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WHAT TYPE OF WATER SYSTEM SHALL I INSTALL?

By E. A. Stewart, Division of Farm Engineering

(Reprinted from Farmers' Institute Annual No. 34)

The purpose of a discussion of this nature is to acquaint the reader with a comparative knowledge of the different types of water systems. Most people get their knowledge of water systems through advertising, either in newspapers and magazines or by displays at fairs. The fact that commercial firms have advertised home lighting plants so persistently is the reason why many farmers install lighting plants before they do water systems. Very few people have a knowledge of simple inexpensive water sys-

Fig. 1
The practical type of power for pumping for most farms. The tank is not protected in winter but gives no trouble with freezing

tems. No one sells these and no one advertises them.

In a discussion of different types of water systems, it is best to classify them. We have three main types of water systems: gravity, hydropneumatic and the pneumatic or air power systems. Since the gravity type of water system has a wider application than the others, it should be treated first.

Gravity System

The name "gravity system" is applied to those water systems where the force to push the water through the pipes is produced by weight of the water. The supply tank must be elevated above the place where the water is to be used. There are few people fortunate enough to have a hill near the house on which a water tank may be placed. At only one home in four, however, where they are so favorably situated, has advantage been taken of this gift of nature. Let's make it one hundred per cent in the next five years. The nearest fool-proof and lowest cost water system available is secured by using a windmill for pumping and storing the water in a tank on a hill. Do not put the tank higher than is necessary, but high enough to supply water to the house. This tank does not need to be buried in the ground. It will not give trouble with freezing if it is on top of the ground, as long as it cannot freeze under the tank. The tank shown in Fig. 1 has given very satisfactory service for nearly 20 years without freezing.

The question is often asked, "Is it practicable to use an elevated tank out of doors?" Our answer to this question is usually "No." If a man wishes to build an expensive milk house, or pump house and place his tank above this, it may be done. The house below the tank must be built exceedingly warm to prevent the freezing of pipes and the freezing of

Fig. 2
This type of tank is not suitable. Any elevated tank must be protected from freezing.

the tank on the bottom. The house should extend clear up around and over the tank to protect it. Tanks like the one illustrated in Fig. 2 should never be used.

It is not necessary to elevate all of the water on a farm unless water cups are used for the stock. In this case an elevation of four or five feet above the cups is sufficient. This is best carried out by placing the stock storage tank in the barn loft. This tank can be protected from freezing by heating it from air in the stock room. This tank would not be high enough to supply water for the house in most cases. The house supply can be secured by placing an elevated tank in the second story of the house.

An elevated water tank holding four barrels, together with an inside toilet, a kitchen sink, a septic tank, water pipes and soil pipes, were installed recently for about $200.00.

Another water system consisting of two elevated tanks, full bath room equipment, an extra inside toilet, a hot water tank, an elegant kitchen sink of the most expensive type, a septic tank, and all necessary plumbing was installed for $650.00.

The gravity system has so few parts to get out of order that it causes less trouble and lasts longer than nearly any other type of system. Where a windmill is used for pumping, the gravity system is the most satisfactory, the cheapest to operate, and costs the least of any type.

Hydropneumatic Systems

These systems are, as the name indicates, water systems using air pressure to force the water to various parts of the home. These systems may be operated by hand, by windmill, by a gas engine, hot air engine, or electric motor. It is not practicable to use them with all of these

