It is possible to have running water in every farm home. The equipment may not look just like that shown above, but it can be made equally serviceable.
The simplicity of getting running water into the average farm home apparently is not generally appreciated. Many assume that a considerable outlay is necessary. It is hoped that this circular will correct the misunderstanding, and make it possible for one interested in water systems to determine what system will fit most practically into his particular conditions.
Water and Plumbing Systems for Farm Homes

By E. W. Lehmann, Chief in Farm Mechanics, and F. P. Hanson, Extension Specialist in Farm Mechanics

No type of equipment for farm homes is needed more than a system of plumbing and water under pressure. It adds health, happiness, and contentment to the life of every member of the farm family. The women especially appreciate a plentiful and convenient water supply, for it means not only more healthful conditions but also a saving of labor in preparing food, caring for the family, and doing other work in the home.

Simple Systems Installed at Moderate Cost

The value of water under pressure and a plumbing system in the farm home cannot be estimated by the cost of installation. A high-priced plumbing system may be something we should all like to have, but a more moderate-priced system will be just as practical and will provide most of the comforts of a more expensive installation. It is true that complete systems such as are commonly advertised in magazines may cost several hundred dollars, but it is not generally known that simple systems can be installed at relatively small cost. The lack of this information is perhaps largely responsible for the small proportion of farm homes that have satisfactory water systems.

System Can Be Built Up Unit by Unit

The plumbing requirements for a rural home do not differ from those of the city home, once a supply of water under pressure has been provided and a plan made for disposing of the sewage. The first answer to the question, What kind of a system shall I install? is—Plan a complete plumbing system, and then if it cannot all be installed immediately, have it installed in units as circumstances will permit.

The fact that a system of plumbing can be installed in units over a period of years as the buyer is able to pay for them is important for those who desire to have such equipment and cannot finance a complete installation at one time. The first unit may be nothing more than a sink and drain, but this unit should be selected and installed with care, so that it can be utilized to advantage when more equipment is added later.

Conditions will vary, of course, but the information in this circular will show how easily a plumbing system can be built up in simple units, without spending a large amount of money at one time. The
problem is to get water into the farm home by some method other than by carrying it in buckets, and to provide for the safe removal of the waste.

FIG. 1.—A FILTER OF THIS DESIGN WILL KEEP THE WATER FREE FROM SEDIMENT

Extreme care in collecting, filtering, and protecting cistern water is important if it is to be used for drinking and cooking purposes.

Purity of Water Is First Essential

In order to assure a pure water supply for the home, the cistern or well must be so located that underground seepage cannot enter, and care must be taken to protect the well from surface drainage. Plans for properly constructed tops for wells and cisterns can be secured from the State Department of Public Health, Springfield, Illinois. If there is any reason to believe that the water supply is not safe for human consumption, it is recommended that the matter be taken up with that department.
Fig. 2.—A Well with a Properly Constructed Top

The platform and curb are so built that no surface water or foreign matter from the surface can gain entrance to the water supply. It is dangerous to permit pumped water to run back into a well or cistern.

Fig. 3.—Avoid Using a Filter That is Too Small

This metal filter is too small to be of much value. Also, the by-pass should be above, and not below, the filter as shown.
Avoid locating a well dangerously near a privy vault, cesspool, septic tank, or sewer line, or at a lower elevation than any of these. In ordinary soil 50 to 100 feet is a safe distance; while in gravel, sand, or open soil a greater distance may be required. A water supply contaminated with sewage is likely to cause an outbreak of typhoid or dysentery.

If a cistern is used, provide an adequate filter (Fig. 1) and see that it is cleaned out at regular intervals. Also have the roof washed thoroly before allowing water from it to drain into the cistern.

**Plan Abundance of Water Under Pressure**

An abundance of water under pressure should be the aim of everyone installing a system of plumbing. In order to estimate the amount needed for a particular household, it is necessary to know the extent of the plumbing system. The amount that will be used will depend on the number of people in the household and the number of faucets and hydrants in the system. How the amount of water varies with different conditions is shown by the following table:

**AMOUNT OF WATER USED BY ONE PERSON IN A DAY**

<table>
<thead>
<tr>
<th>Description</th>
<th>Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>When water is carried by hand</td>
<td>6-8</td>
</tr>
<tr>
<td>1 pump at kitchen sink</td>
<td>8-10</td>
</tr>
<tr>
<td>1 faucet at kitchen sink</td>
<td>10-15</td>
</tr>
<tr>
<td>Running hot and cold water in kitchen</td>
<td>15-20</td>
</tr>
<tr>
<td>Complete plumbing and water under pressure</td>
<td>20-40</td>
</tr>
</tbody>
</table>

