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Water Supply and Plumbing for the Farm Home

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Introduction

IN the Federal Rural Housing Survey made early in 1934, firsthand data were obtained on 4,459 of the 41,674 farm homes in Idaho. Of all the improvements that were needed on the Idaho farms, as shown by this survey, the water system and modern plumbing were most desired. The Rural Housing Survey indicated that about one-third of our farm homes have water piped to the house but that of this number only one-half have hot water or modern sewage disposal. About the same number that have water piped to the house also have electric light and power. The second most desired improvement for the farm homes was additional room, and the third was improvement in the interior walls, ceilings, and floors. This Bulletin is concerned with the two-thirds of the farm homes that do not have water piped to the house, and with the farms that have water in the house but do not have hot water or waste disposal systems.

Water Supply and Plumbing for the Farm Home

By

HOBART BERESFORD*

THE benefits of a simple, hand-operated farm water system are limited largely to the kitchen, where a supply of pure water is needed for human wants, such as drinking and cooking, and where a plentiful supply of water for household needs, such as washing and cleaning, saves the family thousands of steps and the carrying of tons of water during the year.

The benefits of power-operated water systems are not confined to the household. Water under pressure in the dairy may be used in individual drinking cups in the stables, for cooling the milk, and for washing utensils in the milk house. Additional utilization of the water supply can be made in the feed yard and poultry house. A well-planned and properly installed water system affords considerable protection against the ever-present fire hazard on the farm. In addition to this, limited irrigation of vegetables, flower gardens, and lawns is made possible. The saving in labor and the increased production made available by the use of a modern water system should overcome any argument against its installation cost.

A simple water system need not be expensive in its first cost and may be so designed as to permit additions or changes to meet the increased needs of the household or to be improved as additional funds are made available.

The Water System

The type of water system which meets the individual farm requirements varies with the location and type of water supply available. The source of the water supply always should be protected from possible contamination from surface drainage or seepage and should be free from injurious chemicals such as alkali or sulphur. Recognizing that a plentiful supply of pure water suited to human wants is so essential to human health and household needs, this discussion assumes an adequate and satisfactory water supply available and deals with the handling and distribution of the water supply and waste disposal for the farm home. For information on wells, filters, and cisterns or storage tanks, reference is made to Experiment Station and United States Department of Agriculture bulletins.

When a suitable water supply is located near the house, it can often be pumped into the kitchen by means of a cistern force pump located on a table or bracket near the sink. A small additional investment in a barrel or tank in the attic, a range boiler, and a water front for the kitchen stove provides an economical means of supplying hot water, thus adding to the convenience of the water piped to the house.

There are two general types of water systems, one made for shallow wells and one made for deep wells. Pumps used in shallow wells are generally designed to operate under suction lift, which de-

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pends upon the principle of atmospheric pressure to force the liquid into the pump cylinder. Their operation requires that the pump pipe below the cylinder be submerged and that the pump mechanism be capable of exhausting the air from the pipe and cylinder. The limit of their application is dependent upon the weight of the column of air to which the liquid surface is exposed. At sea level atmospheric pressure is about 14.7 pounds per square inch. With this weight of 14.7 pounds pressure upon each square inch of the liquid surface, the removal of air from the suction pipe makes it possible to raise water through a vertical pipe. Theoretically, a perfect vacuum at sea level would cause a column of water to rise 33.957 feet. Under practical conditions 20 to 22 feet is the limit to which water may be raised through the action of a suction pump. Any decrease in the atmospheric pressure lowers the elevation to which water can be raised with suction pumps. Hence, a suction pump operating at an elevation of 8,000 feet above sea level would have a practical suction lift of approximately 15 feet. The suction lift also depends upon the temperature of the water and the resulting vapor pressure above the warm water which further reduces the lift. It is practical to use suction pumps where the total head exceeds the suction lift limit, but it is always necessary to locate the pump unit where the suction lift or vertical distance between the surface of the water and the pump does not exceed the practical suction lift. The vertical distance from the surface of the water to the discharge from the system is known as the total head. In most water-supply installations it is a common practice to place the cylinder under the surface of the water, thus reducing the suction head to zero and insuring self-priming of the unit.

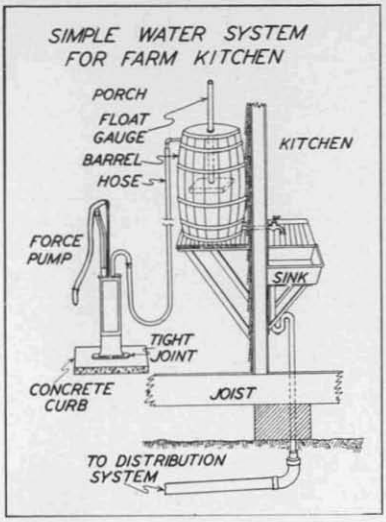


Fig. 1.—A simple water system consisting of force pump and sink with drain.

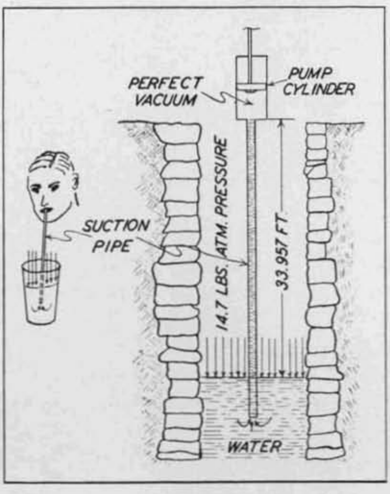


Fig. 2.—The operation of the suction pump depends upon the effect of atmospheric pressure.

Most of the small electric pumping units have at least a ¼-horsepower motor which usually is controlled by an automatic pressure switch. These systems are classified as the fresh-water type, due to the small capacity of the combination air and water supply tank, which

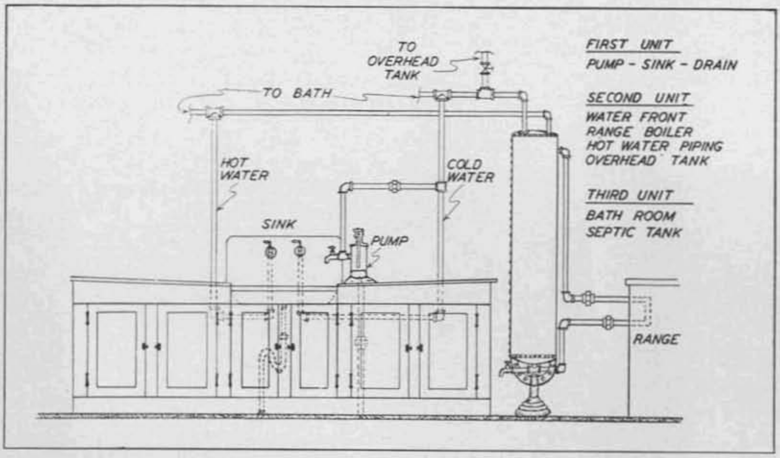


Fig. 3.—An economical type of water system suited to unit development.

ranges from 3 to 5 gallons. This means that if sufficient water is drawn from the faucet, the automatic switch operates starting the pump unit, which maintains the pressure for the operation of the system.

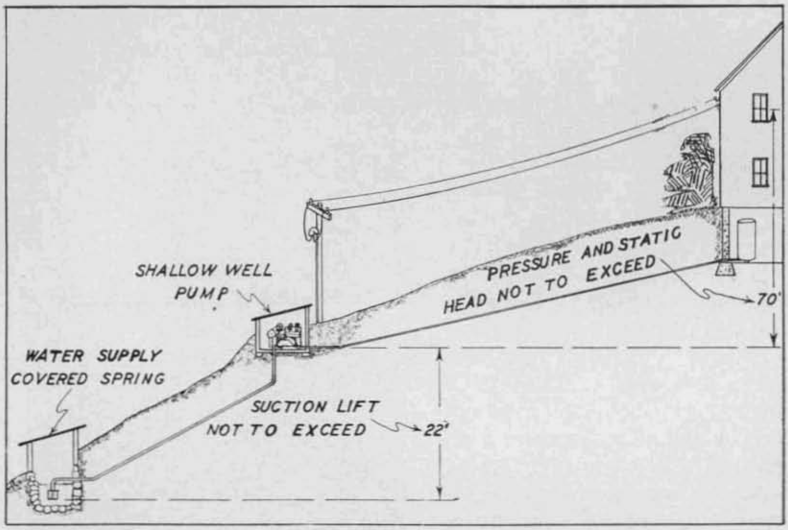


Fig. 4.—A shallow-well pump located to take advantage of the limited suction lift.

In the deep-well installations the pump cylinder necessarily must be lowered into the well casing to a point where the drawdown will not exceed the practical suction lift for that locality. The other features of the water systems are similar except that the deep wells require more power for operating the pumps. Automatic pressure switch controls or float controls in small supply tanks may be used for regulating the operation of deep-well water systems. The simple motor-driven systems cost as little as $75 to $100, depending upon the capacity and type of equipment desired. Deep-well pumps are more expensive, the cost depending upon the lift and capacity required. When electric power is not available, pumping equipment can be operated with the power from a gasoline engine or windmill. The convenience of such a system depends largely upon the additional storage capacity made available for its intermittent operation.