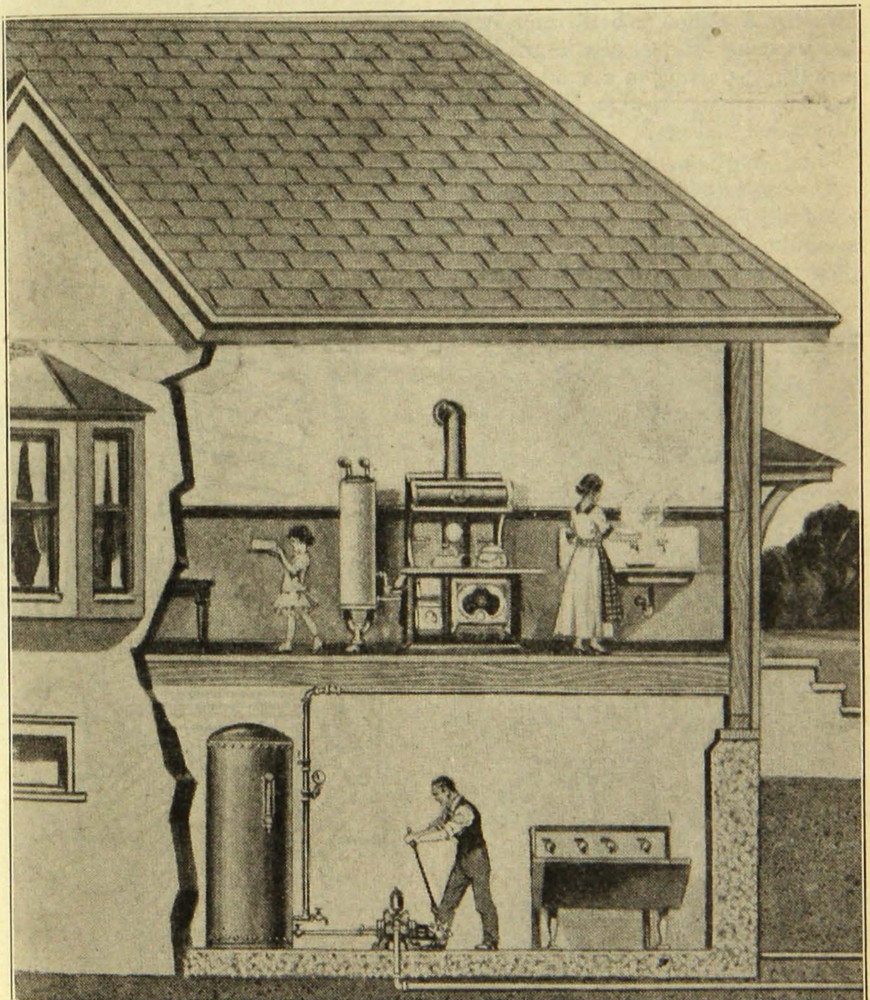

Fig. 3
A hand operated hydropneumatic system. This is not practicable for a complete bathroom equipment

different types of power. This type of system might be used for the hard water for all purposes, hard water just for household purposes, or soft water for house use. It may be used for a household water supply, while a windmill and a large storage tank are used for the stock.

The hand operated systems when water is taken from either wells or cisterns have not proved satisfactory. I have been told by many people that they discontinued using them. One man has a complete bath room outfit that is lying idle because he made the mistake of putting in a hand operated hydropneumatic system like the one illustrated in Fig. 3.

The hydropneumatic systems are not very satisfactory to use with a windmill and should not be used with a windmill to supply water for stock. The back pressure that must be pumped against cuts down considerably the amount of water pumped. If the wells are deep, even with any of the sources of power, these systems are not all that might be desired. They are very hard on plunger leathers and cause some trouble with broken and worn pump rods.

A number of this type of water systems have given satisfactory service with a gas engine as the pumping power. On the other hand, they cause considerable grief when the gas engine balks. If anyone is contemplating a system of this type to use with a gas engine, he should use a large tank of at least 480 or 1,000 gallons capacity and not try to use it for watering the stock. This type of installation may be used satisfactorily with a hot air engine.

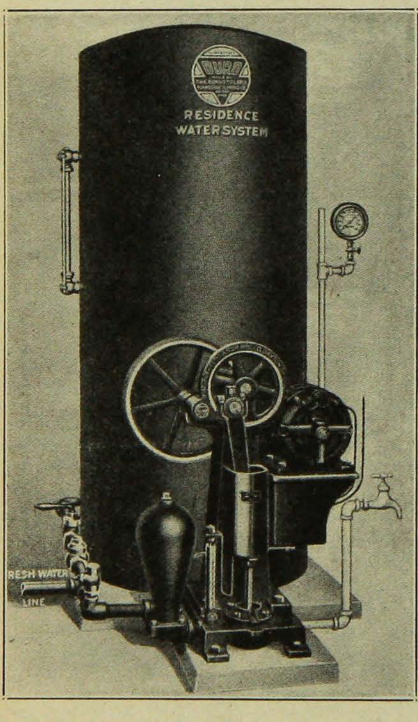

Fig. 4
The ideal power for a hydropneumatic water system

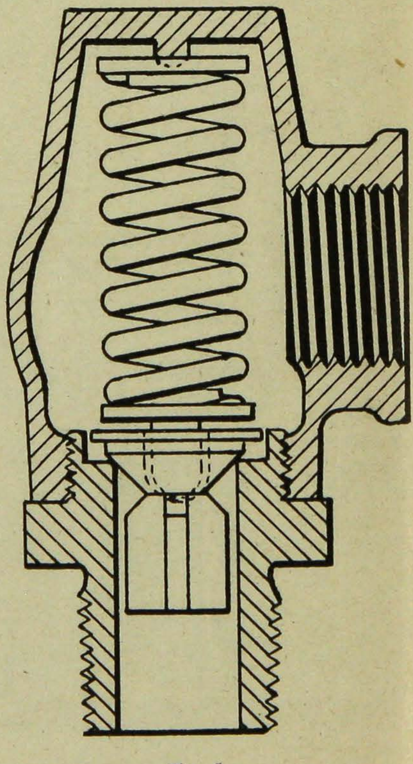

Fig. 5
A relief valve to use on pressure water systems

Ideal Hydropneumatic System

The ideal place for a hydropneumatic system is where power company electric service is available. The system can then be controlled by an automatic switch and the service is fine. Such a plant is illustrated in Fig. 4. For household use a very small tank is all that is needed and the tank and pump need not cost more than $200.00. If this system is to be used for stock a large tank should be used to hold sufficient water to use during times when the pump or motor needs repairing. This system may be operated by electricity from the home lighting plant, if desired. This operation should be restricted, I believe, to cistern and shallow well outfits, and for house use only. They may be used for pumping water for stock providing they are not automatic and are run only when the generator is being run to charge the batteries and then pump the water into a plain stock tank. The cost of any hydropneumatic system will be higher than a gravity system and will probably not last as long, but yet it may be more desirable.

Caution: Every hydropneumatic water system should have a relief valve attached and this valve should be tested regularly.

Air Power System

This type of water system has been well advertised and many farmers have been impressed with the idea that this is the only type of water system that will give pure fresh water to drink and always on tap. One man said, "Well, I want water at the turn of a faucet, just like they have it in town, all over my buildings, chicken coops and all, and how else can I get it?" These systems, called "fresh water systems," have their proper place among water systems, but I hardly believe that a man should put in one of these systems unless he has all other necessary conveniences and desires this as a crowning feature. One man recently installed one of these systems at a cost of $650.00 and all he has for his money is running water at the barn, and air for his Ford.