**AMOUNTS USED FOR SOME GENERAL PURPOSES**

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bath tub</td>
<td>8-20</td>
</tr>
<tr>
<td>Closet</td>
<td>3-5</td>
</tr>
<tr>
<td>Lavatory</td>
<td>1-1½</td>
</tr>
<tr>
<td>Sprinkling lawn</td>
<td>7-8</td>
</tr>
<tr>
<td>Soaking lawn</td>
<td>15-20</td>
</tr>
<tr>
<td>Horse</td>
<td>6-12</td>
</tr>
<tr>
<td>Cow</td>
<td>6-12</td>
</tr>
<tr>
<td>Hog</td>
<td>1½-2</td>
</tr>
<tr>
<td>Sheep</td>
<td>1-2</td>
</tr>
</tbody>
</table>

*Water for these purposes is included also in the last item in the first group.

Information on pages 13 to 20 will show how either the gravity, the hydropneumatic, or the pneumatic water systems can be provided as the plumbing is being installed in units.

The capacity of plain cylindrical cisterns and tanks is given in Table 1.
TABLE 1.—CAPACITY OF PLAIN CYLINDRICAL CISTERNS AND TANKS

<table>
<thead>
<tr>
<th>Depth of cistern or tank in feet</th>
<th>Diameter of cistern or tank in feet</th>
<th>Capacity of cistern or tank in gallons</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>4 5 6 7 8 9 10 11 12</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>376 588 846 1152 1504 1904 2350 2844 3844</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>470 735 1058 1439 1850 2380 2938 3555 4230</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>564 881 1269 1727 2256 2855 3525 4265 5076</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>658 1028 1481 2015 2632 3331 4113 4976 5922</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>752 1175 1692 2303 3008 3807 4700 5687 6768</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>846 1322 1904 2591 3384 4283 5288 6398 7614</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>940 1469 2115 2879 3760 4759 5875 7099 8460</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>1034 1616 2327 3167 4132 5235 6463 7820 9306</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>1128 1763 2537 3455 4512 5711 7050 8531 1052</td>
<td></td>
</tr>
</tbody>
</table>

Kitchen Sink and Drain Should Be First Unit

The installation of a sink and drain as shown in Fig. 4 will be a great labor saver without being expensive. The sink not only removes the waste but also serves as a place where the dishes are washed and where food is prepared for cooking and serving. Remember that the sink is a convenience to the housewife and place it so as to eliminate unnecessary steps. Place it near the stove and, if practical, on the wall nearest the cistern or well. If the kitchen is small, the sink can be placed on the wall opposite the stove, but if it is large this arrangements makes too many steps between the stove and the sink. Another point to consider is the height of the sink; set it to suit the individual—low sinks are back-breakers. Plan the sink installation so that it need not be changed when other improvements are added.

Provide a 4-inch sewer tile to dispose of the waste water. In laying this tile for the outlet, take advantage of as much slope as possible. At least $\frac{1}{4}$-inch fall to the foot is desirable, while a greater slope will be still better since it reduces the likelihood of clogging. In planning a complete system, arrange for a drain of 4-inch cast-iron soil pipe extending to a point outside the foundation wall. Then connect this drain with a bell-mouthed sewer tile.

A Suction Pump Should Come Next

The next improvement will be the addition of a suction pump. This will complete a water system like that shown in Fig. 5. With this simple equipment the labor of carrying water is eliminated.

1Another point to consider in placing the sink is a convenient arrangement for handling dishes. If possible, arrange the sink so the dishes may be handled from right to left as they are being washed. There should be a place to stack them at the right of the sink before they are washed and the drain board should be at the left to receive them after they are washed. An ideal arrangement is to have the cupboard for dishes placed at the left of the sink, thus doing away with or greatly reducing the number of steps necessary in putting the dishes away.
FIG. 4.—A SIMPLE SINK AND DRAIN INSTALLATION

The first unit of a complete plumbing system will usually be an inexpensive sink and drain. It should be so located that other improvements can be added without necessitating costly changes.

