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The Hydraulic Ram
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THE HYDRAULIC RAM

W. H. SHELDON

A flowing well, spring, or stream may be used as a source of power for pumping the farm water supply by means of a hydraulic ram. The necessary requirements for the installation of a hydraulic ram are a constant supply of water with a minimum flow of two gallons per minute with a fall of not less than two feet and facilities for draining the waste water away from the ram. Where these conditions do not exist, a hydraulic ram cannot be used.

The hydraulic ram utilizes the momentum of water flowing down an incline to raise a part of that water to an elevation several times as high as the fall used to operate the ram. The simplicity and durability of the hydraulic ram make it one of the most economical pieces of pumping equipment available for forcing water to distant or elevated places. If properly installed and started, it will continue to operate 24 hours a day with a minimum of attention so long as the supply of water remains adequate.

The power to operate a ram is developed by the weight of the water falling through an inclined pipe, hence the larger the supply of water falling and the farther it falls, the greater will be the power developed. The amount of water a ram will deliver to an elevated tank depends first upon how much power is developed by the falling water and second upon the height to which the water is delivered.

Ordinary sizes of hydraulic rams cost from \$15 to \$75 according to size and quality, and other than an occasional replacement of a valve or a valve seat there is no expense for maintenance.

MEASURE THE SUPPLY OF WATER

In measuring the supply of water from a spring or small stream, build a small earthen dam with a tile or stove pipe for the water to run through and determine the number of seconds required to fill a pail or tub of known capacity. Then figure the quantity that would flow in a minute. (Fig. 3.) Streams generally carry less water during the hot months, and the measurement should be made during this period if possible. Streams too large or swift to measure conveniently can be assumed to have sufficient supply for operating the ordinary sizes of rams.

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MEASURE THE FALL

Having determined the supply of water sufficient for operating a ram, select a place for the ram not closer than 30 feet nor farther than 200 feet from the supply which will give the greatest amount of fall from the top of the water to the ram and still have drainage for the waste water. Measure this fall carefully using a level as shown in Fig. 3. The elevation to which the water must be raised can be measured in a similar way.

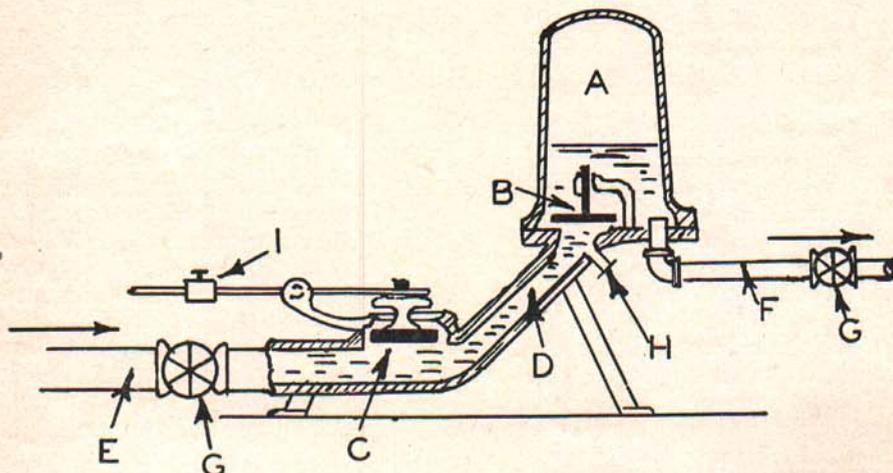


Fig. 1. Hydraulic ram with a high base. (A) air chamber; (B) check valve; (C) outside (impetus) valve; (D) base; (E) drive pipe; (F) delivery pipe; (G) gate valve; (H) air feeder valve; (I) moveable weight for outside valve; (J) adjusting nuts for outside valve.

HOW A RAM OPERATES

A hydraulic ram consists essentially of an air chamber, (A) an inside check valve (B) and an outside impetus valve (C) mounted on a suitable base (D).

A ram is placed two feet or more below the level of the source of water supply and connected to it by means of a drive pipe (E).

