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Bulletin 245 May, 1930

Water Supply and Sewage Disposal Systems for Farm Homes

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TABLE OF CONTENTS

INTRODUCTION—The need of adequate water supply—The choice of a water supply system—Other factors—Water requirements 3

DESCRIPTION OF VARIOUS WATER SUPPLY SYSTEMS 5
- Pitcher spout pump at kitchen sink 5
- Force pump at kitchen sink 8
- Force pump and range boiler 8
- The hot water system 8
- Wash room warm water supply 10
- Special connection to range boiler 10
- Variety of hot water storage tank circulation connections 12
- Attic tank and force pump 13
- Deep tank at well 15
- Elevated tank and tower 16
- The underground masonry reservoir 18
- Protecting well water from contamination 21
- Windmill replaced or supplemented by a motor and ordinary pump jack 21
- Automatic electric water supply system—well near the house 23
- The hydropneumatic tank 25
- Complete automatic electrically operated pneumatic tank system —well remote from the house 26
- Complete automatic electrically operated pneumatic tank system installed in pit and having fresh water attachments 28
- Arrangement for piping hard and soft water to modern plumbing 30
- Installation of air chambers and pressure regulating switches 31
- Air traps 32

ELECTRICITY AS POWER FOR FARM SYSTEMS 32
- Reliability of electric service 33
- Convenience of electric service 33
- Cost of installation of electrically driven systems 33
- Cost of operation when electricity furnishes the power 33
- Amounts of water used in the home 33
- Hints about purchasing a water system 34
- Hints on installation 35
- Hints on wiring to motors 35

COMMERCIAL WATER SOFTENERS 35

SEWAGE DISPOSAL SYSTEMS 37
- A safe farm sewage system 37
- Kitchen sink and disposal tile 39
- Septic tank with tile disposal system 40

WATER-TIGHT CONCRETE 41

HINTS ON CONSTRUCTION 42

QUESTIONNAIRES 43

Water Supply and Sewage Disposal Systems for Farm Homes

IVAN D. WOOD AND E. B. LEWIS[1]

When the well "goes dry" or when the windmill or pump breaks down, every one in the household immediately appreciates the value of plenty of water. In other words, "You never miss the water until the well runs dry". Fortunately, in most sections of this state, plenty of pure water may be obtained by sinking wells of moderate depth, yet surprisingly few farm homes are supplied with running water in the kitchen even tho the barn yards are equipped with hydrants and tanks.

THE NEED OF ADEQUATE WATER SUPPLY

According to the 1929 assessors' reports, compiled by precincts, only 21,854 farm homes in Nebraska have water piped to the kitchen and only 15,672 farm homes have bath facilities, yet there are approximately 127,000 farms in the state.

Many examples could be given of the amount of work done, in many cases by the housewife, in carrying water from wells located at various distances from the kitchen door. It is sufficient to say that many families pump more than 75 tons of water per year and carry it to the house from wells located from 50 to 100 feet away.

It is the purpose of this bulletin to present a number of water supply and sewage disposal systems which have been used in Nebraska and surrounding states and which add greatly to the comfort and convenience of the farm home.

THE CHOICE OF A WATER SUPPLY SYSTEM

No doubt the members of every rural household desire the best of home conveniences but often finances do not permit a very great cash outlay. It is then necessary to seek the best system available for a limited expenditure.

1. The water supply systems shown in Figures 1, 3, and 9 are well adapted to the following:
   a. The renter who cannot afford to spend much money improving a place belonging to some one else.
   b. The landlord who does not care to put expensive improvements on a farm which he is renting to others.
   c. The young farmer just starting in business for himself on his own place.
2. The farm owner in moderate circumstances would probably choose the water supply system shown in Figure 3 and later add to it as shown in Figure 4. Or he might well choose the system shown in Figure 9.

[1] The authors wish to give credit to J. E. Murray, former instructor in plumbing, University of Nebraska, and to Professor E. E. Brackett, Head of the Agricultural Engineering Department, University of Nebraska, for their excellent aid and criticism in the preparation of this bulletin.

3. The owner who wishes to add more expensive and more permanent improvements to his place might well consider either of the systems shown in Figures 10 and 11 or any one of the excellent commercial types which are for sale.

OTHER FACTORS TO BE CONSIDERED

1. If it is desired to install a system which will serve both the house and the barn, then one of the more expensive types shown in Figures 10 to 16 may be used.
2. When the water in the well is always within 15 or 20 feet of the surface of the ground, the simple systems shown in Figures 1, 3, and 4 may be used just as shown with the pipe from the kitchen pump leading directly into the well. In localities where wells are deep, the water may be pumped by the windmill into a cistern as shown in Figure 2. It is then pumped from the cistern to the kitchen sink.
3. If there is higher ground near the buildings where an underground tank of tile, concrete, or brick may be located, a good water supply system may be had by employing the arrangement shown in Figure 11. In a level country, the reserve water supply for serving both house and barn may be had by using an elevated tank, as shown in Figure 10.
4. Figure 4 shows an arrangement whereby water is pumped from a shallow well or cistern. This may be used under almost any circumstances except in very cold weather. The system shown in Figure 9 may be used only where the ground at the windmill and the house are at about the same level.
5. Where electricity is available, consideration should be given to the systems shown in Figures 13, 14, 15, and 16, the use of which provides water under pressure for both household and livestock use.

WATER REQUIREMENTS

The following table will serve to show the approximate amount of water required for household use under various conditions:

Purpose and conditions	Consumption per person per 24 hours
Domestic purposes, pump at kitchen sink, Figure 1	8 gallons
Domestic purposes, faucet at kitchen sink	15 gallons
Domestic purposes, running hot and cold water in kitchen, bath, and laundry	25 gallons

A horse, mule, or cow requires about 12 gallons of water per 24 hours. A sheep or hog will consume, on an average, about 2 gallons in a like period. Some allowance must be made for leakage, waste, cooling milk, sprinkling lawns, and like purposes. A storage tank of from 125 to 150 barrels (32½ gallons per barrel) capacity will provide enough for average farm needs.

DESCRIPTION OF VARIOUS WATER SUPPLY SYSTEMS

PITCHER SPOUT PUMP AT KITCHEN SINK (Figures 1 and 2)

A very simple and inexpensive way of bringing water to the kitchen sink is by means of the pitcher spout pump. Fig-

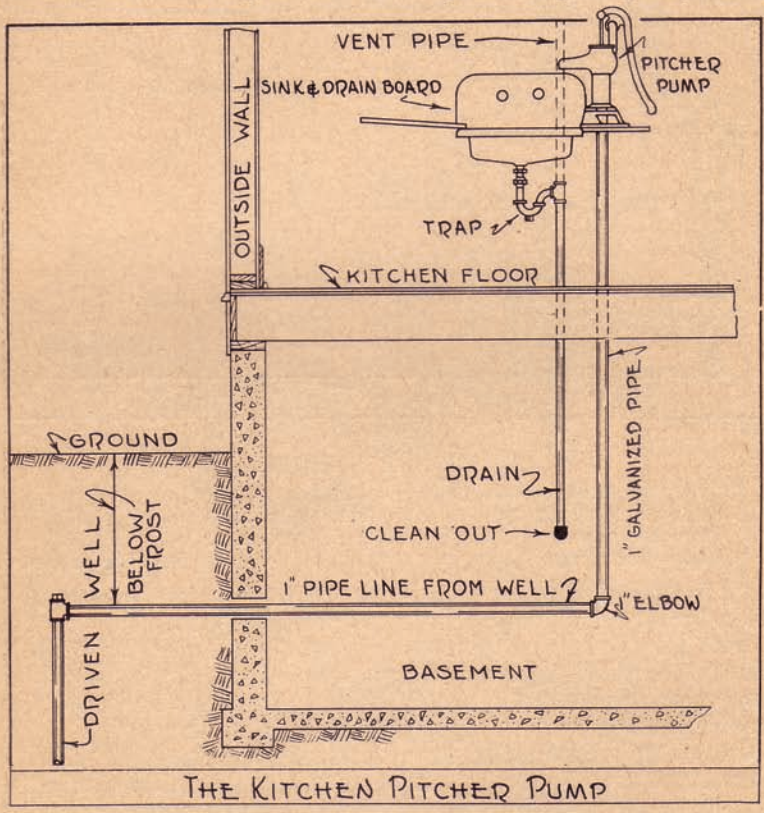

FIGURE 1

MATERIALS NEEDED:

Sink and drain board	Drain from sink
Pitcher pump	Galvanized 1" pipe
Trap for sink	1" elbow

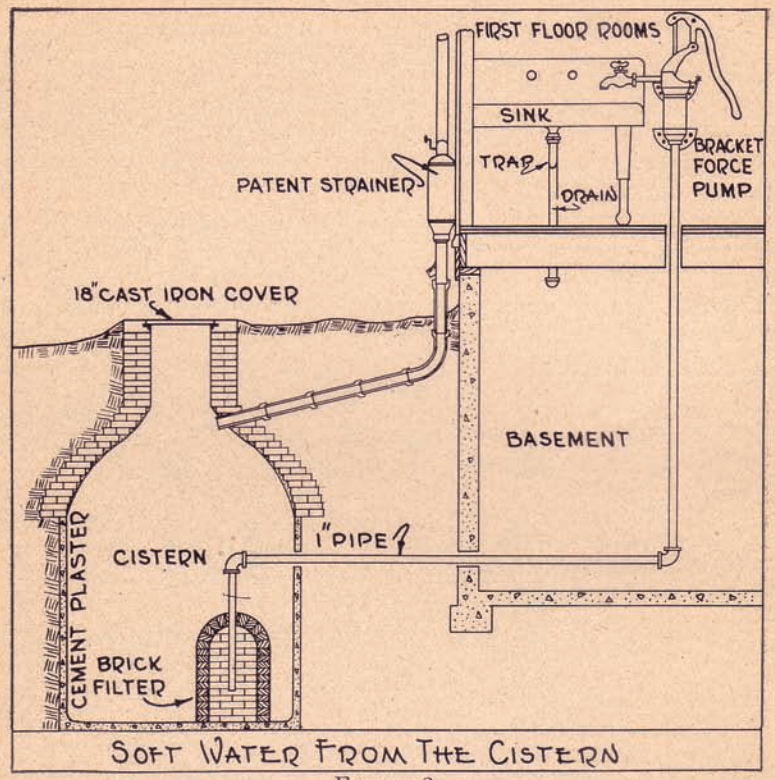

FIGURE 2

MATERIALS NEEDED:

Sink and drain board	Galvanized 1″ pipe
Bracket force pump	Two 1″ elbows
Trap for sink	Patent strainer
Drain for sink	Sewer tile from strainer to cistern

ure 1 shows the pump. The portion just below the spout is the cylinder containing the valves and the plunger.

This pump may be mounted at the right or the left side of the sink, depending upon the position of the drain board. It may be supported on a shelf nailed to the wall or bolted to a special bracket which clamps to the side of the sink.

On a cold night when it is desirable to drain the pipes to prevent freezing, it is only necessary to raise the pump handle to its full distance of travel. This action trips the valves and allows the water to drain back into the well.

A pump of this type will not draw water from a depth greater than 20 feet; therefore, if water is to be drawn directly from the well, the water level in the well must *never* be more than 20 feet below the top of the sink.

In localities where wells are deep, a cistern may be built, as shown in Figure 2, and water from the roof used as a means of supply, or well water may be pumped to it. It is advantageous to have the cistern near the house so that the maximum lift may be obtained from the pump. The low water level in the cistern should not be more than 15 to 20 feet below the top of the sink.