Wherever a shallow well or cistern is the source of the water supply, this system can be used. The only requirement is that the low level of the water be no more than 22 feet below the pump cylinder;
Fig. 5.—No Need of Carrying Either Fresh or Waste Water with This Simple System

The sink, drain, and pump constitute a simple, inexpensive water system which will save valuable time and energy. Note the improvement over Fig. 4.

for a suction pump cannot lift water satisfactorily from a greater depth. Ordinarily the only precaution one needs to take in putting in such a pump is to place the pipe and drain below frost line, and on cold
nights to lift the pump handle so that the water will run back into the well. However, where a check valve is placed on the pipe, this precaution will not work, and a special waste valve, which can be opened and closed, must be provided below the pump cylinder. If there is danger of the trap freezing in the kitchen, a little salt put into it at night during extremely cold weather will prevent trouble.

Attach the pump to the end of the sink or, in the case of a bracket pump, fasten it to the wall. Whether the pump is best placed on the right or the left side of the sink will depend on the individual who is to use it and on the location of the sink. Run the pipe directly thru the floor, thru the foundation wall, and into the cistern or shallow well (Fig. 5). The water can then be pumped directly into the sink.

If the well or cistern is more than 50 feet from the house, it is desirable to have a check valve on the lower end of the suction pipe. With this arrangement provision must be made to keep the water in the valve from freezing during severe winter weather, as just explained.

**Hot Water Unit Calls for Little Additional Expense**

When a force pump, sink, and drain have been installed as described, a little additional expense will provide the comfort of running hot water. The parts needed for the hot water unit are: a hot water front or back for stove or range (or some other means of heating the water), a 30-gallon boiler, a three-way valve, a faucet for draining the system and the necessary pipe for connections.

The main feature of the system is the three-way valve. Use at least a ¾-inch pipe for this installation, as illustrated in Fig. 6. Other ways in which the water may be heated are by means of a coil in a furnace, or with a special coal, kerosene, gas, or electric tank-heater.

With this system either cold or hot water may be drawn from the same faucet, the three-way valve being marked to indicate the ports that are open. For cold water, place the valve in position with the top port closed. With the valve in this position, cold water can be pumped directly from the source to the sink. For hot water, place the valve in position with the top and bottom ports open. Then by operating the pump the cold water is forced thru the supply pipe into the lower part of the tank and the hot water forced out from the top of the tank.

Ordinarily there is little danger of the water freezing in this system if the same precautions are taken as when complete plumbing is installed. The system should always be drained if the house is to be left vacant during severe winter weather. When in use, the tank should be kept filled in order to secure the best circulation of water and to avoid damage to the hot-water front or to the coils. If steam is generated, there is no danger as it passes out thru the hot-water pipe, which is always open to the air.
Completing the System

The next step will be to provide water under pressure and add bathroom and laundry fixtures. The fixtures can be added one at a time, if they cannot all be added at the same time, but a complete plan should be made at the outset. As a rule, the installation of this part of the plumbing is a job for an experienced plumber. There are no

Every housewife appreciates hot and cold water in the kitchen. Note how easily the system shown in Fig. 5 can be improved to provide hot water.
If all the bathroom fixtures cannot be installed at one time, the different units may be added separately, but a complete plan should be worked out before any one of them is installed if the expense of having to reset it later is to be avoided.
ordinances as to how it must be installed in rural homes. However, the requirements for city plumbing are for the protection of the family and therefore are just as important in the country as in the city.

**Three Systems for Supplying Water Under Pressure**

To provide water under pressure, the gravity, the hydropneumatic, or the pneumatic system can be used. The kind of power available, the quantity of water needed, the source of the water supply, and other local conditions will determine which system to install.

**Gravity System Satisfactory for Many Farms**

Where the storage tank can be elevated and protected without great expense, the gravity system will be found satisfactory for many farms. The simplest gravity system is one that has a tank located in the attic and connected, by means of a pipe, to a force pump in the kitchen. Having provided such a water system, complete plumbing can be installed. The size of the tank and the amount of water used will determine how often water must be pumped. Individual conditions will determine what size of tank will give the best service.

When an attic tank is used the water is commonly pumped by means of a windmill or gas engine, and when the tank is filled the overflow runs to the stock tanks. A good feature of this arrangement is that the water for the stock is pumped thru the house tank, thereby keeping the house supply fresh and cool in the summer and usually preventing it from freezing in the winter.

On many farms there may be a hill or slight elevation near the house where a gravity tank can be located. With the tank built on a good foundation a few feet below the surface of the ground, there is no danger of the supports giving way, as sometimes occurs when it is placed on a tower. There is then no freezing of pipes and the water is cool in summer and prevented from freezing in winter. Such a tank may be made large enough to supply the entire needs of the farm.

A tank supported by masonry walls is a good arrangement. A room can be built underneath the tank and used for a milk house.

