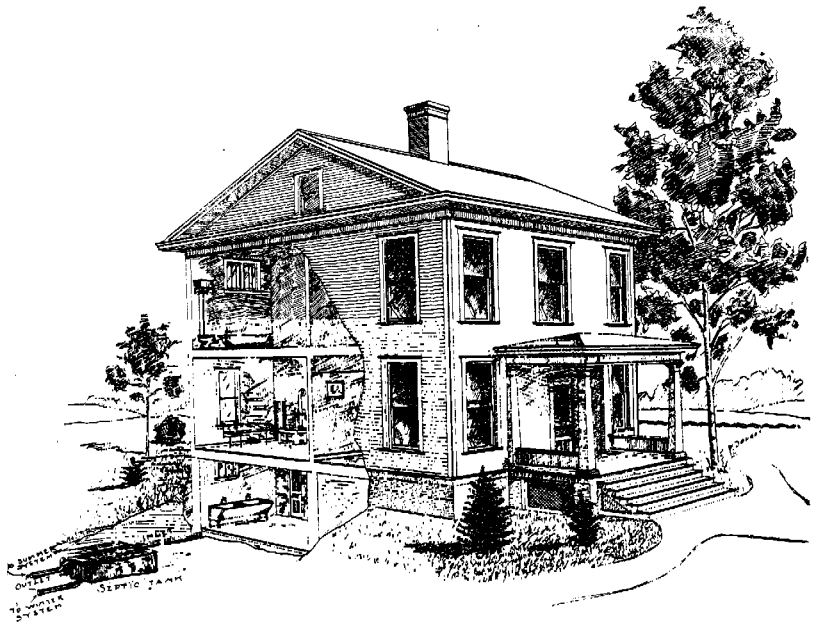
February, 1907 Bulletin 143

Kansas State Agricultural College

Agricultural Experiment Station

Disposal of Dairy and Farm Sewage, and Water-supply



The septic tank as used in connection with a farmhouse.

BY

Oscar Erf

MANHATTAN

PUBLISHED BY THE COLLEGE PRINTING DEPARTMENT

ORGANIZATION

OF THE

Kansas State Agricultural College

Agricultural Experiment Station

Board of Regents

HON. J. W. BERRY (1907), *President*.....Jewell, Jewell County
HON. J. O. TULLOSS (1907), *Vice-President*.....Sedan, Chautauqua County
HON. E. T. FAIRCHILD (1907).....Ellsworth, Ellsworth County
HON. J. S. MCDOWELL (1909).....Smith Center, Smith County
HON. A. M. STORY (1909).....Manhattan, Riley County
HON. GEO. P. GRIFFITH (1909).....Hays, Ellis County
E. R. NICHOLS, *President of College, (ex-officio) Secretary*.....Manhattan

MISS LORENA E. CLEMONS, *Assistant Secretary*.....Manhattan, Riley county

Experimenting Staff

CHARLES WM. BURKETT.....Director
JULIUS T. WILLARD.....Chemist
EDWIN A. POPENOE.....Entomologist
HERBERT F. ROBERTS.....Botanist
ALBERT DICKENS.....Horticulturist
ALBERT M. TEN EYCK.....Agronomist
OSCAR ERF.....Dairy Husbandman
FRANCIS S. SCHOENLEBER.....Veterinarian
ROLAND J. KINZER.....Animal Husbandman
VERNON M. SHOESMITH.....Assistant Agronomist
GEORGE A. DEAN.....Assistant Entomologist
CLARENCE L. BARNES.....Assistant Veterinarian
ROBERT E. EASTMAN.....Assistant Horticulturist
GEORGE F. FREEMAN.....Assistant Botanist
GEORGE C. WHEELER.....Assistant Animal Husbandman
DAVID M. WILSON.....Assistant Dairy Husbandman
CHARLES O. SWANSON.....Assistant Chemist
ETHEL W. EDWARDS.....Executive Clerk

Fort Hays Branch Station

OTTO H. ELLING.....Foreman
ANDREW D. COLLIVER.....Assistant in Agriculture
LORENZ GREENE.....Assistant in Horticulture
GEORGE K. HELDER.....Secretary

Office of Director, Anderson Hall.

The regular bulletins of the Station are sent free to persons residing in the State who request them.

Disposal of Dairy and Farm Sewage, and Water-supply

By Oscar Erf

The health of the public depends upon cleanliness. Since the dairy products of the United States stand first as a food, it is essential that they should be produced under the strictest sanitary conditions. With this in view it is our purpose to give a few suggestions as to the proper manner of disposing of farm sewage from the cow barn, milk house, dairy, and from the dwelling, or any other place that is closely situated to the dairy plant.

This matter is of greatest importance on dairy farms, for if conditions are kept filthy they very soon breed diseases which affect not only people who live on the farm, but consumers as well; for we now well know that many diseases are transmitted through milk and other dairy products.

Where many cows are kept in small places, and where the population is large, sanitary improvements are most important to health and prosperity. Where fewer animals are kept and where the country is sparsely settled, sanitary precautions are not so necessary, for nature usually takes care of these conditions. In cities the sanitary conditions of homes and surroundings are chiefly maintained by a system of cooperation and centralization which brings into existence extensive sewage systems, water-supplies, and the collection of house waste by public authority. Rules are prescribed and enforced under which the individual household must avoid all such conditions which are likely to prove dangerous to the health of the immediate neighborhood, and to the entire community.

