not be run into the tank for they interfere with the action of the bacteria. However, the action in the tank has very great adaptability and will continue successfully even when very much abused.

Cautions from Sickness

There are times when disease-producing bacteria may enter the tank as a result of illness in the home. Conditions within the tank are not favorable to disease producing bacteria; consequently, those producing the majority of diseases die long before they reach the tank outlet. This is not true of Asiatic cholera, but we do not have that disease at present in this country. The fate of the typhoid bacterium in the tank is somewhat uncertain, but it is commonly thought unsafe to deposit the *unheated* excreta from the typhoid patient into the tank. There is a possibility that the bacteria might pass thru the tank. For this reason it is strongly urged that all materials from the room of a typhoid patient be thoroly boiled, or treated with an antiseptic before being flushed into the tank. The better practice is to bury material of this kind rather than pass it into the sewage system, thus avoiding injurious effects of disinfectants on the beneficial bacteria that operate in the tank.

THE TANK

Preliminary Considerations

Water Supply.

As the successful operation of the septic tank depends on an adequate supply of water, it is necessary that a reliable water system be provided. The gravity system, with a supply tank in the attic or elevated on a tower, is perhaps the simplest, altho in many cases the natural contour of the land would permit building of a concrete tank in the hillside above the house. The water is pumped by means of a gasoline engine, windmill, hydraulic ram, or by hand, the power available governing the size of the tank. Satisfactory commercial water supply systems put out by reputable manufacturers, have proven reliable and may be installed at a reasonable figure in the absence of the gravity system. Whatever system is used, precaution should be taken to guard against freezing in cold weather.

The flow of water in any system is dependant on the pressure or head available and the equipment must be of sufficient size to produce the proper flow of water. Each foot of head gives theoretically 0.434 pounds pressure per square inch.

The following cut, (Figure I), shows a gravity pressure system (center foreground) which is common in the Palouse country. This tank is about an eighth of a mile from the house and 44 feet above the bath room. One foot of head gives about 0.434 pounds of pressure per square inch. This gives a pressure of about 19 pounds (minus friction in pipes) in the bath room. Pressures of less than 7½ pounds have been found unsatisfactory for use with bath room fixtures. This tank is placed below frost line and is a very satisfactory installation.

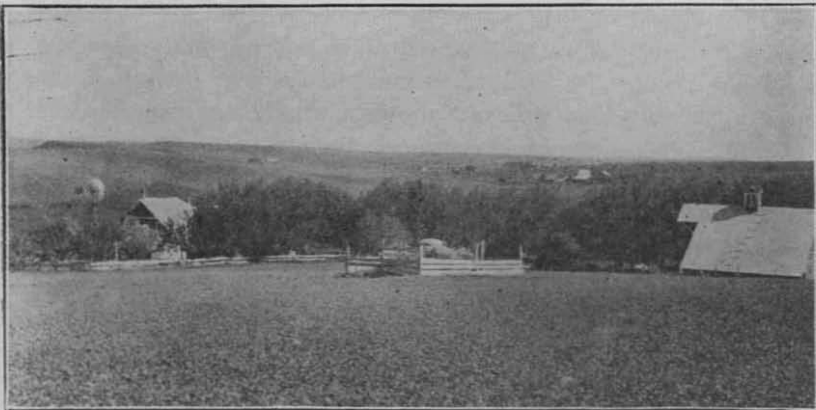


Figure I.—Gravity pressure system. A concrete tank located about an eighth of a mile from the house, at an elevation of forty-four feet above the bath room.

The air pressure systems on the market have proven very satisfactory. They are sure to require attention when worn and should, therefore, be purchased from a local firm prepared to give good service on them.

Size of Tank.

The sewage should remain in the tank for a sufficient length of time for the bacteria to complete their work. Too large a tank will retain the material after the bacteria have complete their action and this is liable to interfere with their best work on the incoming sewage. Too small a tank rushes the material thru before it is completely acted upon. Experience has shown that the following sizes give the best results:

Size of Family	Length	Width	Depth Below Outlet
Four or less	5 ft.	2 ft.	4 ft.
Five or six	6 ft.	2 ft.	4 ft.
Seven or eight	7 ft. 6 in.	2 ft. 6 in.	4 ft.

