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Water Supply Systems for the Country Home

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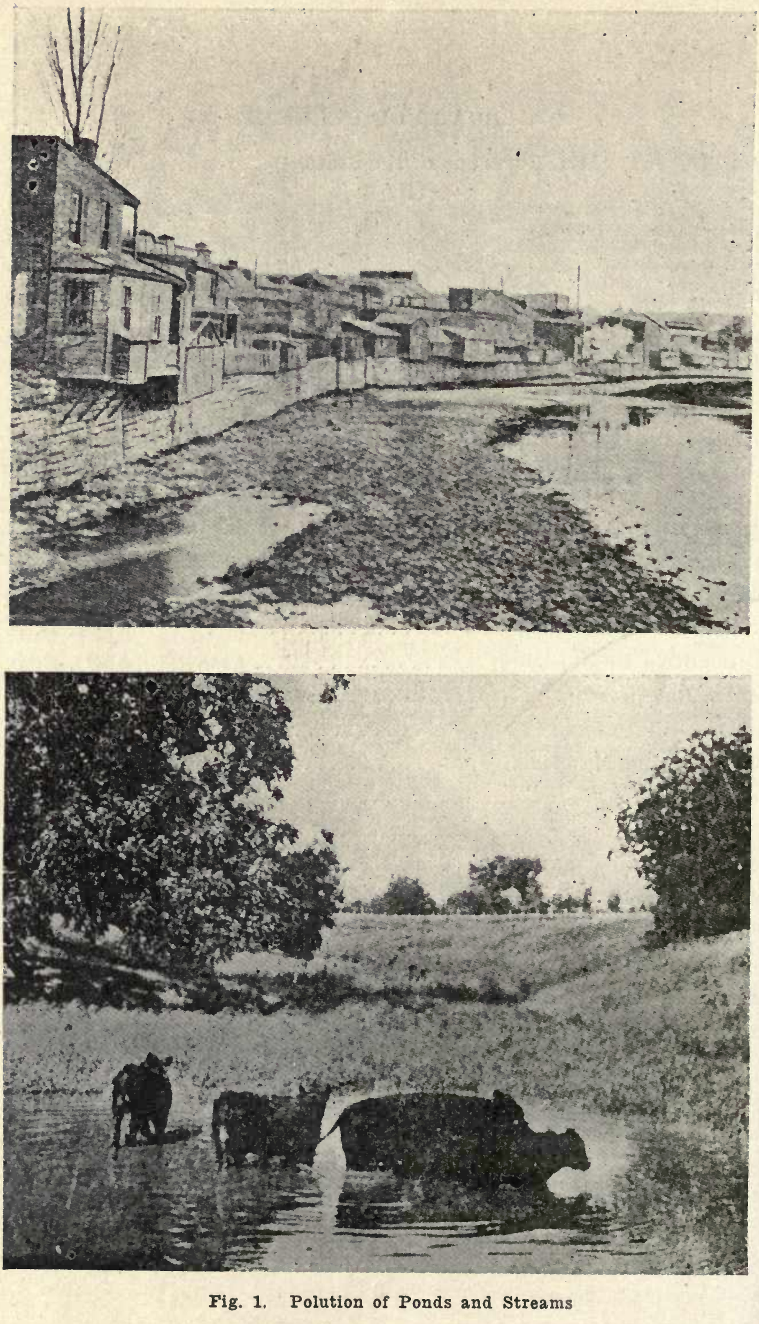


Fig. 1. Polution of Ponds and Streams

Introduction

The modern farmer is coming more and more to recognize the value of labor saving machinery in increasing the profit from his farm. Tractors, harvesters, gang plows and many other machines enable him to complete the field work in season. Large barns house his stock and tool sheds protect his machinery from weather. Everything is tending more and more toward relief from manual labor and especially from drudgery.

One of the most effective modern improvements on the farm, one that has relieved the farmer of hours of weary toil and saved the farmer's wife and daughters much of discomfort, is the modern pressure water system. No other single thing will add so much in comfort to the farm home as hot and cold water in the kitchen, and a bath and toilet in the house; and nothing is more satisfactory to the farmer when he comes in tired from a hot day in the field than to find the water troughs full of water for the stock. Such conveniences make the farm more attractive to the son who is relieved of the drudgery of pumping water for the stock after the day's work is done. They also lighten the work of the daughter in the house, making it possible to do the cooking and cleaning without carrying the water from a well some distance from the house and frequently through storms.

Such conveniences, together with the phonograph, the electric light, the telephone, the radio-phone and the automobile, help to make farm life more attractive than city life, thereby helping to relieve the problems of keeping the next generation from going to the city.

The different systems described are intended as suggestions which the farmer may adapt to meet the conditions on his farm. Exact prices and costs can best be secured from a local dealer in such supplies.

Pumps and Pumping. In general, there are only two types of pumps: (a) pumps in which the water is lifted by the action of a roughly star shaped runner, or runners, revolving rapidly within a somewhat closely fitting case, the centrifugal type. Figure 2).