**Hydropneumatic System More Generally Used**

In the hydropneumatic system the water is stored in an air-tight steel tank and is forced thru the pipes to the fixtures by air pressure. To begin with, the tank is filled with air. Water is then pumped in, and the pressure of the air increases as its volume decreases. As water is used, the air pressure is gradually reduced. In all systems of this type there is a tendency for the water to absorb the air, and some provision must therefore be made for replacing it. This is usually accomplished by means of a small air pump or an air intake valve.

Complete equipment for a hydropneumatic system includes an
FIG. 8.—A GRavity WATER SYSTEM AND COMPLETE PLUMBING EQUIPMENT

This is the simplest and most practical water system for many farms. Sometimes it is best to place the elevated tank on a hill or tower.
In this system, the water is stored in an air-tight tank under pressure. The electric pump automatically starts and stops as the water pressure is lowered or raised to set points. Note the similarity of the plumbing between this and the gravity system, Fig. 8.
air-tight pressure tank, a force pump, pressure gages, and minor fittings. This system is illustrated in Fig. 9. The size of the tank needed for a hydropneumatic system can be figured from the information in Table 2 when the requirements for water and the facilities for pumping are known.

**Table 2.**—**WATER CAPACITY OF A HYDROPNEUMATIC TANK WITH AND WITHOUT AN INITIAL AIR PRESSURE**

<table>
<thead>
<tr>
<th>Gage pressure</th>
<th>Water in tank when no initial air pressure is provided</th>
<th>Water in tank with 10 pounds initial air pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>lbs.</td>
<td>percent</td>
<td>percent</td>
</tr>
<tr>
<td>50</td>
<td>76.9</td>
<td>61.5</td>
</tr>
<tr>
<td>45</td>
<td>75.0</td>
<td>58.3</td>
</tr>
<tr>
<td>40</td>
<td>72.7</td>
<td>54.5</td>
</tr>
<tr>
<td>35</td>
<td>70.0</td>
<td>50.0</td>
</tr>
<tr>
<td>30</td>
<td>66.7</td>
<td>44.4</td>
</tr>
<tr>
<td>25</td>
<td>62.5</td>
<td>37.5</td>
</tr>
<tr>
<td>20</td>
<td>57.1</td>
<td>28.6</td>
</tr>
<tr>
<td>15</td>
<td>50.0</td>
<td>16.7</td>
</tr>
<tr>
<td>10</td>
<td>40.0</td>
<td>....</td>
</tr>
<tr>
<td>5</td>
<td>25.0</td>
<td>....</td>
</tr>
</tbody>
</table>

The effective capacity of a hydropneumatic tank is increased by having an initial air pressure. For instance, if the gas engine which drives the pump is run every other day and the family requires 50 gallons of water each day, 100 gallons of water will have to be provided between pumpings. Assuming that a range of working pressures from 10 pounds to 45 pounds is desired, we find from Table 2 that a tank with a gage pressure of 45 pounds and an initial air pressure of 10 pounds will hold a volume of water equal to 58.3 percent of the total volume of the tank. When the gage pressure is reduced to 10 pounds, the tank is entirely emptied of water. With 100 gallons as the water requirements between pumpings, a tank having a total capacity equal to 171 gallons (100 ÷ 58.3 percent) would therefore be needed. Such a tank would be approximately 24 inches in diameter and 8 feet long (Table 3). If no initial air pressure were provided and one were to operate with the same range of working pressures, a 285-gallon tank would be required. A tank of this capacity would be approximately 30 inches in diameter and 8 feet long.

The hydropneumatic system is not commonly used with a windmill on account of the size of tank which would be needed. A tank large enough to hold a supply of water to last at least a week or ten days would have to be provided with this source of power.

The fact that only about half the volume of the tank can be used for effective water storage is one of the main objections to this system when it is operated with windmill or gas-engine power, neither of which can be made fully automatic. This means that where the water requirements are large an expensive tank must be provided. Such a
system is seldom recommended for watering livestock unless operated by electric power. With a hand pump, however, the system often is used to provide soft water under pressure for household purposes, because it is then the custom to store water only for one or two days' needs.

Best results with a hydropneumatic system are secured where electricity is available. With an automatic control, only a small storage tank is necessary. Many of these systems virtually pump the water direct from the well, having only a few gallons' storage capacity.

**Pneumatic System Pumps Water Direct from Well**

Where electric power is available, the pneumatic system is usually automatic in its operation and air is utilized for pumping the water direct from the well. It differs from the other systems in that air instead of water is kept in storage. This type of water system is often referred to as a "fresh-water" system, but this is rather misleading since several gallons of water must be pumped before fresh water can be got from the well.