For larger plants special plans are necessary.

Location of the Tank.

The location of the tank should be governed by one thing,—the slope of the land. It can be placed in the front yard as well as in the rear. It can be placed at any distance from the house, but twenty to forty feet is desirable. A long sewer line is more liable to clog and give trouble, altho successful plants have been located at a distance of three hundred feet with a fall of two inches to the hundred feet.

Sewer Line to the Tank.

The sewer line to the tank must be laid very carefully both as to grade and water proofing. A constant grade should be maintained where possible. An increase in slope near the tank is better than a decrease. If the slope is decreased the water is slowed down and its ability to carry sediment is lessened, hence, it will fill at that point and give trouble. The tile leading to the tank should have a uniform slope of one-quarter inch per foot.

Bell mouth sewer tile should be used to the tank. Place the tile in position. Unravel an old manila rope and pack one of the strands around the tile and into the bell of the next. Then fill the bell with concrete. This rope packed into the joint prevents the concrete from pushing in between the tile and forming an obstruction.. As a matter of precaution, a swab made out of rags and fastened to the end of a stick, should be used to insure the smoothing up of any projecting cement. (See Figure II.)

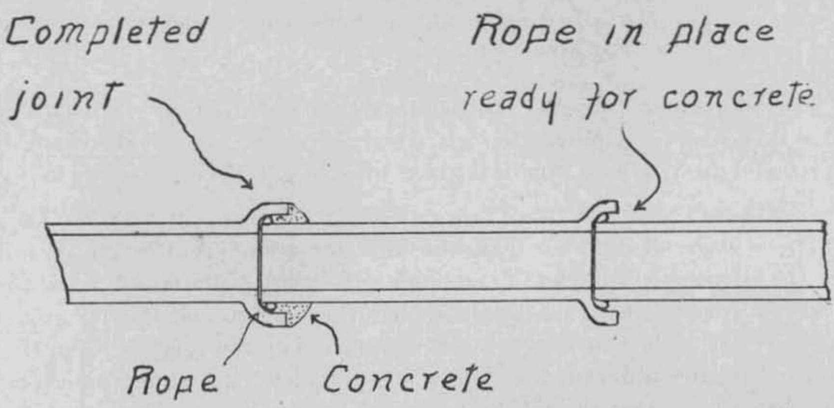


Figure II.—Sewer pipe showing method of joining with rope and concrete.

The Excavation.

After the proper size of tank has been decided upon and the location determined, the excavation should be made. The excavation for the small size tank should be 5 feet 8 inches long, 2 feet 8 inches wide. This provides for four inch side walls. The depth of the excavation will be governed by the depth of the sewer line into the tank. This line must be below frost and the excavation for the tank must be 4 feet 9 inches deeper than this. This will allow for a 4 inch bottom in the tank. In excavating for the other two sizes, allow for 4 inch side walls and bottom. The outlet tile is placed 4 inches lower than the inlet as is shown in the sectional drawing of the tank. It is advisable to dig the hole about two inches undersize and then trim the walls to exact size. If the hole is too large there will be a waste of concrete and if undersize the walls will be too thin. Excavation for tile from the house should be made at the same time.

Construction

Concrete.

It is probably more convenient for the farmer to concrete the bottom and side walls at one time and the top and manhole after the first forms have been removed. Where bank-run gravel is obtainable a mixture of one to four and a half should be used. If rock and sand are secured separately, a mixture of one sack of cement to two cubic feet of sand and four cubic feet of rock will give excellent results. Mix thoroly while dry, then add a moderate amount of water and mix thoroly. Spade and tamp the concrete thoroly as it is placed so that there will be no air or water spaces.

An easy method of securing the proper proportions where the mixing is by hand is to use a bottomless box shown in Figure III. This box will hold four cubic feet and can be used if the rock and sand are not mixed. The box should be filled with rock then lifted over and filled one half full of sand. This provides enough material for one sack of cement and will give a 1-2-4 mixture.