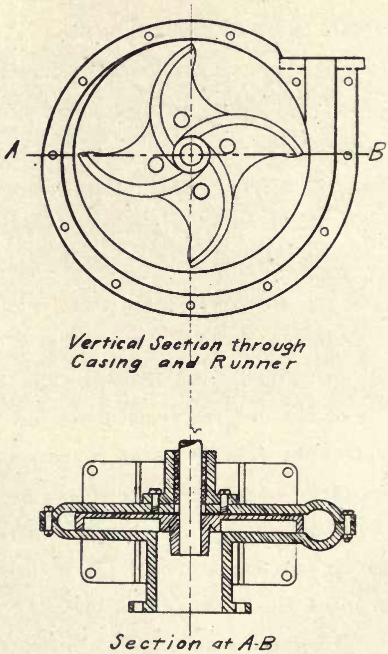


Fig. 2.

(b) pumps in which the water is lifted by the action of a sliding piston or plunger, the reciprocating type.

The ordinary centrifugal pump is not adapted for use in deep wells, but is well adapted to pump from shallow wells or from streams and canals. The lower end of the intake pipe of a centrifugal pump should be fitted with a good foot valve or else it will be necessary to prime the pump every time it is used unless the pump itself is below the water level. The efficiency of centrifugal pumps when properly installed and operated is about the same or a little less than that of reciprocating pumps.

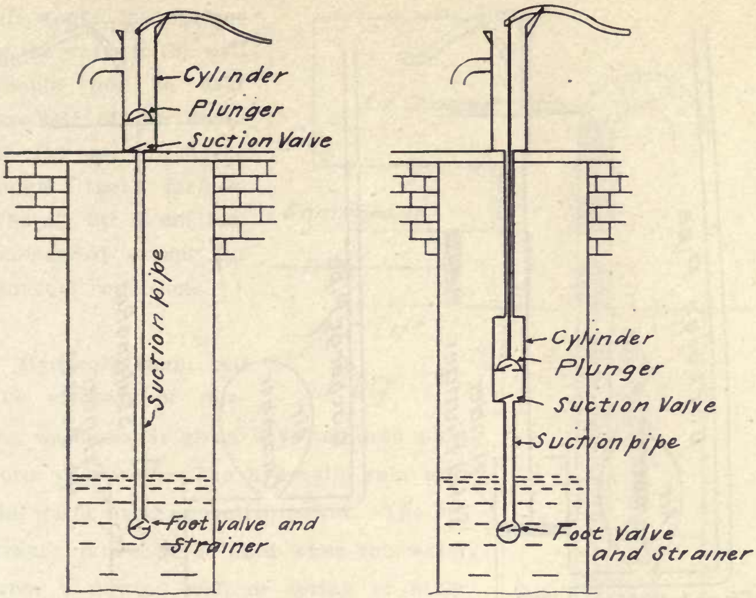


Fig. 3
Lift Pumps

Reciprocating pumps are commonly divided into two classes: the lift or suction pump (Fig. 3) and the force pump (Fig. 4). In both classes of pumps the water is drawn into the cylinder by suction, therefore the cylinder cannot be much over 25 feet above the water and work at all, and for good service it should not be over twenty feet above the water. The closer the cylinder is to the water the better.

Deep Well Pumps. As the available power is always limited pumps intended for use in deep wells or for raising water to great heights are made with cylinders of smaller diameter than those intended for use in shallow wells. In this way a greater pressure may be had from the available power and consequently the water may be lifted or forced to greater heights.