However, the cistern may be placed 100 or 200 feet from the house if so desired. The friction in a long run of pipe

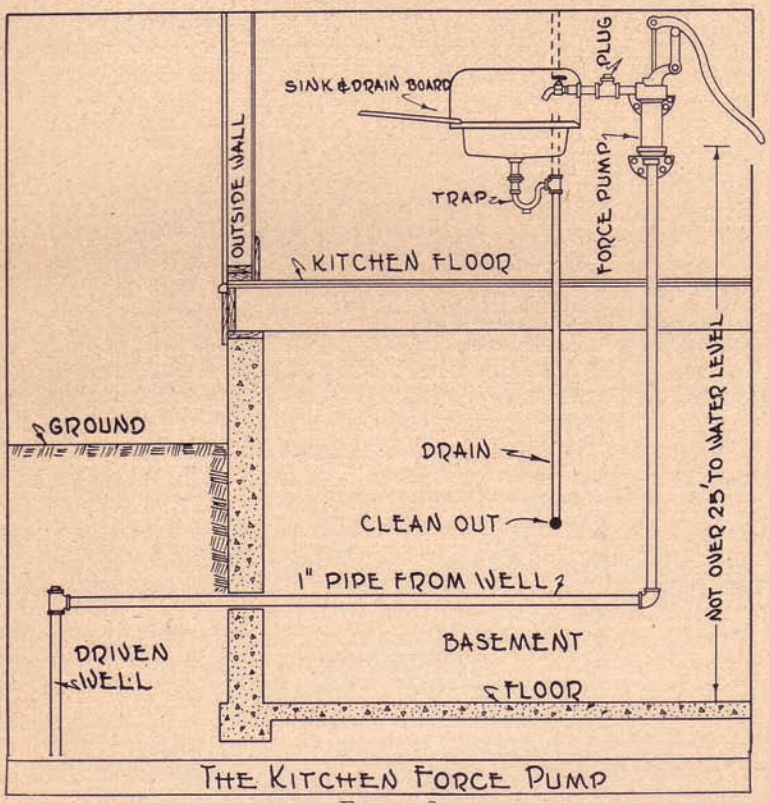

FIGURE 3

MATERIALS NEEDED:

Sink and drain board
Bracket force pump
Trap for sink
Drain from sink
20′ galvanized 1″ pipe
One ¾″ T
One ¾″ hydrant nozzle
Two ¾″ pipe plugs
One 1″ elbow
One 1¼″ bushing
Miscellaneous:
Two ¾″ close nipples
One ¾″ elbow
One ¾″ x 3″ nipple

will decrease the maximum vertical distance thru which the pump can lift the water. If one-inch pipe is used, this decrease in lift will be approximately one foot for every 100 feet of horizontal pipe.

FORCE PUMP AT KITCHEN SINK (Figure 3)

The system shown in Figure 3 does not differ from that shown in Figure 1, except that a force pump is used instead of a pitcher spout pump. In all other ways the arrangement is the same. The advantage of the force pump is that later a range boiler may be used and, when properly connected to a water back in the range, will permit both hot and cold water to be pumped at the sink. The force pump may be of the bracket type which bolts to the wall with wood screws or it may be the kind which fastens to a wooden shelf after the manner of the pitcher spout pump.

At some later time it may be desirable to include the equipment shown in Figure 4.

FORCE PUMP AND RANGE BOILER (Figure 4)

Figure 4 shows a range boiler and water back attached to the force pump shown in Figure 3.

By closing the valve at A and opening the one at B, cold water is pumped to the sink from the cistern or well. It is also possible to pump cold water to the range boiler by closing the valve at B and opening the one at A. When the boiler is full and a fire is started in the range, circulation of water takes place thru the water back on the stove to the boiler. The hot water, being lighter, rises to the top of the range boiler. When hot water is then desired at the sink, it is only necessary to close valve B, open valve A, and pump. The cold water entering the boiler thru pipe C forces hot water out thru pipe D, to the sink.

By placing an additional valve at E above the sink in the hot water line it is possible to force the hot water to a bath tub, situated in another room, thru the pipe F. This pipe must be raised slightly higher than pipe D, however, since water will more frequently be wanted at the sink.

The valve at E should be closed only while pumping water to the bath tub.

THE HOT WATER SYSTEM

The 40-gallon range boiler is the correct size for the average farm family. The water back should be of the proper size for the boiler. It will be noticed that no valves of any kind are put in pipe D, Figure 4. This pipe is left open so that there is always a chance for the steam from the boiler to escape; otherwise an explosion might result.

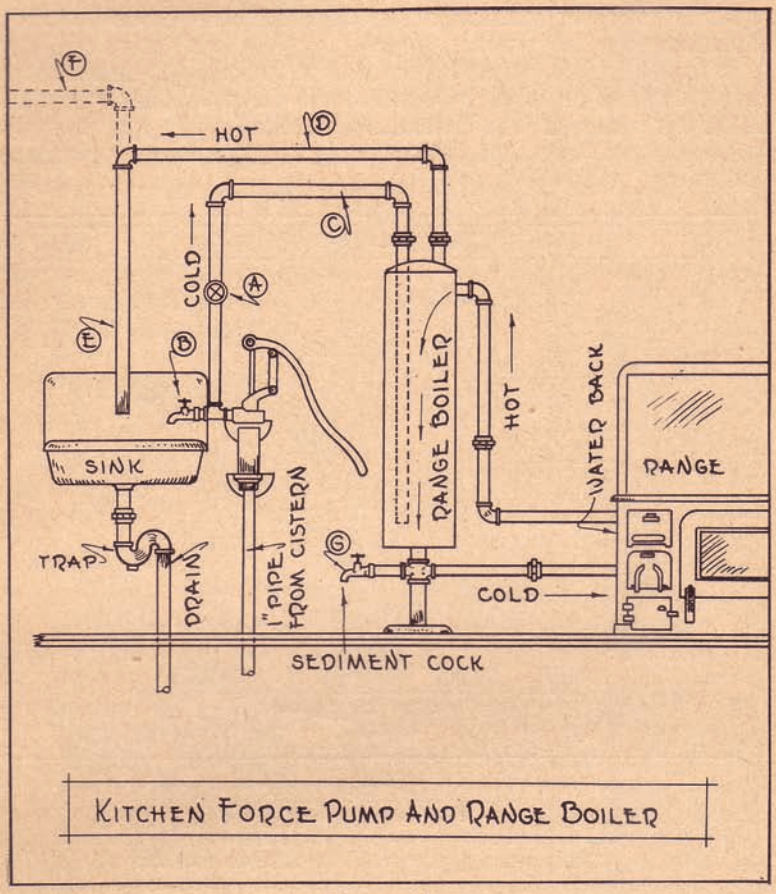

FIGURE 4

MATERIALS NEEDED:

Range with water back	Sink drain
Range boiler	Four 1" unions
Sink	Six 1" elbows
Force pump	Sediment cock
Trap for sink	Faucet

The water in the hot water back or the boiler may not freeze in cold weather, *but water in the pipes connecting the two sometimes does, and an explosion may result if a fire is built in the range while these pipes are obstructed.* Always make sure that none of the pipes is frozen before starting a heavy fire.

At G is a sediment cock which should be opened occasionally

to drain out the accumulation of sediment which would, in time, clog up the pipes.

It should be noted that the cold water pipe C enters at the top of the range boiler and continues down inside it to within about six inches of the bottom. Ordinarily this pipe is tapped with a small hole just after it enters the boiler to prevent siphoning. (See Figure 6.)

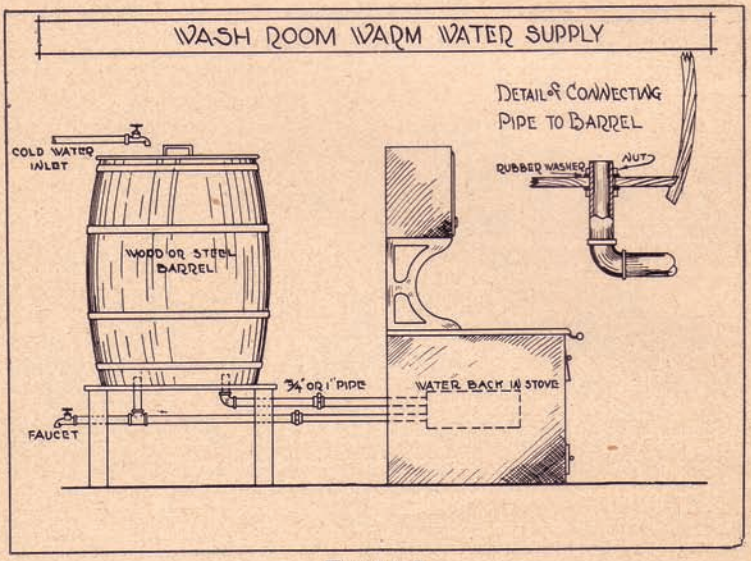

FIGURE 5

MATERIALS NEEDED:

Stove with water back	Two faucets
Wood or steel barrel	Two rubber washers
Two unions	Two nuts threaded to screw onto pipe
One elbow	
One T	

WASH ROOM WARM WATER SUPPLY (Figure 5)

It is often desirable to have a warm water supply for the wash room or other purposes. This may be obtained by using a wooden or steel barrel on a stand as shown in Figure 5. Connection is made as shown to a water back in a range or even to a coil of pipes at one side of the fire box. The water-tight connection to the barrel is also shown in Figure 5. It is made by using two rubber washers and two pipe nuts.

SPECIAL CONNECTION TO RANGE BOILER (Figure 6)

All new hot water storage tanks or range boilers are made with tappings or pipe openings in the side as shown at A and B. The old tapping, as formerly used, is shown at F. (Figure 6.)

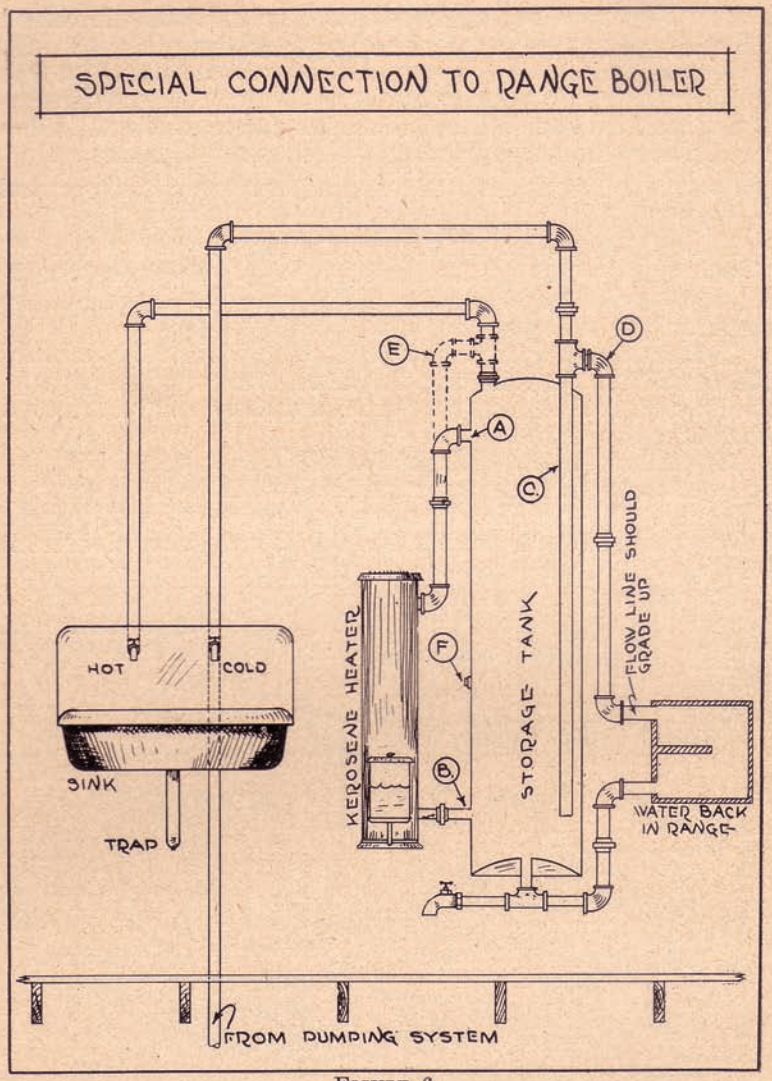

FIGURE 6

MATERIALS NEEDED:

Sink with faucets	Ten 1″ elbows
Kerosene heater	Two T's
Range boiler	1″ galvanized pipe
Six 1″ unions	Sediment cock

Flow pipe D is connected to the cold water tank supply pipe, thus preventing the accumulation of excessive hot water and steam in the top part of the tank.

This system of piping is satisfactory in cases where there is little or no water pressure in the plumbing system, in cases where the tank is small for the water back, or where the water back is subjected to long periods of firing.

Connections A and E are ideal for gas or kerosene heaters, small water fronts, or pipe coils in stoves and furnaces.

VARIETY OF HOT WATER STORAGE TANK CIRCULATION CONNECTIONS
(Figure 7)

In A of Figure 7 is shown a distorted view of a water back tipped up. This installation is wrong. In operation this water back will pound and hammer, owing to the collection of steam in the high part at (a).

In B is shown a drop flow pipe at (a). The result will be the same as in A. The sag on the cold water connecting pipe at (b) will not materially affect circulation, but the pipes will not drain properly.

The correct method of installation is shown in C, Figure 7. In case the water carries considerable solids in solution, the flow pipe (a) should be carried directly upward from the water back. The flow pipe should be one inch in diameter. At (b) and (c) are shown optional drain faucet locations.

The hot water storage tank D of Figure 7 is shown with gas or kerosene heater and water back range connections. The gas heater cold water pipe may be connected at (b) or (a).