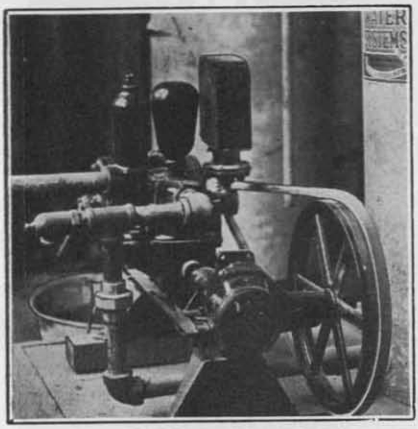


Fig. 5.—A motor-driven shallow-well pump.

The relation between storage capacity and power requirement should be considered for the individual installation. If a large cylinder is used, the pull on the pump rod may be excessive, requiring a greater reduction in speed and a greater decrease in the output of the pumping unit if a minimum power requirement or demand is to be maintained. The same situation may develop in connection with a hand-operated pump where a large cylinder operating against a high head may make it practically impossible to pump by hand. The solution for such a condition is the installation of a smaller-diameter cylinder. Frequently, the difficulty encountered with pump rods pulling in two is due to an attempted use of a too large cylinder and the desire for maximum capacity. Greater satisfaction might be obtained by using a smaller capacity pump and operating it for a longer time interval. Storage may be obtained by use of an elevated cistern or a tower tank. Also, a tank may be located in the attic of the house, or a combination air and storage tank may be used in the basement or other protected location suited to the pneumatic type of system.

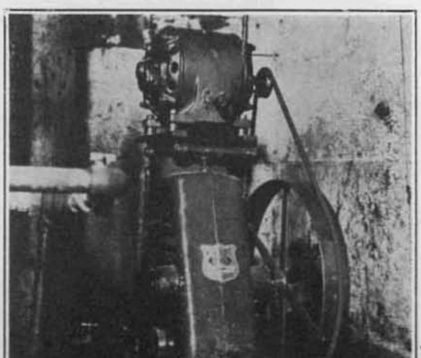


Fig. 6.—A motor-driven deep-well pump.

The hydraulic ram may also be used for pumping the farm water supply. The hydraulic ram is a self-acting pump operated by the flow of water through a slight fall, thus utilizing the momentum of the water flow to force a part of the water through the discharge pipe to an elevation many times the height of the operating head.

With a given fall from the supply to the hydraulic ram, an increase in the amount of water supplied will increase the amount of

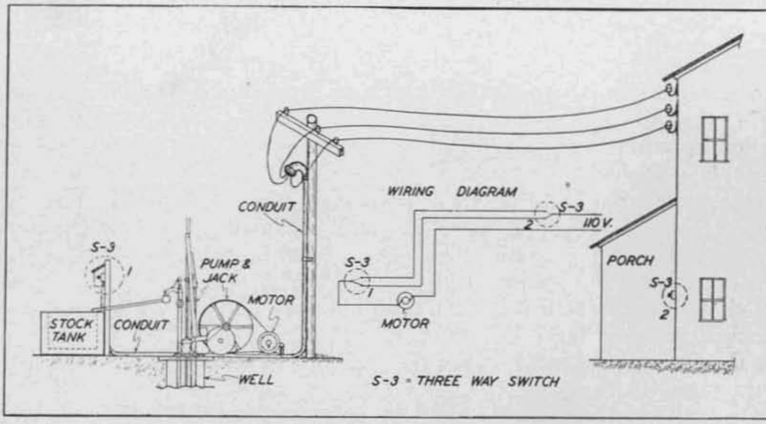


Fig. 7.—Pump jack and motor controlled by 3-way switches at the house and well.

water delivered or deliver the same amount of water to a greater height. Increasing the amount of fall from the supply to the hydraulic ram will attain the same result.

For domestic supplies the hydraulic ram, like the shallow- and deep-well pumps, may be used to deliver the water to a storage tank

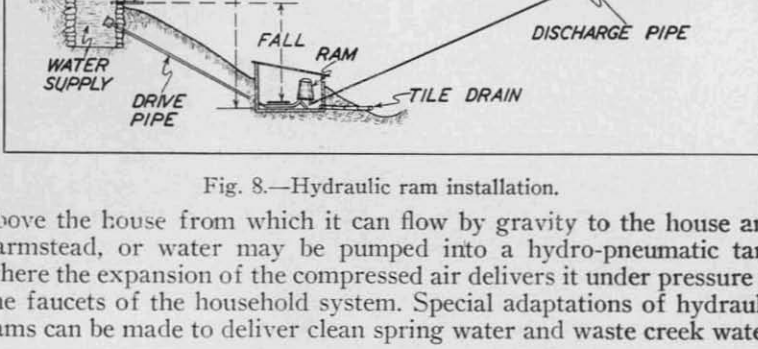


Fig. 8.—Hydraulic ram installation.

above the house from which it can flow by gravity to the house and farmstead, or water may be pumped into a hydro-pneumatic tank where the expansion of the compressed air delivers it under pressure to the faucets of the household system. Special adaptations of hydraulic rams can be made to deliver clean spring water and waste creek water, where there is a small supply of clean water insufficient to operate a hydraulic ram and an abundant supply of creek water with the necessary fall.

A satisfactory installation of a hydraulic ram requires a supply of water at least 3 feet above the waste valve and, as a general rule, there should be 1 foot of fall to 7 feet of elevation through which the water is to be pumped. For example, if water is to be pumped 100 feet above the ram, there should be a fall of one-seventh of 100 feet, or approximately 14 feet for the best operation.

The drive pipe should be about as many feet in length as the number of feet against which the water is to be elevated. It should be air-tight, smooth, and straight as possible, avoiding sharp bends or obstructions with the upper end submerged at least 1 foot at all times and suitably screened to prevent the entrance of trash. If the supply is farther from the hydraulic ram than the required distance, it should be piped on the level to a barrel or standpipe, using a pipe at least one size larger than the supply pipe. The hydraulic ram should be set on a solid foundation and protected from cold by a house or pit, from which the waste pipe or ditch should have sufficient fall to prevent backwater or flooding.

Rubber valves in the hydraulic ram are less noisy than metal, but if the pounding noise is objectionable, as in a dwelling, a piece of good quality rubber hose may be used as part of the delivery line to overcome the trouble.

When a modern water system delivers the household supply, the average family finds that it will use several times the amount required when the water was being carried from the pump to the kitchen by the pailful. The number of gallons of water required daily by the individual family varies, but on the average will be from 40 to 50 gallons per person per day when cooking, bath, laundry, and waste disposal are considered. The water requirement for the farm depends upon the number and kind of livestock, and the various incidental uses, such as in the milk house, or watering the lawn and flower gardens. A horse, mule, or cow may need from 12 to 25 gallons of water per day, while a hog or sheep will not drink in excess of a gallon per day.

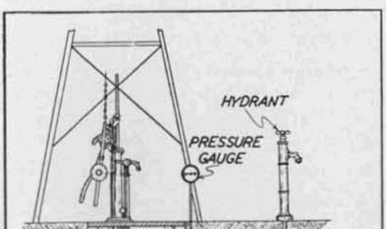


Fig. 9.—Windmill and pneumatic storage tank installation.

The capacity of the pump and storage tank or cistern should be adapted to the type of power available, the water supply source, and the individual needs of the farm and household. In general, greater economy of operation may be expected from the smaller-capacity pump operating for a longer period of time. As a rule, the small-capacity pumping units require greater storage facilities and in case of emergency, such as fire, the smaller units are at a disadvantage. The larger-capacity pumping units are more readily adapted to the fresh-water type of system where small capacity storage is employed. When wind power is used, larger storage facilities are usually required. It is possible to obtain the fresh water feature from the small-capacity pumps and large storage facilities by using an auxiliary pneumatic or gravity tank through which the entire supply is pumped and from which the supply to the household is maintained.

Fig. 10.—Suggested bathroom arrangement.

The theoretical capacity in gallons per minute of a cylinder or other positive displacement type of pump is equal to the displacement per minute divided by 231, the number of cubic inches per gallon. Where D is the diameter of the cylinder in inches, S the length of the stroke in inches, and N the number of strokes per minute, the theoretical capacity in gallons per minute equals:

$$G.P.M. = \frac{D^2 \times S \times N}{294}$$

The delivery from the cylinder type of pump may be controlled by varying the number of strokes per minute. The maximum capacity of a cylinder type pump is limited by such mechanical features as for instance, the length of stroke, which limits the number of strokes per minute.

The theoretical horsepower required for pumping is equal to the weight of the liquid times the total head in feet divided by the horsepower equivalent of the same time interval.

$$\text{Theoretical H.P.} = \frac{\text{Weight of Liquid per Second} \times \text{Total Head in Feet}}{550 \text{ (Foot Pounds per Second} = 1 \text{ H.P.)}}$$

A cubic foot of water under standard conditions weighs 62.46 pounds and is equal to about 7½ U. S. gallons. One U. S. gallon of water weighs about 8 1/3 pounds.