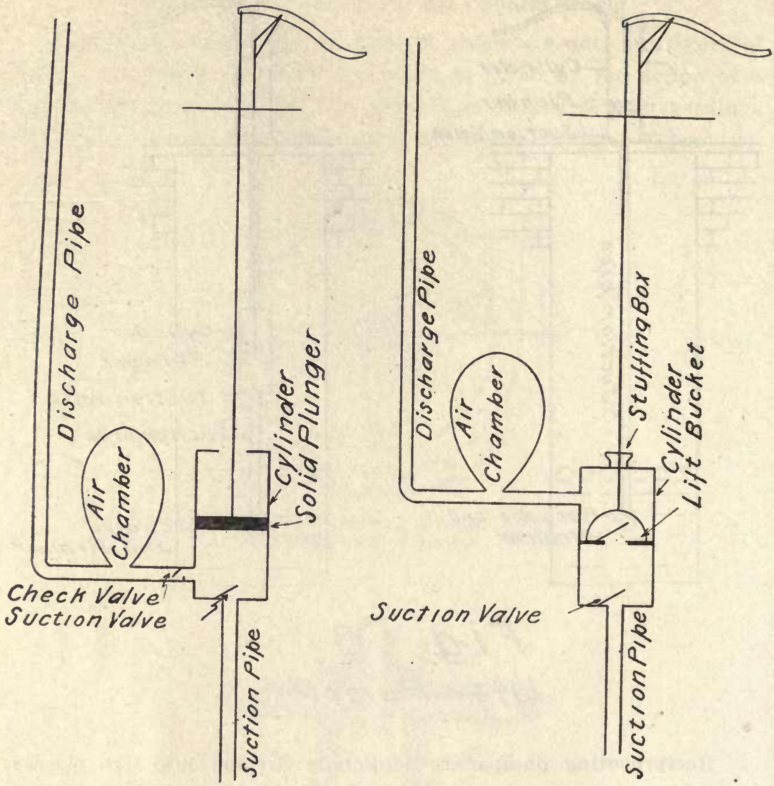
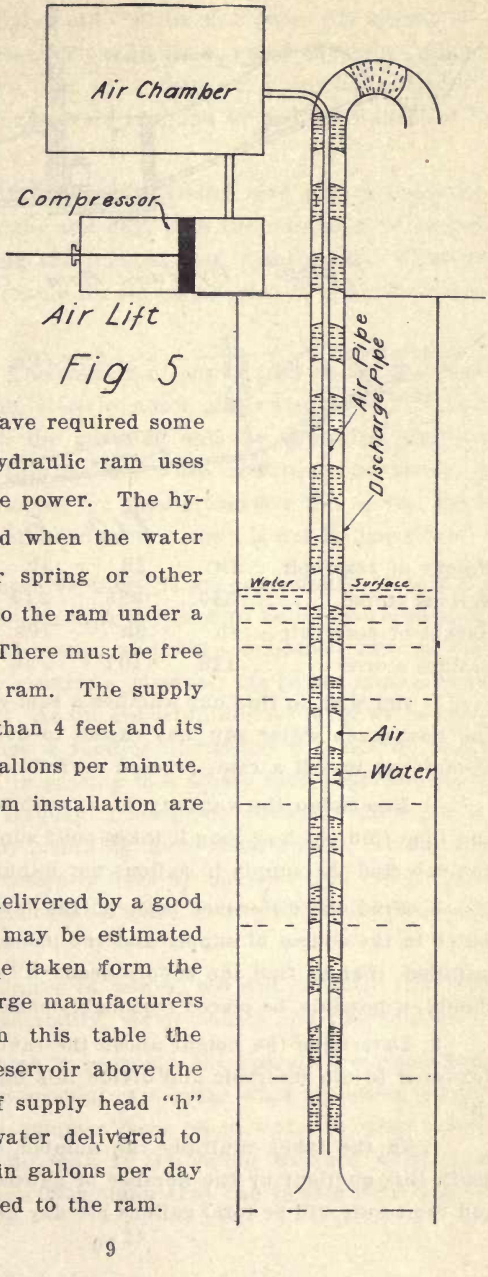


Fig 4

Force Pumps

The Air Lift. While not a pump in the accepted use of the word, it is sometimes used for raising water from wells. This manner of raising water consists in forcing compressed air through a small pipe inserted within the casing of the well and the air emerging from the pipe near the bottom of the well can escape only by passing upward between the air pipe and the casing. As the air rises the water is carried along with it and is forced out at the top of the casing as shown in (Fig. 5). For good service the height of lift above the surface of the water in the well should not be over one-half of the depth of the air discharge below that surface. The air lift is not recommended except for unusual conditions.



Air Lift

Fig 5

Hydraulic Ram. All the methods of raising water so far given have required some form of power. The hydraulic ram uses the water itself as motive power. The hydraulic ram may be used when the water from a flowing well or spring or other source may be supplied to the ram under a head of 4 feet or more. There must be free drainage away from the ram. The supply head should not be less than 4 feet and its supply not less than 4 gallons per minute. Two typical forms of ram installation are shown in Fig. 6.

The amount of water delivered by a good ram, properly installed, may be estimated from the following table taken form the catalog of one of the large manufacturers of hydraulic rams. In this table the height of the storage reservoir above the ram is given in terms of supply head "h" (see Fig. 6) and the water delivered to the storage reservoir is in gallons per day per gallon minute supplied to the ram.

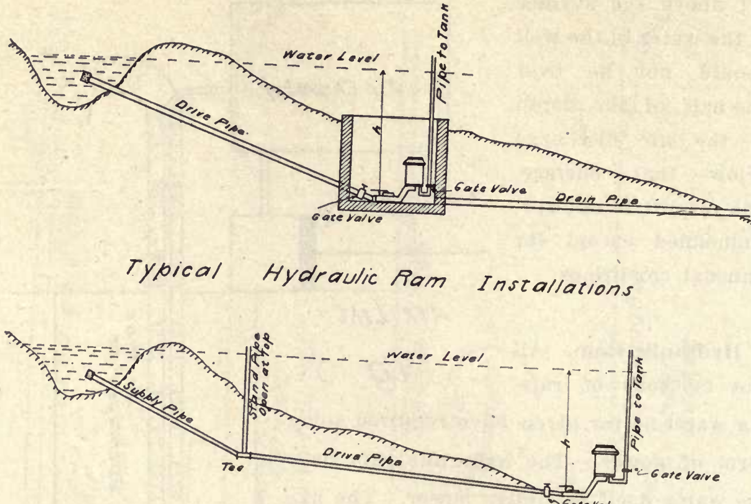


Fig 6

Height of reservoir . . 2h	3h	4h	5h	6h	7h
Gallons stored 540	336	240	192	160	137
Height of reservoir . . 8h	9h	10h	15h	20h	30h
Gallons stored 120	107	96	64	43	24