The principle underlying the disposal of the sewage on the farm should be essentially similar to that of the cities. The proper method of disposing the sewage on the farm eliminates a great many dangers which constantly face the farmer. (Fig. 1.) One of the most serious dangers is contamination of the water-supply, If the water-supply on the dairy farm is contaminated it will be impossible to produce sanitary milk, since utensils washed in impure water will directly affect the milk. The cesspool, so

common on dairy farms, quite frequently secures a direct connection with the well, especially if located near it, and thus contaminates the water. Polluted water comes from improper sewage disposal, and is generally infected from household excrements, barn-yarn drainage, etc. Its use leads to bowel disturbances, typhoid fever, and dysentery, affecting man and beast alike. The health of large communities of people who draw their food supply from the country is in a measure dependent upon the healthful-

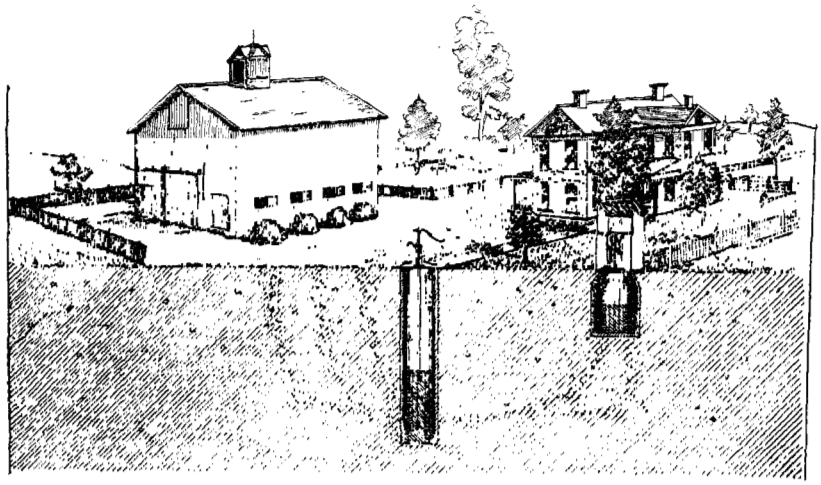


FIG. 1.—Showing method of contamination of well water from manure yards and cess pools.

ness of the farming community. In fact, there is scarcely a city child whose health is not in a degree dependent upon the sanitary condition of the barn and house of the dairyman. Milk has frequently been shown to be the means of disease distribution.

With these conditions before us it is absolutely necessary to have a good sewage-disposal plant on every farm. Health cannot be measured by cost; for a small cost should not stand in the way to any great extent in erecting a plant that is effective for this purpose.

The Dairy Department of the Kansas State Experiment Station has for the past few years been experimenting on the different methods of sewage disposal, and it is now ready to advocate a system that is comparatively inexpensive, and is practical for every farm; in fact, in some cases it has proven to be a source of great profit when used for irrigating and fertilizing truck patches and farm crops. It has furthermore proven to be a labor-saving contrivance in the way of cleaning cow stables, providing the stables are properly constructed, as shown in (Fig. 2 and 3.)

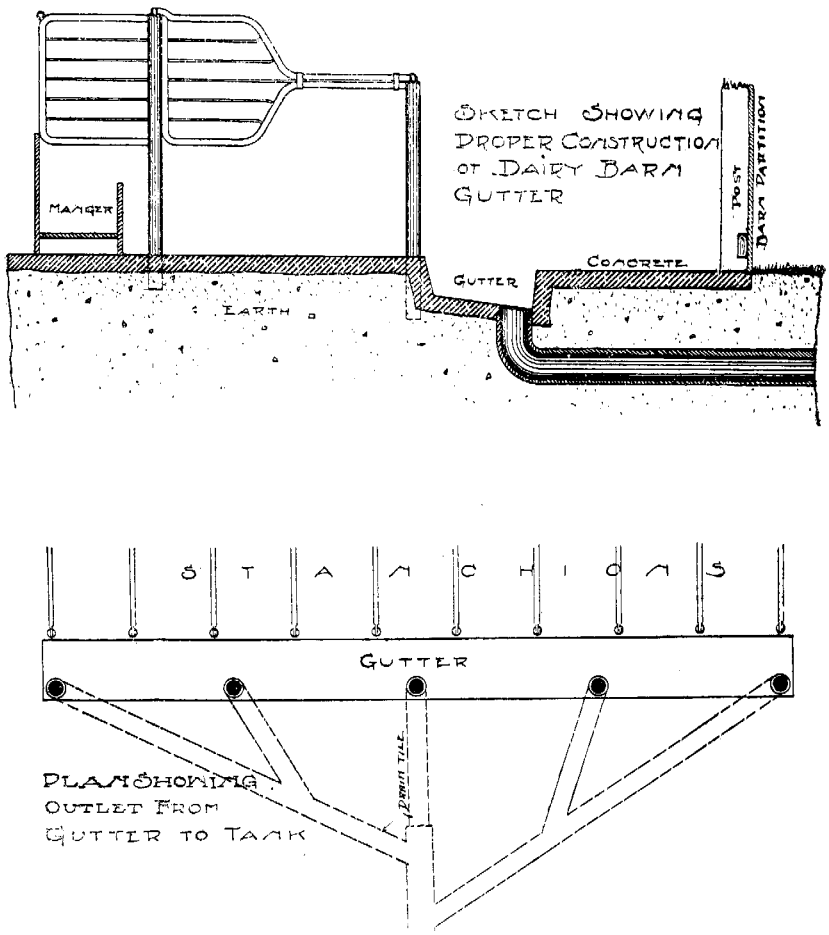


FIG. 2.—Showing a sketch of the proper construction of a gutter in a dairy barn which will remove the liquid manure. This gutter should be twenty-seven inches wide. The bottom should be inclined one-half inch to the foot. The spaces between the outlets may range from twelve to fifteen feet. The depth of the gutter on the cow's side should be at least one foot. The advantage of this gutter over a narrow trough or half circle is as follows:

It has been the experience with dairymen having square, narrow gutters back of cows that the solid manure blocks the flow of the liquid manure. Hence it is necessary to remove by hand both the liquid and the solid manure. With the scheme as shown above the gutter is wide and the solid manure is voided on the side of the gutter on which the cow stands. The gutter being wide, the solid manure does not cover the bottom of the gutter, thus allowing the liquid manure to flow on the lowest end of the gutter, and from there to the sewage disposal system.

The average cow voids about 20,000 pounds of manure per year, of which approximately 9500 pounds are liquid and 10,500 pounds solid. If the gutters are properly constructed the liquid manure will take care of itself and will reduce the labor one-half of what it would be were the liquid absorbed by some absorbent like straw and then removed with the solid excrements.

Liquid manure contains a high per cent of nitrogen, the most expensive part of a fertilizer. According to Snyder, liquid ma-

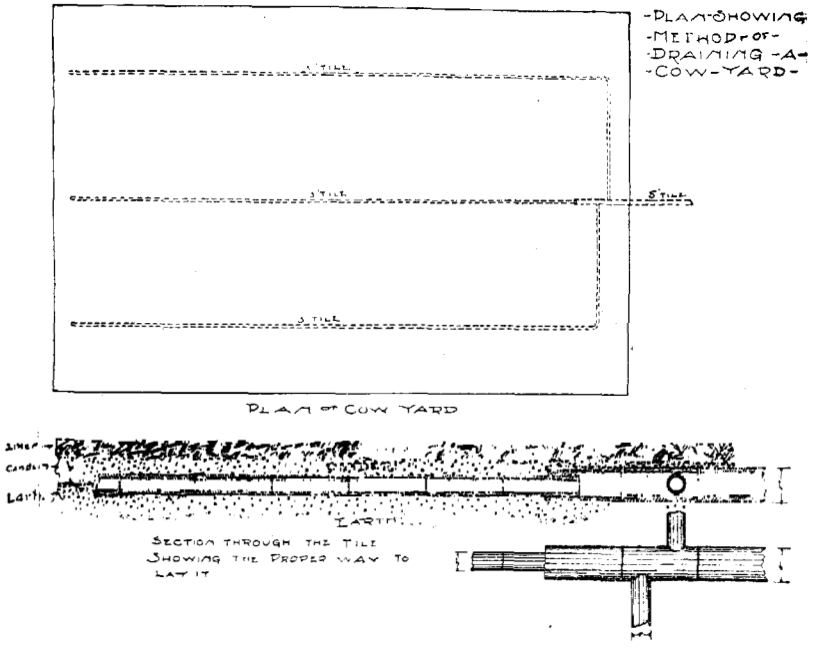


FIG. 3.—Showing method of drainage of a cow yard, or the covered-yard system.

nure from cows fed a well-balanced ration contains about 89 per cent water and 1.2 per cent of nitrogen; solid manure contains 76 per cent of water and .5 per cent of nitrogen. This shows the comparative high value of liquid manure, which, on average farms of Kansas, is allowed to flow into streams and pollute the same.

According to Woll, the value of manure from a cow for one year, fed on a well-balanced ration, is estimated at $29.97. This is a source of income for the farmer which is seldom taken into consideration because his conditions are such that he is not able to take care of it. By means of a proper sewage-disposal system the value of this manure may be fully recovered, besides making conditions on the farm more sanitary.

MANNER OF DISPOSING OF SEWAGE

The disposal of sewage is brought about by the decomposition of the organic matter. All sewage is largely organic matter and water. All organic matter decays. This decaying process is simply the disintegrating action of minute organisms known as bacteria upon the solid parts of the sewage, dividing the same into such a form that it becomes fluid. The superficial layers of soil from six to twelve inches are thoroughly inoculated with bacteria. The action of the bacteria upon any organic material is to reduce the complex organic compounds into simpler compounds. Hence, decay is the destruction of complex substances that have been built up by growth. There are certain kinds of bacteria that can penetrate organic substances to a slight extent only. Some must have air, particularly oxygen, to decay a portion of the mass, while there are other bacteria that have the power of decomposing organic material without the presence of air or oxygen. In the system herein described it is chiefly the last kind of bacteria with which we have to deal. The sewage discharges into a receptacle that is air-tight, known as a "septic tank." This sewage is acted upon by these bacteria, which partially decomposes and liquefies the same. Most of the disagreeable odors are liberated by this process, and the liquid can then be discharged into an open stream with a great bulk of the running water, or into an irrigating system.

