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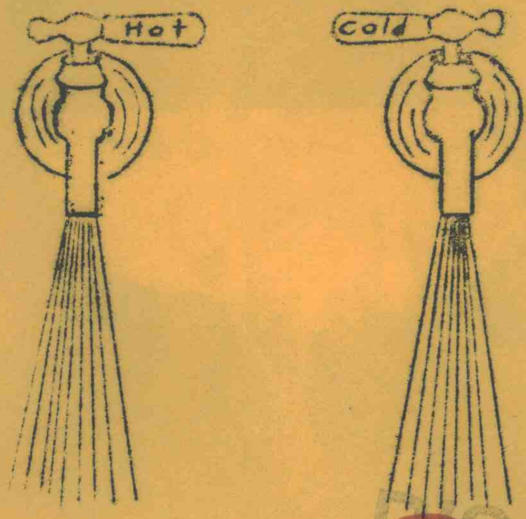

FARM WATER SYSTEMS

by

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A plentiful, convenient supply of pure water is the most important item in the establishment and operation of a farm. The general simplicity of obtaining running water in the farm home and outbuildings is not appreciated in many communities in Oregon.

A complete system of running water and plumbing should be installed at one time if possible, but the system can be installed in units as the farm can afford them. At the beginning only a pump at the sink with plumbing to carry off waste water might be installed (Figure 2). Sinks should have proper traps and vents and the waste water should be disposed of underground. This initial installation should, however, be made with an eye to the future so that nothing need be discarded when more equipment is added later. The improvement of water systems is one of the major issues on farms in many counties over the state. Having running water available at the turn of a faucet releases time and energy of the farmer and his family for more interesting and profitable occupations.

Purity of Farm Water Supplies

The purity of the supply should be the first consideration of the farmer in planning a water system. The location of wells, springs, or streams with respect to possible sources of pollution such as cesspools, septic tanks, septic tank drain systems, and barnyards, should be a matter of first concern. Distance does not add safety where polluted water is concerned. Disease organisms such as the typhoid bacillus survive longer in clean, cold waters than in other waters. Purity tests are made without cost by the Bacteriology Department at Oregon State College at Corvallis and the State Board of Health, 816 Oregon Building, Portland. Instructions and containers for submitting water samples to these offices may be obtained from either of them upon request.

When the water source is determined satisfactory, steps should be taken to protect it from underground seepage and surface drainage. Where water is taken from a stream a diversion works that is properly screened will prevent foreign matter from entering into the supply line. The portion of the stream above the diversion point should be free from possible pollution from nearby farmsteads and should be fenced off from livestock and well posted to warn people that the water is used for human consumption.

If a spring is the source of supply, it should be curbed with concrete and provided with a tight fitting cover or roof which should be kept locked. A drainage ditch should be dug around the spring insofar as possible to carry off all surface water to a point below the spring.

If a well is used for the water supply, it should be located where there is no possibility of it becoming polluted. Cast-iron pipe with lead joints must be used for all sewer and waste lines within 50 feet of a well.

In some irrigated sections of Oregon, water from irrigation ditches is used for domestic purposes. Water is periodically diverted from the ditches into cisterns. Such water should always be chemically treated at the time of each refill of a cistern.

For complete instructions on the treatment of water supplies, the protection of water supplies from contamination, and specifications for well construction, send to the College or your county agent for the Extension Circular on Water Purification and Protection. Further details may be obtained from the Bacteriology Department at Oregon State College and the State Board of Health.

Hand Pump Installations

In many communities in Oregon, farm people have shallow wells from which they obtain their water supply for domestic use. These wells are often of the dug type with open tops and are usually located where it is necessary to carry water long distances to places where it is used. Two types of hand pumps can be used in connection with shallow wells whereby the necessity of carrying water is eliminated.

Pitcher Pumps

The pitcher pump is simply a suction pump and water cannot be raised above it or discharged against pressure. The maximum practical suction lift on this type of pump at sea level is approximately 22 feet. The practical suction lift of a pump is reduced one foot with each 1000 feet rise in elevation above sea level. Even though the well may be located as much as 100 feet from the house, a pitcher pump can be installed in a convenient location in the kitchen. The suction pipe should slope upward from the well to the pump, should be air tight, straight, and no smaller in diameter than the suction connection on the pump. A foot valve on the end of the pipe in the well is recommended.