If you wish to find out whether a ram can be used in your case, and how much water you may expect to deliver into your reservoir should you install a ram, proceed as follows:

1. Determine the capacity of a washtub or other large vessel and then find out how long it takes your supply to fill it. From this you can find the supply in gallons per minute.

2. Find the difference between the level of the surface of the water in the source of supply and the place where the ram is to be installed, that is, find the supply head "h" (See Fig. 6). The ram should, if possible, be placed reasonably close to the source of supply.

3. Determine the height above the ram that the water is to be delivered to the reservoir and divide this height by the supply head "h".

4. In the table, multiply the number of gallons found underneath this quotient by the number of gallons per minute of supply, and the result will be total gallons per day delivered to the reservoir.

To illustrate. Suppose we find (1) the supply to be 7 gallons per minute; (2) the supply head "h" to be 5 feet; (3) height of a reservoir above ram 45 feet. Then 45 divided by 5 equals 9. Underneath 9h in the table we find 107, whence the number of gallons per day delivered to the reservoir is found to be 107 multiplied by 7 equals 749.

The hydraulic ram when once installed and put in operation, operates continuously, night and day, with the minimum of expense for repairs; its life is long and its first cost is not great. Wherever conditions are at all favorable for its installation it is highly recommended.

Sources of Power. The sources of power used on the farm are; windmill, gasoline engine, electric motor and water power. Any of these may be used both for pumping and for operating machines about the farm. For this reason, when selecting the source of power to be used for pumping we should consider the service which may be had from that source when the pump is not in operation.

Water Power. Wherever there is an opportunity to install a water power plant on the farm, it is found to be a most economical and dependable source of power; and when combined with an electric generator and other electric appliances, the power system is the most convenient possible. As the opportunities for farm water power installations are very few a further discussion will not be undertaken except to mention in passing that where such opportunities do exist, the farmers have frequently been very successful in supplying themselves with power by installing home made wheels. In one such instance the farmer successfully used an old cast iron pulley wheel to the rim of which he had bolted grain elevator buckets from some old threshing machinery.

In discussing the source of power, we will consider first cost, operating expense, dependability, serviceability and convenience.

A windmill ranks high in economy, the operating expense being almost negligible, but on account of varying wind velocities it is not dependable. In the hot summer days, when water is most needed, there is usually less wind than in the colder weather when water is less needed. It is not uncommon that the farmer who depends upon the windmill for his pumping is forced to resort to hand pumping at the time of year when he can least afford the time, or else he must have a small gasoline engine for use at such times. **To avoid this difficulty, a very large storage reservoir is needed.** The reservoir must hold enough water to tide over any probable period of calm weather. A windmill used in connection with such a reservoir and with a proper distributing system may make a very convenient water supply system.

On account of the variable power output of a windmill, it is limited in service. Many attempts have been made to devise methods of storing the excess output electrically at times of high wind and making it available in times of calm, but all attempts, so far, have been only partially successful.

Gasoline Engine. The modern gasoline engine is nearly, if not quite, as dependable as the steam engine and thus takes high rank in dependability. When properly mounted on a small truck it can be moved about the farm and used for many purposes. In this way it becomes very convenient and serviceable. Its first cost is not high but it is comparatively short lived and its operating cost is fairly high. When operating at its rated capacity the gasoline engine does its work efficiently and cheaply but it will not carry overload at all. When operating at less than full load the fuel cost is very high, being nearly or quite the same as when fully loaded. The convenience of the gasoline engine may be increased by combining it with an electric generator but cost is correspondingly increased.

Electric Motor. Electric power is the most convenient and serviceable, and whenever such power can be obtained from a cross country line it is very dependable. Electric motors are not high in first cost and are comparatively long-lived, having an ordinary life of several times that of a gasoline engine. As with the gasoline engine, the high operating cost is its one drawback. The following table gives an approximate comparison between a gasoline engine and an electric motor of the same horsepower. See local dealer or catalog for exact prices.