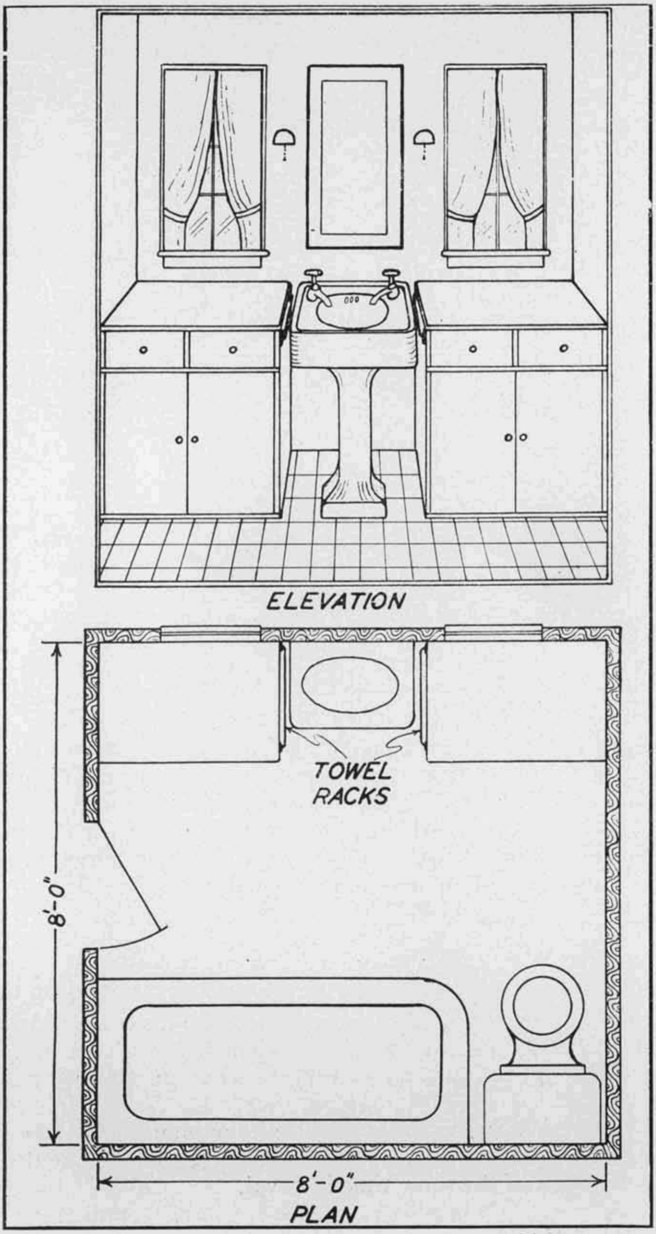


Fig. 11.—Suggested bathroom arrangement.

Under favorable conditions the cylinder and piston type of pump may have as high as 90 per cent efficiency, but under average conditions efficiencies usually run from 20 to 50 per cent.

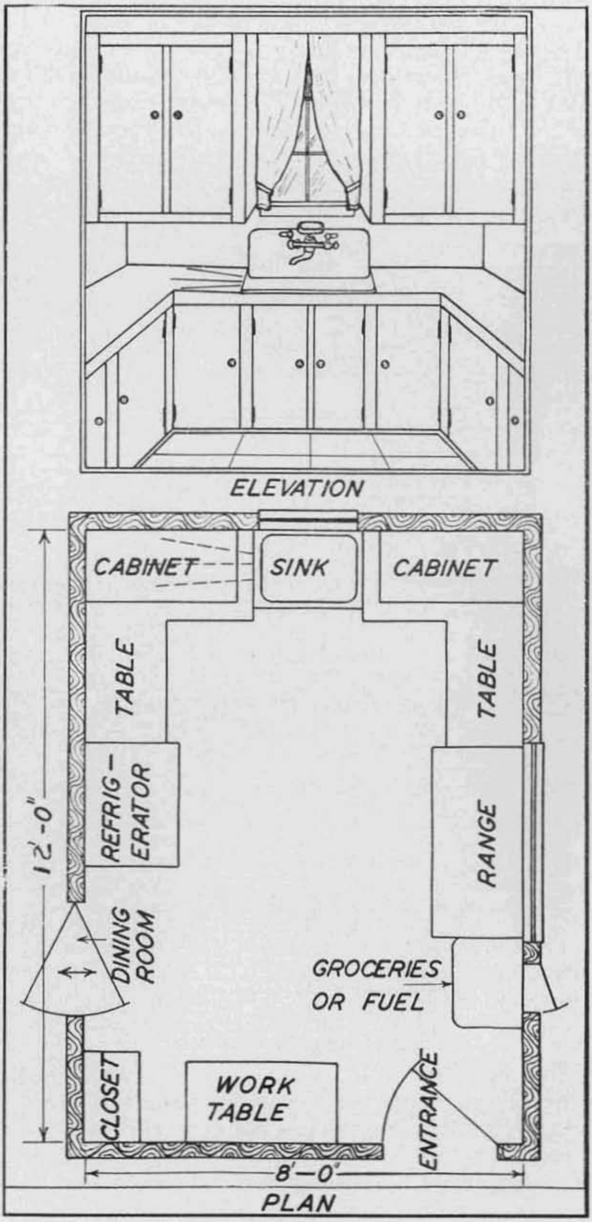


Fig. 12.—Kitchen sink and work tables.

The cylinder-piston type of combination suction and force pump is made in both single- and double-acting units. Cylinders commonly are made of cast-iron lined with a thin brass tube to resist corrosive action of the water. The more expensive type of cylinder commonly is made entirely of brass protected by steel spiders which also serve to hold the cylinder caps in place. The different types of valves used in the cylinder-piston type of pump may be classified according to their action: hinge valves generally made of leather with a weighted center and cut-away section, the disc-type poppet valves fitted with seat guides, and the ball-type valves used in pumps operating against high heads. Valves are sometimes made of rubber operating on glass valve seats; however, valve seats are usually made of brass. The pump pistons usually are made with leather cups or pump washers, which are

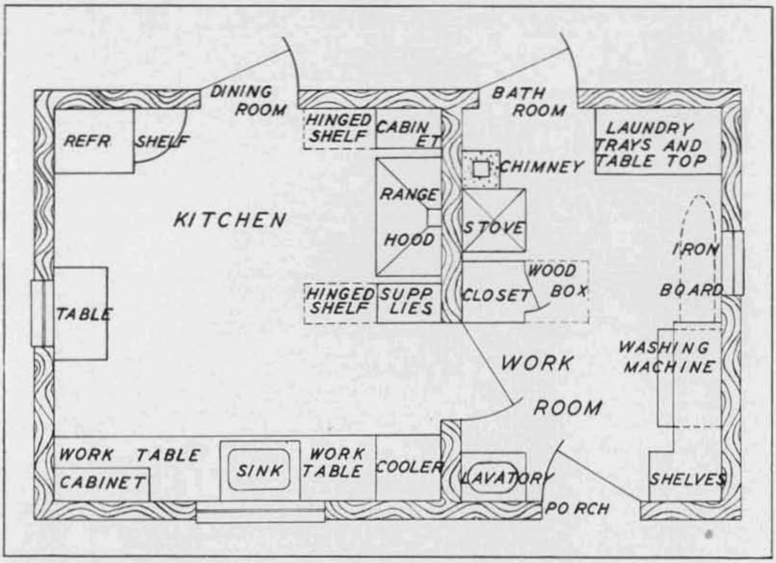


Fig. 13.—Suggested kitchen arrangement of cupboard and work tables.

formed to fit the pump cylinder and treated to resist the wear produced by the movement of the piston in the cylinder. The number of leathers used on a piston varies with the design of the pump and ranges from one to four. Common service operations for pumps used in domestic water supply systems are the renewal of valves, the replacement of the pump leathers, and the repacking of the pump rod stuffing box.

The Farm Bathroom

The final development in the water system for the household is the modern bathroom plumbing and sewage disposal through the medium of a septic tank. In farm homes not designed originally for the installation of a bathroom, one of the first problems will be the selection of its location. This will depend upon the individual requirements and ideas, and, when it is finally answered, usually means that one of the existing rooms must be partitioned off to provide a floor space of at least 5 x 8 feet, or the equivalent additional space must be built onto the house. A larger floor area than the minimum requirement of 5 x 8 feet can be used conveniently for the bathroom, as provisions made for linen and towel closets are always desirable. Also, many bathrooms are fitted with a clothes chute which leads to the basement laundry, and in other homes storage space for the cleaning equipment is found in closets located either in the bathroom or in the bathroom entrance hall.

When the bathroom is being considered, it is usually a good time to replan the kitchen. If the kitchen is large, it may be possible to provide enough space from the present kitchen for a bathroom at least 5 x 8 feet and also a hallway or entrance closet for coats and shoes. Replanning and reorganizing the farm kitchen is a project in itself and one that is very much worthwhile, especially when it saves steps and makes the working equipment more convenient. If it is decided to locate the bathroom in the space partitioned off from the present kitchen, the location of built-in cupboards, work tables, and sink should be considered carefully.