The process of decomposition in this septic tank is greatly aided by using a great quantity of water. This is an advantage on dairy farms, for water is used in abundance for washing utensils and cleaning the cow barns.

PLAN OF DISPOSING OF SEWAGE AFTER LIQUEFYING

As stated above, the sewage, after once being decomposed in a septic tank, can be discharged into a running stream or river without emitting offensive odors. This is the simplest way to dispose the sewage, but there are many farms which are not located so as to allow the sewage to be discharged into such a stream. For such a farm, in fact for every farm where it can be adopted, the disposal of sewage by irrigation is by far the best method. There are two methods used for irrigation: the surface method and the subsoil method. With the surface method liquid sewage is drained through glazed tile to a piece of ground set apart for this purpose. The ground is ridged and the sewage is allowed to flow over the ground in shallow channels. The liquid slowly disappears by filtering through the soil. Patches of ground that are

met must be carefully under-drained so as to allow the surplus water to be drained from the surface. This method of disposing sewage is objectionable from the standpoint that the sewage flows on the surface and animals crossing such fields may carry sewage on their feet, and if there are any disease germs in the sewage it may be carried from one place to another.

The safest method is subsoil irrigation. This consists of a system of underground porous tile, laid in the manner shown in Fig. 4, so as to allow the sewage to seep through the tile. The tile are connected directly with a septic tank and laid so as to leave approximately one-eighth of an inch between each tile in order to allow the sewage to seep through the tile into the soil. The main line should consist of a five-inch tile, depending somewhat upon the sewage. If a great amount, of water is used with sewage, four-inch tile may be used. The lateral drains may be four-inch tile, or if the main drain is a four-inch tile the laterals may be three inch. Nothing smaller than a three-inch tile should be used for this purpose.

For irrigation purposes tile should be laid from eight to sixteen inches beneath the surface of the ground, with a gradual incline of one or two inches for every one hundred feet. The depth to which these tile should be laid depends on the nature of the soil. There should be two systems for each septic tank. One of these systems should be laid below the frost line for winter sewage disposal, while the one laid shallow is used for summer disposal. By this method the sewage which is so objectionable on the dairy farm or in the creamery is removed and is used for irrigating and fertilizing purposes.

This subsurface method of sewage irrigation is particularly profitable for intensive farming and horticulture. The author knows of a number of instances where in one year such a system has paid for itself by the increased crop production which resulted from irrigating and fertilizing the soil. It is authentically stated that a horticulturist in Ohio has grown enough berries on his irrigated and fertilized soil in one year to pay for three such sewage disposal plants.

CONSTRUCTION OF A SEPTIC TANK

There are numerous ways for building septic tanks. Some of these are shown in Figs. 5, 6, 7, and 8. Such tanks may be built of any tank material, but for durability it is preferable to construct them of brick, stone, or concrete. The partitions may be built of concrete or wood. It is generally advisable to build them of concrete if convenient to do so. The tank should be built as