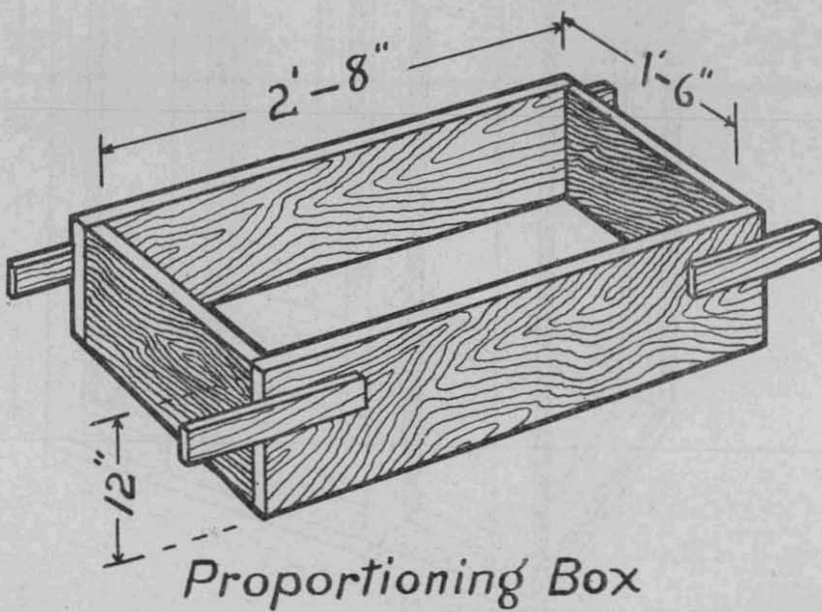
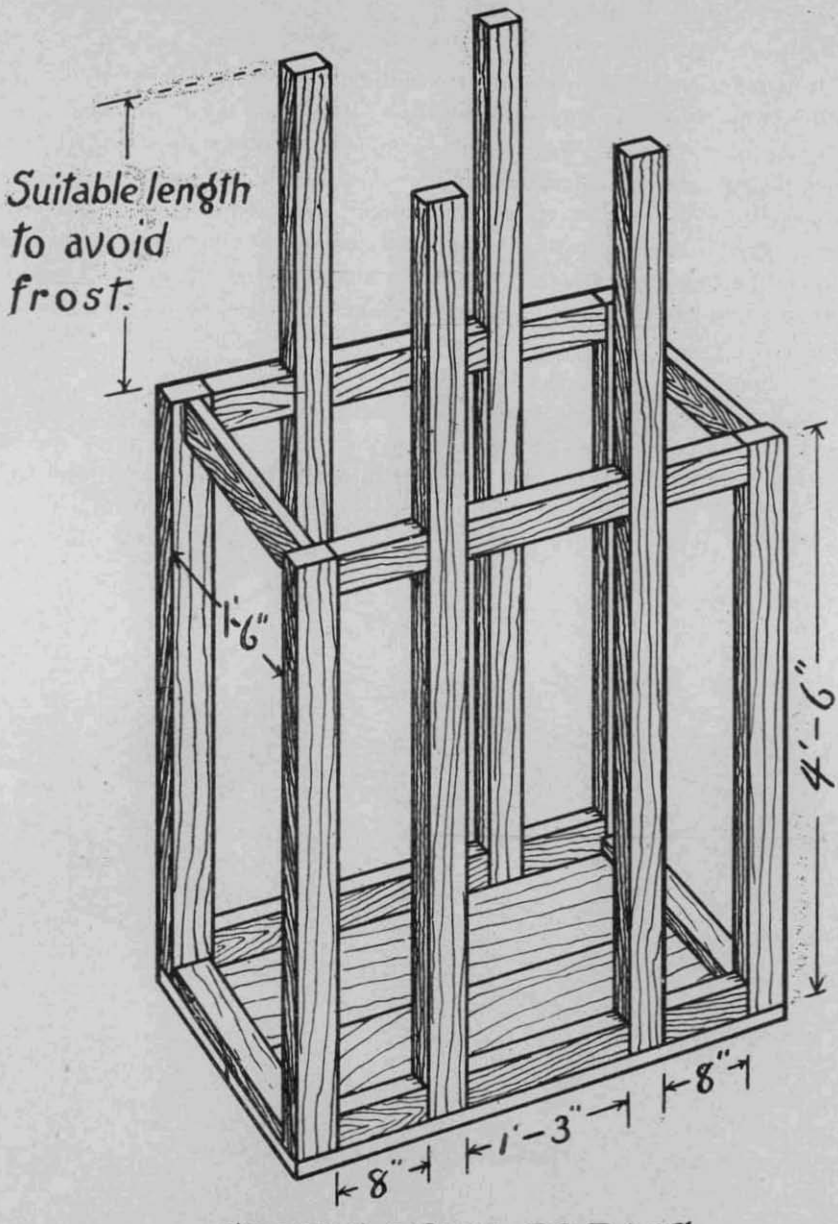