It may be possible to partition off one of the upstairs bedrooms, forming a bathroom, closet, and small hall. The stairway landing may be extended to provide space for a bathroom midway between first and second floors and on the ground floor convenient storage space for garden tools and lawn mower may be made accessible from the lawn. The location of the bathroom may depend upon the type of water supply available. If the water supply is furnished from an automatic pressure system or a gravity supply located well above the upstairs floor, the location of the bathroom on the first or second floor is a matter of choice. One of the simplest types of water systems is the overhead tank or gravity supply where the attic of the house is used for housing the tank. The increased pressure that can be obtained by placing the tank in the attic might make the space obtained from the kitchen or other downstairs locations the more desirable.

The selection and location of plumbing fixtures such as bathtubs, washstands, sinks, etc., should be a part of a carefully-worked-out plan. There are many different types of fixtures varying in quality from the cheap cast-iron shells coated with enamel to those of vitrous ware obtainable in attractive color schemes suited to the most elaborate surroundings. An average-size sink is 20 x 30 or 36 inches with a rolled rim or apron and with a 12-inch integral back which allows space for the necessary pipe connections. Also, sinks may be obtained in cabinet units with attached drainboards and with single or double compartments. The modern development in kitchen sinks is the built-in dishwasher and the use of stainless steel or Monell metal for the construction of the drainboards and bowls.

An average-size bathtub is one measuring 30 x 60 inches, made of enameled cast-iron with the various forms of rolled rims and enclosures permitting the tubs to be built in the corners or recessed, depending upon the location for which they are intended. The enclosed type of tub has the advantage of preventing the collection of dirt underneath and back of the tub. Washstands and lavatories usually measure from 18 to 24 inches or 20 to 24 inches with a 12 x 16-inch bowl. Washstands are similar to sinks in that they can be mounted on wall brackets or fitted with legs or pedestals depending upon their weight and design. The minimum space required for a shower is about 30 x 30 inches, an average being 36 x 36 inches.

Artificial stone and other similar materials are used for the construction of laundry tubs, which are made in sizes averaging about 24 x 48 inches by 15 inches deep. Laundry tubs may be supported by wall brackets or on legs and frames, depending upon the location. Portable galvanized steel laundry tubs are adapted to installations where it is necessary to use the work space for other tasks. Laundry tubs may be fitted with table tops and thus furnish additional table space.

The Septic Tank

The kitchen sink and bathroom fixtures utilize the same waste disposal system. The sewage disposal requirements of the farm home are met very effectively and economically by the use of a septic tank. A simple and very satisfactory septic tank is known as the single-chamber type, which consists of a rectangular concrete tank fitted with baffles. The septic tank is connected to the sewer tile which carries the waste from the house and discharges into a tile system known as the distribution field. The action of this tank is to receive the waste materials from the house in such a way that they do not disturb the contents of the tank, and to discharge the material from the tank after it has been retained there long enough (about 48 hours) to allow bacterial or septic action to take place. This means that the outlet passage must be baffled to prevent any discharge of effluent from disturbing the action of the bacteria. The size of the tank depends upon the number of persons living in the house and the volume of waste materials from the kitchen or farm dairy. Septic tanks usually are designed to hold a minimum of 40 to 50 gallons for each person served. The smaller sizes should have a reserve capacity as shown in the following table.

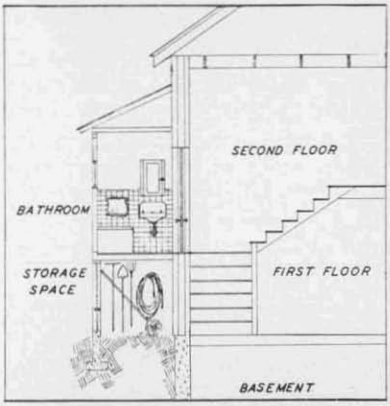
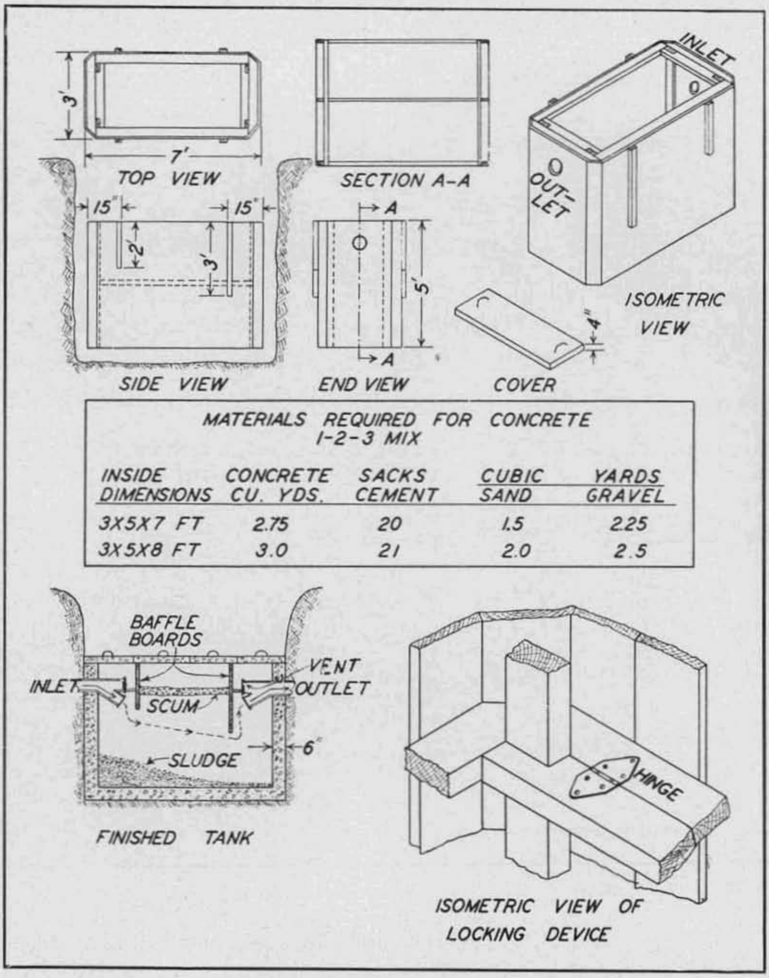


Fig. 14.—Suggested bathroom locations. (Stairway landing.)

Size of Single-Chamber Septic Tank

Number of Persons Served	Inside Dimensions in Feet Length	Width	Depth	Capacity in Gallons
7 or less	6	3	5	540
10	7	3	5	630
14	8	3	5	720
21	9	4	5	1080
24	10	4	5	1200

The construction of a satisfactory septic tank is neither expensive nor difficult. For a family of 5 to 7 persons the tank should be 5 feet deep, 3 feet wide, and 7 feet long, and may be built by digging a rectangular hole about 7 or 8 feet deep, 4 feet wide, and 8 feet long. A box-like form is made from rough lumber or sheeting and placed in this hole. The bottom and the space between the sides of the form and the sides of the excavation make the forms for the concrete, which should be mixed and placed similar to any standard water-tight con-



MATERIALS REQUIRED FOR CONCRETE
1-2-3 MIX

INSIDE DIMENSIONS	CONCRETE CU. YDS.	SACKS CEMENT	CUBIC SAND	YARDS GRAVEL
3X5X7 FT	2.75	20	1.5	2.25
3X5X8 FT	3.0	21	2.0	2.5

Fig. 15A.—Plan for a septic tank.

crete construction. The bottom, side, and top sections of the concrete walls should never be less than 4 inches thick, and the top slabs should be reinforced with ½-inch square bars or heavy hogwire fence. A water-tight concrete can be obtained if good quality, clean, well-graded sand and gravel or suitable crushed rock are used in a 1:2½:3 mix with not more than 7½ gallons of water per sack of cement.

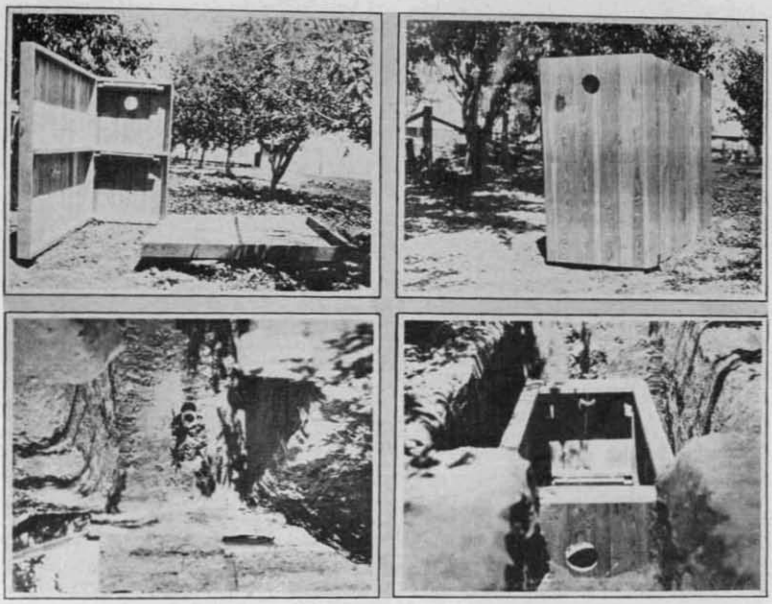


Fig. 15B.—Collapsible community form that has been used for the construction of more than a dozen farm septic tanks.