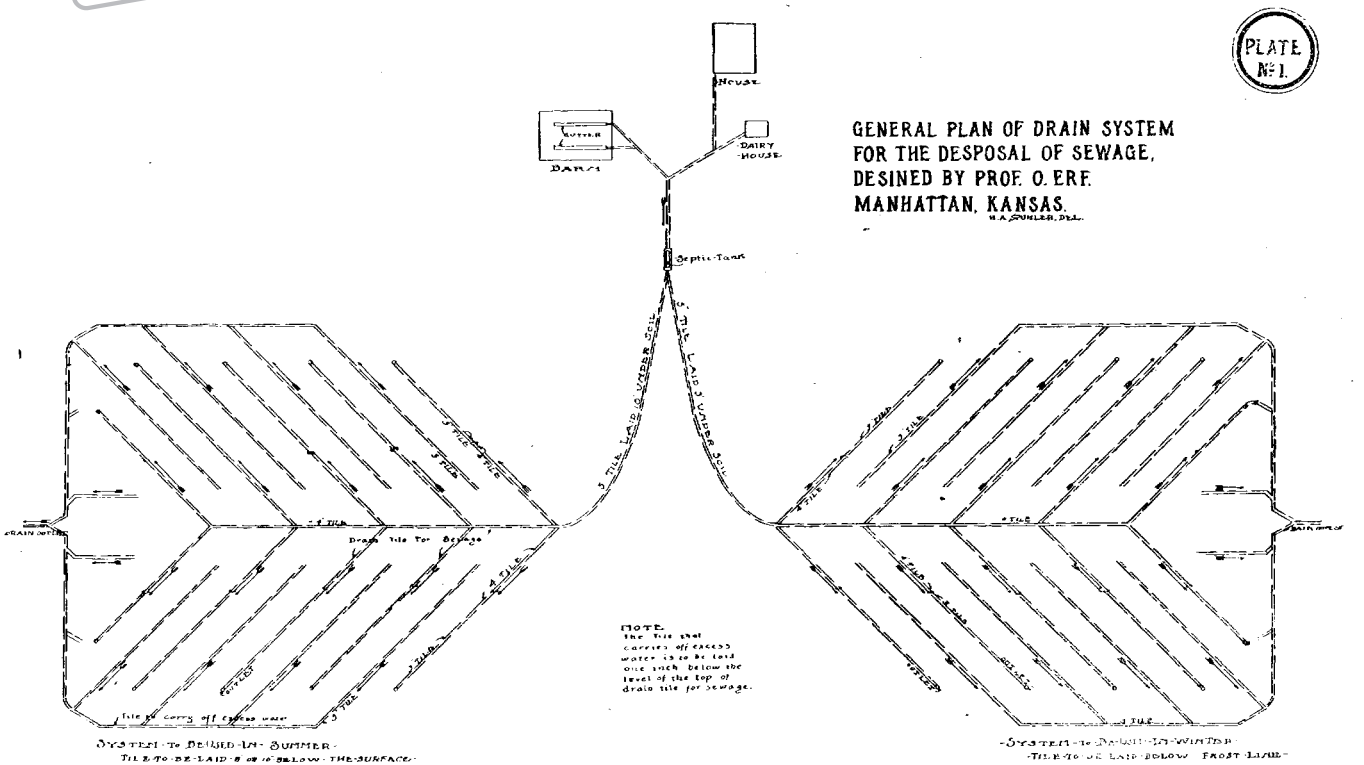


FIG. 4.—Showing a complete irrigating system with dairy house and residence attached with the same system of the barn. It is essential to provide for an air vent at the end of each branch of tile to allow the escape of air in the tile when sewage is emptied into the irrigating system.

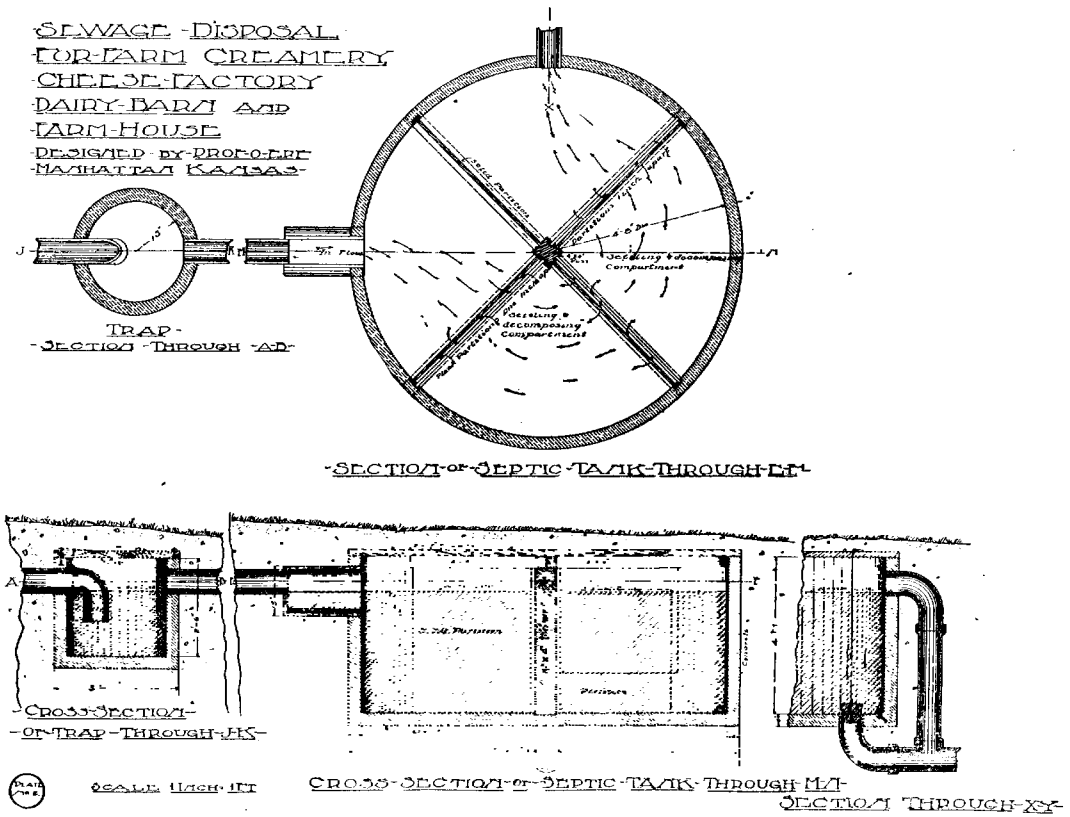


FIG. 5.—Showing the detailed construction of a round septic tank, with four compartments. The partitions are made of wood. This septic tank disposes of the sewage by over-flow. This plant can be attached to an irrigating system but the plug must be pulled whenever irrigation is wanted.