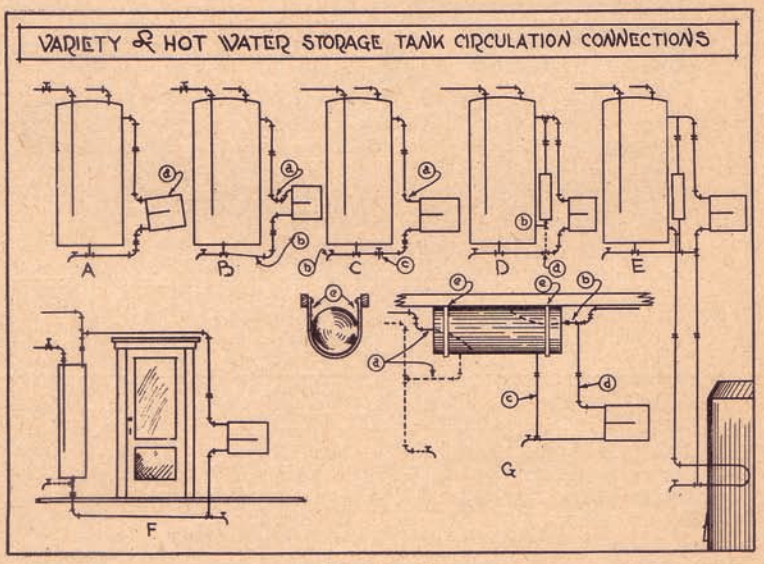

FIGURE 7

The range water back, kerosene heater, and house furnace coil are connected with the hot-water storage tank as shown in E of Figure 7.

In F is shown a range water back connection to a storage tank with intervening door.

The common hot-water storage tank or range boiler may be placed horizontally against the ceiling as shown in G. Pipe (a) supplies cold water at the bottom of tank, and pipe (b) discharges water from the hottest part of the tank to plumbing fixtures. Pipes (c) and (d) are circulating pipes only. Supporting strap-iron bands are shown at (e).

ATTIC TANK AND FORCE PUMP (Figure 8)

The water supply problem of the household may often be solved by the use of a tank placed in the attic or even in some unused room on the second floor. Figure 8 shows how the connections may be made when using a horizontal double-acting pump in the basement to force water from a cistern to the attic tank.

An ordinary galvanized-iron stock tank is used for storage. These tanks may be obtained in various sizes and shapes but the oblong type with rounded ends is to be preferred, since it may be set directly over a partition. This lessens the load on the joists. If not placed over a partition, additional joists must be used under it to take the weight from the ceiling joists. A tank 6 feet long, 2 feet wide, and 2 feet deep will hold about 150 gallons, which should ordinarily be a two days' supply. Very little trouble is experienced from freezing if water is pumped at least twice a day in cold weather. The warmer water from a well or cistern keeps the temperature in the tank above the point where solid freezing takes place except in the coldest weather. Trouble due to condensation may be prevented by placing a galvanized iron pan and drain under the tank. The use of a tight cover is recommended.

The overflow pipe should be 2 inches in diameter and may be carried out under the eaves or returned to the basement beside the supply pipe. Regular tank connections may be purchased for attaching the 1-inch supply and 2-inch overflow pipes to the attic tank. When complete bath room fixtures as well as kitchen sink are used with this system, a 250-gallon attic tank should be purchased if a two days' supply is desired.

Various modifications of the system are in use. For instance it may be desirable to pump water to the tank from a force pump at the windmill. The overflow can then be carried down thru the partitions and out to the stock tanks. It is desirable to have this overflow pipe 1½ to 2 inches in diameter.

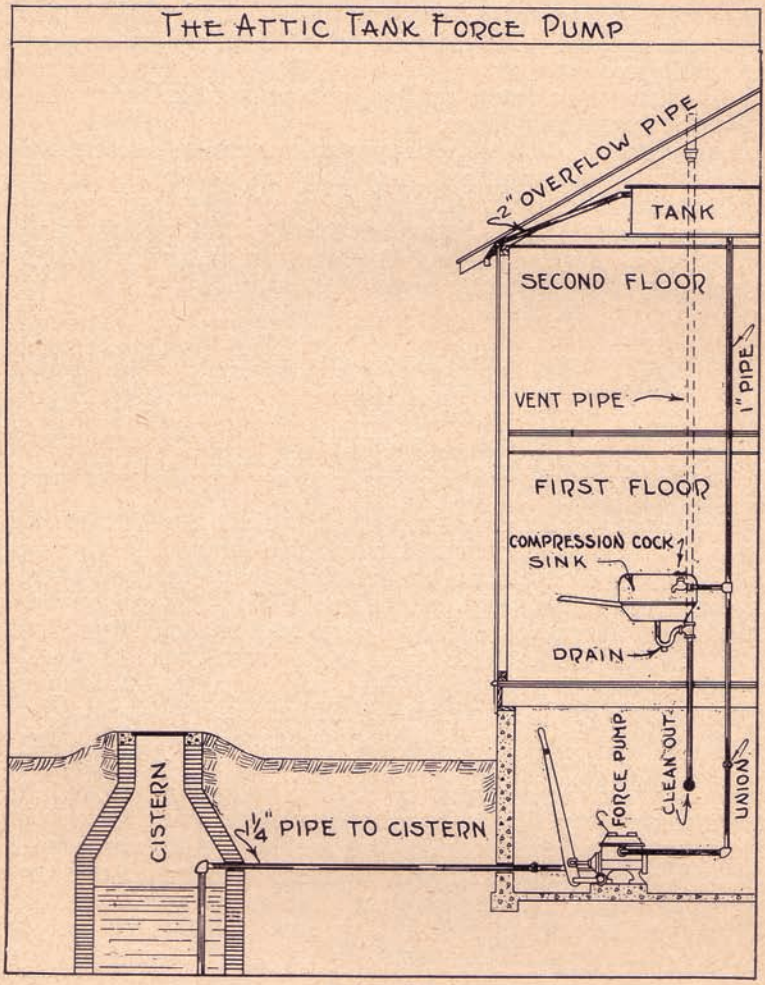

FIGURE 8

MATERIALS NEEDED:

Horizontal double acting pump
Galvanized steel round-end stock tank
Sink, drain and drain board
1″ pipe—pump to tank
2″ overflow pipe
1¼″ pipe—cistern to pump
¾″ compression cock
Elbows, T's and reducers, depending on conditions
Additional stringers to support tank
NOTE:—Other fixtures than a sink may be used if desired

DEEP TANK AT THE WELL. (Figure 9)

A satisfactory method of obtaining cool drinking water at the kitchen sink is shown in Figure 9. It has the advantage of requiring no force pump.

At A is shown a deep concrete tank. From the bottom of this tank, a 1¼-inch pipe is laid, 4 feet underground, to the

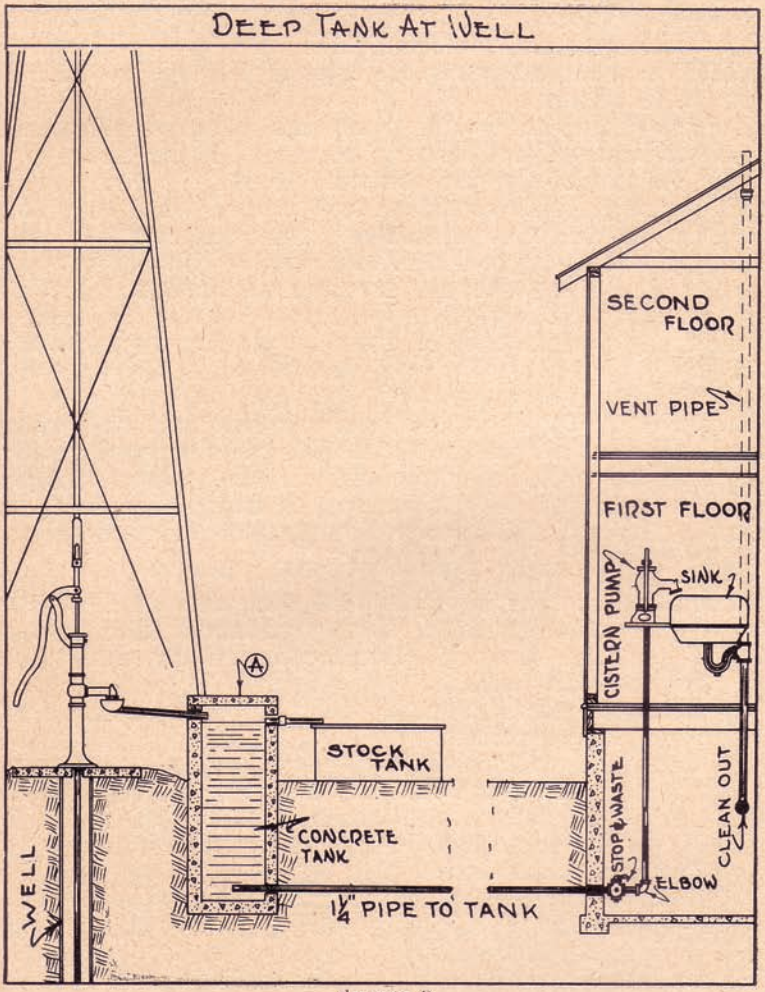

FIGURE 9

MATERIALS NEEDED:

A concrete tank 2′ x 2′ and 7′ 6″ deep
1¼″ pipe to tank
Drain from sink
Stop and waste cock
Cistern pump
Sink and drain board

NOTE—This system to be used where elevation of ground at well is same as at the house

basement and then turned upward to a pitcher spout pump, such as is shown in Figure 1. All the water pumped by the windmill, for all purposes, passes thru the tank at A, keeping it filled with cool water. Any pumping done at the house draws cool water from the bottom of tank A.

The elevation of the ground at the windmill and at the house should be about the same when this system is used, altho good results have been obtained where the bottom of tank A was 15 feet below the level of the sink at the house and 100 feet away.

A stop and waste cock is in the line where the pipe enters the basement. When turned, this cuts off the water to the pump and drains the pipe between it and the pump to prevent freezing. This cock need not be used when the ground elevation at tank A is 5 feet lower than that at the house, as the pipe leading up to the kitchen may be drained by simply raising the pump handle as explained in connection with system shown in Figure 1.

Freezing at tank A is prevented by packing manure around and covering the top with old blankets or 12 inches of sawdust. The tank at A is made 2 feet square and 7½ feet deep. The walls are 5 inches thick and are reinforced with woven wire. The cover must be tight fitting and may be made of concrete or two thicknesses of 2-inch plank. It is sometimes possible to find an old iron tank which may be bought second-hand and used at A, instead of building one of concrete.

ELEVATED TANK AND TOWER[1] (Figure 10)

The elevated tank has been used for years as a means of water storage for the farm. It has the following advantages:

1. It provides running water for the residence as well as for the barn yards.
2. It may be placed near the well; hence water need not be piped long distances.
3. It may be used in a level country.
4. Leaks in the tank are easily detected and repaired.

The following disadvantages must be considered:

1. It is more expensive than an underground tank, both in first cost and upkeep.
2. Some trouble may be experienced from freezing.
3. Water is warm in summer for household use.
4. It is somewhat unsightly.

The main features of the system shown in Figure 10 are:

1. A round tank 8 feet in diameter and 10 feet deep made of cypress or redwood staves held in place by means of

[1] Persons interested in installing this system should procure the following blueprints from the Extension Service of the Agricultural College, Lincoln, Nebraska:
No. 10.873-11 Elevated wood tank in tile tower.....15 cents
No. 10.873- 8 Pump and hydrant connections.....10 cents
These prints give complete details of construction.