Fig. 15C in revised

The grade for the cast-iron or vitrified tile inlet pipe should be about ¼ inch per foot. The grade for the outlet pipe and distribution system should be about 1 inch in 10 feet. The distribution system is a very important part of the sewage disposal system because it takes care of the discharge from the septic tank. The total length of the drain tile required in the distribution system depends upon the capacity, the use made of the sewage disposal system, and the nature of the soil in which the tile is laid.

Distribution System—Length of Drain Tile

Soil Type	Length of Tile Per Person Served
Light porous	30 Feet
Medium porous	50 Feet
Average tight	75 Feet
Very tight	100 Feet

The length of drain tile in a distribution system laid in light porous soil and serving from 5 to 7 persons should be from 150 to 200 feet in length. In very tight soil it might be necessary to increase the distribution system length to 300 or 400 feet. Locating the distribution tile within 100 feet of the water supply, near trees or in low, wet areas should be avoided. If the soil is very tight, it may be more convenient to place the tile in a cinder or gravel fill than to increase the length of the system. If the disposal of the effluent is difficult, a double-chamber septic tank may be used in connection with a syphon discharge. The intermittent discharge from such a system permits the distribu-

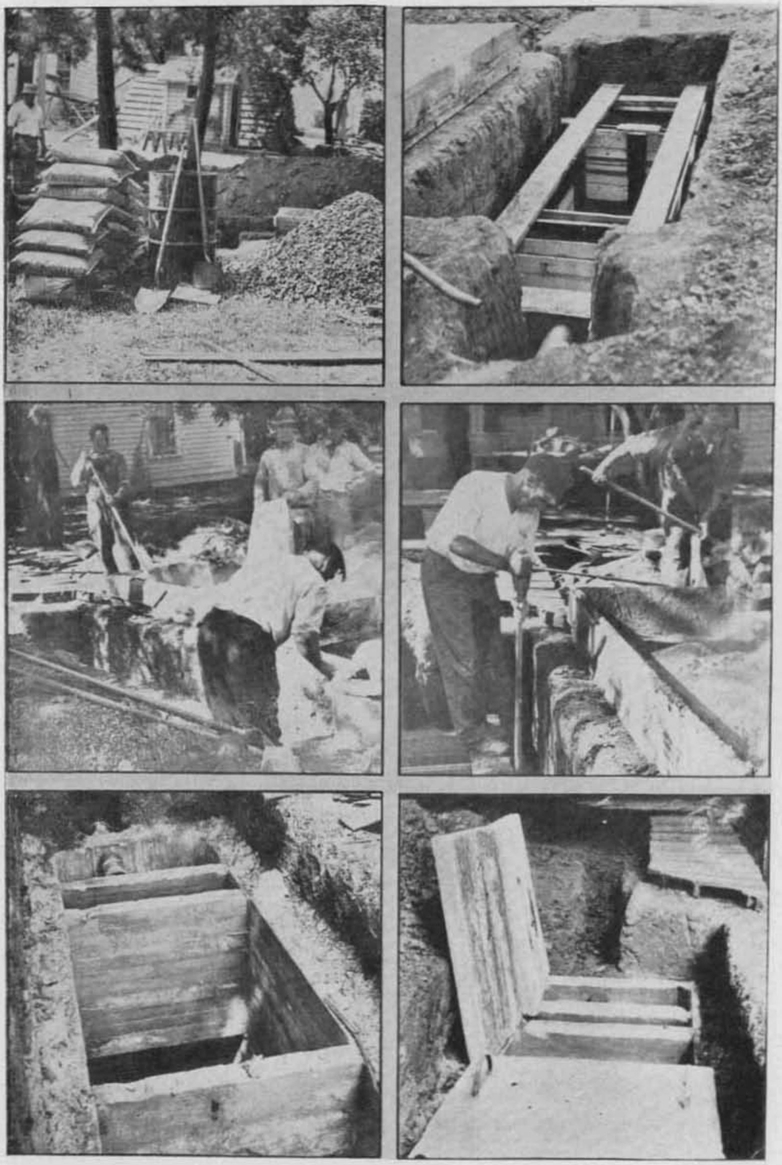


Fig. 16.—Steps in the construction of a double-chamber septic tank.

tion field to dry out while the syphon chamber is filling, thus facilitating the absorption of the effluent. The syphon-discharge system is adapted to the large capacity septic tanks required for the waste disposal from groups of 15 to 25 persons.

When septic tanks are used for the disposal of large amounts of waste water from laundry, milkroom, or dairy, the action of the wash-

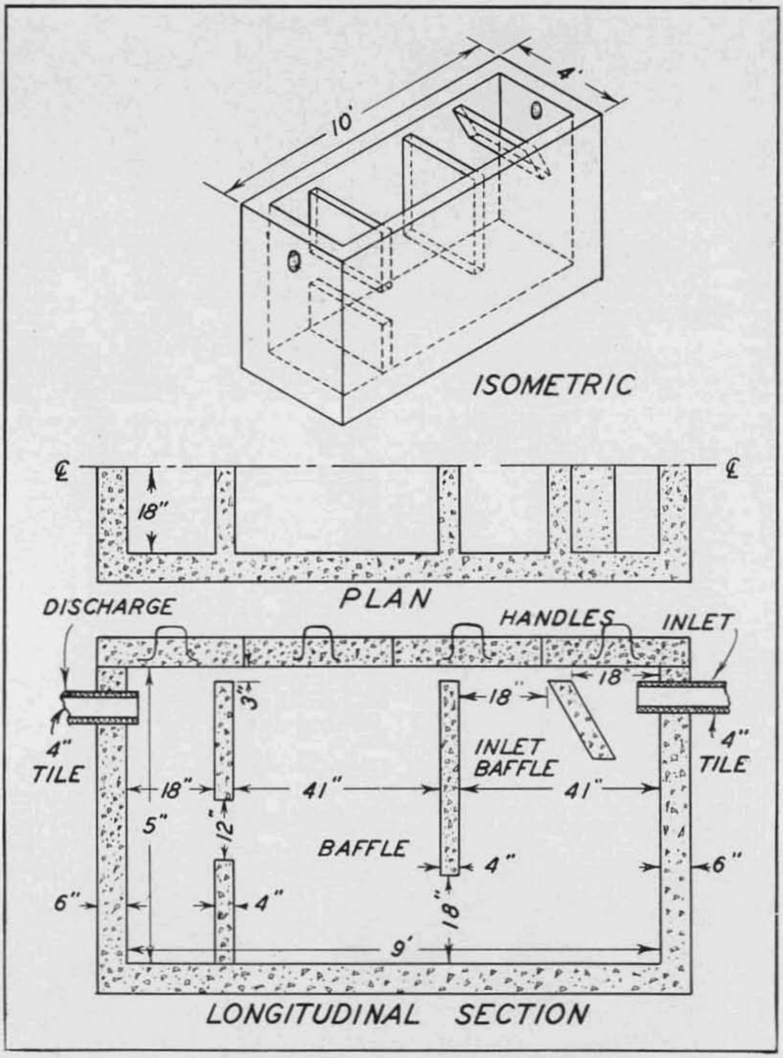


Fig. 17.—Plans for a double-chamber spectic tank.

ing solutions and disinfectants sometimes prevents the bacterial action in the septic chamber. For such cases the drain, discharging the waste water from the milk house or laundry, should be extended past the septic tank and empty directly into the distribution system.

A simple septic tank may be built and used before the bathroom plumbing is installed. The waste water from the kitchen sink provides enough liquid to permit septic action on the sewage from an outdoor privy located to discharge into the baffled section of the septic tank.

The materials for the average-size septic tank cost about $25 and the work for its construction usually can be managed during odd times by the regular farm labor.

A satisfactory job of plumbing may be accomplished readily by anyone who has worked with the tools required for the care and repair of modern farm machinery and equipment. Plumbing jobs like the septic tank installation can be done at times when it is unnecessary or impractical to work in the field. On most farms it is not a question of

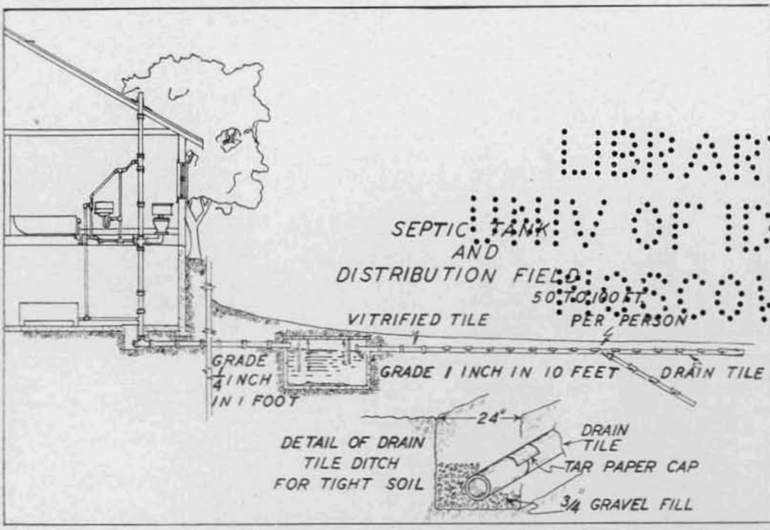


Fig. 18.—Waste disposal system consisting of a single-chamber septic tank and drain tile distribution system.

time, but one of planning and of having the necessary materials and tools on hand when the job is to be done.