Figure III.

If bank-run gravel is used and a 1 to 4½ mixture is desired, the box should be made three feet long. When filled, this will provide four and one-half cubic feet for the one sack of cement. One sack of cement equals practically one cubic foot.



SEPTIC TANK FORMS

Figure IV.

Forms.

Two things should be borne in mind in the construction of forms:

First, forms should be braced sufficiently to prevent bulging from the pressure of concrete when it is in a semi-liquid state.

Second, forms should be readily removed without damage to the concrete and without wasting form lumber.

An outer form will not be necessary where the excavation will stand. The framework for the inner form is shown in Figure IV. It is seen to consist of a number of 2-inch by 4-inch uprights to which are toe-nailed a number of one by four and two by four spacers which serve to keep the uprights the proper distance apart. It is advisable to use a certain amount of cross bracing to hold the form in shape. (See Figure V.) The up-

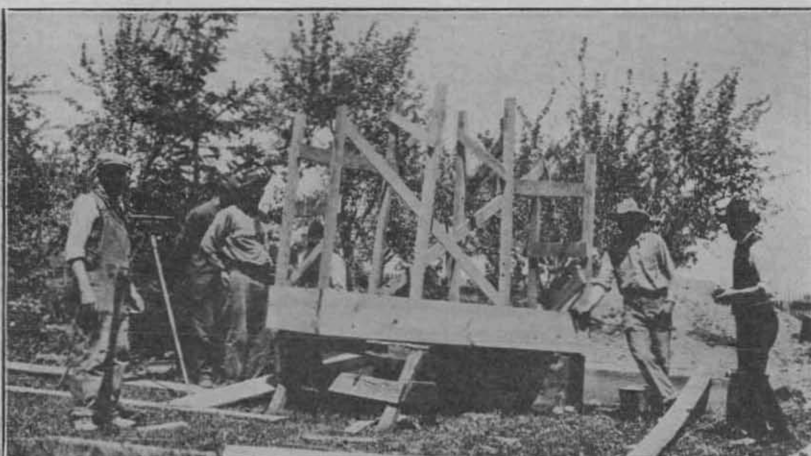


Figure V.—The form ready to be placed in the excavation.

rights and spacers serve as a frame to which one by twelve horizontal boards are nailed so as to cover the entire frame, shown in Figure IV, with the exception of the manhole opening which is on top. Holes should be left at the proper places, as shown in Figure VI, to admit the inlet and outlet tiles.

In Figure VII a 2x2 strip is shown tacked on the outside of the form. This is to make the groove in the concrete for the baffle planks. The groove with the planks in place is shown in Figure VI. The 2x2 strips (one on each side of the form) should be beveled on the corners which are imbedded in the concrete. This is to make removal easy. The two by two strips should also be well soaked in water before being nailed to the form, otherwise the swelling from the water absorbed from the concrete will cause cracking of the concrete. Instead of soaking these strips,