A gasoline engine requires about .17 gallons of gasoline per brake horse-power hour. An electric motor requires about 0.9 to 1.0

H. P.			Floor Space			
OF	Weight in Lbs.		Inches	Approx.	Price	
Motor	Engine	Motor	Engine	Motor	Engine	Motor
5	1200	250	30 x 50	28 x 36	$175-225	$100-150
3	650	200	25 x 45	23 x 28	80-150	75-125
2	350	150	24 x 30	21 x 24	60-125	60- 90
1	200	100	18 x 30	16 x 20	50-100	50- 65
½		60		12 x 16		35- 45

kilowatt hour per brake horse-power hour. On this basis gasoline at 30 cents per gallon is the equivalent of electricity at about 5 cents per kilowatt hour. But we should remember that an electric motor will last as long as two or more gasoline engines and for this reason we can afford to pay a little more for electricity; that the electric motor will always deliver its full rated capacity and for short times will carry a 25% overload without difficulty; that the motor operates at constant speed at all times without noise or vibration; that the gasoline engine is dependent upon a proper adjustment of the valves and sparking to give even rated capacity, and that there is always a great deal of noise and vibration.

A one-half H. P. motor is sufficiently large to run any one of the small farm machines such as fanning mill, food chopper, cream separator or churn. When it is learned that a one-half H. P. motor can be carried easily from one place to another by one man its great convenience is seen. When the farm buildings are once wired a small motor becomes of service anywhere.

Several companies are now putting out farm lighting plants consisting of a gasoline engine, an electric generator, a storage battery and switchboard. These are set up, connected and arranged with automatic controls ready for use. They are usually of small size as they are intended to produce only sufficient power for lighting the house and other farm buildings, vacuum sweepers, etc., and are not intended for heavier power purposes. The same arrangement, with larger capacity, could be used for general power plant.

Storage of Water

That the water may be convenient for use it is necessary that a pressure system be installed. Some sort of storage is necessary unless water is obtained from a large spring or similar source located at a point above the house or from one of the new systems which automatically starts pumping as soon as the faucet is opened and stops when it is closed. There are three common ways of providing for this storage. (1) The hill reservior. (2) The elevated tank. (3) The pneumatic pressure tank. The first two of these operate alike and are here treated separately only because they are applicable to different local conditions.

The Hill Reservoir. This is valuable only for such houses as have a hill nearby that is considerably higher than the peak of the house and other farm bulidings. An excavation large enough to hold at least several days supply of water is made in the earth at the top of the hill. The excavation is lined with brick set in cement mortar, or better with a 6-inch wall of concrete and then covered over with a concrete slab or brick arch. All inlet, outlet and overflow pipes should be carefully built into the walls. The cover of the reservoir should be about two feet underground. This depth of earth cover prevents freezing in winter, and keeps the water in the reservoir from becoming warm in summer. An opening of about two feet in diameter should be brought up to the surface of the ground so that access may be had to the reservoir for purposes of examination or possible cleaning. With a force pump water is forced into this reservoir and from the reservoir is distributed to all parts of the farmstead. A pressure water heater may be installed in the house and hot and cold water may be had in the kitchen, bath room and laundry, and water may be had at the stock trough or other places at the barn, simply by opening a cock.

If the source of power operating the pump is not very dependable, the reservoir should be large enough to hold sufficient water to tide over any probable period of scant supply. Generally the reservoir should have two chambers, each connected with the inlet, outlet and overflow pipes. In this way one chamber can be used when the other is being cleaned or repaired and a supply of water is insured at all times.

The Elevated Tank. A wooden or metal tank large enough to hold the necessary supply of water may be constructed on the top

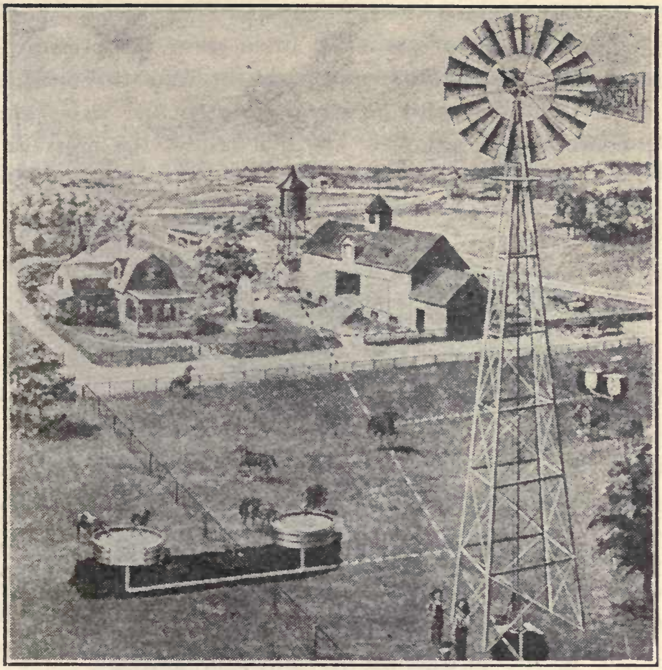


Fig. 8

of a tower sufficiently high to furnish the desired pressure. See Fig. 7. Its operation is exactly the same as that of the hill reservoir, the tower, instead of the hill, furnishing the necessary elevation. But the elevated tank is not protected from changes in temperature and the water becomes warm in summer and is liable to freeze in winter. Unless the tank and the connecting pipes are carefully surrounded with frostproofing there will be some trouble with broken pipes in cold weather. If it is desired to use the water for lawn sprinkling or fire protection purposes the tank tower should not be less than thirty feet high.