The tools required for the installation of the farm plumbing also are needed for the maintenance and repair of the water system and for other farm shop work, which makes the investment in the few additional tools required well worthwhile. Many farm shops have at least a few of the tools that are needed for simple pipe fitting and plumbing work.

Tool List

Pipe vise	Spirit level
Pipe cutter	Plumb bob
Combination wrench	Carpenter's rule
Stillson pattern wrench, 14"	Measuring tape
Pipe reamer	Soldering copper
Dies ½", ¾", 1¼", and die stock	Cold chisel
Hand hacksaw	Ball pein hammer
File	Calking tools

Pipes

The pipes used for farm water systems usually are made of galvanized wrought iron and galvanized steel, which come in three different thicknesses or weights known to the trade as standard, extra strong, and double extra strong. Of these weights the standard or regular thickness is suited to most farm installations.

For the waste disposal system cast-iron pipe coated with coal tar pitch varnish is desirable because of the ease of installation and its

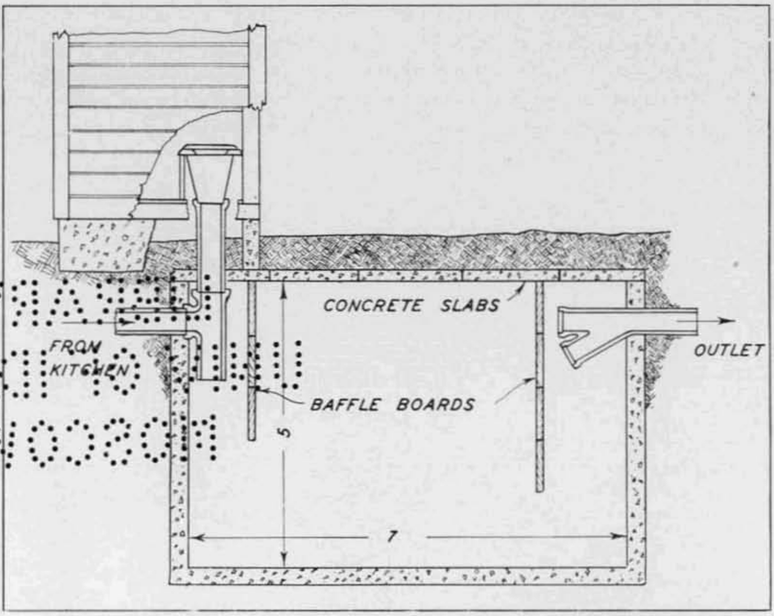


Fig. 19.—A farm-made septic tank and outside privy.

durability. Pipes also are made of lead, brass, bronze, and copper. Lead is used very little and the use of copper and bronze is limited by the cost. The convenience and service life of an installation of copper piping or tubing and its durability under certain conditions may offset its higher first cost. Most plumbing fixtures utilize nickel-plated pipes for connecting the fixture to the waste pipes and to the piping of the water supply.

Piping comes in various sizes—the ½-, ¾-, 1-, 1¼-, and 1½-inch sizes being commonly used in farm plumbing. The pipe size refers to the measurement of the inside diameter of the pipe. The larger diameters of 1 to 1½-inches are used for piping the water underground, and the ¾- and 1-inch sizes are used for the distribution of water in the house. If water is to be piped any great distance, the restriction to the flow of water caused by the pipe or pipe friction should be considered in selecting the size of the pipe for the installation. The relation between the pipe friction and flow for various sizes of pipes is shown in the following table:

Friction Head or Loss and Comparative Discharging Power of Pipes

Discharge in G.P.M.	Diameter of Pipe in Inches											
	¼	⅜	½	¾	1	1¼	1½	2	2½	3	4	5
	Friction loss in feet for each 100-foot length of pipe											
1	28.0	6.4	2.1									
3		49.0	15.8	4.1	1.26							
5			41.0	10.5	3.25	0.84	0.40					
10					11.70	3.05	1.43	0.50	0.17			
20						11.10	5.20	1.82	0.61	0.25		
50								9.90	3.32	1.38	0.34	0.11

The above table may be used as a guide for determining the most economical and satisfactory size of pipe for a water system installation. If a cistern is located 30 feet above and 300 feet from the discharge pipe, the table indicates that a 20-gallon per minute flow could be obtained from a 1½-inch pipe with a friction head loss of 15.6 feet, leaving the effective pressure head of 14.4 feet. The 1¼-inch pipe would give about 20 gallons per minute discharge without any appreciable pressure. The flow of water through the pipes of a water system is caused by the pressure; the greater the pressure, the greater the discharge, providing other conditions remain the same. Pressure results from the head which is the difference between the elevation of the supply and the discharge, or from the expansive force of the air confined in the pneumatic system. Pressure is designated in pounds per square inch, a pressure of 1 pound per square inch resulting from a head of 2.3 feet, or each foot of elevation produces a pressure of .434 pounds per square inch.

Pipe Fittings

Various pipe fittings are used to connect the runs of pipe needed to complete the water delivery and waste disposal systems. These fittings may be made of cast-iron and of either black or galvanized malleable iron. The galvanized malleable fittings commonly are used for water system installations. Couplings are supplied for the various sizes of pipe and are used to join two pieces of pipe by means of the threaded connection. Tees are fittings used to turn corners and take off branch lines, and unions are used for joining pipes where it may be necessary to disconnect the piping without disturbing the entire system. Elbows are commonly supplied in the 45- and 90-degree form. Couplings, tees, and elbows may be supplied with a reducing feature which permits the use of the next size larger or smaller piping. Nipples are short pieces of pipe threaded on both ends, commonly known as close, medium, and long, and are used mainly for fitting pipe to plumbing fixtures. Other miscellaneous fittings are the return bends which are used for furnace and steam coils, the cross-overs used for the installation of pipe where it is necessary to limit the space occupied or to keep the pipes next to the walls of the rooms, and pipe collars and straps.

The installation of piping and fittings between fixtures is known as a run. Pipe runs should be located carefully and the most economical arrangement determined from the standpoint of the desired location of the plumbing fixture and the necessary connections. These runs always should be planned to scale on paper before measuring and cutting the length of pipe required. The measurement for a run of pipe necessarily must allow for the threads on the pipe and fittings. Pipe threads play a very important part in the satisfactory installation of a plumbing system. The standard pipe threads are 60 degrees V-shaped known as Briggs Standard and are tapered ¾ inch per foot, the number of threads depending upon the diameter or size of the pipe. The taper feature of the threads makes it possible to obtain a metal-to-metal contact between the fitting and the pipe and requires that exactly the correct number of threads be cut on the pipe; otherwise, the metal-to-metal contact will not result and the joint will leak, or if too few threads are cut the joint will be mechanically weak. The relation between the size of the pipe and the number of threads is shown in the following table:

Standard Weight Galvanized, Wrought Iron, and Steel Pipes

Nominal Size in Inches	Inside Diameter	Weight Per Foot Threaded and Coupled in Pounds	Threads Per Inch	Length of Thread to Cut
1/8	0.269		27.0	5/16
1/4	0.364		18.0	7/16
3/8	0.493	0.568	18.0	7/16
1/2	0.622	0.852	14.0	9/16
3/4	0.824	1.134	14.0	9/16
1	1.049	1.684	11.5	11/16
1 1/4	1.380	2.281	11.5	11/16
1 1/2	1.610	2.731	11.5	11/16
2	2.067	3.678	11.5	3/4
2 1/2	2.469	5.819	8.0	1 1/16
3	3.068	7.616	8.0	1 1/8

When preparing a length of pipe for its place in a run, the pipe should be measured and cut to permit the correct extension into the fittings. After the threads have been cut, the ends of the pipe should be reamed out to remove the restriction to the flow of the liquid through the pipe and fittings. White lead, litharge, and glycerine or cement and linseed oil can be used as an aid in assembling the threaded sections; however, such material should not be used as a substitute for good workmanship. On water supply pipes, small leaks sometimes rust shut and a few drops of water around a threaded joint should not mean that the entire run has to be taken out in order to correct the fault. In pipes carrying hot water, a small leak may develop into serious proportions due to the temperature changes that occur in the piping. The final completion of a run of pipe usually is made by means of a union; however, there may be some runs that can be completed by a fixture coupling. The piping should have sufficient slope to drain, avoiding sags or pockets which might cause air locking, thus allowing the water to remain in the pipe and freeze. All soil and drain pipes should have a slope of 1 inch in 4 to 5 feet. The vent and water pipes should slope 1 inch in 8 to 10 feet. In the piping used for hot water heating the correct slope aids in the circulation of the water throughout the system. Pipe runs should be supported to prevent vibration due to water hammer or from other causes. The use of pipe straps or hangers, and collars or flanges should not be neglected after the completion of the assembly of pipes and fittings.