If a farmer has power company electric service and wishes both soft and hard water on tap, then he has the ideal situation in which to use an air power or pneumatic system. This system is fully explained in the article dealing with it. We had one inquiry recently from a man who wishes to use this system in connection with a Delco lighting plant. Consider for a moment what transformations of energy and what value of machinery he was going to wear out for pumping. He was going to run his generator with the gas engine, the generator would charge the storage batteries, the storage batteries would run his motor, the motor would run the air compressor, the air compressor pump air into the tank, the compressed air in the tank do the pumping. From every dollar's worth of gasoline he would get about sixteen cents worth of pumping. Compare using his $1,300 outfit, for pumping, in wear and expense with a $100 windmill and see which you will choose.

In Conclusion

The automatic, more complicated systems of water supply are very fine to use where power company service is available, but in other cases the gravity system will be the cheapest, the most satisfactory and last the longest.

WELLS AND WATER SUPPLIES

The wells of our fathers may bring to us memories of the "Old Oaken Bucket," but not memories of cleanliness. The well shown in Fig. 1 may incite a poet to nobler efforts, but its unsavory aspect is a disgrace to our civilization. The water from nine out of ten such wells is dangerous to drink. I have frequently heard people remark concerning such a well, "The water is cool and clear as crystal." It may be, but this does not inform us concerning the thousands of dangerous disease producing bacteria in each spoonful.

Sources of Water Supply

We find the water for home consumption is still taken from many sources. Altho wells provide nearly 90 per cent of the population with water, the other ten per cent get their water from springs, lakes and cisterns. The large number of wells that are polluted (See Figure 4) is a serious menace, but the four other sources named above are much more dangerous unless carefully handled.

Seepage springs are quite likely to be polluted in a closely populated district, but may be pure if properly protected at the surface. The spring should be so protected as to keep all animals away from it. A concrete housing and cover with overflow pipe can be arranged as shown in Fig. 2.

The purification of water from cisterns, lakes, and rivers may be done by filtration through a brick and sand wall. One excellent illustration of how this may be done is shown in Fig. 3. This shows the method used by Mr. Holder at Eveleth to get his water supply. The basement floor is about two feet above the water level in the lake. The ground is hard clay around the lake and he did not desire to dig very deep for the pipe. The water siphons into the well or cistern in the basement. It then filters thru the partition as shown. The water is then pumped to the tank above.

Fig. 1
Cool, but dangerous

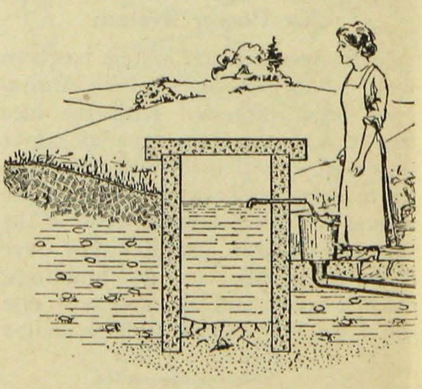

Fig. 2
Showing how a spring may be protected from pollution. After State Board of Health

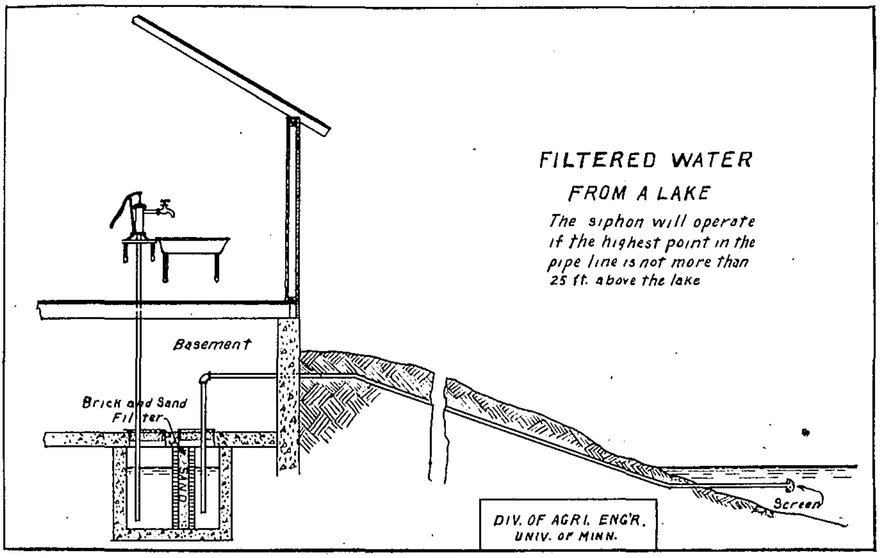

Fig. 3
Diagram showing method of getting a water supply from a lake

Cisterns

It might be well at this point to refer to cisterns. Cisterns may be placed either outside of the house or in the basement. If the house is built without a basement then the cistern obviously must be built outside. However, any house that is being built at present should have a basement. This basement can be used for many things and costs the least of any room in the house. If the house is built with the basement, by all means place the cistern therein. This has several advantages. It is more permanent, there is no danger of dirty surface water leaking into it; it costs less, and it is more easily cleaned than the outside cistern. Types of outdoor and indoor cisterns are illustrated in Bulletin No. 55 on "Low Cost Water Systems." These outside cisterns can be used where necessary and if well constructed, they will last many years. Many people have had trouble with cracks in the walls owing to freezing of the ground. This often allows dirty surface water to seep in. The outdoor cistern is considered very dangerous as a source of drinking water.