The Pneumatic Pressure Tank. Water and air are pumped into a large water and air-tight tank. The outlet pipe from this tank is at the bottom.

Since the discharge from a hill reservoir or an elevated tank is by the action of gravity only, it is necessary to increase the height of the reservoir hill or the tank to increase the pressure. On the other hand, since the pressure tank operates in opposition to gravity it is only necessary to pump more air and water into the tank to increase the pressure. In this respect the pressure tank has an advantage over the other ways of storage, since the pressure may be increased at will without additional cost. Fig. 8.

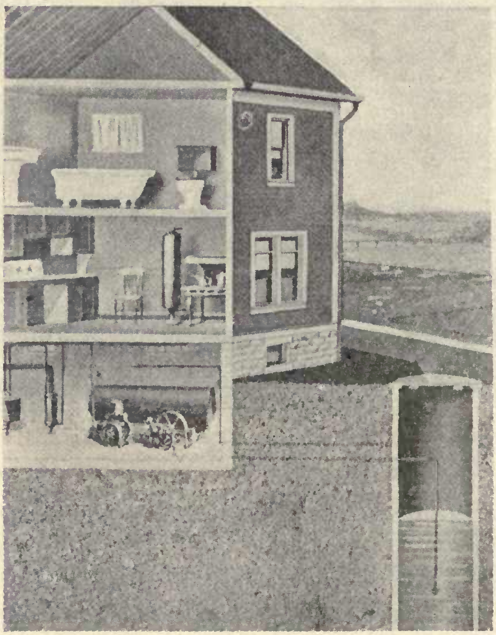


Fig. 7.

It is customary to place the pressure tank in the basement of the house or barn, or to bury it in the ground with one end projecting into the basement. It must be fitted with a water gauge so that the quantity of water in it may be determined at any time. It must also be fitted with a pressure gauge so that the pressures may not run so high as to burst the tank nor run so low that there is no discharge of water. The pressure gauge should be in a conspicuous place, such as immediately over the kitchen sink, so that the pressure will be under observation at all times.

When the tank is placed in the basement or buried in the ground, there is very little chance for the water in it to freeze in winter or get warm in summer. The principal objection to the tank is that the pressure falls off rapidly as water is drawn from the tank.

Tanks may be had of almost any capacity. The operating capacity of any tank is only three-quarters the rated capacity, as there must always be sufficient air in the tank to provide the required pressure. Any good force pump may be used to force the water into the tank, but it is best to secure a pump made for use with these tanks. These pumps are provided with an air valve through which the proper amount of air is drawn into the pump and forced into the tank with the water to keep up the pressure. Unless such provision is made, it will be necessary to force the required air into the tank with a small air pump. (The regular pump would operate as an air pump for this purpose, if the suction pipe below the cylinder could be taken from the water and everything could be kept tight).

There will be but little difference in the cost of construction of the three types. A very high tower or large tank will be costly, but so will be a large sized pressure tank or a long line of pipe to the top of a distant hill. The local condition determines the cost.

Another type of water system developed in recent years consists of a small electric motor operating a small pump. The motor operates the pump to accumulate a predetermined pressure in the system, when a pressure controlled switch opens the circuit and stops the motor. When the faucet is open the pressure is released, allowing the switch to close the motor circut thus again starting the motor. Pumping continues until the faucet has been closed and the pressure restored, when the motor is again automatically stopped. The motor gets its energy either from a commercial power line or from a farm lighting plant. Still a further development of this system consists of a small gasoline engine driven pump with automatic electric switch as above. The engine also drives a generator which charges a small storage battery for starting use alone. The starting switch closes the battery circuit through the generator which acts as a starting motor to start the gasoline engine, after which it again operates as a charging generator. Such a machine is very compact and self contained so that it can be installed independent of any other source of power.

Hill Reservoir

Advantages

Constant temperature
Constant pressure
Low upkeep cost
Water in reservoir always available for use.

Disadvantages

Not always possible

Elevated Tank

Advantages

Constant pressure
Water in tank always available for use.

Disadvantages

Water warm in summer and freezes in winter. Consequently high upkeep cost.

Pressure Tank

Advantages

Constant temperature
Complete pressure control

Disadvantages

Variable pressures
Water in tank not all available
Medium upkeep cost.

Automatic Electric Pressure System

Advantages

Avoids cost of large pressure tank
Moderate first cost
Fresh water as used
Can be located in basement
Practically noiseless
Small upkeep costs
Automatic in action
Reliable
Requires very little attention

Disadvantages

Must have current supply from external source.

Automatic Gas Electric Pressure System

Advantages

Avoids cost of large pressure tank
Fresh water as used
Can be located in basement
Can be used remote from current supply.