Hot Water Systems

The convenience of hot water plumbing in laundry, kitchen, and bathroom is regarded by many as the most enjoyable feature of the farm plumbing system. The most common method of heating the hot water supply is by means of a coil or water front in the kitchen range.

Other heating units are the laundry stove and furnace heating coils which are located usually in the basement. In addition, oil, gas, and electric heaters are available in sizes suited to the needs of the farm home. Very often it is desirable to combine two or more sources of heat, as, for instance, the range front and furnace coil, or the furnace coil and the electric, gas, or oil heaters.

Range boilers are available in sizes commonly ranging from 30 to 60 gallons. The average family washing requires about 50 gallons of hot water and represents the maximum needs of most families. For a 50-gallon range boiler, 125 square inches of heating coil surface is recommended. The range boilers are made of varying weights of tinned copper and galvanized steel, depending upon the pressures for which they are intended. The location of the range boiler in the plumbing system is important because of the loss of heat that may result from long runs of exposed pipe between the boiler and faucets.

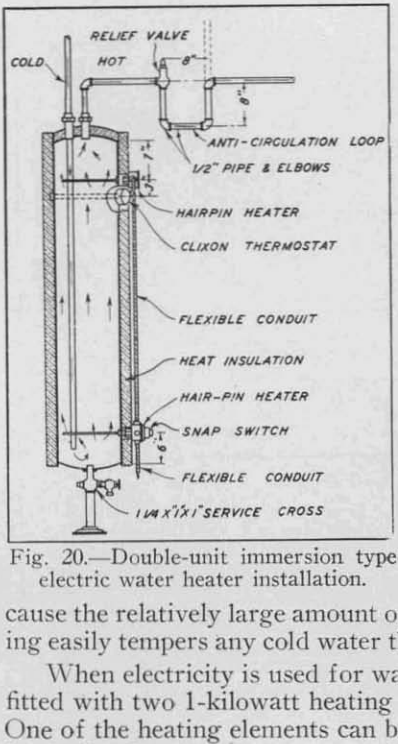


Fig. 20.—Double-unit immersion type electric water heater installation.

Wherever possible the boiler should be close to the faucets that are used frequently and where the water is drawn in small quantities. For example, it is more important to have the hot water tank close to the kitchen sink than it is to the bath or laundry tub because the relatively large amount of water required for a bath or washing easily tempers any cold water that might be in the piping.

When electricity is used for water heating, a 60-gallon range boiler fitted with two 1-kilowatt heating elements will be found satisfactory. One of the heating elements can be controlled by a thermostat located in the insulated tank cover and the other circuit can be controlled by a manually operated switch.

If it is desired to keep a small quantity of water hot all of the time, the upper heater is left on and its operation is controlled by the thermostat which is set to maintain the temperature of the water in the upper part of the tank at approximately 160 degrees Fahrenheit. If a full tank of water is needed for doing the family washing, the lower heater is turned on, thus insuring an adequate supply of hot water. When electricity is used for heating water, it is important that the tank and piping be insulated to conserve all of the heat possible and thus lower the consumption of energy by the heater.

Another method of utilizing the immersion-type electric heater is in the circulating type of installation as shown in Figure 21. A means of securing quick heating is to insert in the pipe union above the heater element a lead or fiber washer with a ¼-inch diameter restricted opening in place of the regular union washer. This restriction holds back the flow of the water in the circulating system causing the water around the heater to become hot before it passes into the upper part

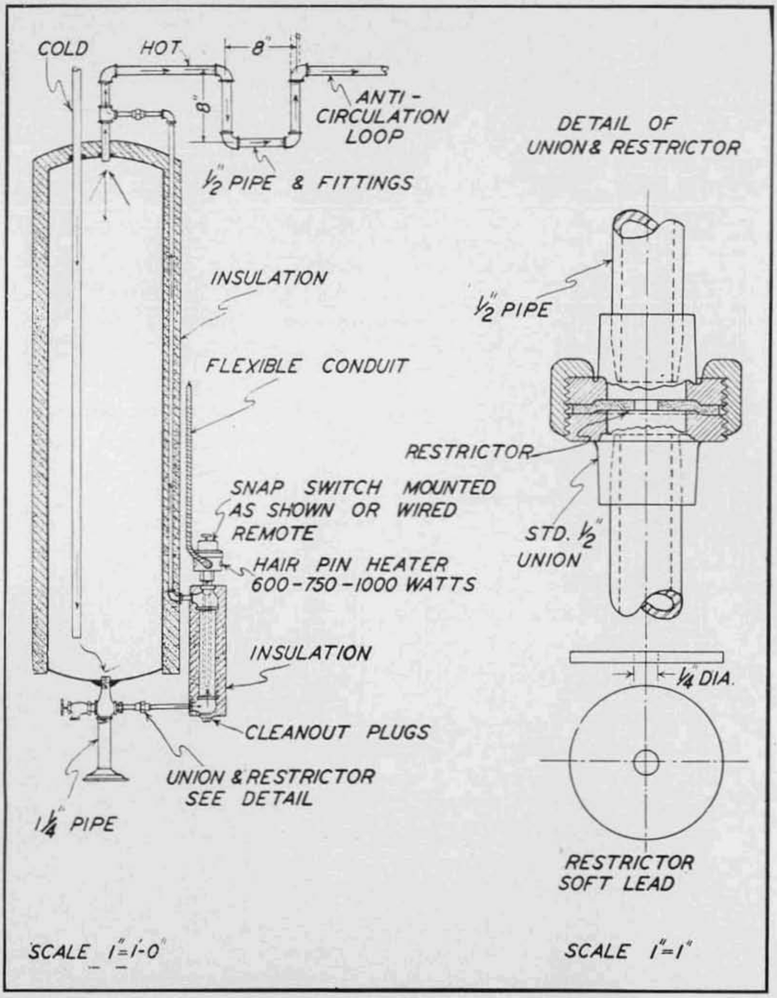


Fig. 21.—Circulation type electric water heater.

of the range boiler. By this system a small amount of very hot water may be secured with a minimum period of operation of the heater. When conventional heating installations are used, provision should be made for cutting off the circulating system between the furnace coil and the range boiler or the range water front and boiler. These cut-offs are necessary because the coils in the furnace and water front in the range that are not used will act as a radiator and cool the water in the range boiler. The cut-off valves should be located so that their use will remind the operator to open them before attempting to start a fire in the range or furnace. If the valves are not opened before the equipment is fired, serious damage may result to the coils. It is possible to reduce the circulation of the hot water through the coils by the

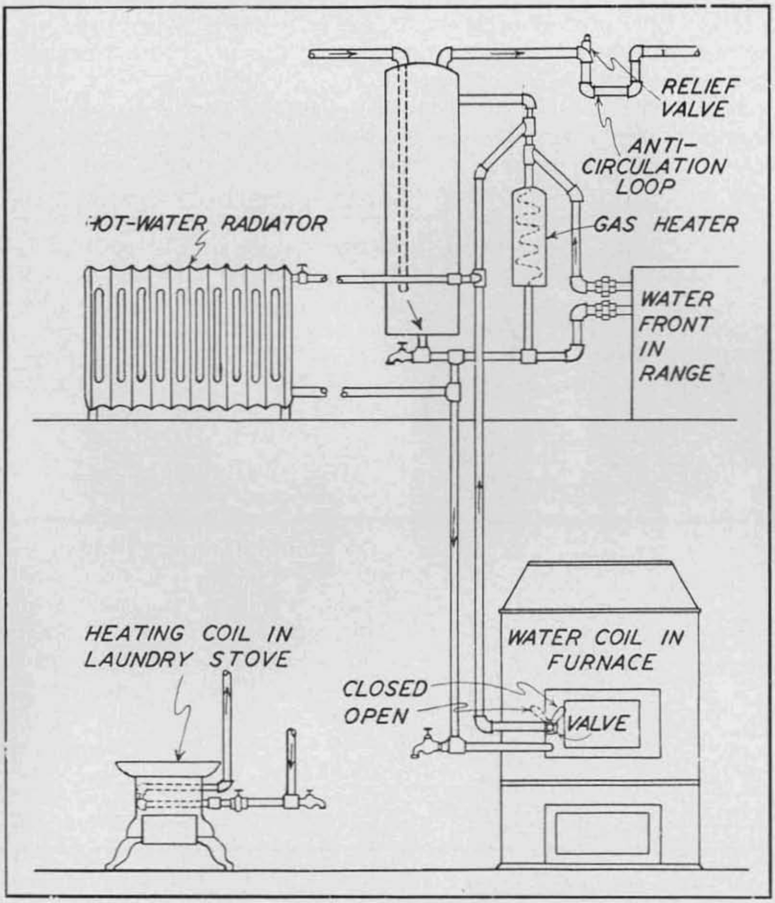


Fig. 22.—Excess hot water relief through the use of a hot water radiator.

use of an anticirculation loop in the piping between the range boiler and the heating coil. This anticirculation loop, however, restricts the flow of hot water in the piping and for that reason is not as satisfactory as the valves. The use of the ½-inch pipe for hot water piping will tend to restrict the circulation of the water and lessen the amount of water wasted when small amounts of hot water are desired. Insulated copper or brass tubing may also be used to advantage for hot water delivery.