Water flows freely from the source of supply through the inclined drive pipe and through the outside valve until its momentum is sufficient to close the outside valve. This valve closes suddenly, and due to the momentum of the water in motion the pressure in the base is increased to several times as great as that due to the weight of the water alone. This pressure opens the check valve and drives some water into the air chamber. At the moment the water in the drive pipe comes to rest, the pressure in the air chamber drives the column backward until the check valve closes. This back-flow or recoil lowers the pressure in the base so that the outside valve quickly drops open. This backward movement of the water, although sufficient to open the outside valve is very slight since it is in opposition to gravity and

as soon as it ceases the water again flows down the drive pipe and through the outside valve, thus beginning another cycle.

The discharge or delivery pipe conveys the water under pressure from the air chamber to a storage tank from which the water is drawn as needed. Some means of drainage must be provided for the water that is wasted out through the outside valve.

To replenish the air in the air chamber and prevent water-logging, an air feeder valve (Figs. 1 and 2) is usually provided in the base of the ram. At each recoil a small amount of air is drawn into the base and is forced into the air chamber with water during the next stroke. If an excess of air is taken in it will be carried to the storage tank along with the water. Sufficient air can be taken in to prevent water-logging a large pressure tank.

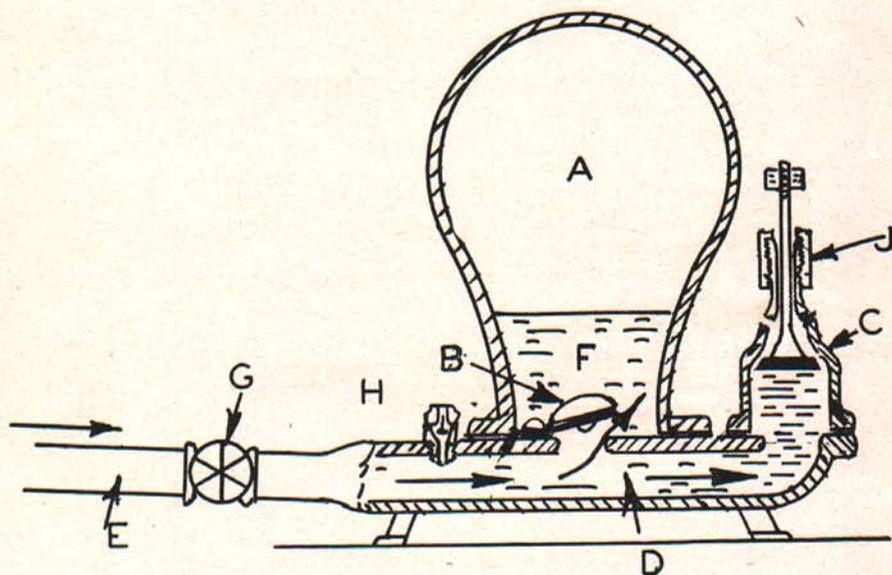


Fig. 2. Hydraulic ram with low base.

How Much Water Will a Ram Deliver?

To determine the approximate number of gallons of water a ram will deliver to a storage tank during 24 hours, multiply the number of gallons used per minute by the fall in feet. Then multiply the product by 900 and divide by the elevation in feet.

For example: If the flow is 5 gallons per minute with a fall of 4 feet and the water is to be delivered to an elevation of 30 feet

$$\frac{5 \times 4 \times 900}{30} = 600 \text{ gallons during 24 hours}$$

(This factor 900 is the product of 1,440 minutes per day times 62½ per cent for the efficiency of the ram.)

SIZES OF HYDRAULIC RAMS

All makes of rams built for a given size of drive pipe will use about the same amount of water. The following table can be used as a guide in selecting the proper size of ram:

1	inch size will use	2 to	4	gallons per minute
1¼	inch size will use	3 to	6	gallons per minute
1½	inch size will use	5 to	10	gallons per minute
2	inch size will use	7 to	15	gallons per minute
2½	inch size will use	10 to	25	gallons per minute
3	inch size will use	20 to	40	gallons per minute
4	inch size will use	30 to	75	gallons per minute
6	inch size will use	75 to	150	gallons per minute
8	inch size will use	150 to	250	gallons per minute

INFORMATION REQUIRED

In order to select the proper size of ram to use, the following information must be known:*

1. The quantity of water available in gallons per minute at the source of supply. This may be learned by observing the time required to fill a vessel of known capacity. (Fig. 3.)
2. Vertical fall in feet from supply to ram. This may be determined by using a carpenter's level. (Fig. 3.)
3. Vertical height to which the water must be raised above the ram.
4. The quantity of water required per day. (See page 9.)
5. The distance from the source of supply to the ram.
6. The distance from the ram to the storage tank.