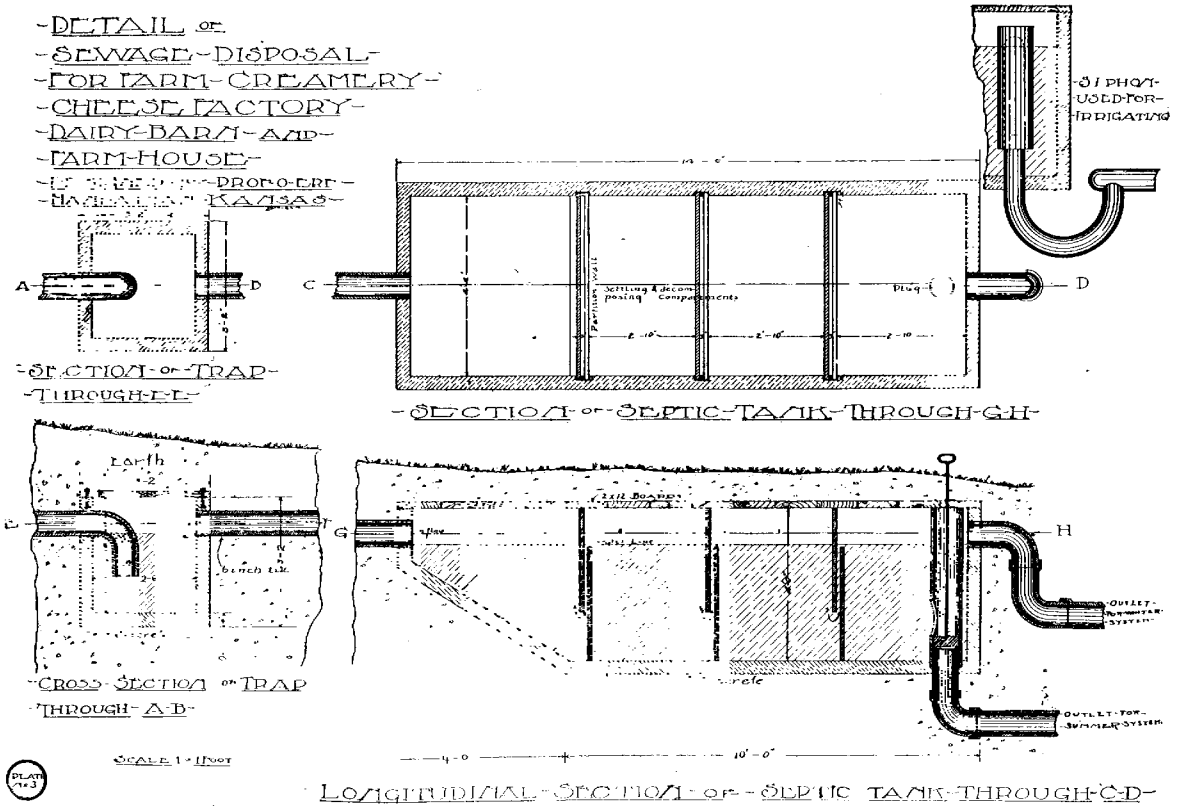


FIG. 6.—Showing the detailed construction of a rectangular tank, a combination disposal plan in which the over-flow runs into the winter system, and if irrigation is wanted the rod is drawn and runs into the system for summer irrigation. In irrigating it is essential to have the whole irrigating system filled at once, to distribute the sewage uniformly. To accomplish this it is necessary to have a large drain tile connecting the septic tank to the irrigating system, and provided with a large outlet, so as to allow the filling of the irrigating system as quickly as possible. In this way every branch of the distributing system is filled with sewage. A siphon may take the place of rod and plug. A siphon works automatically.

nearly air-tight as possible, with a slight vent of one-half inch pipe to allow the gas to escape. There should be a trap door in the first compartment so as to allow the same to be cleaned when necessary. The partition should be built in such a way as to allow the water to be taken from the center of the tank, where the sewage is all liquid. The most of the solid particles of sewage either

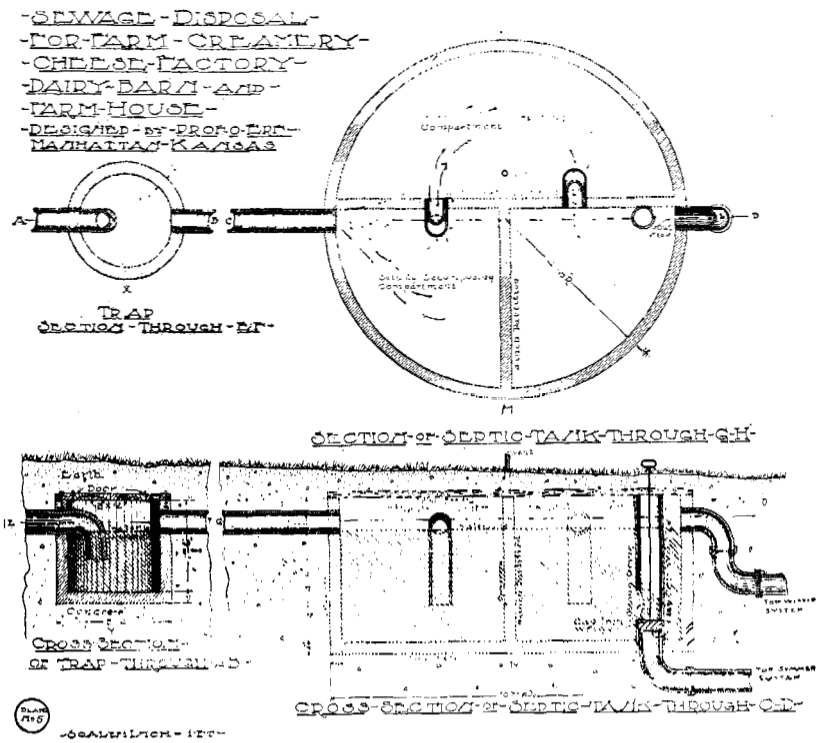


FIG. 7. – Showing the detailed construction of a round septic tank which can be connected with a summer and winter system of sewage disposal. This tank can be used where the sewage is more liquid than in the case of tank in Fig. 5.