Wells

Wells are classified into four types: namely, dug, bored, driven and drilled. These types are based on the manner of securing the well. For a complete discussion of these different types and the methods used in securing them refer to Farmers Bulletin No. 941, Division of Publications, U. S. Department of Agriculture, Washington, D. C.

The dug wells and bored wells are quite often unsatisfactory and very frequently polluted. Analyses show that the water from about three out of four wells under twenty-five feet in depth is dangerous for human consumption. More than one-half of these can be remedied easily. Fig. 4 shows the condition found around many dug wells. This is a type of dug well and pump that we are glad to see pass into oblivion. The bored wells are usually more free from pollution than are the dug wells.

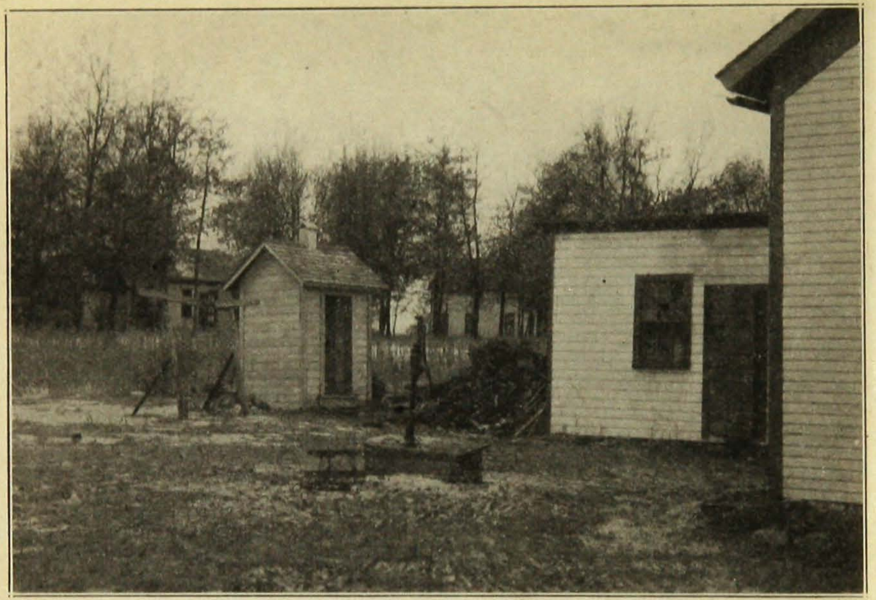

Fig. 4
An unsanitary location for a well. Poor platform and curbing. This well is dangerous

The Dug Well

The illustration No. 5 shows how the dug well should be built and equipped. If you hear water running through the well platform into the water below, don't drink water from that well. The platform should be made of reinforced concrete where possible. If it is made of planks it should be double planked with planks staggered and run both layers of planks in the same direction with tarred paper between. The cracks in the lower planking may be covered with tin or zinc strips. The curbing of the well should be water tight down to the water level, or at least for twenty feet below the surface of the ground. The well curbing or wall may be made of concrete, tile, brick, or iron culvert pipe. The latter is not very suitable and should be used in emergencies only.

The set length cylinder and pump are used a great deal for this type of well. The main reason for this is because no plumber or well man is required to set it up. These pumps can be used when the water comes within 26 feet of the surface. The owner should get a pump that can be used with a windmill. If, instead of getting a set length pump, the owner would have the cylinder let down into or near the water, he would have a better pump. It would not need to be primed, and the leathers would last longer. A great many of the set length pumps on the farms are in bad condition. The leathers are not renewed when they should be, and over one-half of the farmers have to prime the pumps. Priming a pump is usually very unsanitary. Just recently a farmer wanted me to see how clear and cool the water was in his dug well. He took the water from the stock tank near by to prime the pump. When he handed me some water, I was not thirsty—"No, thank you."

The illustration in Fig. No.6 shows one of the better types of cylinders used for dug or bored wells. The

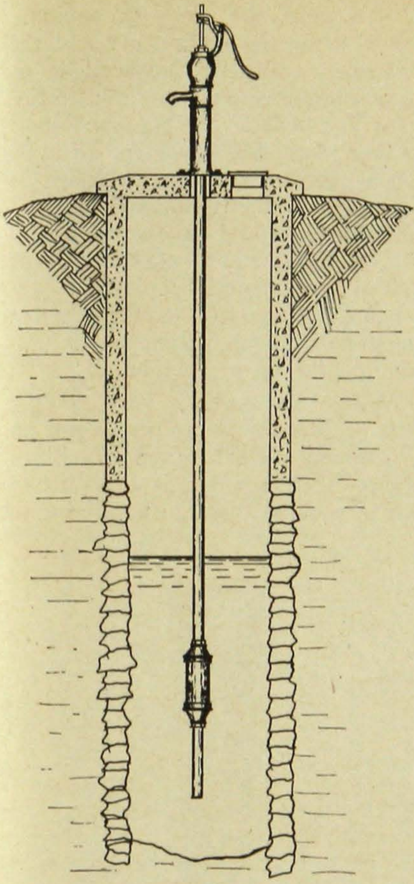

Fig. 5

A good type of dug well. Note cylinder in water. The platform is water tight and curbing is water tight down to water

Bored Wells

Everything that has been said concerning dug wells also applies to bored wells. It is a good sign of sanitary improvement that both of these types of wells are going into discard. There are cases however, in some districts where the soil is such that the farmer cannot secure a driven well, and the cost of a drilled well is prohibitive, then he should use a dug or bored well. Either of these wells may be made sanitary if taken care of. If properly constructed as shown above, with soil elevated around them, placed a considerable distance (150 to 200 feet) from privies, barnyards, etc., they will probably be safe. A large number of dug wells and bored wells go dry after being used for a time. The

poppet valve at the bottom of the cylinder, sometimes spoken of as the "clack valve" or "inlet valve," is constructed so as to require no repairs for years. The leathers on the plunger occasionally wear out, and should be renewed. Evary farmer should carry on hand a few plunger leathers for his pump. Do not use too small a pump pipe on these cylinders. The water must move through this pipe three to five times as fast as the plunger moves. A small pipe makes pumping hard, wears out leathers rapidly, and breaks pump rods.