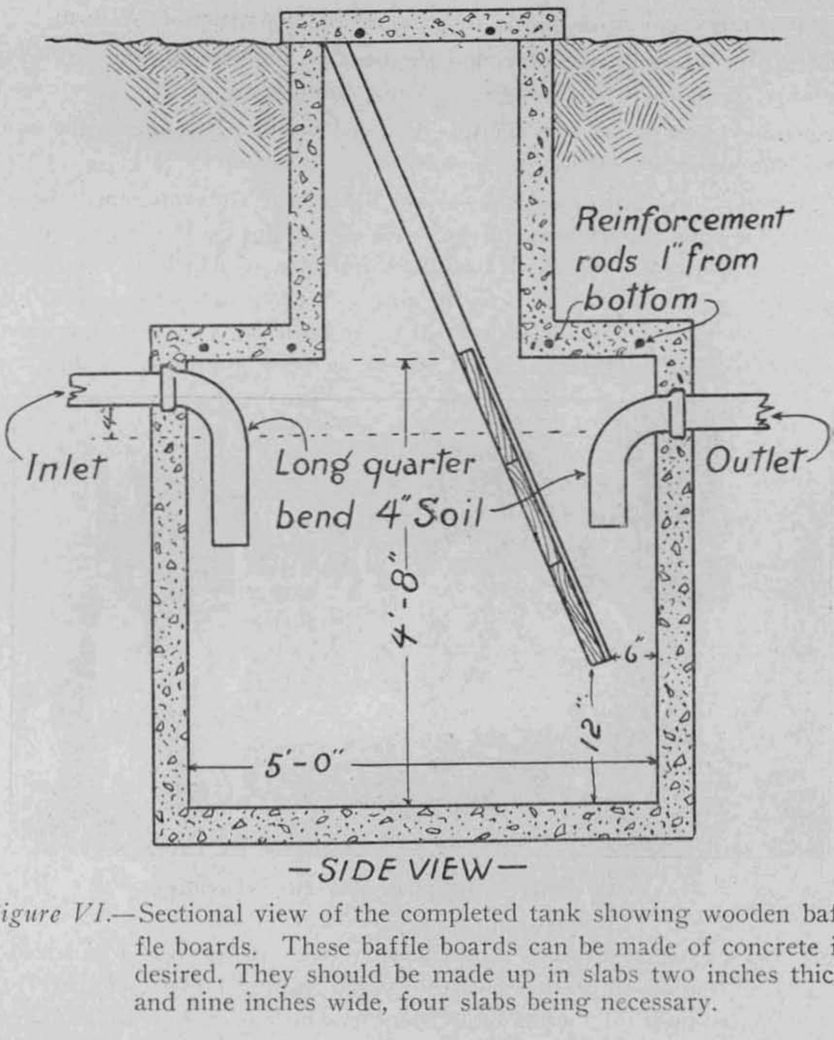


Figure VI.—Sectional view of the completed tank showing wooden baffle boards. These baffle boards can be made of concrete if desired. They should be made up in slabs two inches thick and nine inches wide, four slabs being necessary.

they can be wrapped, not too tightly, with several thicknesses of paper—newspaper will do. The paper takes up expansion of swelling wood.

An outer form will be needed on part of the manhole shaft. Figure VIII shows this clearly enough so that explanation is unnecessary.

Six penny nails should be used thruout so that the forms can be easily removed when the concrete has set. No form boards should project into the concrete. To avoid this cut them as shown in Figure IX.

The concrete floor is placed first then the form is lowered into place on top of the floor. When the form has been set into place the concrete for the side walls should be built up evenly so as not to crowd the form to