Disadvantages

Reguires frequent inspection
Gasoline and oil must be kept in supply
Storage battery subject to depreciation regardless of use.
Expensive upkeep, after long continued service.
Noisy

From this summary, it is evident that the hill reservoir is to be recommended wherever there is opportunity to construct it. When the hill reservoir cannot be had, the constant temperature and moderate upkeep cost of the pressure tank probably outweigh the constant pressure of the elevated tank.

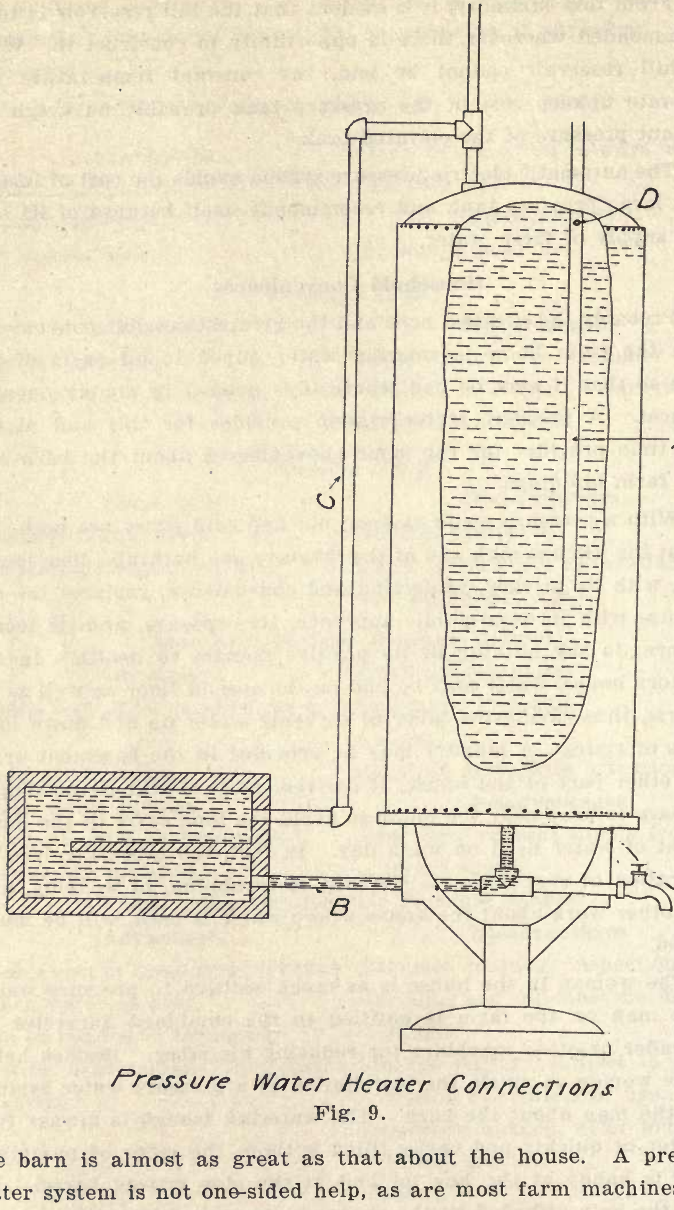
The automatic electric pressure system avoids the cost of installing a large pressure tank and recommends itself because of its constant supply of fresh water.

Household Conveniences

Probably the greatest need and the greatest possible convenience about the farm home is running water, piped to all parts of the house so that it may be had where it is needed by simply opening a faucet. A pressure water system provides for this and at the same time provides for the same conveniences about the barn and other farm buildings.

With a pressure water system, hot and cold water are both "on tap" at the kitchen sink and at the lavatory and bathtub. The inside toilet, with its privacy, protection and convenience, replaces the old outhouse with its semi-public approach, its exposure, and its inconvenience, to say nothing of its positive menace to health. In the two-story house, water may be had on the second floor as well as on the first, thus saving the labor of carrying water up and down long flights of stairs. A laundry may be provided in the basement or in some other part of the house, if desired, since it will be no longer necessary to keep near the pump to avoid the long carry of the large amount of water used on wash day. In fact, the labor involved in preparation of vegetables, in cooking, in scrubbing, in washing, and in all other work about the house where water is used, will be much reduced.

The woman in the house is as much entitled to pressure water as the man on the farm is entitled to the combined harvester or the header or other machines for reducing his labor. Besides helping the woman so much, the installation of a pressure water system helps the man about the barn. The watering trough is always full of water or quickly and easily filled without the labor of pumping. Water is handy at the hog lot and at the slop mixing barrel. In short, the help afforded by the convenience of pressure water about



Pressure Water Heater Connections

Fig. 9.

the barn is almost as great as that about the house. A pressure water system is not one-sided help, as are most farm machines, but it is a help to the whole family.