Force Pumps

A force pump differs from a pitcher pump in that it is equipped with a cylinder that forces the water above the pump against pressure. The force pump can be used where it is desired to pump water to distant points or into an overhead storage tank. This type of pump is provided with a faucet which permits drawing off water at the pump. When closed, water is forced through another outlet to an overhead tank or to distant points.

The practical suction limit with this pump is the same as with the pitcher pump, that is, 22 feet below the cylinder. The force pump like the pitcher pump can be conveniently located in the kitchen by installing a suction pipe from the pump to the well. The use of a foot-valve is also recommended. Where a pump is between 22 and 27 feet above the water the pump cylinder can be lowered to within the practical suction limit of 22 feet. This is accomplished by having a regular pump rod to connect the pump head with the cylinder which is lowered in the vertical pipe directly beneath the pump. Power driven deep-well equipment is recommended where a hand force pump is located more than 27 feet above the water in a well.

If a hand force pump is used in connection with a running water system, the overhead storage tank should be of sufficient capacity to store a day's supply of water at one pumping. The size of the tank can be determined from the following table of average daily requirements for the farm:

Per person	40	gallons
Per cow	15	"
Per sheep	1	"
Per hog	1	"
Per horse	12	"
Per 100 head of chickens	5	"

Hot Water Unit

When a hand force pump with an elevated storage tank, a sink, and drain have been installed, a hot water system can be provided at a little additional expense. The equipment needed for a hot water unit consists of a heating element, called a water back or water front when used in connection with a kitchen range or stove; a 30-gallon hot water tank, a faucet for draining the system (usually located at the bottom of the hot water tank); and the necessary pipe for connections. Other methods of heating water are by means of a coil in a furnace or with a kerosene, gas, sawdust, or electric tank heater. The elevated storage tank must have water in it at all times in order to secure the best circulation of water and to avoid damage to the hot water heating unit.

If an elevated storage tank cannot be conveniently installed, the hot water system can be used by installing a three-way valve on the force pump, (Figure 3). With this arrangement either cold or hot water may be drawn at the sink depending upon the position of the three-way valve. For cold water, the valve is placed in a position where water can be pumped directly from the source of the sink. For hot water, the valve is placed in a different position and then, by operating the pump, cold water is forced through the supply pipe into the lower part of the hot water tank and hot water is forced from top of tank to faucet.

Caution: A relief valve must be installed in connection with all hot water systems to prevent the possibility of boiler explosion, (Figures 3, 4, and 5). Care should be taken with hand operated systems in keeping the hot water tank filled.

The Completed System

The final step in completing the water system is to provide water under pressure with either gravity flow or some type of power driven pumping equipment. Bathroom and laundry fixtures are usually added at this time. Also at this stage of developing the water system if not before, the employment of a licensed plumber is recommended. Plumbing regulations as set up by the Oregon State Board of Health apply to the rural areas and although it is permissible for a farmer to install his own plumbing, the installation must meet the requirements of the state plumbing code and the rules and regulations of the State Board of Health governing plumbing and interior water supply and distribution in buildings.

There are two general systems for providing water under pressure, the gravity method and the hydropneumatic method. The source of the water supply, the amount of water needed, the kind of power available and other local conditions will determine which system to install.

Gravity Systems

Where the storage tank can be elevated and protected at a reasonable cost the gravity system will be satisfactory for many farms. Water may be stored in wood, metal, or masonry tanks and to secure gravity delivery the tank must be elevated above all fixtures and faucets in the home and farm buildings. The simplest gravity system is one that has a tank located at a spring on a nearby hillside with a pipe line leading to the buildings.

A stream can sometimes be tapped at an elevation sufficient to provide gravity flow through a pipe line. The size of pipe to install depends upon the distance between the stream and buildings, the elevation of the point of diversion above the faucets and fixtures in the buildings, and the amount of water desired for proper management of the farm. (See pipe friction table, page 7).

When an elevated tank is used the water is commonly pumped by means of a windmill, a gasoline engine, or electric motor. A good feature of this arrangement is that the overflow water from the tank can be used to supply the stock tanks (Figure 4). Supply tanks should be designed to hold more than a day's supply, particularly so if a windmill is used for power. For windmill operation the storage of a week's supply or more may be desirable. Tanks should be provided with a waste pipe and valve to facilitate emptying and cleaning, should be tightly covered for protection against dust and other possible sources of contamination, and should be insulated against heat and cold.

In some sections of the state entire communities involving from five to forty families have organized water associations and are serviced from central pipe systems which bring water by gravity flow from streams or springs located in nearby hills. The costs of these community systems vary with local conditions but usually range from $80 to $250 per farm for materials and labor.