The Drive Pipe

For best results the length of the drive pipe should be equal to the elevation against which the ram will deliver water. It must be air-tight and as free from bends as possible. The upper end should be several inches under water to prevent air from being sucked in. A small amount of air in the drive pipe will stop the operation of a ram. A good strainer with ⅛-inch holes will prevent sticks, leaves and other foreign matter from entering the drive pipe and clogging the valves in the ram.

A gate valve in the drive pipe close to the ram is not necessary but is convenient for shutting off the water in case repairs are needed. The gate valve if used should be installed in a horizontal position to avoid an air pocket forming in the bell of the valves.

METHODS OF INSTALLATION

A hydraulic ram is usually installed in a masonry lined pit with the drive pipe arranged as in Fig. 4. Where the supply is too far away from the ram to use this arrangement, a supply pipe (at least one size larger than

*Note: When writing to manufacturers regarding hydraulic rams, enclose this information.

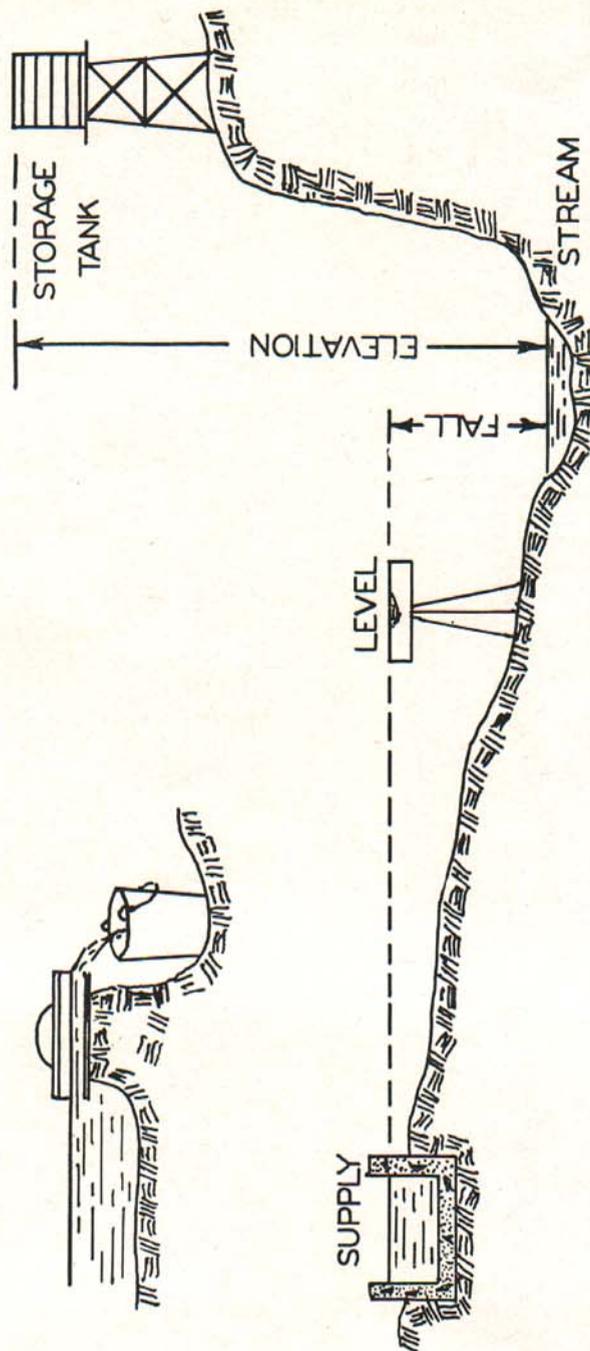


Fig. 3. (upper left) Measuring the water supply. (lower) Measuring the fall of the water.