sink or float; consequently, by taking the sewage from the center of the basin only such liquid and particles as are of a semi-solid nature, or have the same density as water, are discharged into the second compartment. Decomposition is carried on still further in this compartment. When transferred to the third compartment it should be thoroughly liquefied. When transferred to the fourth compartment it is ready to be deposited into the irrigating system, where it is to be taken up by the soil. If the sewage is not to be utilized for irrigating purposes, but drained

directly into a stream, the sewage may be taken from the top of the tank, as shown by the connection marked X, in Fig. 5, and H, in Fig. 6. In case the tank is to be cleaned, the plugs of the same systems may be removed and thoroughly drained. For irrigating purposes it is advisable to use a siphon. This siphon removes the water from the last compartment of the septic tank automatically

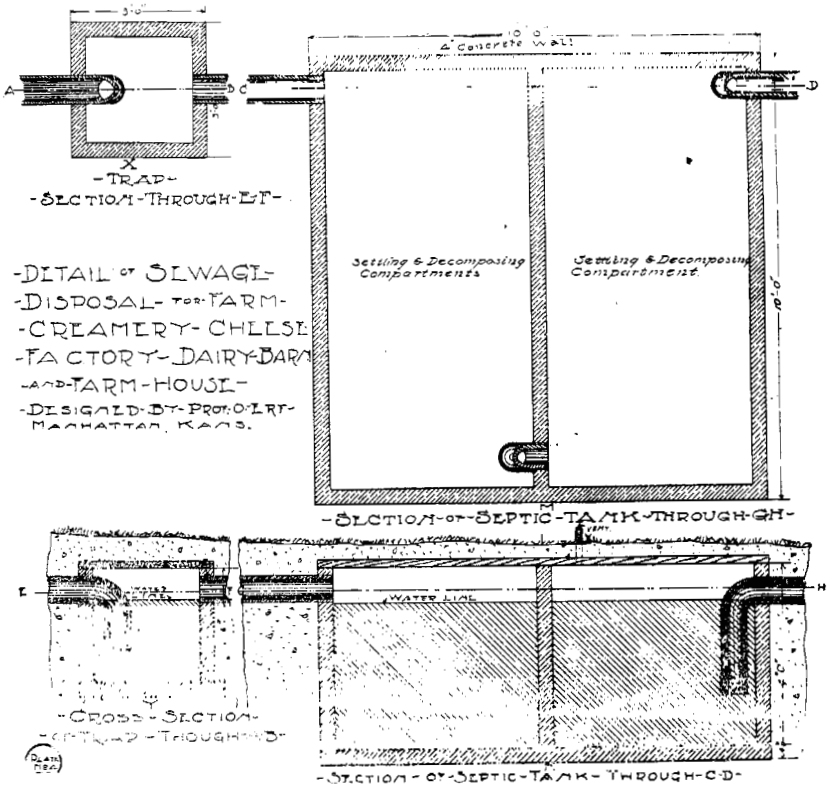


FIG. 8.—Showing a simple square septic tank, used in places where there is mostly liquid sewage to be disposed of.

at intermittent discharges. The discharge at one time of a quantity of sewage large enough to fill the irrigating system will scour the system of pipe; besides it more uniformly distributes the sewage throughout the whole irrigating system. Without a siphon, on pulling the plug occasionally the same effect can be secured, but if the sewage is allowed to overflow into the tile it will run out into the soil nearest to the septic tank. In the latter case the soil will become over-saturated with the liquid, and the purification of the sewage in the soil is thereby rendered imperfect.

SEWER CONNECTION TO SEPTIC TANK

Sewer connection from the cow barn to the septic tank should be constructed of not less than five-inch glazed sewer pipe, and preferably six-inch pipe. The sewer should be connected directly with the gutters and allowed to enter into a trap, as shown in designs herewith. This trap is a small box, in which a pipe bends down into the liquid to prevent the gases or odors coming from the septic tank from going into the stable. Similar traps should be put in when connected with the gutters of a creamery or cheese factory, or to the house or dairy house on the farm. The diameter of the sewer pipe from the house need not be more than four inches, and may connect with the same tile as that coming from the dairy barn.

THE SIZE OF SEPTIC TANK AND IRRIGATING SYSTEM

The size of the septic tank depends somewhat upon the amount of sewage run through the tank and the consistency of the sewage. For average conditions the last two compartments should hold the average discharge in twenty-four hours, and the irrigating system should be of equal capacity to hold the sewage from this compartment. However, the larger the tank the greater will be the chance for the organic matter to thoroughly decompose, and at the same time the irrigating system can be of greater capacity, irrigating a larger tract of land. For an ordinary farm a septic tank of such capacity as shown in Figs. 5 and 6 will handle the average dairy farm, creamery, or cheese-factory sewage.

NECESSITY OF COMPARTMENTS

Since the decomposition of the sewage depends upon the action of bacteria, it is essential in order to have the process go on effectively that the germs should not be disturbed to any great extent. Sewage, as a rule, when it comes from the house or dairy barn, runs into the tank with a rush, which has a tendency to roil the sewage in the tank. To overcome this sudden rush a partition should be put across the septic tank close to the inlet of the tank, which is supposed to prevent the disturbance in the second, third and fourth compartments. However, it is quite impossible to regulate the force of sewage in such a manner as to prevent any disturbance in the second tank. For this reason it is advisable to put a third partition in the tank, which will give the germs a chance to act thoroughly upon the sewage before it enters the discharge tank, or last compartment.