In many irrigated sections water is turned into cisterns from irrigation ditches and then piped by gravity flow to the buildings. If the irrigation ditch and cistern cannot provide water by gravity flow to the buildings, some type of equipment is installed to pump water from the cistern.

Methods of Calculating Capacities of Circular and Rectangular Tanks

A. Circular tank: Radius squared, multiplied by 3.14, multiplied by depth in feet, multiplied by 7.5 (gallons per cubic foot) equals total gallons. Example: Calculate the capacity of a tank 6 feet in diameter and 6 feet deep.

$(3)^2$ (radius) x 3.14 x 6 (depth) x 7.5 = gallons

9 x 3.14 x 6 x 7.5 = 1272 gallons

The following table may be helpful in calculating capacities of circular tanks:

Diameter in feet	4	6	8	10	12	14
Capacity in gallons for each foot of depth	94	212	376	588	848	1154

Multiply lower figure by depth of tank in feet to get total gallons.

B. Rectangular tank: Length multiplied by width multiplied by depth multiplied by 7.5 equals total gallons. All dimensions in feet.

Pressure Tank Systems

Water may be stored and delivered to fixtures by the use of hydropneumatic (water - air) tank. A complete hydropneumatic system consists of an air-tight pressure tank, a force pump, pressure gage and the necessary fittings including a pressure relief valve on the tank. One important advantage of these systems is that the tank need not be elevated but can be conveniently located in a cellar, basement or utility room.

As water is pumped into the pressure tank which is already filled with air, the pressure of the air increases as its volume decreases. When faucets on the system are opened, water is forced through them by the pressure of the air in the tank. In systems of this type when air and water are under pressure there is a tendency for the water to absorb the air. The air supply must be replenished from time to time by means of a special device on the water pump.

The hydropneumatic system is not commonly used with a windmill because of the large size of tank which would be required. With this source of power, a pressure tank large enough to store a supply of water to last at least a week would be expensive. 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 a windmill. This also applies to gasoline engine driven systems where large amounts of water are required necessitating the installation of a large tank.

Electrically driven water systems (Figure 5) being fully automatic usually operate with small storage tanks (40 gallon common size). It must be kept in mind, however, that if only a small storage tank is provided, a pump with capacity to supply the full need during periods of heavy demand must be installed.

Power Available and Source of Water Supply

The kind of power available and the source of the water supply are the main factors which determine the kind of water system to select for the farm.

Extension of rural electric lines has increased interest in the use of electricity for pumping water on Oregon farms. With electricity available for power, pumping is controlled automatically and at existing rural rates the cost of operation is economical. The cost of pumping water varies according to the amount required, depth of well, pumping pressure, and the efficiency of the pumping equipment. Shallow-well systems usually require from one-half to one kilowatt hour of electricity to pump 500 gallons of water. Deep-well systems ordinarily will use one to one and one-half kilowatt hours in pumping the same amount of water. Assuming a charge of four cents per kilowatt hour for electricity the cost of pumping 500 gallons of water with a shallow-well system will be two to four cents while with a deep-well system, the cost would be four to six cents. With a good hand pump it would take a person one hour and 25 minutes of continuous pumping to pump 500 gallons of water.

A gasoline engine, when used to operate a water system, needs starting by hand but with the aid of a circuit breaker and a float in the tank, the engine can be automatically stopped when the tank is filled. Gasoline driven water systems are generally higher in initial cost and are more expensive to operate than systems operated by electricity.

Because windmills are not as dependable as either gas engines or electric motors for power, their use is best adapted to gravity systems where elevated tanks of large capacity are provided.

Types of Power Driven Pumps

Pumps commonly used on farms are of two main types, namely centrifugal and reciprocating (plunger type).

Centrifugal Pumps

Centrifugal pumps are now used to pump water from both shallow and deep wells. The suction lift of this type of pump on shallow wells is generally considered to be about 15 feet, although lifts of 22 feet are possible by the use of specially designed centrifugal pumps now on the market.

One of the most recent developments in deep-well pumps is the jet system which uses a vertical centrifugal pump located at ground level. This type of pump can be located in a convenient place several feet away from the well. Two pipe lines extend into the well, one carrying a portion of the discharge from the pump into the well where it passes through a jet and tube into the other pipe line. By virtue of this passage of water through the jet and tube additional water is forced up into the suction pipe within reach of the suction of the centrifugal pump. At the pump a portion of the water is discharged into the storage tank while the other portion is forced back into the well to continue the process.