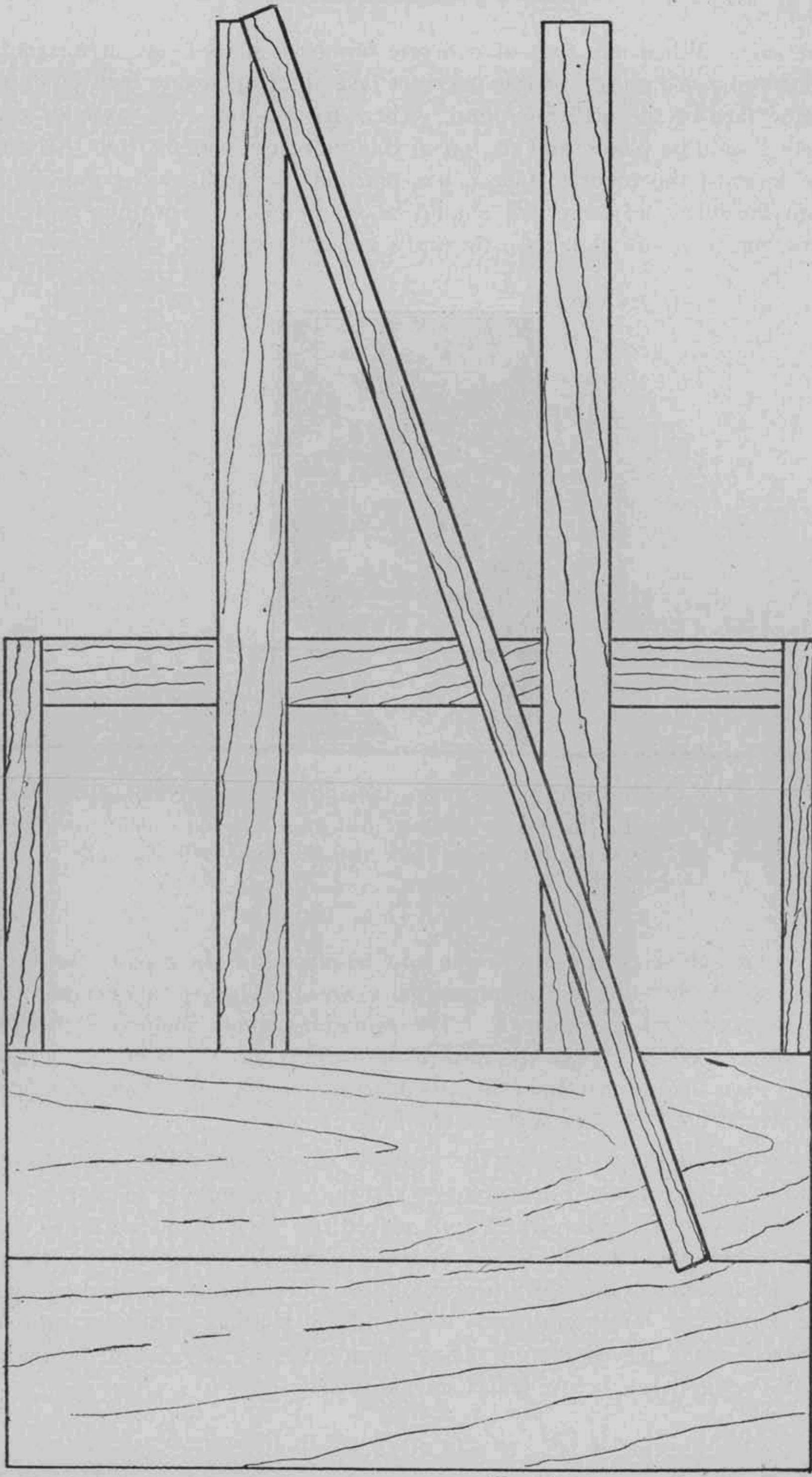


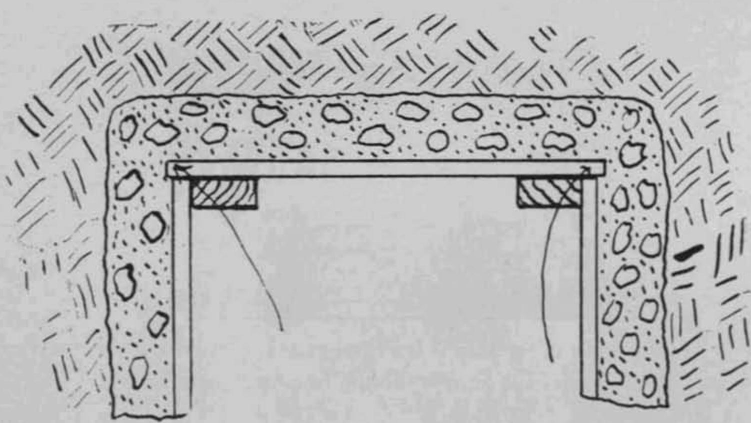
Figure VII.—Two by two strip tacked on outside of form boards.