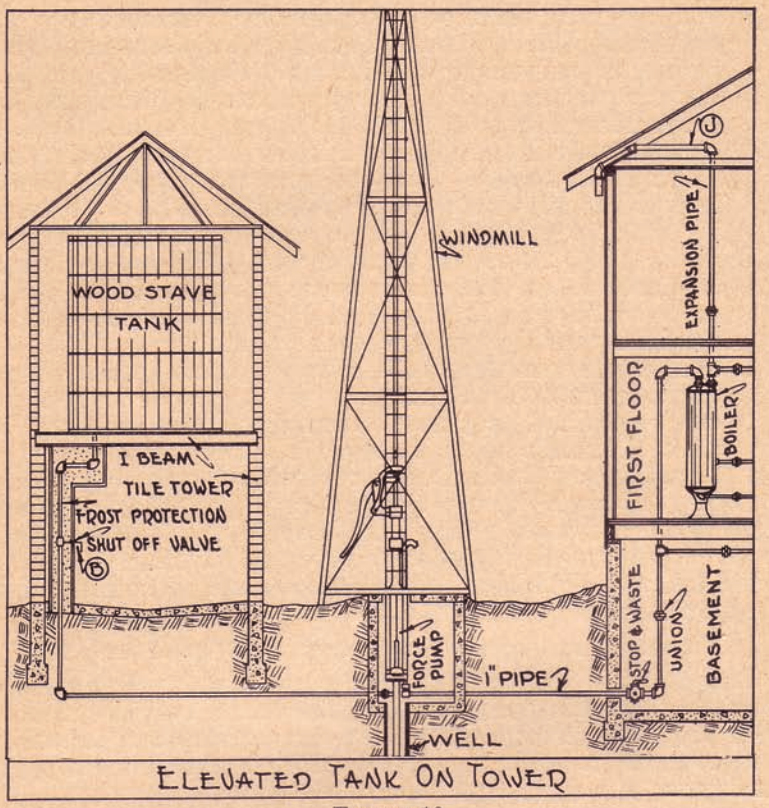

FIGURE 10

MATERIALS NEEDED:

Round cypress wood tank 8′ x 10′	Windmill tower
Shut off valve	Frost protection
Tower 12′ diameter	Range boiler
I-beams support for tank	Stop and waste cock
Force pump	Expansion pipe

NOTE: Barnyards may also be served from tank

adjustable iron hoops. The capacity is about 115 barrels or a week's supply for the average farm.

2. A tower 12 feet in diameter made of tile, brick, or concrete masonry to support the tank and protect it from the sun in summer and from freezing in winter. The tower wall should be 12 inches thick up to the "I" beam supports, and 5 inches thick from there up. It should be covered with a conical roof. The space in the tower beneath the tank may be used for storage.

3. The 1- or 1¼-inch pipe connections from well to tank and to all places where water is to be delivered. This pipe must be well protected where it passes up thru the tower to the tank, or freezing will result. This may be accomplished by placing it in a box 12 inches square packed with dry sawdust or mineral wool. A shut-off valve at B provides a way to save the supply if a leak is detected anywhere in the system, or it may be closed for making repairs.
4. A three-way force pump at the well. The under-ground connections are made in a pump pit of concrete. This pit is made 4 feet square and 6½ feet deep and should be tightly covered with a concrete slab.
5. A stop and waste cock in the supply pipe where it enters the basement. By closing this, all the pipes in the house can be drained to prevent freezing. When this cock is shut, the range boiler pressure is relieved thru the pipe J, which goes to the attic and then out under the eaves.

Unless the tower is made higher than shown, the bath room must be on the lower floor of the house. A height of 8 feet to the bottom of the stave tank is usual for fixtures on the lower floor. This height should be increased to 14 feet when the bath room is on the second floor.

THE UNDERGROUND MASONRY RESERVOIR[1] (Figure 11)

One of the most satisfactory gravity systems obtainable consists of an underground reservoir, placed on high ground, with proper pipe connections to a force pump and to points where water is to be delivered. It has the following advantages:

1. The work of building the reservoir may be done by the owner.
2. The water is fairly cool in warm weather.
3. No trouble is experienced from freezing.
4. The cost of upkeep is low.

The disadvantages are:

1. Limited number of farms where it may be used.
2. Leaks are not easily detected.
3. Long pipe lines often necessary between reservoir and buildings.

The main features of the system shown in Figure 11 are the same as those of the system shown in Figure 10 with the exception of the storage reservoir.

Any one of a variety of masonry reservoirs may be used, for instance:

[1] Those interested in installing this system should obtain the following blueprints from the Extension Service, Agricultural College, Lincoln, Nebraska:
No. 10.873-16 Plans for underground concrete reservoir.....10 cents
No. 10.873- 8 Plans for concrete pump pit and hydrant connections.....10 cents

1. A cylindrical reservoir "bricked up" and plastered.
2. In some soils, cement plaster may be applied directly to the dirt with fair results as shown in Figure 2.
3. A rectangular or circular reservoir of solid concrete construction. A concrete reservoir rectangular in shape, 7 feet deep, 7 feet wide, and 10 feet long, has a capacity of about 115 barrels or a week's supply for the average farm. This particular shape may be easily made since simple forms may be used in pouring the concrete. The

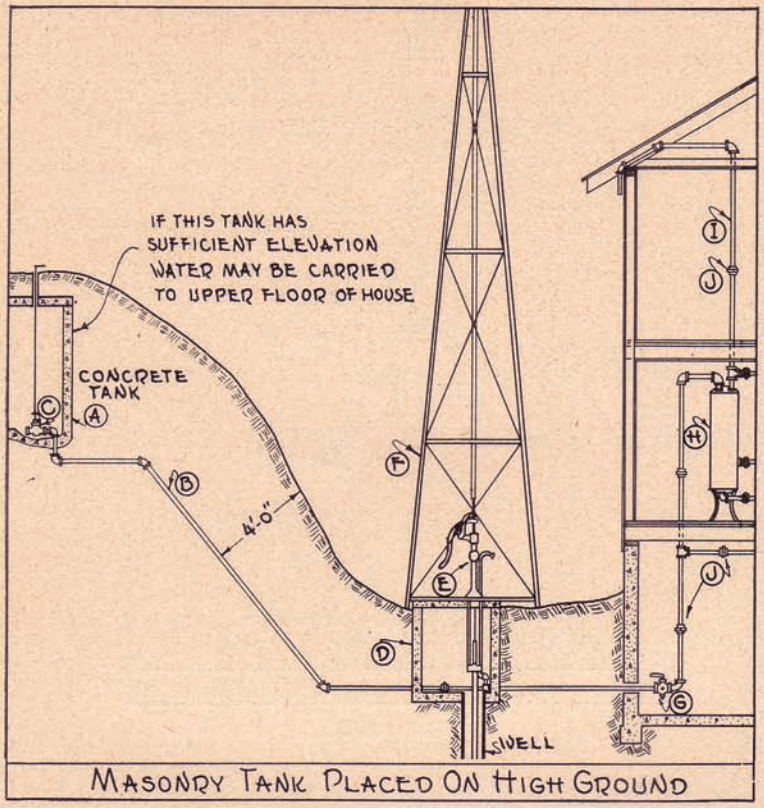

FIGURE 11

MATERIALS NEEDED:

A square or rectangular concrete tank, at A
1" pipe from well to tank, at B
Shut off at tank-gate valve, at C
Well pit, at D
Force pump, at E
Windmill, at F
Stop and waste cock, at G
Range boiler, at H
Expansion pipe, at I
Unions, at J

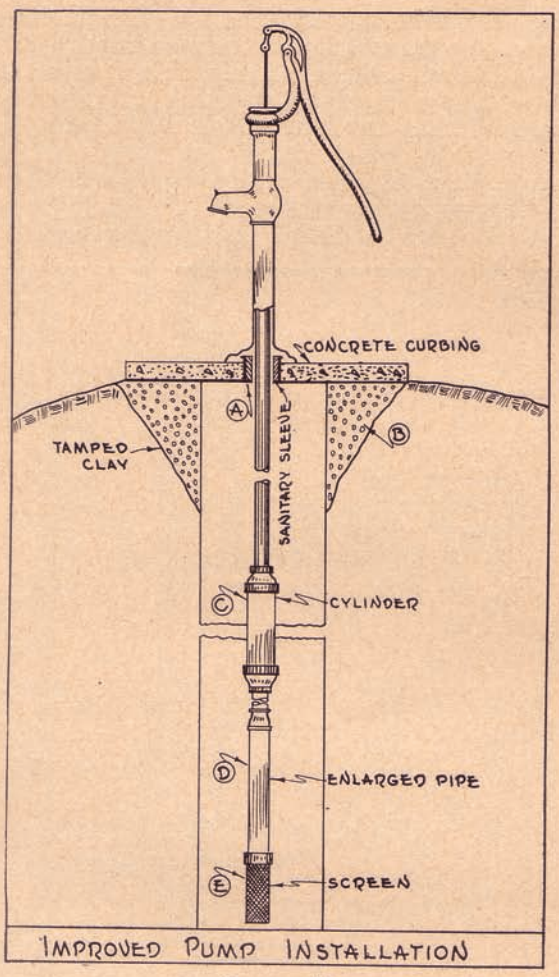

FIGURE 12

reservoir should be made of water-tight concrete.[1] The walls are made 6 inches thick and the reinforced concrete cover is 5 inches thick. The reinforcing in the concrete cover consists of ¼-inch bars 6 inches apart crosswise, and ¼-inch bars 12 inches apart lengthwise.

The same 1- or 1¼-inch pipe line may be used for drawing water from the reservoir as is used for pumping into it. Systems are in successful operation where the reservoir is located on higher ground 800 feet from the well and build-

[1] See "Water-tight Concrete" on page 41.

ings. A standard gate valve is placed at C in the reservoir to control the supply when repairs are needed. At G is a stop and waste cock which will allow the house plumbing to be drained. This is the same type as described in Figure 10.

PROTECTING WELL WATER FROM CONTAMINATION (Figure 12)

Much of Nebraska's water supply comes from deep tubular wells and the danger of contamination is slight. There are, however, some communities where the shallow bored, dug, or driven well is still in use. In such cases it is imperative to protect the top of the well against the entrance of flood water and the drippings from the pump. Protection against flood water may be obtained by raising the well platform above the general level of the ground. Stiff clay should then be tamped around the curbing as shown at B in Figure 12. After this, the surface of the ground should be raised around the well by grading.

Protection against dripping can well be provided by arranging a sanitary sleeve in the well curbing as shown at A.

The cylinder C should be placed in the water. Not more than 6 to 10 feet of suction pipe should be necessary below the cylinder. Where sand is near the end of the suction pipe, an enlarged pipe, as D, (to cut down the velocity of the incoming water) and the screen E will lessen the amount of sand drawn thru the cylinder leathers.

WINDMILL REPLACED OR SUPPLEMENTED BY A MOTOR AND ORDINARY PUMP JACK (Figure 13)

When the farm is supplied with electricity from any source and the windmill becomes worn and in need of repair, or trees and buildings begin to shut out too much wind, a small motor is often belted to a pump jack to furnish the needed supply of water. It has the following advantages:

1. Fresh water is not dependent on the moods of the wind.
2. Rate and time of pumping are under control.
3. The cost of the motor is usually less than that of a new mill.
4. The upkeep cost of motor and jack is low.

The disadvantages are:

1. The gears in the ordinary pump jack, usually built for a gas engine, are not in correct ratio to give the desired pumping speed when a motor, which has a much higher speed and is equipped with a smaller pulley, is the source of power.
2. More oiled bearings, etc., are exposed to weather and dust.
3. Possibility of no current because of breakdown in power source.

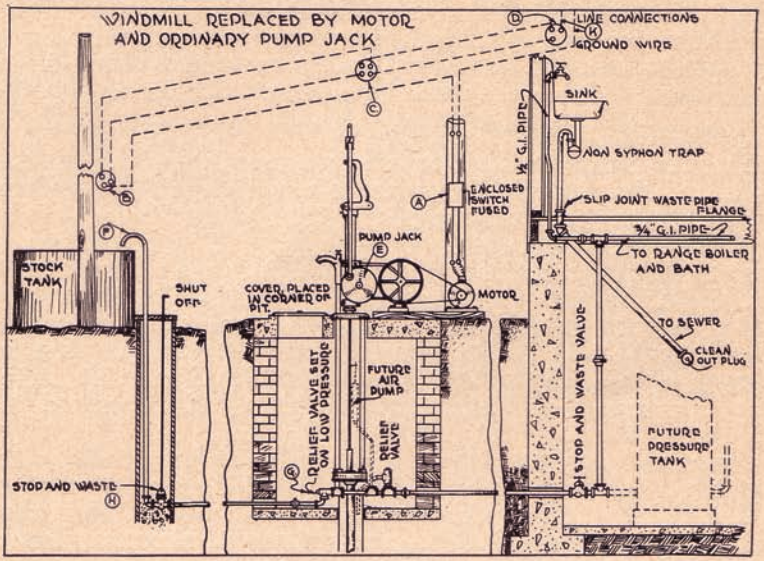

FIGURE 13

4. To date only about 10 per cent of Nebraska farms have any kind of electrical service.

The main features brought out in Figure 13 are:

1. The pump jack and motor replacing or supplementing the windmill.
2. Control of motor by one switch usually placed near the motor at the well.
3. Multiple switch arrangements for control of motor at two or more points.
4. The addition of relief valves on the water line to prevent excessive pressure in case faucets are not open when pump starts working.
5. Provision for connecting air pump if pressure tank is added at later date.
6. Manual control only.
7. Water can be run directly from well to faucet without installation of storage tank.
8. Any type of elevated storage tank can be installed if desired.