Deep-well centrifugal turbine-type pumps are also on the market but they are designed primarily for irrigation purposes where large quantities of water are required.

Reciprocating Pumps, Plunger Type

Reciprocating, plunger type pumps operate on the same principle as hand force pumps. A piston operating in a cylinder in either a horizontal or vertical position, draws and discharges water on both strokes. This type of pump is used for either shallow or deep wells or other sources of water. For deep well operation the cylinder is placed in the well and is usually submerged in the water. Reciprocating deep-well pumps must be placed directly over the well.

If a good hand force pump is already in the well, a pump jack with an electric motor or gasoline engine can be added to furnish water for a gravity or hydro-pneumatic system (Figure 4). The power unit should be properly housed for protection against the weather.

The amount of power required to operate shallow and deep-well pumps depends upon the capacity of the pump, the height or pressure water must be delivered against, the depth of water in the well, the distance water must be conveyed in pipes to where it is used, and the efficiency of the pumping equipment. A close estimate of power requirements for pumps can be made by the manufacturer or dealer supplying the equipment.

Calculating Power Requirement for Water Systems

The horse-power required to pump water is determined by multiplying the gallons pumped in one hour by the total head in feet, (total head includes suction lift, discharge head, and pipe friction), and dividing the product by 240,000 times the pump efficiency which may be estimated at 50%. The formula:

$$\frac{\text{Gallons per hour x total head in feet}}{\text{240,000 x pump efficiency}} = \text{Horse-power}$$

Total head is determined in the following manner: Vertical distance from the surface of the water to the ground level, plus pressure in the tank times 2.3, plus friction in feet in the main supply pipe.

FRICTION LOSS IN FEET PER 100 FEET OF PIPE

The following table gives the loss of head, due to friction, per 100 feet of ordinary pipe when discharging given quantities of water through various sizes of pipe.

Flow, gallons per minute	Size of Pipe					
	1/2 inch	3/4 inch	1 inch	1-1/4 inch	1-1/2 inch	2 inch
2	7.4	1.9				
3	15.8	4.1	1.26			
4	27.0	7.0	2.14	.57	.26	
5	41.0	10.5	3.2	.84	.40	
6		14.7	4.5	1.20	.56	.20
8		25.0	7.8	2.03	.95	.33
10		38.0	11.7	3.05	1.43	.50
12			16.4	4.3	2.01	.70
14			22.0	5.7	2.68	.94
16			28.0	7.3	3.41	1.20
18				9.1	4.24	1.49

It is false economy to install pipe of too small diameter to carry the required amount of water because more power is required to force a given quantity through a small pipe than a larger one. The importance of selecting the correct size pipe is shown in the following example:

A pump 50% efficient is to deliver 5 gallons per minute through 3/4 inch pipe from a shallow well to a pressure tank at the house 500 feet away and 30 feet above the pump. Depth of water in the well is 20 feet. Maximum pressure in the tank is 40 pounds.

$$\frac{\text{Gallons per hour x total head in feet}}{\text{240,000 x pump efficiency}} = \text{Horse-power}$$

$$\frac{\underset{\text{(Gals.per hr.)}}{(5 \times 60)} \times (\underset{\text{(Vertical dist.)}}{50 \text{ feet}} + \underset{\text{(Pressure)}}{(40 \text{ lbs.} \times 2.3)} + \underset{\text{(Friction)}}{52 \text{ feet}})}{240{,}000 \times 50\ \%} = \text{Horse-power}$$

$$\frac{300 \times 194}{240{,}000 \times 50\ \%} = .48 \text{ Horse-power}$$

If 1-1/4 inch pipe is used instead of 3/4 inch the friction loss would be 4 feet instead of 52 (see friction table), thereby reducing the actual power requirement from 1/2 horse-power to 1/3 horse-power. The saving in power cost with the 1/3 horse-power unit would soon pay for the additional cost of the 1-1/4 inch pipe.

Hydraulic Rams

Frequently farmers are unable to obtain gravity flow from a spring or stream because of their low elevation, but by installing a hydraulic ram, running water is often realized. If the supply of water is at least 5 gallons perminute and a fall of at least 3 feet to the ram can be obtained, the installation of a ram may be practical; providing other local conditions are satisfactory.