Figure 8 shows the installation of some of the household conveniences that have been mentioned. In the figure, a pressure tank is the indicated source of supply, but a hill reservoir, an elevated tank or an automatic electric, or gasoline pumping plant would serve just as well.

Figure 9 shows the best methods of making the connections to a pressure water heater tank. In the figure, pipe A is the main supply pipe, pipe B leads from the heater to the water back or heating coils in the kitchen range, pipe C leads from the heating coils to the top of the storage tank. The pipe C should always slope up from the heating coils toward the tank. D is a small hole in the main supply pipe to prevent siphonage. With the connection as shown, hot water may be had in a very few minutes after the fire in the range is started.

Fire Protection. It is not probable that any water supply system that may be installed on a farm will be adequate to put out a fire that is once under good headway; but taken at the beginning the fact that a large supply of water is available for immediate and continuous use, makes it possible to put out a fire that could not be checked by pump and bucket methods. It should be kept in mind that large pipes give much better service than small ones in putting out fires. For this reason, it is true economy to make the main pipes large enough to supply all the taps at the same time.

Costs

Pumps and Machinery. The cost of lift or force pumps of such size as are used on the farm is only a few dollars. There are so many different sizes and styles of pumps used that the actual cost prices cannot be given with any assurance of accuracy. In every case, the local dealer will be able to advise as to type and size needed and cost of same. Any local hardware dealer can furnish prices on all types of pumps, engines, rams, windmills, etc., or prices of same may be secured from popular farm supply catalogs. If there is a local company supplying electricity, always consult them as to the type of electric motor to buy; that is, direct current or one, two, or three phase alternating current.

Storage. The hill reservoir can be entirely constructed by the farmer himself, with the assistance of his regular help. In this case, the money outlay would be for material only. An excavation fourteen feet long, seven feet wide, and ten and one-half feet deep would be required for a reservoir of sufficient size to contain 4000 gallons. A reservoir of this size should be divided into two chambers, as described in the bulletin.

If a concrete lining is to be used, the excavation should be carefully trimmed to the given dimensions and the earth used for the outside forms for placing the concrete. The side walls should be six inches thick with a small amount of reinforcement to prevent cracking; the bottom, six inches thick, with sufficient reinforcement to prevent cracking caused by settlement; the top, six inches thick, reinforced to carry the two feet of earth cover safely; the partition wall twelve inches thick will require a small amount of reinforcement to prevent cracking when one chamber is empty. This construction leaves the water chambers each six feet by six feet by eight feet deep.

The materials required for the concrete lining are as follows:

Portland cement	72 sacks or 18 bbls.
Sand	5.5 cubic yards
Screened gravel or crushed rock	10.6 cubic yards

The amount of reinforcement required will depend somewhat on the character of the soil in which the excavation is made. For average conditions, the top slab will require three-eighths inch round steel rods spaced five inches apart running one way across the slab and one foot apart the other way. In good firm earth, the bottom slab should have about the same reinforcement. For the side walls, vertical rods spaced one foot apart for half the height from the bottom and two feet apart for the remainder, with a horizontal rod every two feet, should be sufficient in any soil.

The total amount of excavation required is forty cubic yards.

A wooden tank, of the same capacity as the hill reservoir noted above, placed on a steel tower thirty feet high, will cost approximately $275.00 exclusive of erection.

A 2000-gallon pressure tank will cost about $300.00 exclusive of installation. (See local dealer or consult catalogs for exact prices of above.)

The cost of the piping and installation for the three types under circumstances favorable to each, would be about the same and would depend entirely on local conditions.

Conveniences. Since the cost of installation is usually one of the largest factors in the total cost of sanitary household equipment, it will be necessary to consult your local dealer or plumber to determine the cost of pressure water heaters, bathtubs, sinks, and other household equipment.

Conclusion

If pumping is done by hand from a well of any considerable depth, the cylinder must be of small diameter and the discharge will be correspondingly small. Even when a windmill is used in direct connection with a pump, it is best to use a cylinder of small diameter so that the mill will pump with light winds (eight miles to twelve miles per hour). But when a gasoline engine or electric motor is used, power is supplied at a constant rate and the pump should be selected to use this power.

This allows the selection of a pump with larger cylinder and consequently less time is required to do the pumping. A 2 H. P. motor, connected to a pump of proper size, will deliver about 150,000 gallons of water one foot high in one hour. This is the same as pumping 1500 gallons per hour to an elevation 100 feet above the surface of the water in the well. The motor will require from 5 to 6 K. W. hours of electricity to do this pumping. Or, if a gasoline engine is used, it will require from one and one-fourth, to one and one-half gallons of gasoline.

Should you attempt to pump this quantity of water by hand it would require many hours of hard work. Forty-five cents worth of gasoline and the wear and tear on the engine are the dollars and cents offset against extreme weariness and a scant water supply. Conveniences cannot be measured in dollars and cents. Besides the saving of time and strength, there is a satisfaction in having what you need, and this satisfaction is increased by the pleasure which replaces the drudgery.