Quite often on the first change-over from the windmill to the electric motor the simplest wiring and equipment are used. This usually consists of two wires from the house supply lines and the single throw switch as shown at A. Later when more convenience is desired, switch controls at two or more places may be installed. An arrangement of

this kind is shown with the dotted lines and the indicated 3-way and 4-way switches at B, C, and D. When this switch control is used it is possible for anyone in the house to start the motor by throwing switch D. *This switch should not be within reaching or touching distance of any plumbing fixture.* It is also possible for someone else to start the motor by throwing switch C at the pump or switch B at the stock tank. Either 32-, 110-, or 220-volt direct current, or 110- or 220-volt alternating current circuits are permissible for this convenience, *provided the switches when open always disconnect the ungrounded wires.* Usually the 220-volt circuit is not grounded when the 110-220-volt 3-wire system from power lines is used. Hence the 220-volt power line circuit should not be used thru switches as indicated at B, C, or D. When motors of ½ H. P. or larger are required, the 220-volt service is the better if proper switches and fuses are installed. Line K is from the distributing panel or switch.

Attention should be called to the low pressure relief valve at G. If pipe F at stock tank were much lower than the faucet at the kitchen sink, it would be impossible to draw any water at the sink if water were allowed to flow freely at F. By placing this relief valve G in the line to the tank, enough resistance to water flow can be set up to allow some water to be drawn at the sink. This is a special convenience when a meal is being prepared and the teams from the field want fresh water at the same time.

AUTOMATIC ELECTRIC WATER SUPPLY SYSTEM—WELL NEAR THE HOUSE

(Figure 14)

If the well, either shallow or deep, is close enough to the house, a well pit may be connected to the basement. In the case of a cistern the pump and motor may be placed on the basement floor. The advantages are:

1. The equipment is easily accessible.
2. Warmth from the basement has some advantages in winter.
3. More room to work than is found in many small pump pits.
4. Short runs of pipe to house.
5. Additions and changes take minimum labor and expense.
6. The system is completely automatic.
7. Any type pump head or system can be used.
8. A broken belt or other trouble may be noticed soon.

The disadvantages are:

1. Many well men are not equipped to make a well so close to the house.
2. Noise of pump and motor operation may be disturbing.

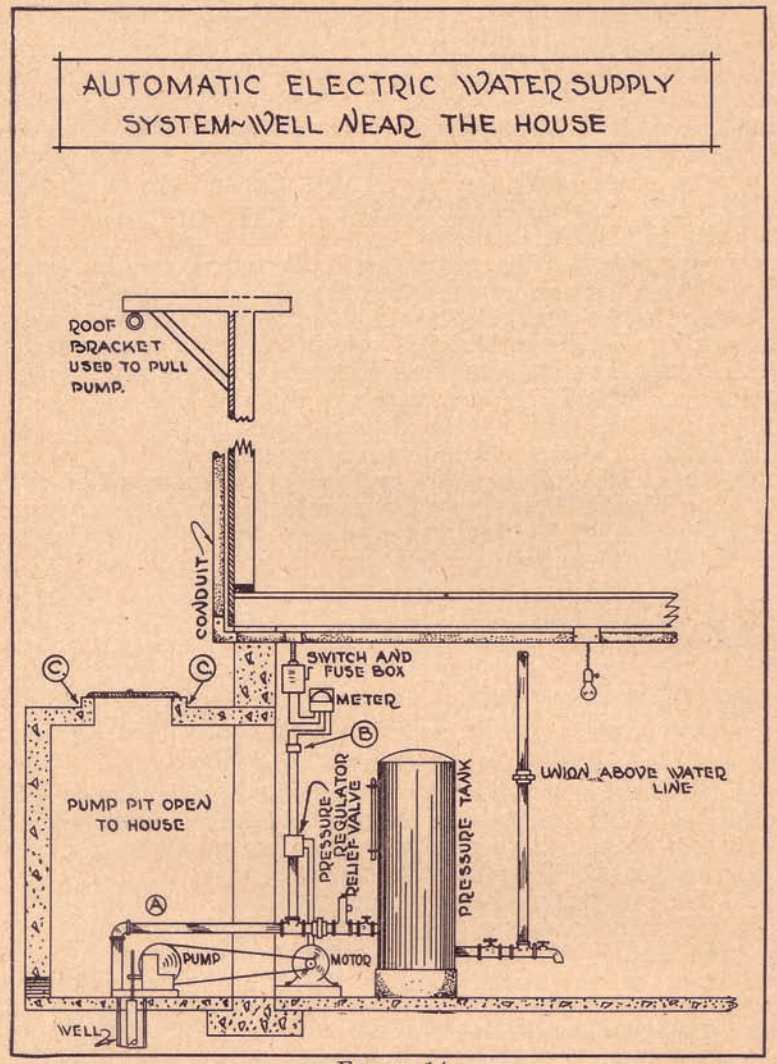

FIGURE 14

3. Leaks may cause foundation dampness.
4. Well too close to a possible leak from floor drain or sewage disposal pipe.

The main features not emphasized in previous systems are:

1. The use of the gable when pulling pump pipe.
2. The manhole cover also essential if long pipe need be removed.

3. An elevated cover to prevent filthy wash leaking into the well.
4. The addition of pneumatic pressure tank.

In installations of water systems for which pits are necessary, it is much more convenient when men are working on the pump connections to have the well to one side or towards one corner *rather than in the center of the pump pit.*

This type of installation is as good for the shallow as for the deep well pump, and with a slight change in suction connections, pumping from the cistern can also be done to good advantage.

Pipe A as indicated is shown to represent discharge pipe from any type of pump head. The motor and pump may be belted or direct connected and relative positions changed to fit local conditions. At B is indicated a thermal cutout installation. While the thermal cutout is not necessary to the working of any electrically operated water system, it is an inexpensive protection against burning out the motor if for any reason continuous excessive current passes thru it. The line fuses do not prevent motor burn-outs in many cases. CC indicate prevention of surface wash from entering the pit or well.

THE HYDROPNEUMATIC TANK

The small tanks used in the present-day water systems are called pneumatic water tanks or hydropneumatic (water-air) tanks. Air occupies the upper portion of these tanks and causes increased pressure on the water when more air or more water is pumped into the tank. The air must be maintained in some manner. Some of this air is absorbed by the water and must be replaced at intervals to prevent water logging. *If an automatic water system becomes water logged the pressure regulating switch cuts in and starts the motor each time a faucet is opened.* A sufficient quantity of air must be trapped at all times to produce the pressure necessary for a steady flow of water. The pressure regulating switch usually is set to start the motor when the pressure falls to 25 pounds and to stop the motor when the pressure builds up to 50. All these pressure regulating switches are adjustable. Often a range from 20 to 40 pounds is very satisfactory. When the best service is obtained, about the upper third of the tank is occupied by air alone and only from one-fourth to one-third of the water in the tank can be drawn when the regulator works between the limits indicated. Except in special cases tanks of 40 to 75 gallons capacity are large enough when used in automatic systems. This does not provide a large storage capacity but is enough to prevent the

motor from starting every time a small amount of water is drawn. The distinct advantage of the small tank is recognized when fresh, cool water is desired at all times.

COMPLETE AUTOMATIC ELECTRICALLY OPERATED PNEUMATIC TANK SYSTEM—WELL REMOTE FROM THE HOUSE (Figure 15)

On many farmsteads the well is located some distance from the house. In these cases convenience, permanence, and dependability must be emphasized. The system pictured in Figure 15 brings out many features of the complete pump head and the installation recommended by the authors. The advantages of such a system are:

1. Dependable water service at any place desired on the farmstead at a satisfactory pressure.
2. Very little care is necessary.
3. Water under pressure at all times makes possible in the country home any of the modern plumbing found in the city home.
4. Automatic switches and running water save steps that are required when there is only manual control or but one faucet from which all water is carried.
5. Sanitary conditions are better because of good tight platform and covers at the well pit.
6. Very little stale water will accumulate in the tank or pipes.

The disadvantages are:

1. More care needed in installation.
2. Relation of air pressure to water distribution must be understood.
3. Absolute dependence on one source of power—electricity.
4. Higher first cost than that of simpler systems.
5. When the 40 to 80 gallon pressure tank is used, shortages of stored water may occur when both the house and barnyard require large amounts at the same time.

The main features to be emphasized in Figure 15 are:

1. The complete unit in motor and pump head, including frost set-length installed above ground for easy accessibility (this should have a good removable cover built to keep out dust and snow).
2. A good reinforced concrete platform having raised flanges at both pump and manhole.
3. The pit should be 6½ to 7 feet deep and at least 5 feet in diameter if round, or 5 x 6 feet if rectangular, to allow two men to work in the pit. This pit should be of masonry construction with drainage from the floor allowed thru lower part of pit wall. (Drainage out the lower part of the side walls seems better than a posthole

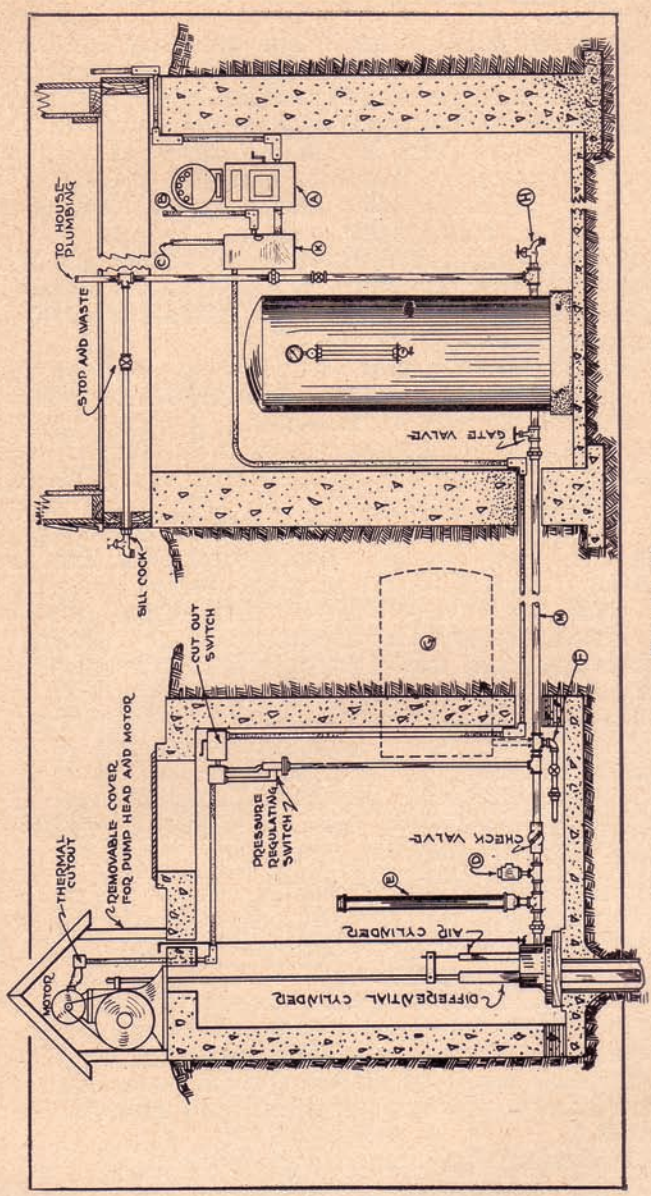

FIGURE 15
Complete automatic electrically operated pneumatic-tank water system—well remote from the house

sump near the well—there is less chance of this water getting back to the well.)

4. For the pneumatic system an air pumping cylinder is desirable; an air chamber E near the pump serves as a cushion and prevents water hammer in the pipe system and allows the pressure-regulating switch to work normally and not open and close at each stroke of the pump.
5. The relief valve D prevents excessive pressure; the check valve prevents water running back into the well from the pipes and storage tanks.
6. Any pipe lines may be taken off on the under side of the service pipe for hydrants as at F or in some cases at H and the cutoff and gate valves become necessary when changes or repairs are wanted.
7. The pressure regulator is placed on the discharge line from the pump. This can be adjusted to start and stop the motor at the desired pressures.
8. A cutout switch with proper fuses is installed in a convenient place to cut off current while working in the pit or on the pump.
9. Near the motor a protective thermal cutout should also be used. These thermal cutouts prevent motors from becoming too hot if something goes wrong.
10. At A is the entrance switch and meter—panel box at K. This installation is being replaced in many districts by placing meter and switch on a pole in the farm yard. B and C represent conduits to house and appliance circuits. At G is a convenient place to install pneumatic tank in the absence of a good cool basement. This installation has many points in its favor.