The hydraulic ram operates in the following manner: Water flows down a drive pipe to the ram where it passes through a release valve and is wasted. When the flow reaches a certain velocity the release valve in the ram is closed and due to the weight and velocity of the water sufficient pressure is developed to force a portion of the flow through the discharge pipe into the storage tank. The valve then opens and water begins flowing again in the drive pipe until it flows fast enough to close the valve again. This action takes place automatically from 25 to 100 times a minute.

Table Showing Discharge of Rams Under Varying Conditions

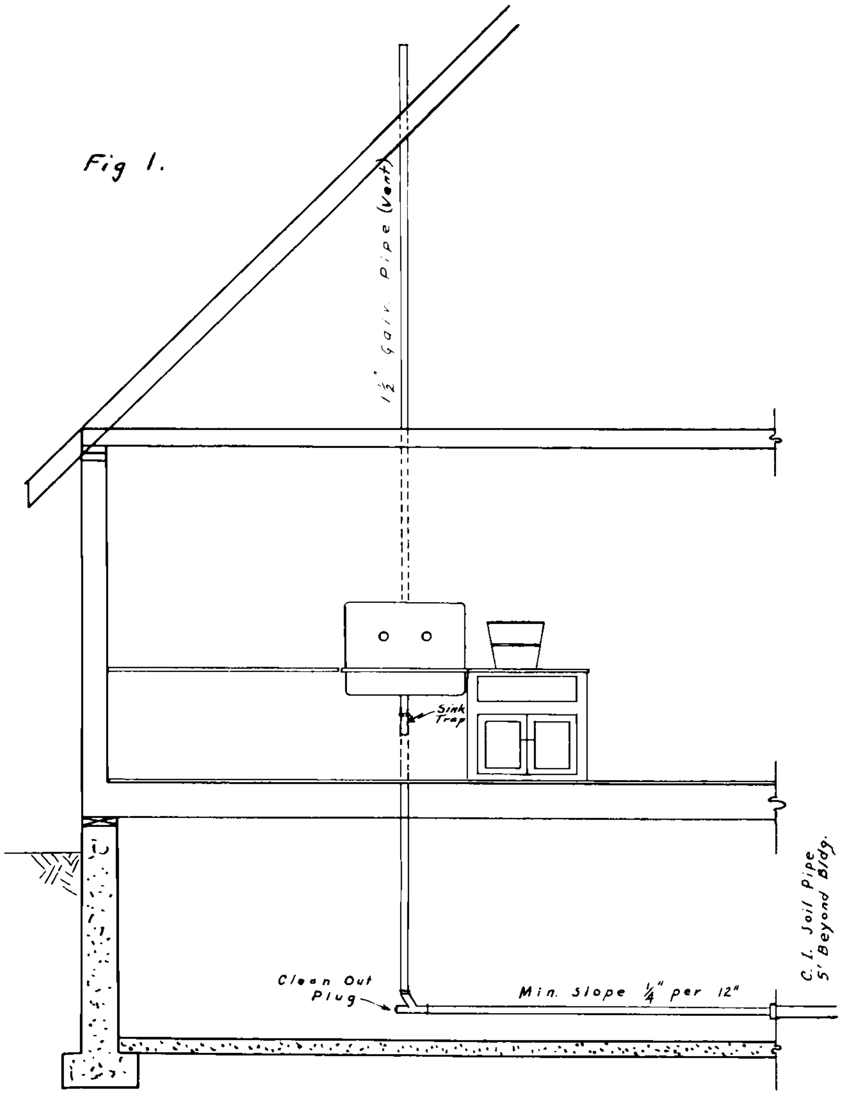
Supply Water Gals. Per Min.	Feet Fall to Ram	Delivery Head in Feet	Gallons Delivered Per Hour
5	3	30	15
6	5	60	18
8	10	90	33
9	15	40	97
10	25	80	120
12	40	125	156

The following additional information on water systems is available at the offices of county agricultural agents and home demonstration agents.