In water heating installations there is always the danger of getting the water too hot. Where water is supplied under pressure, the normal expansion caused by heating tends to back the warm water into the supply line, and if excessive pressures result, plumbing fixtures ordinarily designed for cold water use may be injured by the hot water. For this reason a relief valve should be installed on the hot water outlet of the tank. This valve should be set to operate at 5 to 10 pounds more than the normal pressure of the system which insures against damage which might result from the failure of the thermostat or neglect on the part of the operator.

When heating coils are installed in hot-air furnaces used in cold climates during severe winters, the high temperatures required from the furnace usually produce an excessive amount of hot water in the range boiler. Such a condition requires frequent relief in the system by permitting the discharge of the steam and hot water which represent waste heat. This heat may be utilized by the installation of a hot-water radiator in the piping between the furnace coil and the range boiler with a return to the cold water inlet of the heating coil. When the hot water system shows evidence of too high a temperature, the radiator valve can be opened and additional radiation secured for such rooms as the bath or nursery.

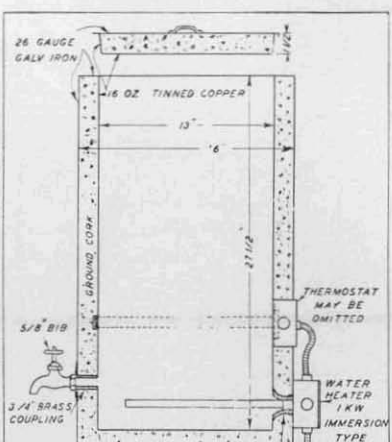


Fig. 23.—The "Idaho portable farm electric water heater."

Where water under pressure is not available in the house and dairy, a portable oil or electric water heater may be used. Such a heater has been developed by the Idaho Power Company and has met with such success that a similar model is being manufactured by one of the leading manufacturers and will be known as the "Idaho portable electric water heater."

In its present stage of development, the "Idaho" water heater consists of a 15-gallon cork-insulated tank provided with a 1-kilowatt immersion-type heater, which may be controlled by means of a thermostat located in the insulated cover or by means of a manually operated switch.

The tank is filled through the top, which is provided with a removable insulated cover, and the hot water may be drawn from the bottom of the tank through a compression bib located about 2 inches above the heating element. This location of the outlet allows for an automatic protection of the heating element, insuring economical operation and a maximum service life for the unit. The best results have been secured by using a tinned copper lining for the inside of the tank, brass pipe fittings in order to prevent rusting, and an outside shell of 26-gauge galvanized iron large enough to provide about 1½-inch space for the ground cork insulation.

This water heater was developed primarily for the purpose of supplying a convenient and economical means of heating water in farm homes and dairies, where water under pressure was not available and where the reservoir on the wood or coal range was inadequate.

Plumbing Care and Repair

On the farm it is often impractical to call an experienced plumber for the numerous adjustments and small repairs necessary for the maintenance and operation of the farm plumbing system. One of the chief causes of difficulty with plumbing is the extremely cold weather frequently occurring in the northern states. All pipes should be installed safe from frost, especially small water pipes which freeze more quickly than the waste pipes and sewers which carry water and waste which is more or less warmed. The depth at which pipes should be placed depends upon the location and climatic conditions. It is common knowledge that ground in one location freezes to a greater depth than in another; for instance, pipes passing under a driveway must be better protected than pipes under the same depth of soil but located where the frost penetration would be less severe. In Idaho the average depth for locating pipes ranges from 4 to 6 feet and is governed by the temperature extremes and the location of the installation.

In general, insulating coverings are recommended for pipes located in buildings. There are a variety of insulating materials available; however, satisfactory home-applied insulation may be made from sacks, corrugated paper, old automobile tires, tar paper, and canvas. To be of most benefit, all insulating materials should be made waterproof after their installation by a coat of heat resisting waterproof paint.

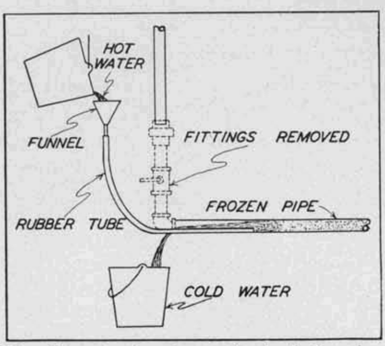


Fig. 24.—A simple method of thawing frozen pipes.

If the plumbing is not protected from frost, frozen pipes may result in serious damage and inconvenience. There are three common methods of thawing frozen pipes, the most common being the use of the blow torch on the outside of the pipes that are exposed and can be reached conveniently. However, this practice is limited by the location of the pipe and contributes to the fire loss resulting from carelessness and accidents in the use of the blow torch. This is particularly true of the attempted thawing of pipes located between walls. Where pipes can be reached with a small rubber tube or copper tube, hot water can be directed into the pipe through the tube by means of a funnel and tube, and the return flow of cooled water resulting from the melting of the ice can be discharged from the end of the pipe. If a long run of pipe has been frozen, a small force pump used instead of the funnel will be an added convenience. Where steam is available under pressure, a jet of steam can be applied through the hose instead of the hot water. Frozen waste pipes and traps may be thawed by the use of chemicals such as caustic soda; however, most traps can be reached with hot water or the blow torch. The use of electricity for thawing pipes is common practice where electric service is available. This method requires a special transformer and heavy cable and connectors, the principle of operation being the heating effect of the electric current which is applied to the section of the frozen pipe which reacts as a heating element thus melting the ice.

The clogging of pipes usually results from the presence of rust or dirt in the water supply. One of the most satisfactory means of clearing the clogged pipes is to flush the system with a powerful force pump. If the deposit in the pipe contains considerable lime, it may be necessary to flush the system with a dilute solution of muriatic acid. The acid treatment should be allowed to stand in the pipe for at least one hour. Rust and dirt can also be dislodged from a pipe by the use of a cord and chain or by a wire brush or swab attached to the end of a small steel or brass rod. In attempting to remove scale or lime deposit, sharp blows from a hammer may be used to dislodge the scale. Clearing clogged waste pipes and sink traps may be accomplished by the use of a rubber force cup, or by directing hot water under pressure into the traps, the hot water melting the grease accumulations which tend to stop the traps.

Scale accumulations in water fronts and heating coils may make it advisable to keep a spare water front or coil on hand for use when cleaning is necessary. The use of one part of muriatic acid to 5 to 7 parts of water will be found satisfactory for dissolving ordinary lime or scale. The application of the acid solution requires the removal of the coil or front and may be facilitated by the jarring or scraping of the scale deposit. In severe cases it may be necessary to drill and tap the sides of the water front before the scale can be removed. The holes should be located in the corners or edges of the water front casting to be of the greatest advantage in the removal of the sediment. After the casting has been cleaned out, the holes should be filled with standard pipe plugs cut flush with the water front casting by means of a hacksaw.

Leaks caused by cracks or breaks in pipes and tanks may be repaired temporarily by the use of gaskets, clamps, and compounds such as cement mortar or concrete. A small hole in a cast-iron pipe may be repaired permanently by tapping and threading a screw plug. Leaky joints can be stopped sometimes by calking with a blunt chisel and hammer. Lead, tin foil, and commercial iron cement also are used in cracks or holes that can be cleaned, thoroughly plugged and repaired. Washers, gaskets, and rivets also are used for the repair of leaks, especially in tanks where it is relatively easy to use this type of repair. Cracks and breaks in laundry tubs made of slate, soapstone, and cement may be repaired with commercial cement or with a mixture of litharge and glycerine.

Other repairs that are required frequently on plumbing that has been in service for sometime are the replacement of washers and the packing in the valves and faucets used in the system. The replacement of the Fuller balls in the Fuller-type of faucet and the fiber or metal washers in the compression type of faucet are relatively simple but very important repair jobs. A supply of hose menders or splicers, washers, and hose clamps always should be kept on hand because with this equipment emergency repairs can be made quickly and a fuller utilization of modern plumbing made possible.

Additional Information on Farm Dwellings and Equipment:

Idaho Agri. Exp. Sta. Circ. No. 66—*Irrigation Pumping Plants.*

U. S. Dept. of Agri. Farmers' Bull. No. 927—*Farm Home Conveniences.*

" " " " " " " No. 1227—*Sewage and Sewerage of Farm Homes.*

" " " " " " " No. 1426—*Farm Plumbing.*

" " " " " " " No. 1448—*Farmstead Water Supply.*

" " " " " " " No. 1460—*Simple Plumbing Repairs in the Home.*

" " " " " " " No. 1513—*Convenient Kitchens.*