THE COMPLETE AUTOMATIC ELECTRICALLY OPERATED PNEUMATIC TANK SYSTEM—INSTALLED IN PIT AND HAVING THE FRESH WATER ATTACHMENTS (Figure 16)

In many districts in Nebraska soil conditions are such that a well pit can be kept comparatively dry. Under these conditions the installation of the motor and pump head in the pit is good practice. Many times even when a small storage tank only is used, a fresh water outlet brings water direct from the well without wasting stored water that may be warm. The advantages of the system as shown:

1. The installation is usually free of the dust that causes much of the wear when pump head and motor are more exposed.
2. The frost set-length is no longer necessary.
3. At a small extra expense the added benefit of fresh drinking water is provided.

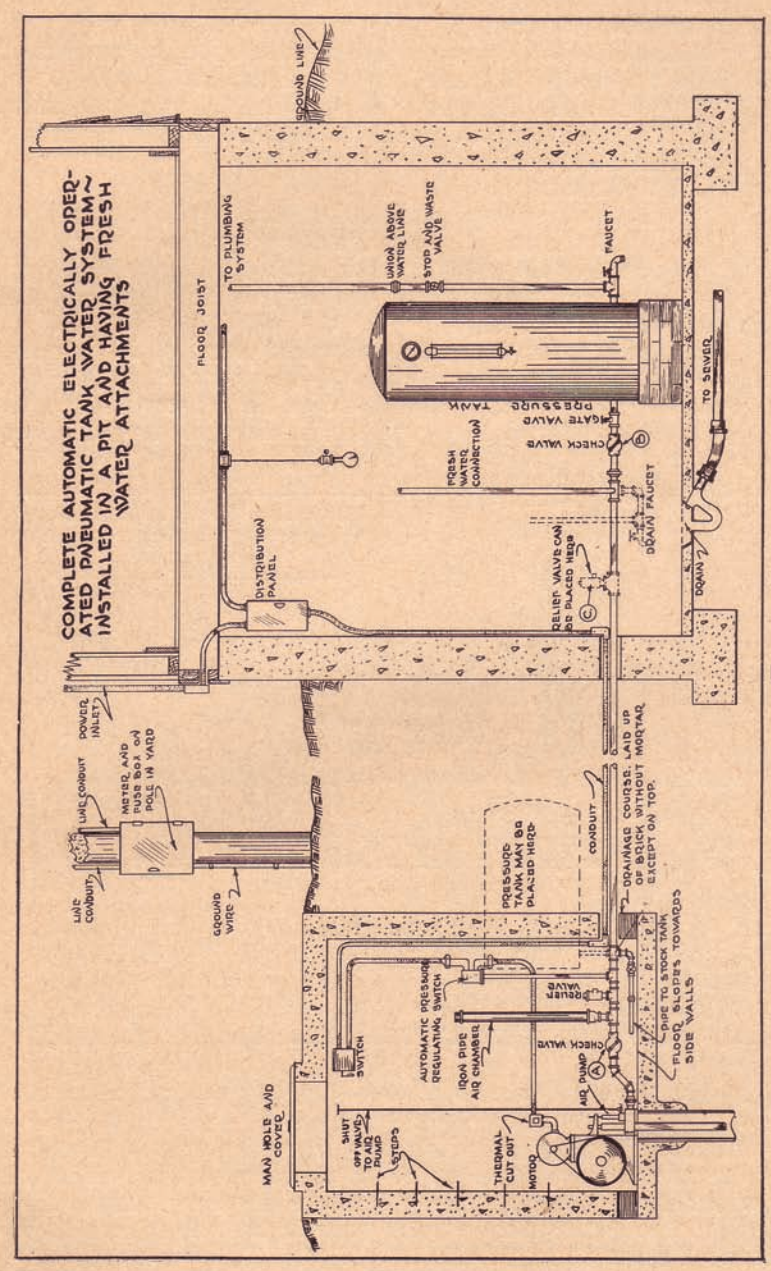
COMPLETE AUTOMATIC ELECTRICALLY OPERATED PNEUMATIC TANK WATER SYSTEM~ INSTALLED IN A PIT AND HAVING FRESH WATER ATTACHMENTS
GROUND LINE
FLOOR JOIST
TO PLUMBING SYSTEM
VALVE ABOVE WATER LINE
STOP AND WASTE VALVE
FAUCET
TANK PRESSURE
GATE VALVE
CHECK VALVE
FRESH WATER CONNECTION
TO SEWER
DRAIN FAUCET
DRAIN
DISTRIBUTION PANEL
RELIEF VALVE CAN BE PLACED HERE
DOWN INLET
LINE CONDUIT
METER AND FUSE BOX ON POLE IN YARD
LINE CONDUIT
GROUND WIRE
PRESSURE TANK MAY BE PLACED HERE
CONDUIT
DRAINAGE COURSE LAID UP OF BRICK WITHOUT MORTAR EXCEPT ON TOP.
AUTOMATIC PRESSURE REGULATING SWITCH
IRON PIPE AIR CHAMBER
SWITCH
POWER VALVE
CHECK VALVE
AIR PUMP
PIPE TO STOCK TANK
FLOOR SLOPES TOWARDS SIDE WALLS
MAN HOLE AND COVER
SHUT OFF VALVE TO AIR PUMP
STEPS
THERMAL CUT OUT
MOTOR

FIGURE 16

The disadvantages are:

1. With all installations in the pit out of sight, neglect in care and oiling is more likely to happen.
2. The owner does not hear the operation of motor or pump and may not discover worn or loose parts until expensive repairs are needed.

The main features are:

1. The cover for pump head and motor is not required.
2. The fresh water outlet changes the position of the check valve at A, adds another check valve at B, and a T-pipe fitting at the point where the fresh water line is taken off for the stock tank.
3. In recent farm connections, when service is received from central station lines, the entrance switch and master meter have been installed in a well-constructed metal box placed on a pole in the farmyard rather than in the house or an outbuilding.

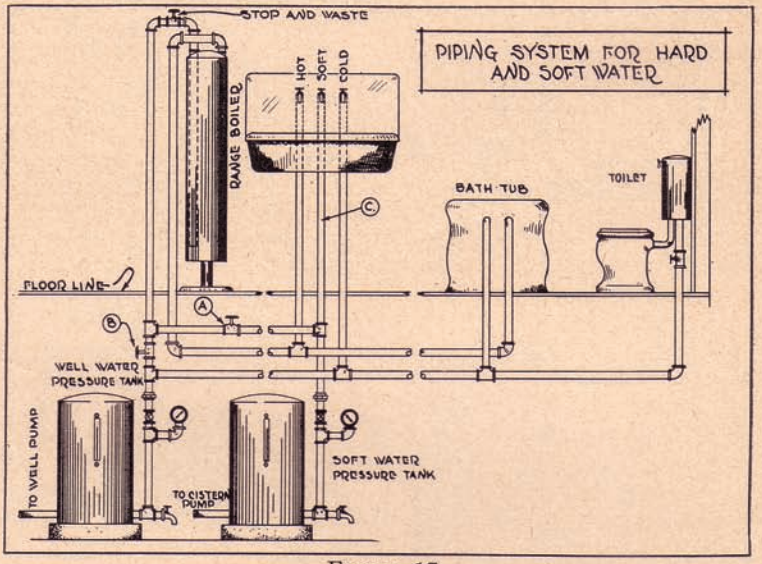

FIGURE 17

AN ARRANGEMENT FOR PIPING HARD AND SOFT WATER TO MODERN PLUMBING (Figure 17)

On many Nebraska farms the well water is "hard", and soft water from the cistern or a water softener is wanted for household use. In Figure 17 is shown a system that is being used to good advantage where electric service makes it possible. The advantages are:

1. It is possible to have either hard or soft water or both at any plumbing fixture in the house.
2. When soft water is on hand it may be used in the range boiler, thus preventing much of the scale deposited when hard water is used.
3. Pipes are so arranged that well water can be distributed in the soft water pipes if the soft water supply fails.

The disadvantages are:

1. More piping and pipe fittings.
2. Necessity of drilling extra faucet outlets in sinks or of buying special sinks.
3. The scheme is not practical where a dependable pressure system can not be used.

The main features are:

1. The gate valves A and B are used as by-passes to control the distribution.
2. The use of soft water where wanted.
3. The use of well water to flush-box or other places where soft water would be wasted.
4. The adaptability to use if a commercial water softener is installed.
5. A commercial water softener may replace the soft water storage tank of Figure 17 and connections may be made directly from well water system.
6. When valve A is opened, soft water flows to range boiler; then warm water flows back to kitchen sink, lavatory, bath, etc. thru pipe C.
7. Cold soft water or cold well water can also be piped where convenient.
8. If the supply of soft water is exhausted, closing A and opening valve B will allow well water to flow thru the range boiler and, as warm water, supply the fixtures.

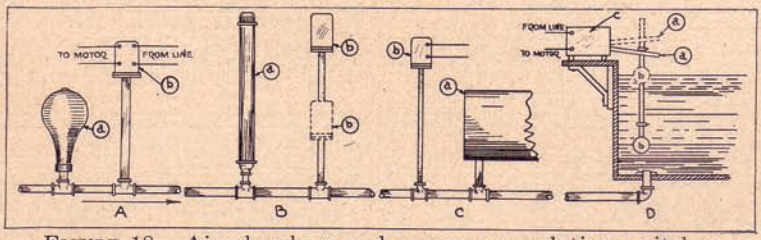

FIGURE 18.—Air chambers and pressure regulating switches.

INSTALLATION OF AIR CHAMBERS AND PRESSURE REGULATING SWITCHES (Figure 18)

Some kind, size, or type of air chamber should be placed near each pump. The pressure regulating switch should be installed near an air chamber. While the exact location of

these pieces of equipment may be varied, all relative positions may be classified as shown in A, B, and C, (a) in each case being the air chamber and (b) the pressure switch. If the well is some distance from the house and other places where water under pressure is used, the air chamber (a) as in A should be large. If the well is near the house a short length of 2-inch pipe, as (a) in B, is satisfactory if good pipe threads and connections are made. If a small storage or pneumatic tank is close to the well, the air chamber is provided as in C. Great care in pipe fitting must be used to prevent air leakage if pressure switches are to work satisfactorily.

Many times it is convenient to have some switch arrangement on an open tank as in D. Lever (a) is shown in open and closed switch position while float (b), forced up or down by the water, controls the action of lever (a).

AIR TRAPS (Figure 19)

All piping, whether suction line to a pump or discharge from a pump, or lines to any plumbing fixtures, should have sufficient grade to avoid air traps as shown in a suction line

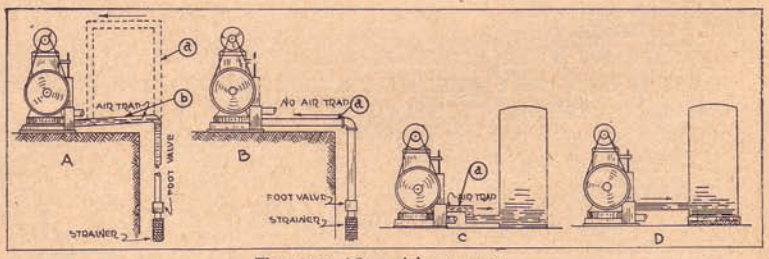

FIGURE 19.—Air traps.

at (a) and (b) in A and in discharge line (a) in C. This grade or slope of the pipe also facilitates drainage to prevent freezing if the family is to be gone in cold weather. Air traps cause irregular flow of water in pipes, extra wear on pump, and extra consumption of power. B and D indicate correct installations.

ELECTRICITY AS POWER FOR WATER SYSTEMS

Since 1923 the Department of Agricultural Engineering, University of Nebraska, has definitely been engaged in observing the performance of, and securing data of operation from, several types of electrically driven pumping systems. Apparently no use of electricity on the farm is giving the entire family more satisfaction and pleasure than the use of electricity to operate a water pump. A supply of hot and cold running water in the home can be as conveniently arranged, and can have much the same reliability, as water supplied to city residents.

RELIABILITY OF ELECTRIC SERVICE

It is very seldom that scarcity of water results from breakdowns in electric service. Power lines are supervised carefully to prevent any let-down in service and the small individual light plants are sturdy and usually can be depended upon to furnish electricity for pumping.

CONVENIENCE OF ELECTRIC SERVICE

Most industries have recognized the convenience of pressing the button to start operations. Motors take very little attention, give steady speed performance and especially the small sizes can be started or stopped as easily by women and children as by the men of the family.