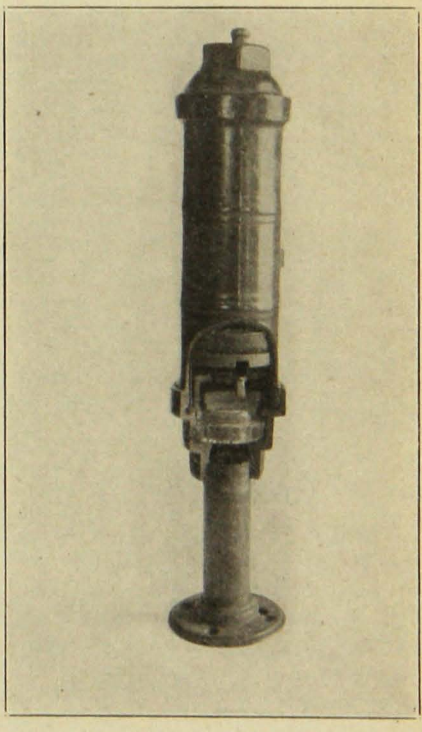

Fig. 6

A drop cylinder. These should be brass or brass lined. The check valve is shown at the bottom. This plunger has two leathers on it

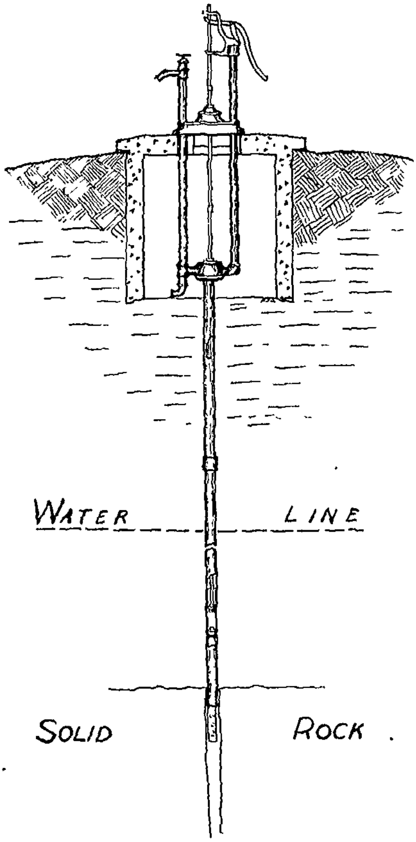

Fig. 7

Type of pump head to use for pumping water underground. A safely constructed well. The cylinder is a tubular cylinder used in driven and drilled wells

farmer should then secure a drilled well. Some farms have five or six dry bored wells.

Driven Wells

The driven well is very popular in districts where the water table is high in the surrounding territory. Dug wells are usually used where the water table in the soil is low. A hole is dug down into a hardpan layer. The water seeps along on top of this hardpan layer and enters the well. This water may come for a considerable distance in a short time and carry disease germs with it. Where a driven well is used, the whole surrounding soil is saturated with water and the movement towards the well is so slow, that these wells are much safer than dug wells. No one can blame a man for using this type of well when, as one man says, "Why, it took me less than two hours to put it in, while it would have cost $100.00 to $150.00 for a drilled well." A driven well should be placed a reasonable distance (100 feet) from sources of contamination and if possible on the up grade side.

Where the well is very shallow (10 to 20 feet) many people put on a common pitcher pump or cistern pump. Here again it is advisable to put in a pump that can be used with

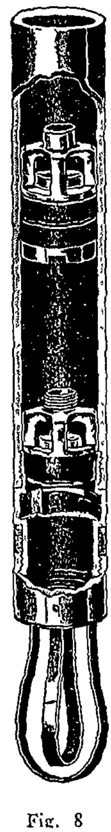

Fig. 8

A tubular cylinder. The plunger and check valve are easily removed

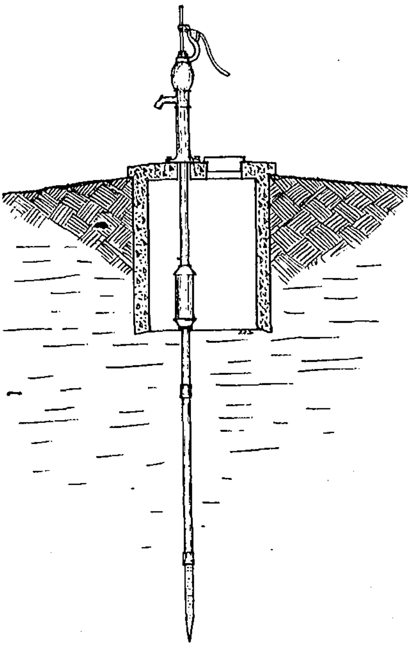

Fig. 9
A drilled well with drop cylinder. A poor type of pump, but a sanitary well

a windmill or any other mechanical source of power. The pump should be of the so-called "three way" type, that allows water to be pumped under ground to storage tanks. This type is illustrated in Fig. 7. When a dry well as shown in this figure can be used, then the pump can be made non-freezing. The type of cylinder to be used is shown in Fig. 8. These are known as tubular well cylinders. They are to be used in driven wells and single pipe drilled wells.