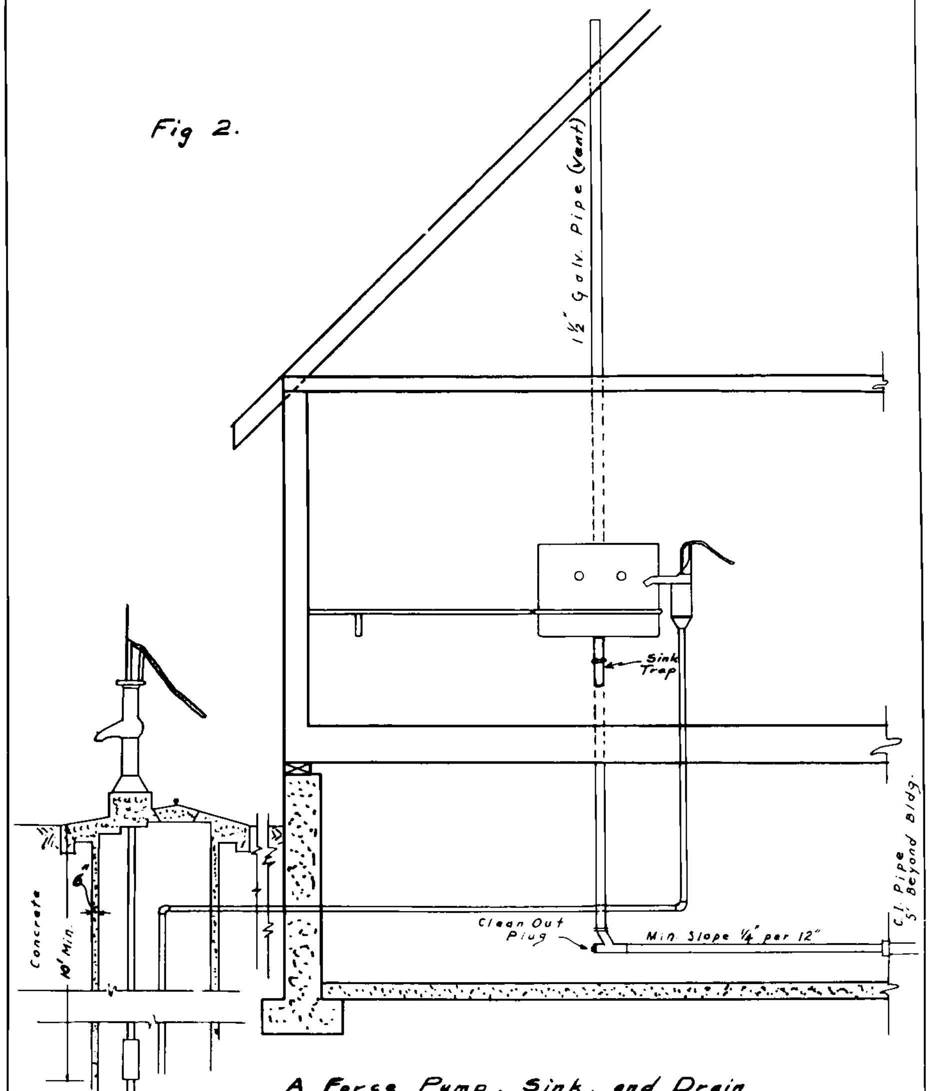
Plan of "Diversion Works for Gravity Water Systems"

Mimeograph - - "Hand Pump Installations"

Extension Circular No. 333 - - "A Concrete Septic Tank for the Farm"