one side. When one foot of concrete has been placed, lay a horizontal reinforcing rod on top of this one-foot layer placing it one inch from the inside face of the wall all round. Then another one-foot layer of concrete should be placed and on top of this more reinforcing rods. Before the level of the concrete placed has reached the level of the outlet tile, both the inlet and outlet tile should be set in place. Continue with the concrete in this fashion until the walls are complete.

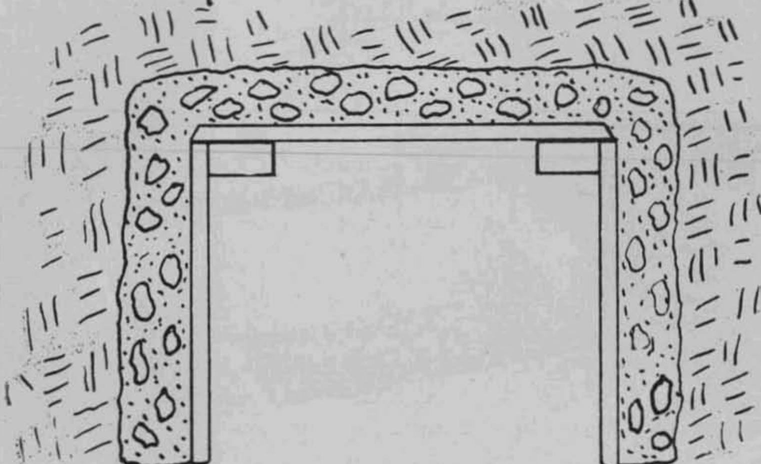
Figure VIII.—This picture was taken when the side walls had been placed and the forms for the top and man hole had been completed. This is the large size tank and the man hole was placed near one end.

A one-inch layer of concrete can now be placed on the roof of the form. On top of this the reinforcement bars are laid across about one foot apart, as shown in Figure X. The remaining three inches of concrete are next filled in. When the roof of the form has been covered, the manhole shaft forms can next be filled with concrete in much the same manner as were the side walls of the tank proper.

A fairly easy way to make the manhole cover is to fill with concrete a bottomless box made of one by fours resting on the mixing platform. This cover should be reinforced by rods placed one inch from the lower face and spaced about twelve inches apart. It may be of great convenience to have handles to assist in lifting the top. These can be secured by making handles of reinforcing rods with ends so bent as to anchor into the concrete when placed therein. (See Figure XI.) They should be placed in the wet concrete before it has started to set.



Showing end boards cut too long



Showing proper cutting of end boards to remove easily.

Figure IX.

Figure X.—One inch of concrete was poured and then the reinforcement bars were laid across, about one foot apart.

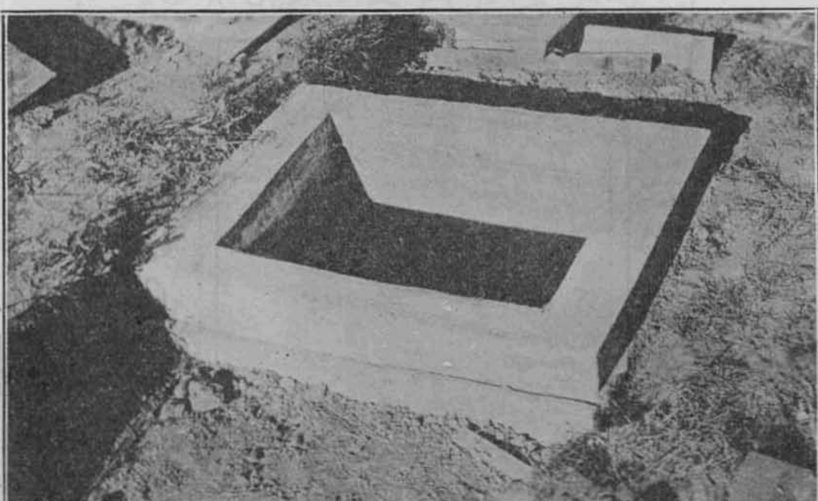


Figure XI.—Completed tank ready for the cover.