In many places, the water may be 30 or 35 feet below the ground surface, and farmers try to use an ordinary well cylinder or drop cylinder as shown in Fig. 9. They dig a pit or dry well down 6 feet or even 12 feet and put this cylinder at the bottom of the pit. This is poor practice. The renewing of plunger leathers is very difficult and the pumps are unsatisfactory. The pump pipe has to be taken off the cylinder

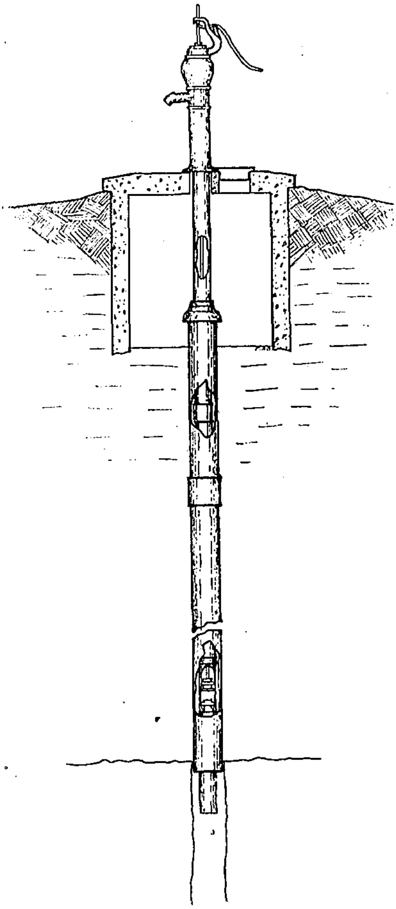

Fig. 10
A cased well. The best type. The pump head shown in Fig. 7 may be used. Note pump pipe and cylinder

to renew the leathers. This is very difficult at times in a small pit.

Once in a while a man uses a working barrel type of cylinder (see Fig. 11) in a driven well and calls it a tubular well. This should not be done. Many wells of this type proved very unsatisfactory and many gave out in eight or ten years in the southern part of the state. A driven well properly located is very satisfactory and quite frequently the softness of the shallow water is desirable.

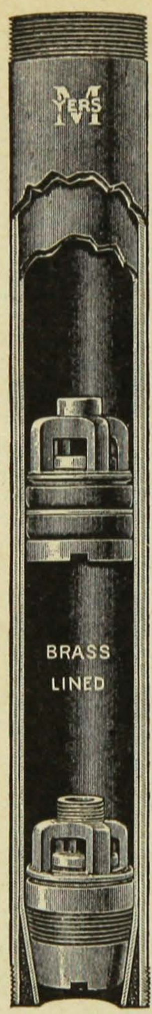

Fig. 11
A working barrel type of cylinder

Drilled Wells

According to our records about 30 per cent of the wells in Minnesota are drilled wells. A very small percentage of these are flowing wells. The rest are mainly artesian wells, but the water has to be pumped. Artesian well is used here to designate any well in which the water rises above the strata in which it is found. The number of drilled wells is too small. Their number is increasing yearly but it should increase more rapidly. A drilled well provides, when suitably equipped, the safest source of water supply. Out of tests on 3,500 wells over 100 feet deep only 13 per cent were found to be polluted. By proper equipment this percentage can be cut in two.

All drilled wells should be equipped with a pump on which power, windmill or otherwise, may be used. The pump head should be a "three way," non-freezing, as illustrated in Fig. 7. The well may be a single pipe well made with a 2-inch or 2½-inch pipe. On the other hand it may be a cased well with a 4-inch or 6-inch casing. The pump pipe and cylinder in the latter type may be 2 inches or larger.

The single pipe drilled well is cheaper to put down, but it is not as desirable nor as long lived. The tubular well cylinder should be used in all single pipe drilled wells. The cased well is the best type of well made. This should be equipped with a working barrel type of cylinder built in as a section of the pipe. The well is illustrated in Fig. 10. This cut shows a plain pump head, but we recommend the type shown in Fig. 7. Note the casing head around the pump pipe. Some drillers carelessly leave off the casing head. Your well may become polluted if it is not protected. The working barrel is illustrated in Fig. 11. If the pump pipe or cylinder wears out, it may be renewed and the well should last for generations. The air-pump cylinders and the Luitweiler pump cylinders may be used on cased wells, but not on the small single pipe wells.

In Conclusion

Many wells are not operating satisfactorily because they are not cared for. Many others were not put in and equipped properly. A well should be permanent equipment and it pays in health and money to put it in but once and put it in properly that time.

PUMPS FOR WELLS AND CISTERNS

All types of pumps bear a certain similarity to each other. They all have at least two valves and work on the principle that can be explained by reference to the pump shown in Fig. 1. This is the ordinary cistern pump that has caused so much grief. The illustration shows it in section. The operation of the pump can be explained, as follows. When the handle is pushed down, the plunger is raised. As the plunger is raised, it has a tendency to produce a vacuum underneath it. The air pressure on the water in the well or cistern then forces the water up through the pipe and the check valve into the pump cylinder. On the downward stroke of the plunger, the water is held in the cylinder by the closing of the check valve. The water is then forced up through the poppet valve in the plunger. On the next upward stroke, the water is raised up by the plunger, because the poppet valve is then closed.