The essentials of the system are: a motor, or engine; an air compressor; a tank to hold the compressed air; an automatic, air-operated pump submerged in the well; piping; and necessary gages and fittings.

The system is most satisfactory when used in shallow-dug wells and cisterns; it is shown in Fig. 11.

**Provision for Soft Water**

Except for drinking purposes, soft water under pressure is preferable to hard water. The supply of soft water, however, is usually limited, and hard water from a well must be used part of the time. This complicates the installation of the farm water system somewhat, for extra piping and pumping equipment are required in order to have both hard and soft water under pressure.

When the water from the well is within 22 feet of the surface of
the ground, one shallow-well pumping unit can generally be used to pump from both the cistern and the well with either a gravity or hydropneumatic system; but if the water in the well is lower than 22 feet, two pumping units will be needed. With the pneumatic system the same air compressor and pressure tank can be used for both hard- and soft-water pumps, provided the lift of water is not over 100 feet.

Where there is sufficient hard water for all needs, a water softener may be used to soften all the water used in the house, except that for the toilet, sill cocks, and for one faucet at the sink. This does away entirely with the need of a cistern. The cost of running a water softener is not high, since ordinary salt is used to regenerate the plant.

**Choice of System Depends First on Power Available**

The kind of water system to select for the farm home depends on the power available, the needs of the household, the source of the water supply, and the local conditions to which the system must be adjusted.

Where electric power is available, any one of the three systems described can be used, since water can be pumped from any source. With its automatic feature, only a relatively small storage tank is needed. It must be kept in mind, however, that if only a small storage tank is provided a pump must be selected with capacity to supply the need at any time.

Where a gasoline engine is available it can be used to operate any of the systems described. In this case, however, a tank should be provided large enough to store water for several days' supply.

The fact that the wind is not so dependable as is either a gas engine or an electric motor as a source of power makes a still larger tank necessary if the windmill is to be used. The windmill is best adapted to a gravity system, but it can be used with a hydropneumatic system where a large-sized pressure tank is provided.
Fig. 11.—A Pneumatic Water System, Without Plumbing

With the pneumatic system, water from different sources can be pumped with one central air-pressure tank and one air compressor. This unit may be used to supply water under pressure to the plumbing systems shown in Figs. 8 and 9.
If a reasonable value is put on human labor, it will be found more expensive to provide an adequate water supply under pressure, for a large family, by a hand-operated pump than by mechanical power. However, it may be practical to pump water by hand from a shallow well or cistern for either a gravity or hydropneumatic system, when only a relatively small quantity of water under pressure is required. In many homes soft water is supplied in this way. When the pumping is done by hand, storage for one day's supply is all that is needed.

**Storage Tank Should Provide a Comfortable Reserve**

With a slow-flowing well or any other slow-running supply, a small capacity pump should be provided with a large storage tank, so that a reserve will be always on hand. Do not make the mistake of installing a system that does not furnish sufficient water. It is much better to have a gravity storage tank with greater capacity than actually is needed than to have one too small. The same is true in selecting a pressure tank for a hydropneumatic system, or an air tank for the pneumatic system. The first cost will be a little greater but the expense will be less in the end, and the convenience and satisfaction of always having plenty of water for all purposes will more than pay for the larger initial outlay.

**Septic Tank Best Way to Dispose of Waste**

No modern water system is complete without proper disposal of the waste water and sewage. The septic tank\(^1\) is recommended as the proper means of disposing of sewage from the farm home. In it the sewage is partially purified and put in condition to be completely purified by means of a filter or system of tile.

The cesspool cannot be recommended for sewage disposal. It is a constant source of danger, as will be evident from a little study of how it functions. The leachings from the cesspool may contaminate the drinking water supply, thereby spreading such diseases as typhoid, dysentery, and summer complaint.

Often the sewer consists of a single tile that leads into a field, a ditch, or a small stream. This method of disposing of sewage is not safe. Rivers are capable of handling pollution without apparent damage, but small streams become foul when raw sewage is turned into them. Any town or individual who discharges sewage into a small stream without at least a partial purification should be prosecuted.\(^2\)

\(^1\)A blueprint plan of a septic tank can be secured from the Farm Mechanics Department of the University of Illinois, Urbana, for ten cents. Instructions for installing and using the tank accompany the plan.

\(^2\)The State Department of Public Health should be consulted before the effluent of a septic tank or sewage of any sort is discharged into a stream or other body of water.