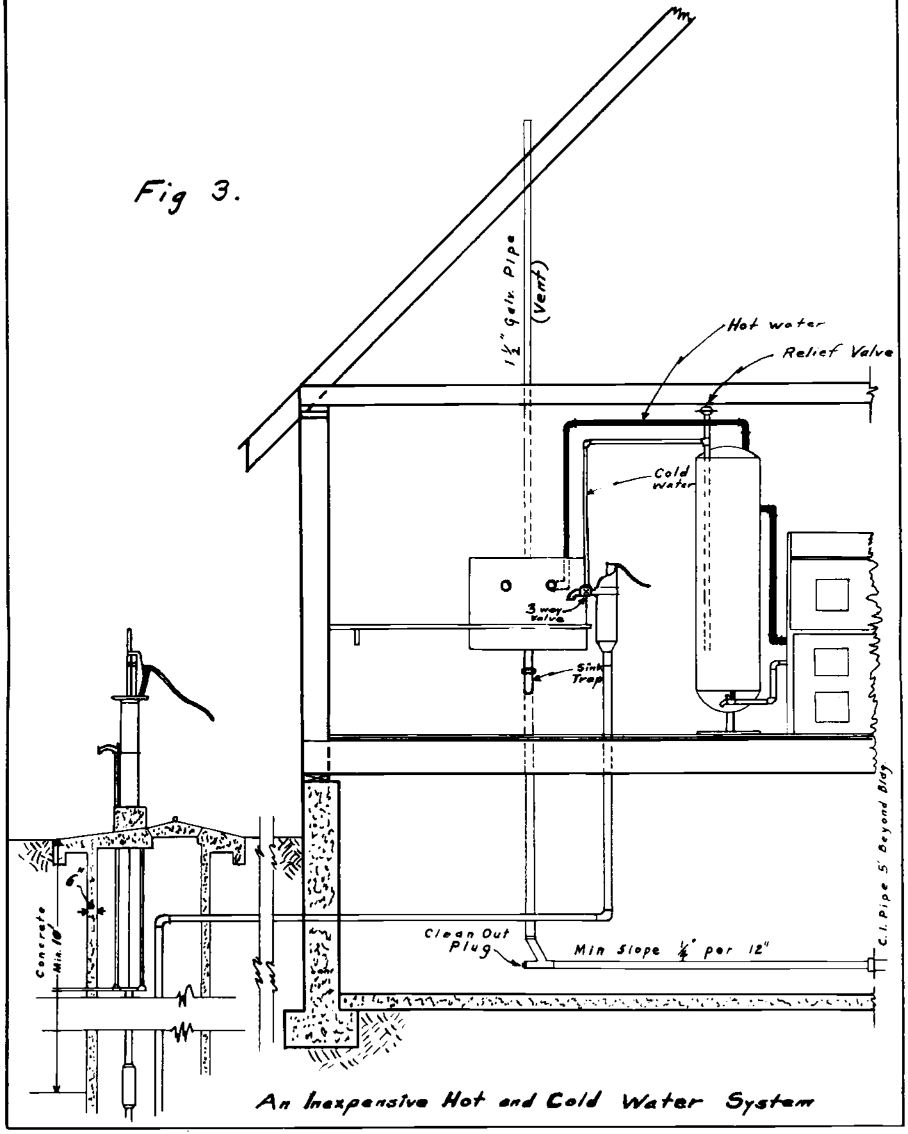


A Simple Sink and Drain Installation



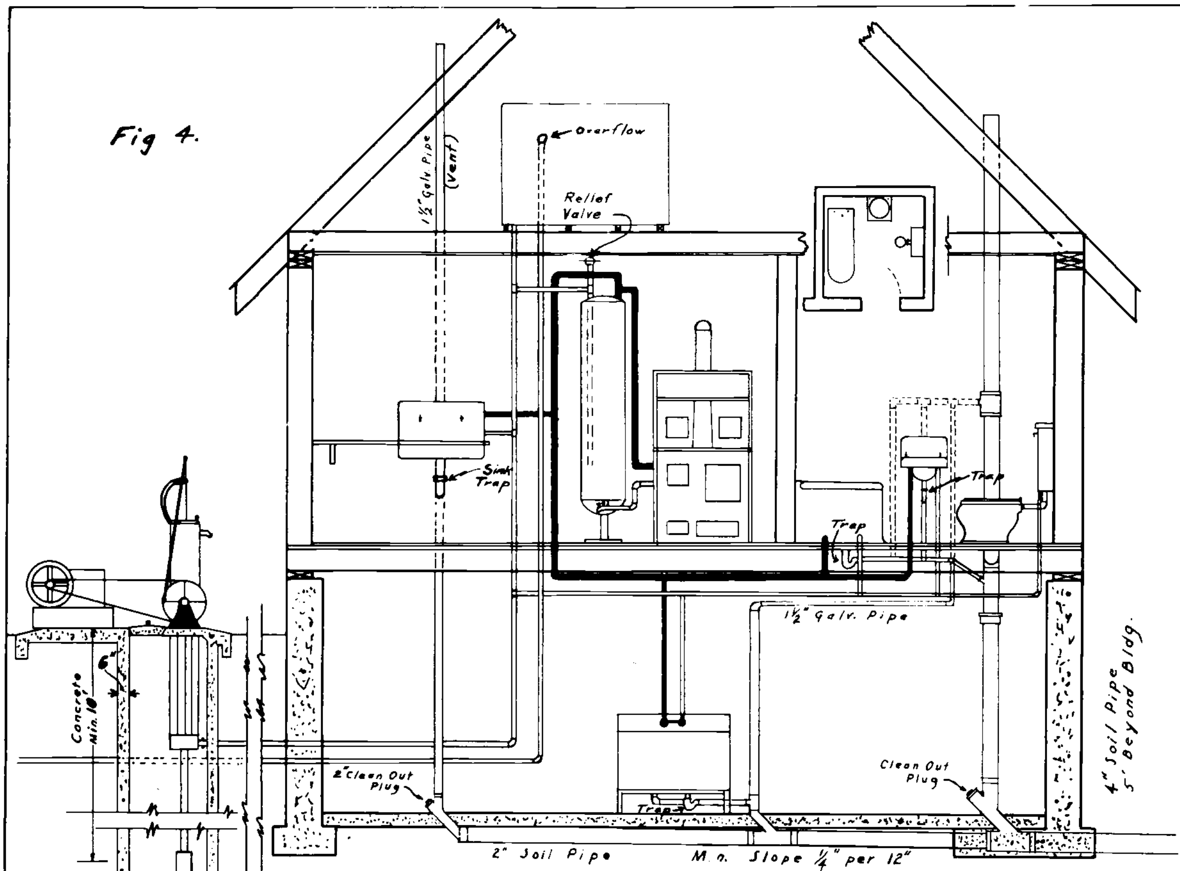
A Force Pump, Sink, and Drain

Fig 3.