COST OF INSTALLATION OF ELECTRICALLY DRIVEN WATER PUMP SYSTEMS

Water systems and complete plumbing costs vary in much the same way as automobile costs. The more convenient, elaborate systems cost more money than the simpler systems. However, the first cost of a system to supply water when and where needed would have to be very elaborate indeed to cost as much as the *cheapest new car on the market.*

COST OF OPERATION WHEN ELECTRICITY FURNISHES THE POWER

Since the project on rural electrification was started in 1926, accurate costs of operation, amounts of water used in the house, and data on depths of wells from which the water was pumped have been kept. On one farm the well is 65 feet deep. The maximum pressure in the pneumatic tank is set at 48 pounds. The electrically operated water system has required 1 kilowatt hour of electrical energy for every 400 gallons of water. The farmer pays 5 cents per kilowatt hour for electricity for the pump operation. At this rate the power cost is 12½ cents per 1,000 gallons pumped. On another farm a well is 35 feet deep, maximum pressure in tank is 50 pounds, and 670 gallons of water per kilowatt hour are pumped. At 5 cents per kilowatt hour this cost is about 7.4 cents per 1,000 gallons pumped. One system pumping into open tanks about 500 feet from a well 70 feet deep is pumping 900 gallons per kilowatt hour. A shallow well system pumping from a cistern and against a maximum of 50 pounds pressure in a pneumatic tank is pumping 940 gallons per kilowatt hour of electrical energy used. At 5 cents per kilowatt hour the power for this pumping is costing less than 6 cents per 1,000 gallons.

AMOUNTS OF WATER USED IN THE HOME

On all of these systems water meters as well as electric meters have been used and read once each month. Where modern toilet, bath, and kitchen plumbing are installed, the family of six is using slightly more than 100 gallons per day. This is an average from nearly three years' observation.

HINTS ABOUT PURCHASING A WATER SYSTEM

Buy that system that fits your needs, both present and future. Buy a product of a reputable manufacturer. Buy from a dealer who honestly wishes to give good service. Unless one water system furnishes water for more than 50 head of stock beside the water for the house, a capacity of more than 200 gallons per hour is not necessary.

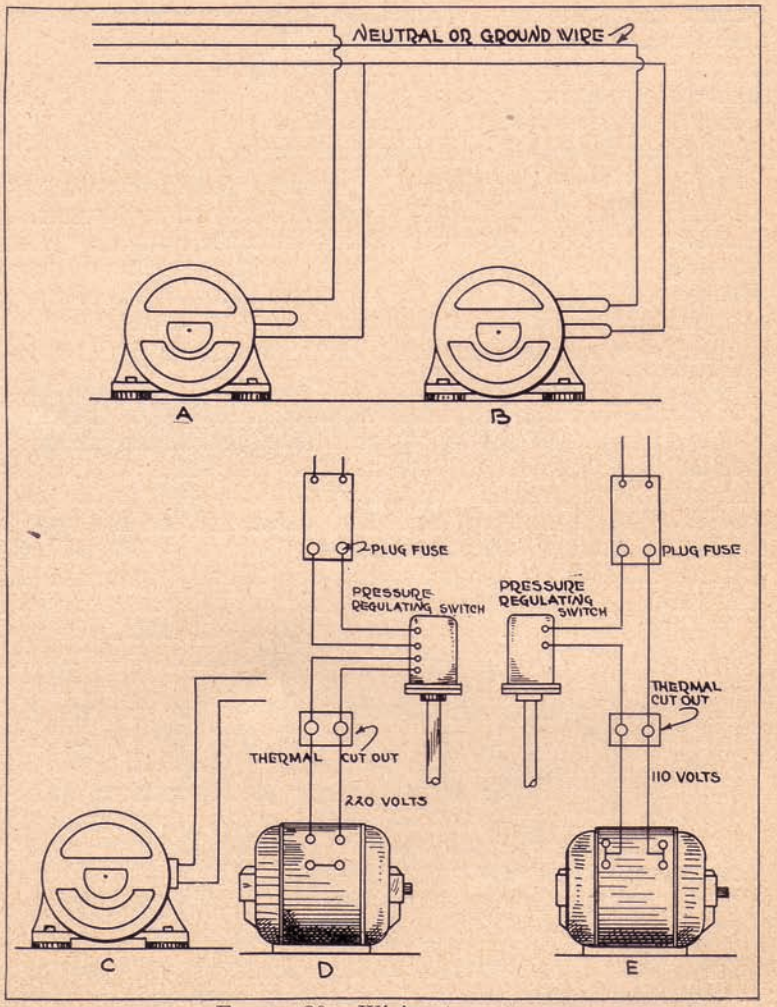

FIGURE 20.—Wiring to motors.

HINTS ON INSTALLATION

Get a good careful mechanic to install the pump, piping, and plumbing. See that tests are made for leaks, performance, etc., before settlement is made. Do not expect good motor performance and long pumping service if the working and oiled parts are neglected or allowed to be exposed to sand, scaling walls, dust, grit, or other foreign substances. Care should be taken that stuffing boxes, differential cylinders, and bearings are not too tight.

Before attempting to start the pump-system motor, be sure the data on the name plate of the motor correspond with the data of the circuit to which the motor is to be attached.

Usually very good instructions for installation and operation accompany each water system. These should be followed carefully.

HINTS ON WIRING TO MOTORS (Figure 20)

In Figure 20, A shows how wires may be connected at the motor for 220-volt alternating current, B is for 110-volt alternating, C is a hookup for any of the direct-current circuits, D is motor hookup thru a protective thermal cutout and a 2-pole pressure regulating switch. This is the safe hookup for a 220-volt ungrounded circuit. E shows the thermal cutout and a single pole pressure switch for the circuit in which one side of the line is grounded. This hookup can be used for 32-volt direct or 110-volt, either alternating or direct, circuits.

The drawings in Figure 20 are not placed there to show definitely how any motor is to be hooked to service line. *Always consult the wiring diagram that accompanies each motor.* Then know you are right before throwing a switch to start the motor.

COMMERCIAL WATER SOFTENERS
(Figure 21)

There is considerable interest at the present time in commercial types of water softeners which soften the entire household supply. These can be used only where some kind of pressure water system is available, however, from either a pressure tank, automatic electric pump, or gravity tank mounted on a tower or on a hill.

These softeners are manufactured in small units for household use. They somewhat resemble a range boiler in appearance and are connected to the water line where it enters the house. After softening a certain number of gallons of water, depending on conditions, the softener is easily reconditioned for further service. It is desirable to arrange the piping so that the water used in the toilets and at the cocks (where water is drawn for watering the lawn) does not pass thru the

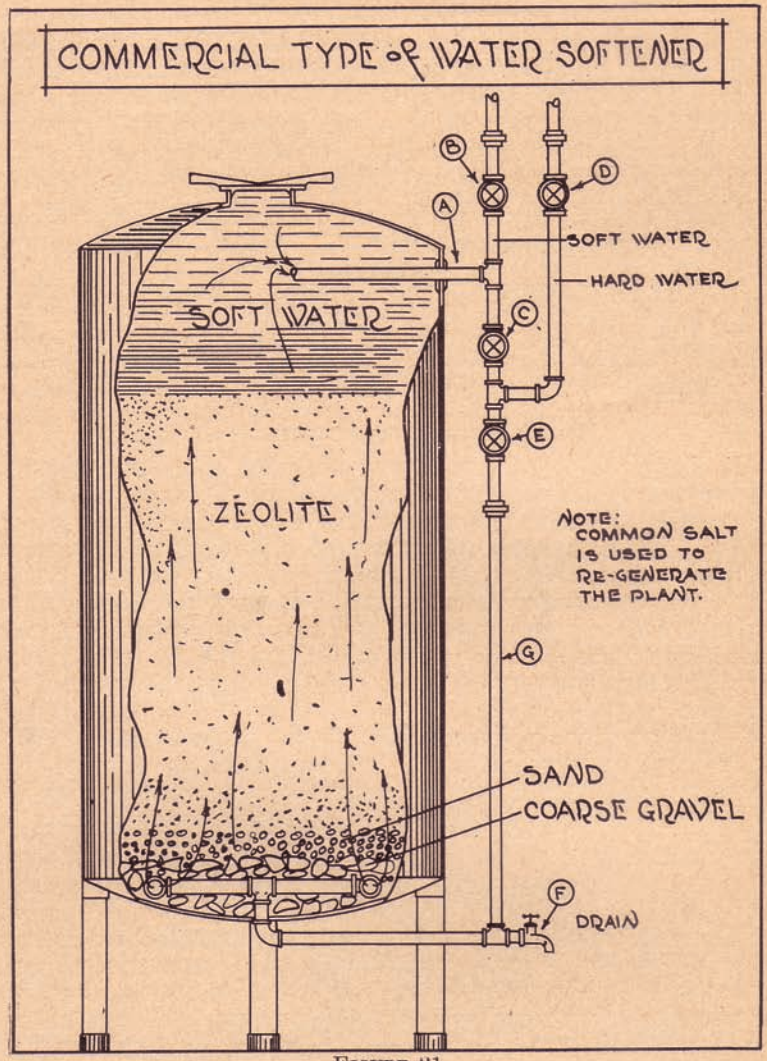

FIGURE 21

softener. By so doing it will not be necessary to recondition the zeolite so frequently.

There is little to get out of repair about this piece of apparatus. Its action is positive and the care required not difficult. Figure 21 shows a section of one using zeolite as the softening agent. The action is as follows.

In this type the hard water enters thru the pipe D and passes downward thru the pipe G, entering the bottom of the

softener where it encounters the layers of gravel and sand which support the zeolite. Here some filtering action takes place which removes silt and fine sand. It then passes up thru the zeolite granules where the magnesia and lime are taken out by chemical action. It then passes out thru the pipe A as soft water which can be piped to any part of the house. Other softeners are sold in which the hard water enters at the top and passes downward thru the zeolite to be softened. Advantages are claimed for both types.

After a time the zeolite will absorb no more lime or magnesia and the supply of water will be found to be coming thru as hard as it was on entering. It is now time to recondition the zeolite by backwashing and the addition of common salt. First, the direction of flow thru the softener is reversed by closing valves B and E and opening valve C (Figure 21). The hard water now enters the top of the softener and passes down thru the zeolite and the gravel, washing out any silt or other foreign material which may have accumulated. The drain valve at F is opened so that this dirty water can run to the sewer. After 10 minutes or so of washing, the water is shut off and the charging door at the top of the softener is opened and a quantity of fine salt is spread over the top of the zeolite. The charging door is replaced and a slow flow of water turned on thru valve C. This carries the salt solution down thru the zeolite and removes the lime and magnesia which it has collected and washes it out thru the drain valve at F. When a salty taste is no longer present in the drain water, the softener is reconditioned and ready for use again.

SEWAGE DISPOSAL SYSTEMS

A SAFE FARM SEWAGE SYSTEM

The sanitary disposal of sewage, including all of the wastes from the kitchen sink and the bathroom, can be accomplished safely and at reasonable cost by means of a concrete septic tank and a carefully laid-out absorption field. Such systems have been in use on farms for more than forty years and have proved their value as safe, sanitary methods of sewage disposal.

The septic tank is a water-tight receptacle having a capacity sufficient for at least 24 hours' sewage detention, or 50 gallons capacity for each person served. The tank acts as a settling chamber where the solids in the sewage are decomposed and changed to liquids or gases. As the sewage enters the tank, the solids sink to the bottom, where they are decomposed by anaerobic bacteria which live without air. The greases rise to the top and form an air-tight blanket over the sewage, which aids the bacteria in their work.

The liquid flowing from the tank, while almost clear, is not

necessarily pure. The final purification is accomplished in the absorption bed as the liquid seeps into the top soil and comes in contact with other bacteria.