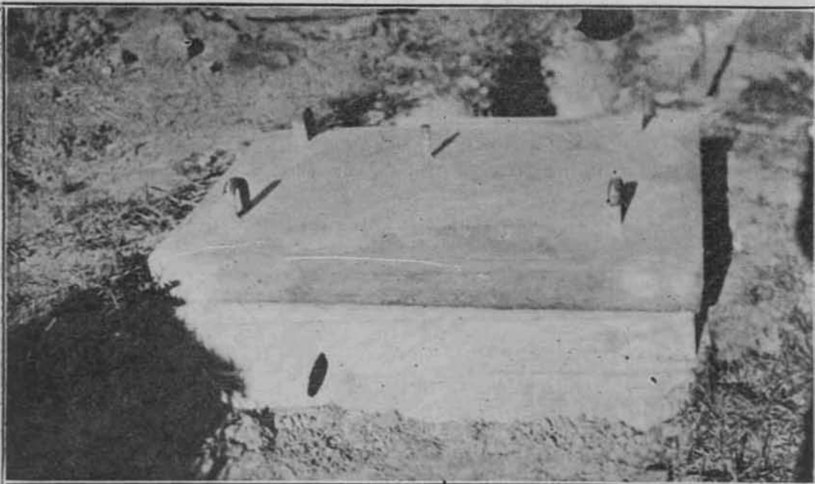


Figure XII.— Cover in place.

Material List for the Small Tank. 2′ by 5′ by 4′

Forms.

2 - 2″x4″ - 16′ Frame.
2 - 2″x4″ - 10′ Frame.
2 - 2″x4″ - 12′ Frame.
7 - 1″x12″ - 10′ Bottom sides and ends.
2 - 1″x12″ - 12′ Man-hole form.
1 - 2″x12″ - 8′ Baffle board. Not needed if concrete board is used.

Concrete.

2 yds. bank-run gravel.
12 sacks cement.

Reinforcement.

6 one-half inch reinforcing rods 5′ long.
8 one-half inch reinforcing rods 2′ long.

Plumbing fixtures.

2 four inch, quarter bend soil pipes 18″ long.

Material List for Medium Sized Tank. 2′ by 6′ by 4′

Forms.

2 - 2″x4″ - 16′ Frame.
2 - 2″x4″ - 10′ Frame.
2 - 2″x4″ - 14′ Frame.
9 - 1″x12″ - 12′ Sides, ends, bottom, etc.
1 - 2″x12″ - 8′ Baffle board. Not needed where concrete slabs are used.

Concrete.
- 2½ yds. bank-run gravel.
- 15 sacks cement.

Reinforcement.
- 6 one-half inch reinforcing rods 6′ long.
- 10 one-half inch reinforcing rods 2′ long.

Plumbing fixtures.
- 2 four inch long quarter bend soil pipes 18″ long.

Material List for Large Size Tank. 2½′ by 8′ by 4′

Forms.
- 4 - 2″x4″ - 16′ long. Frame.
- 2 - 2″x4″ - 10′ long. Frame.
- 5 - 1″x12″ - 16′ long. Sides, ends, etc.
- 2 - 1″x12″ - 10′ long. Sides, ends, etc.
- 5 - 1″x12″ - 12′ long. Sides, ends, etc.
- 1 - 2″x12″ - 10′ long. Baffle board. Not needed if concrete is used.

Concrete.
- 3 yds. bank-run gravel.
- 20 sacks cement.

Reinforcement.
- 6 on-half inch reinforcing rods 8′ long.
- 12 one-half inch reinforcing rods 3′ long.

Plumbing fixtures.
- 2 four inch long quarter bend soil pipes 18″ long.