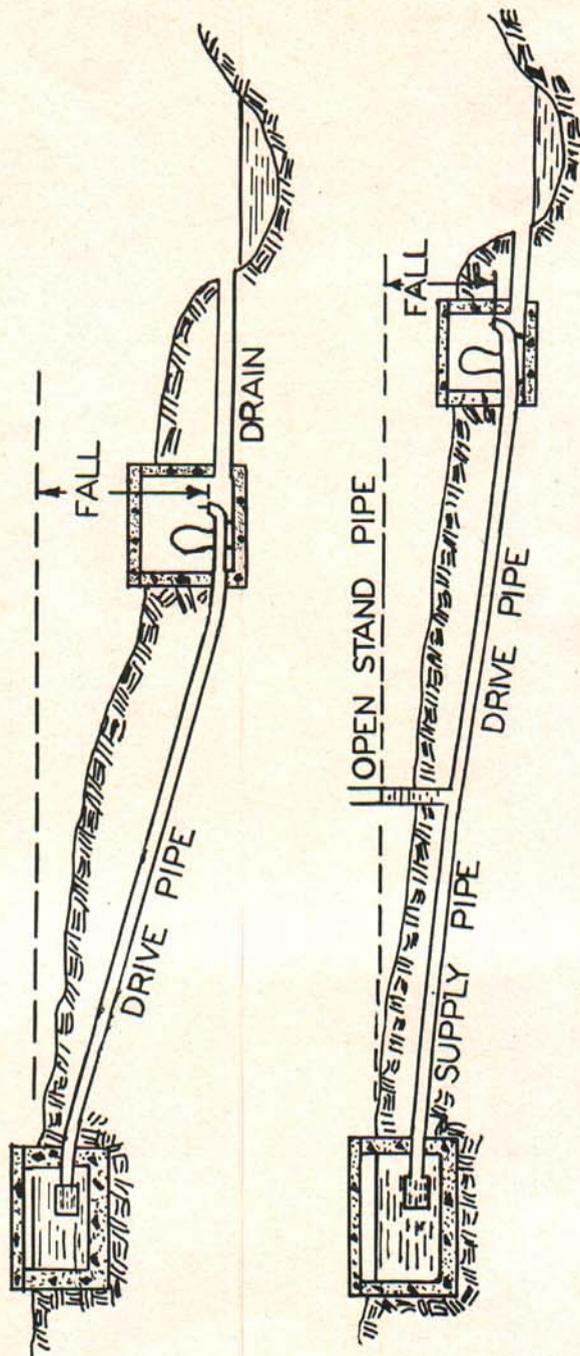


Fig. 4. (upper) The usual arrangement of the drive pipe. (lower) Arrangement of the drive pipe for a distant supply.

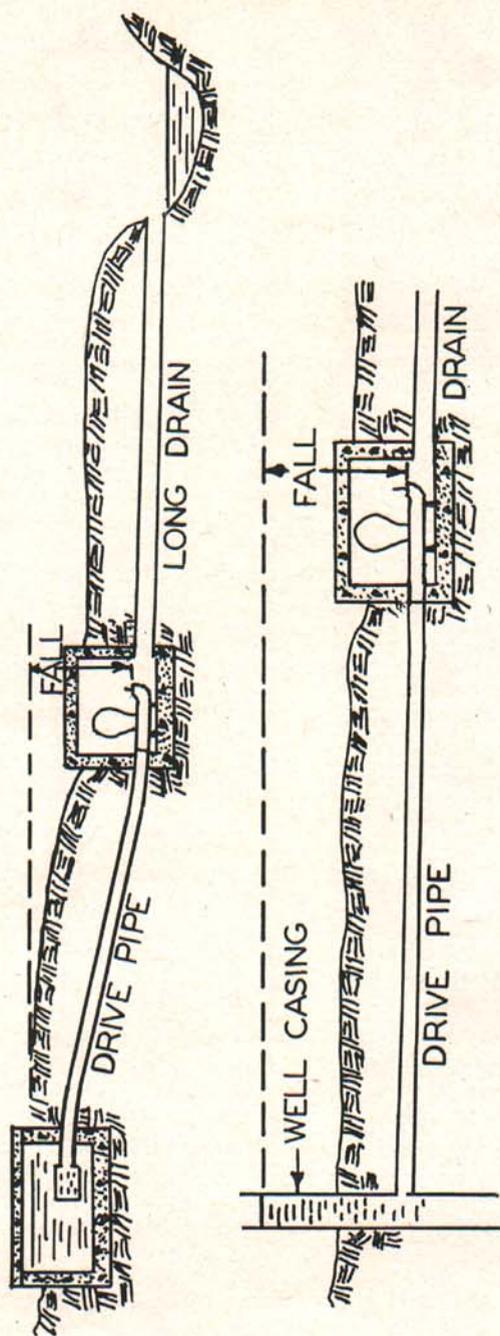


Fig. 5. (upper) Another arrangement for a distant supply. (lower) Using a flowing well to operate a ram.

the drive pipe) is used to convey the water to a concrete tank or an open standpipe. Thus, one can use a drive pipe of the proper length (Fig. 4).