The absorption bed consists of one or more lines of ordinary 4-inch drain tile laid with open joints. A minimum of 100 feet of tile should be used with any installation. As a rule 20 to 50 feet should be used for each person of the family served, sandy soils requiring less tile than clay. The tile should be laid at a depth of 18 to 24 inches and should be given a fall of 4 inches in one hundred feet. The tile lines

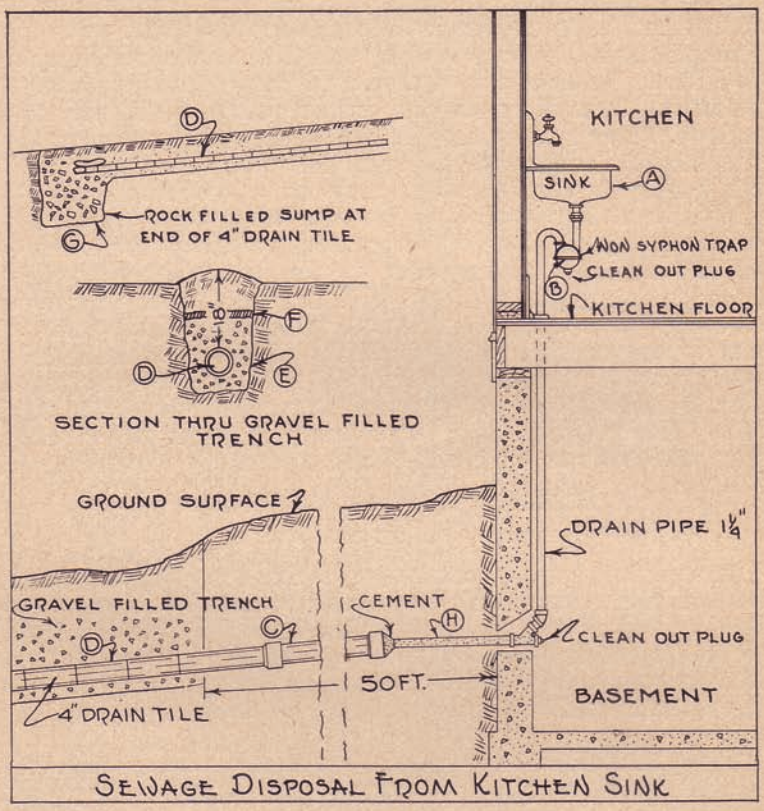

FIGURE 22

MATERIALS NEEDED:

Sink, at A
Non-siphon trap
4" sewer tile 50′ to drain tile, at D
Ordinary 4" drain tile, 50′. Fall ¼" per foot
Cast-iron soil pipe, 5′ from house to sewer tile, at H
Trench 2′ deep gravel filled
Layer of tight clay, at F
Rock filled sump 5′ deep, at G

should be laid in a bed of gravel as shown in Figure 23, the joints being covered with tar paper to prevent soil from working into the joints. The success of the system depends largely upon the use of a sufficient number of tile and their careful installation.

As a rule the septic tank is located 40 or 50 feet from the house and on the down-stream side opposite from the well. The tank should be placed only deep enough in the ground to allow for the proper depth of the absorption system. The tile connecting the house and tank should be a 4-inch sanitary sewer pipe, with all joints cemented and laid with a slope of 8 inches in one hundred feet. The sewage must enter the tank slowly, as undue agitation retards the action within the tank.

This system if properly installed will require little or no attention for five or six years, when the tank should be cleaned out. The sludge which collects at the bottom of the tank must not be allowed to come up to the bottom of the baffle boards; likewise the scum on top must not be allowed to occupy too much space. Regular inspections to determine the amount of sludge and scum are advisable.

KITCHEN SINK AND DISPOSAL TILE[1] (Figure 22)

The main features of this simple system are:

1. The kitchen sink, which should be firmly set to the wall with the top of the rim or apron about 36 inches from the floor.
2. The trap at B provided with a clean-out plug. The trap is necessary since it prevents foul gases from entering the house from the sewer.
3. The clean-out plug in the basement which permits removal of any material clogged in the pipe.
4. A 5-foot length of cast-iron soil pipe shown at H, connecting the sink drain and the sewer tile.
5. A string of 4-inch sewer tile with cemented joints to lead the sewage at least 50 feet from the house before it enters the gravel-filled trench where it soaks away into the ground. This vitrified sewer tile should have a fall of from ⅛ to ¼ inch per foot (C, Figure 22).
6. Fifty feet of ordinary 4-inch drain tile laid in a gravel-filled trench with a fall of ¼ inch per foot (D, Figure 22). This trench is dug approximately 2 feet deep and the tile are laid not more than 18 inches below the surface. No trouble will be experienced from freezing. At the end of the ordinary drain tile is a rock-filled sump—just a hole filled with rock and covered over with dirt.

[1] This sytsem cannot be used with safety except for the disposal of waste from the kitchen sink or the cellar drain. No bathroom fixtures may be connected to it.

In extremely sandy soils it will not be necessary to do more than lay the tile in a trench and cover them up. The gravel and the rock-filled sump will not be necessary.

SEPTIC TANK WITH TILE DISPOSAL SYSTEM[1] (Figure 23)

The main features of this system are:

1. Complete plumbing in the house as shown in Figure 23. This includes fixtures for the bath room, kitchen sink, cellar drain, laundry tubs, etc. At A, Figure 23, is shown the cast-iron soil pipe which extends from roof out under the foundation of the house a distance of 4 or 5 feet to where it joins the sewer tile. At D is shown the galvanized iron vent pipe, 1½ inches in diameter. Recessed, cast-iron fittings are used on this pipe.
2. From 30 to 50 feet of 4-inch sewer tile with cemented joints shown at G laid from the house to the septic tank. This pipe should have a fall of from ⅛ to ¼ inch per foot and should be laid to a uniform grade.
3. A water-tight concrete septic tank consisting of two chambers, the first one of which is 3 feet wide, from 5 to 7 feet deep, and 5 feet long. The second one is 3 feet wide, from 3 to 4 feet deep, and 4 feet long. The walls of the tank are 6 inches thick while the covers are made of 10 concrete slabs 4 inches thick which may be removed for cleaning the tank.
4. From 300 to 500 feet of ordinary 4-inch drain tile laid to a grade of 6 inches per 100 feet, in a gravel-filled trench about 18 inches deep. After the tile and gravel are placed in the trench a layer of tight clay is tamped over the gravel to keep the fine soil particles from washing down into the gravel and filling the spaces.

The raw sewage from the house enters the first chamber of the tank thru the pipe G. After it has been in the tank for a certain period, bacterial action takes place which liquefies a part of the sewage, turns part of it into gases, and reduces some of it to a sludge which settles to the bottom of the tank. This sludge must be cleaned from the tank once in five or six years.

The effluent which leaves the tank is usually a colorless, thin liquid which soaks away into the soil surrounding the drain tile. This colorless liquid is not free from germs, however; therefore the strings of drain tile should not be located near the well or other sources of water supply.

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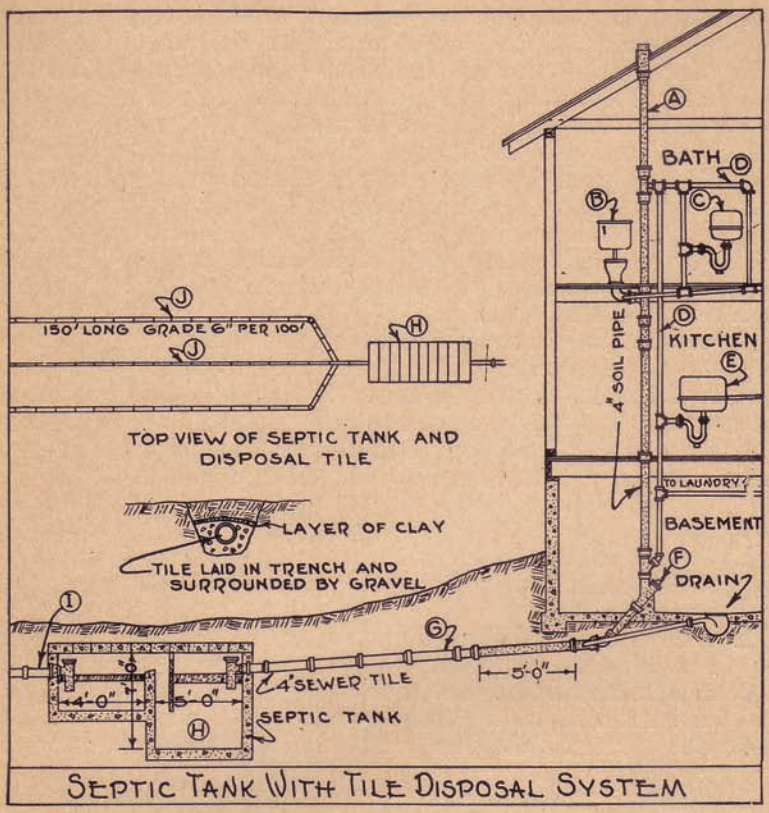
[1] Persons interested in installing complete plumbing fixtures in the house and a septic tank for disposal should procure the following material from the Extension Service, Agricultural College, Lincoln, Nebraska:

No. 10.812-2 Disposal Chamber Septic Tank.....20 cents
Extension Circular 703.
United States Department of Agriculture, Farmers Bulletin 1227.
United States Department of Agriculture, Farmers Bulletin 1426.



SEPTIC TANK WITH TILE DISPOSAL SYSTEM

FIGURE 23

MATERIALS NEEDED:

4" soil pipe, at A	4" sewer tile—fall ⅛" to ¼" per foot, at G
Toilet, at B	Septic tank—50 to 100' from house, at H
Lavatory, at C	4" drain tile laid in trench 18" to 24" deep, at I and J
Vent pipe, at D	
Kitchen sink, at E	
Clean-out plug, at F	

If the tile disposal system shown at J can be used, it is always good policy to do so. Sewage should never be emptied into an open draw or into a stream. It not only causes polution, foul odors, and endangers the health of the community, but considerable trouble is experienced from freezing at the end of the pipe.

WATER-TIGHT CONCRETE

All reservoirs, pump pits, pump platforms, septic tanks, etc., should be made of water-tight concrete.

To secure dense water-tight concrete it is necessary that not more than 5½ gallons of water be used in mixing each sack of cement. In case the sand-gravel is wet instead of moist the amount of mixing water should be reduced to 4 or 4½ gallons with each sack of cement.

Enough sand-gravel aggregate must be added to the cement paste to bring the mixture to a jelly-like stiffness. This sand-gravel must be well graded and clean. The mixture must contain just a few more sand particles than are required to fill in the spaces between gravel particles. It is next to impossible to produce a water-tight concrete with a coarse or under-sanded aggregate.

To produce a water-tight concrete the curing process must be guarded carefully. Time is required to build up a dense structure that is impervious to water; hence in building tanks, cisterns, or any water-tight concrete it should never be permitted to dry out rapidly, but should be kept moist for at least a period of two weeks and longer if possible.

HINTS ON CONSTRUCTION

1. Underground water pipes in Nebraska should be laid 4 to 4½ feet deep. Use only galvanized wrought iron pipe.
2. Carry water pipes to second story thru inside partition. Put fixtures on inside walls if possible.
3. Keep sewer and water pipes away from wall or windows in basement where freezing may take place.
4. Use pipe compound on joints when screwing water pipes together.
5. Arrange all water piping with slight slope so that it may be drained if necessary and air traps may be avoided.
6. To lessen the expense of plumbing, plan the bath room above or near the kitchen.
7. Remember that the water in the range boiler and water back expands when heated and an explosion is likely to result when pipes are frozen or when piping is not properly installed.

Write to the Extension Service, Agricultural College, for more definite instructions before installing the complicated water supply and sewage disposal systems.

[15M]

QUESTIONNAIRE I

Information Regarding Water System

Persons wishing to inquire further regarding water supply systems may fill in the following blank and mail it directly to the Extension Service, College of Agriculture, Lincoln, Nebraska.

1. What is the source of your water supply?.....
2. (a) If well, state: Type..... Depth.....

   Lowest level of water.....Whether well ever goes dry.....

   (b) If spring or stream, state gallons per minute.....
3. Which is higher, source or buildings?.....

   How many feet fall between them?.....
4. Distance between source and buildings.....
5. For what service is the water required—house, barns, lawns, gardens, etc.?..... If for stock, what kind and how many?

   Horses..... Cows..... Pigs..... Sheep.....
6. How many persons will use the service?.....
7. Do you require both hard and soft water service?.....
8. What is your estimate of the gallons of water required per day?

   .....
9. Is the pumping to be done by hand, windmill, gasoline engine, electric motor, or hydraulic ram?.....
   If electric motor, give the following information:

   (a) Direct current?.....If so, what voltage?.....

   (b) Alternating current?..... Cycles..... Phase.....

   Voltage.....

   Note: If in doubt about these, ask the company that supplies your electric current.
10. What system do you propose to use?.....
11. Describe your present pumping machinery, if any, and we will advise you whether it can be used in connection with your proposed system or not.....

    .....

    .....

    .....
12. Make a sketch showing relative positions of source of water supply and pumping machinery, tank, etc., marking in the distances vertical and horizontal.

    Name.....

    Address.....

(DETACH HERE)

QUESTIONNAIRE II

Information Regarding Sewage Disposal System

Persons wishing to inquire further regarding the installation of sewage disposal systems should fill in the following blank and mail it directly to the Extension Service, College of Agriculture, Lincoln, Nebraska.

1. Number of persons in the household where septic tank will be used .....
2. Is house located on level ground or does it slope from the house in any direction? Give details.....
   .....
3. Is house now equipped with plumbing fixtures?.....
4. Does sewer leave from bottom of basement or near ground surface?
   .....
5. Is a basement drain necessary?.....
6. Nature of the soil where disposal field must be constructed. State whether sandy or heavy clay.....
7. Type of septic tank preferred—Metal.....Concrete..... Vitrified materials.....

Name.....

Address.....