As the sewage travels from one tank to another it is gradually purified, and as it flows into the discharge tank all organic matter

is in a liquid or semi-liquid state. At this point the sewage is practically deprived of any disagreable odor, and that which is still retained is not objectionable. To prove the efficiency of this method of purification, sewage after passing through the tank, being thoroughly decomposed, can be kept for weeks at a very favorable temperature, showing no signs of the development of putrefactive odors. It should require from three to four days, however, for sewage to pass through this tank to thoroughly deodorize it. Three partitions in a tank, as described above, have proven very efficient. However, a tank with two compartments is very satisfactory, but in no case can a tank without compartments be recommended.

LOCATION OF SEPTIC TANK

There should be a slight fall from the stable to the septic tank, and from this tank to the irrigating system. A septic tank can be located as far as convenient, or as near as desirable, to the traps. This is a matter that depends upon conditions entirely. However, in all cases the inlet and outlet drains of the system, as far as the point of irrigation, should consist of sewer pipe with joints cemented. A preferable location for the tank is about a foot to eighteen inches in the ground. This prevents freezing, which checks decomposition. However, there are instances in which the slope of the ground from the stable to the irrigated field is so slight that, the septic tank needs to be put above the ground, In that case it is advisable to cover the tank with earth, straw, or barn-yard manure, to prevent freezing.

PRECAUTIONS

Care should be taken that no strong disinfectant, such as corrosive sublimate, is allowed to be run into the septic tank from the stables or house, since any disinfectant prevents the action of the bacteria in the tank; consequently a large part of the sewage will remain in a solid form and the tank will soon fill up.

CLEANING OUT THE TANK

The frequency of cleaning this tank depends entirely upon the kind of sewage discharged into the tank. All organic matter is readily decomposed and will flow through the tank, as has been stated before, but inorganic matter, such as sand, crushed rock, cinders, etc., cannot be decomposed and will remain in the same. If due precaution is taken in not allowing too much of this inorganic matter to flow into the tank, there is little need of cleaning it. For a cow barn such a tank need not be cleaned oftener than once in eight months. The tank at the College has not been

cleaned for two years, and there is at the present time not more than a foot of sediment in the bottom of the first compartment. For creameries and cheese factories these tanks need not be cleaned oftener than once a year.

SIPHON

The siphon to be used in this tank for irrigating purposes can be purchased from any plumbing concern.

COST OF A SEPTIC TANK

The cost of a tank depends somewhat upon the locality and the price of material in that locality. The following estimate is based on average prices:

COST OF TANK, FIG. 5.

Digging	$ 4 00
Concrete and labor	21 00
Lumber, 200 feet of 2-inch plank, @ $30 per M	12 00
Posts, 4x4	50
Labor	2 00
One 15-inch sewer pipe	75
Two 4-inch sewer-pipe bends	1 50
One 4-inch sewer pipe	50
One length of sewer pipe	25
Total	$42 50

COST OF TANK, FIG. 6.

Concrete and labor	$24 20
Digging	4 00
Lumber	9 00
Labor	2 00
Two sewer-pipe bends	1 00
One 4-inch T	50
Two 4-inch pipe	40
Total	$41 10

WATER-SUPPLY.

While this plan of sewage disposal will practically eliminate any pollution of well water, there are, however, other conditions to which due regard must be given to prevent any contamination of the well. It must be borne in mind that the well cannot be given too much care, for it supplies water to creameries, cheese factories, the dairy farm, and the household. Well water is usually contaminated in two ways: First, by surface water which runs directly into the well and, second, by barn-yard drainage, household slops, and cesspools.

Nearly all of the bacterial life exists in the upper strata of the soil. Soil ten or twelve feet below the surface of the earth is perfectly sterile, unless it has within it a crevice or opening so that surface sewage can run down. Therefore, due care should be taken in digging and constructing a well so that direct contamination will be prevented.

CONSTRUCTION OF A WELL

The well itself must be so constructed that the impurities cannot get into it from above or from the sides. Water should be filtered through ten to twelve feet of fine soil. To prevent the surface pollution, a water-tight wall should be built in a well down below the water level. This can be built of hard, burned brick and cemented on the outside. Clay should be pounded around this.

Where drilled wells are used, the lining of the well should be an iron tube driven into the bore and the outside should be flushed with thin cement. The well should be properly covered and the surrounding ground should be considerably higher than the general level of the soil. The walls should extend at least three feet above the surface of the ground and a ground fill made so that it will slope from the wall. The top of the fill should be covered with at least twelve inches of clay or loam, upon which it is advisable to have some sod or a layer of sand, or best of all a pavement sloping in all directions.

Owing to the great quantity of water needed in the dairy and the expense connected with the proper kind of filters, it is quite impracticable to use rain water.

CONCLUSION

If due precautions are taken in the disposal of sewage and in the proper construction of wells and care of waste and garbage, there is little danger of water becoming polluted, and it will be a great step toward increasing the healthfulness of dairy products.

The attractiveness of dairy farms depends largely upon the promptness with which all kinds of waste material are disposed of, and while there is an abundance of space on the farm to get rid of the rubbish and waste, it should be ever borne in mind that the removal of garbage should also be attended to as promptly as the disposal of sewage.