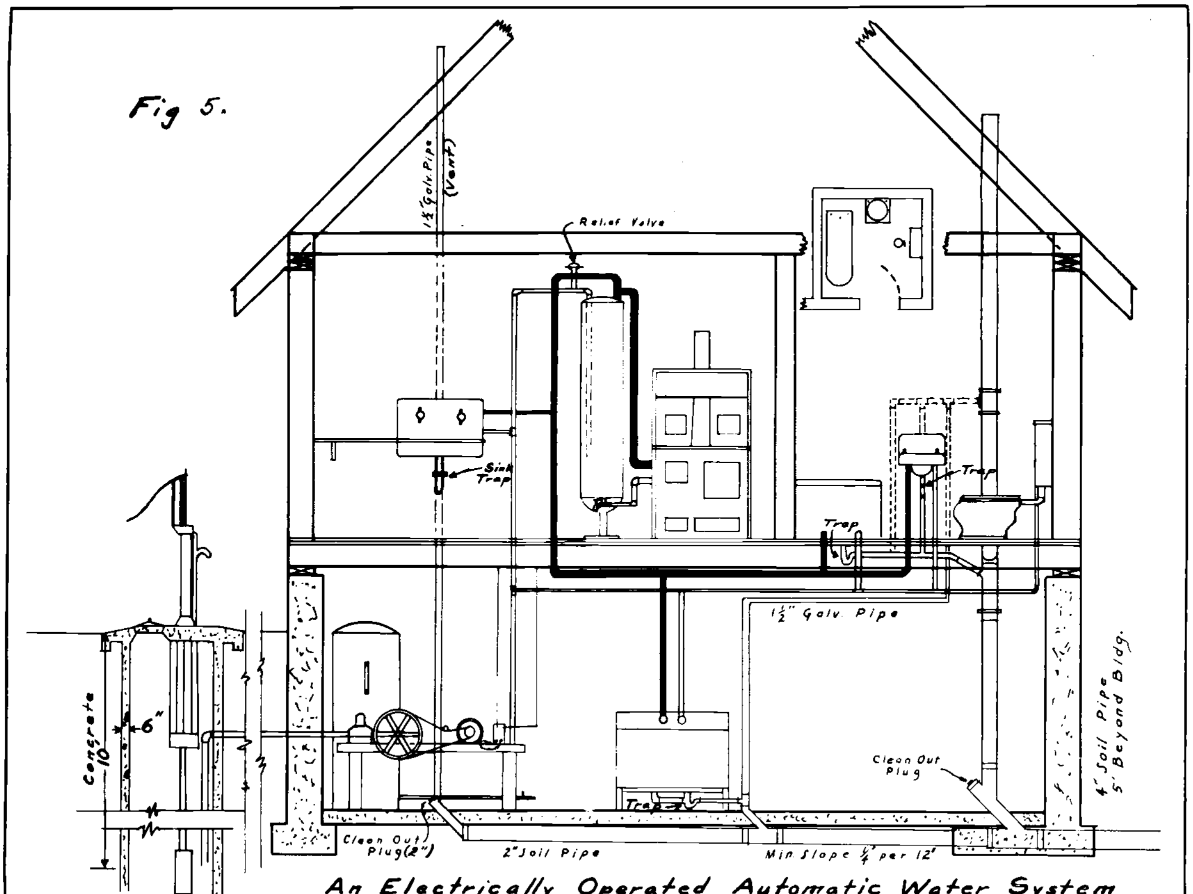
An Inexpensive Hot and Cold Water System

Fig 4.



A Gravity Water System Operated with Gasoline Engine

Fig 5.



An Electrically Operated Automatic Water System