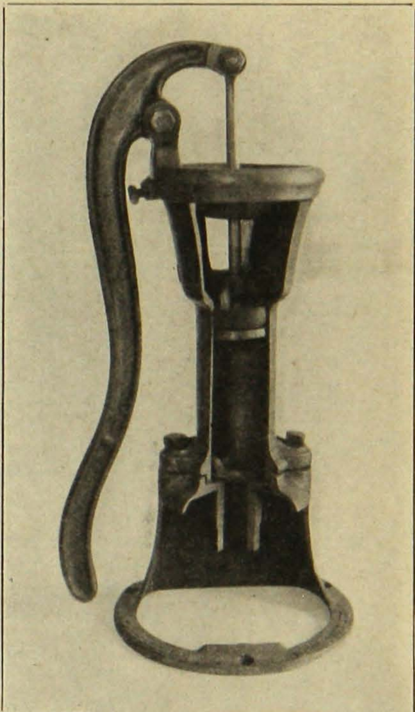

Fig. 1
The common pitcher pump. The section at the right shows the two valves

The leather on the check valve may become worn, or some sand may be deposited under it and then this valve leaks. When this happens, the pump has to be primed. If the leathers on the plunger are worn very much these leathers seldom fit tight enough to keep the air from going down by them. If there is water on top of the plunger, the water cannot get by the plunger as fast as the air can and the water is forced up from below. The purpose of the priming is to get water on top of the plunger. These pumps are arranged so that when the handle is raised clear up, both valves open and drain the pump.

A great many pumps of this type give unsatisfactory service. All that the pump usually needs is a new leather on the plunger or a new one on the check valve. Why should a person use a pump for months in such condition that you can hardly raise any water, when a few minutes work will make it act like a new one?

These pumps have their place, but a person will get more value for the money from a pump like the one illustrated in Fig. 2. This is very similar to the pitcher pump, but it is a force pump. This pump may need priming and repairing the same as the other type, but not as often. This latter pump has the advantage that it can be used to force water into a pressure tank as shown in the illustration (note the pipe leaving one side of the pump and the faucet on

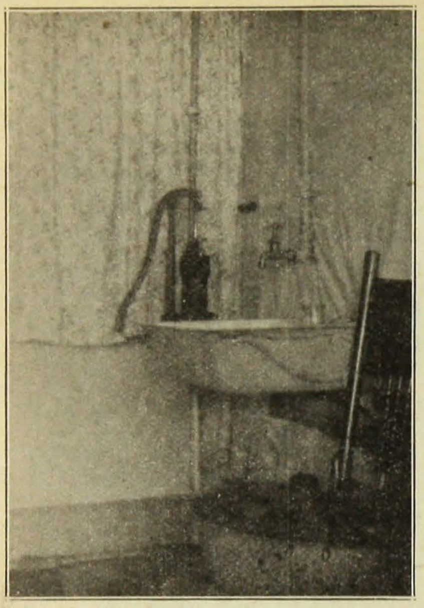

Fig. 2
A hand force pump. This pump gives good service

the near side). Another force pump very similar to this is shown on page 7 which does not have any faucet opening direct from the pump.

In the article on "Wells and Water Supply" the types of pumps for driven and drilled wells are discussed. Any pump will give more trouble with plunger leathers, if the cylinder is above the water level. That is why the hand force pumps are placed in the basement as shown in Figs. 1 and 2 in article "A Complete Gravity Water System" in Special Bulletin No. 55. The set length pump using the drop cylinder illustrated in Fig. 3 will give trouble with leathers and require priming.

Drop Cylinders

The drop cylinder should be used in dug and bored wells, when these wells are not very deep. The cylinder should be below the water level. The disadvantage of this type of cylinder is that the cylinder must be disconnected from the pump pipe in

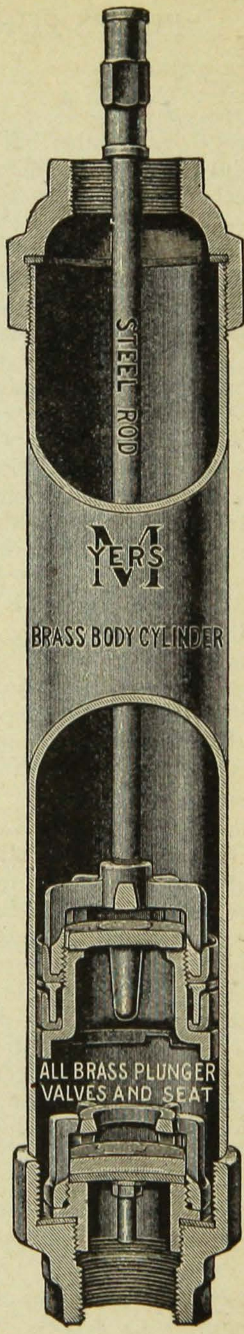

Fig. 3
Sectional diagram of a drop cylinder. Note the valves in the plunger and at the bottom

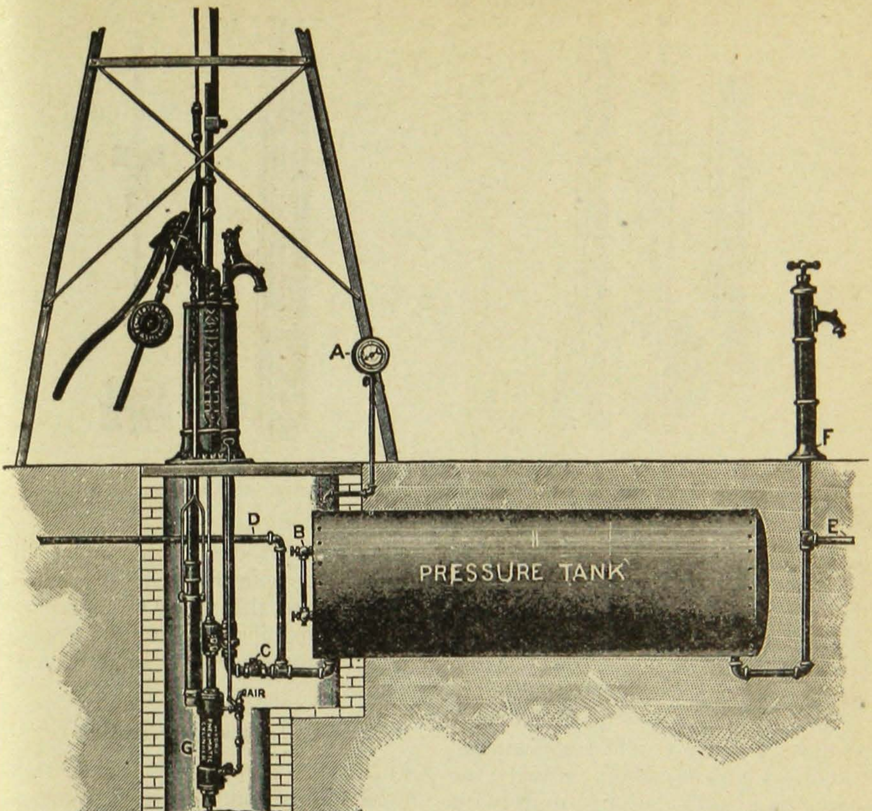
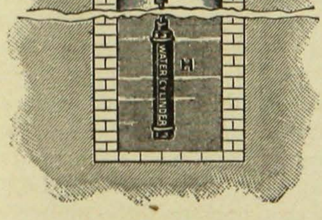

Fig. 4

A hydropneumatic system operated by a windmill. Satisfactory for house use, but not for much stock. "A" is the pressure gauge; "B" is the water gauge; "D" is the pipe to the house; "G" is the air cylinder; "H" is the water cylinder.

order to renew the plunger leathers. This means usually that the pump pipe, cylinder, and all must be pulled out of the well. This type of cylinder should not be used in deep drilled wells.

Force Pumps

Whenever the water is to be driven through a long pipe or elevated to a tank, a force pump should be used. The main difference between these types of force pumps and those already described is that an air chamber is provided. Since most pumps deliver water on the upward stroke only, the water in the whole long pipe would need to be started under motion with each stroke of the plunger unless some relief is provided.

The illustration in Fig. 5 shows the air chamber that is provided for this purpose. This is a section of a single acting three way force pump. This pump is illustrated in a well in Fig. 7 in the article on "Wells and Water Supply." The water compresses the air in the air chamber on the upward stroke of the plunger and then the compressed air delivers water through the pipe during the downward stroke. The water thus flows in a continuous stream. The right

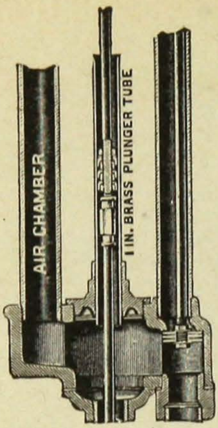

Fig. 5
Three way pump head, showing air chamber and valve

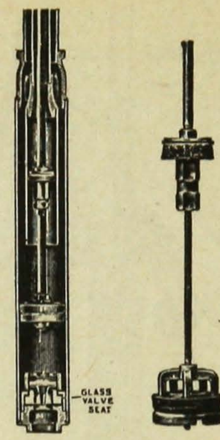

Fig. 6
A double acting force pump cylinder

hand part of this illustration shows how the valve operates. In the position shown, the water would be pumped through the underground pipe. When the valve is lowered, the water is pumped onto the platform.

If a person wishes to fit his well so that he can use a hydropneumatic water system, he should provide for pumping air into the tank along with the water. One way of doing this is illustrated in Fig. 4. The upper cylinder (G) pumps air while the lower one (H) pumps water. The valve at the right side of the illustration, marked "Air," can be left closed if the pressure tank contains sufficient air.

Double Acting Force Pump

There is another way in which a steady stream of water may be maintained. This is by use of a double-acting force pump. The double cylinder and double plunger are shown in Fig. 6. During the upward stroke of the plunger only a part of the water pumped is lifted through the pump pipe. About one-half of it fills the inside cylinder. On the downward stroke the water is forced up the pump pipe, when the upper plunger forces it out of the inner cylinder.

The Luitweiler System

This type of pump is unique and novel. This pump has two plungers, one operating below the other. The lower plunger with its valve takes the place of the regular check valve. However, there is this difference: when the upper plunger is moving downward, the lower plunger is moving upward. The cams on the pump head that operate these plungers are so designed that there is no time during a complete stroke, when one plunger or both plungers are not moving upward. The motion is so compound as to produce a steady flow of water without any jar or vibration to the pump. This type of pump has a very high efficiency and should last for many years.