In some cases it is cheaper to install the ram at the right distance from the supply and use a tile drain of considerable length in order to secure sufficient fall (Fig. 5).

The drive pipe may be connected to the casing of a flowing well as in Fig. 5 but *the casing must be left open*; otherwise, the entire casing would act as part of the drive pipe and might be loosened in the ground by the constant pounding.

The Delivery Pipe

Water may be discharged horizontally practically any distance so long as the pipe is of adequate size. The delivery pipe of a ram is usually one-half the diameter of the drive pipe. For example, a ram with a 2-inch drive pipe has a 1-inch delivery pipe. Resistance to the flow of water through the delivery pipe is equal to raising the water about 1 foot for each 100 feet of pipe used.

The delivery elevation should be at least five times as high as the fall used. If this condition does not exist naturally, partially close the valve in the delivery pipe to increase the pressure in the ram. In case the delivery pipe line goes over a hill and down through a valley between the ram and the storage tank, air will accumulate at the highest point and retard the flow of water.

Starting a Ram

After all pipes are laid and before any underground pipes are covered, start the ram by opening the gate valve in the drive pipe to allow water to run out through the outside valve. This valve will close but must be opened a few times by hand until sufficient back pressure is developed to cause it to open and close automatically.

Methods of adjusting the number of strokes per minute vary with different makes of rams but for any given installation a ram will use more water and deliver more water to a storage tank if the valve is set for a slow rate, 25 to 40 per minute. If the water supply is limited the ram will use less water if set for 60 to 90 strokes per minute.

A storage tank is needed in all cases. A gravity storage tank provides cheap storage for a large quantity of water under low pressure, but it must be protected against freezing and provision must be made for the over flow. During warm weather moisture from the air will condense on the outside of a tank. As a precaution against damage to a house by this condensation a drip pan of galvanized iron is used under a gravity storage tank if it is installed in an attic. A drain pipe is also connected with the drip pan. Since 240 gallons of water weigh a ton, a water tank must be well-supported.

A pneumatic pressure tank can be used for storage of water delivered by a ram if there is plenty of fall to operate the ram against an elevation of 50 to 70 feet in addition to the elevation of the house above the ram.

The pressure tank can be located in the basement or buried in the ground. A safety valve must be used to prevent excessively high pressure in the tank. Water from the safety valve may be piped to a stock tank or to a drain. A 120-gallon size pressure tank will hold in storage at 10-40 pounds pressure a maximum of 60 gallons of water. Larger or smaller tanks hold proportionately more or less water.

Adjust the ram for operation against the highest pressure that will be used in the pneumatic tank and if necessary partly close the valve in the delivery pipe to hold enough pressure in the ram when the tank pressure is low.

WATER REQUIREMENTS FOR DOMESTIC USE

For each member of the family, kitchen, laundry, bath and toilet purposes	25	gallons per day
Each horse	10	gallons per day
Each cow	12	gallons per day
Each hog	2	gallons per day
Each sheep	1½	gallons per day
100 chickens	4	gallons per day

The actual consumption will vary with the season of the year and the local conditions.

THE DOUBLE-ACTING RAM

By means of a double-acting ram, dirty water from a stream may be used to deliver clean water from a nearby spring without danger of the dirty water's being delivered to the storage tank.

The double-acting ram has, in addition to the drive pipe, a smaller sized supply pipe attached to the base. This supply pipe is equipped with a check valve and an open standpipe close to the ram. Clean water from the standpipe fills the upper end of the base, and some wastes through the outside valve with the dirty water between the compression strokes. The drive pipe is arranged as for a single-acting ram, but the spring water supply needs to be only 18 inches above the outside valve of the ram. With this arrangement approximately $\frac{2}{3}$ of the spring water supply is delivered to the storage tank. The other $\frac{1}{3}$ is wasted with the dirty water between the compression strokes.

The double-acting ram is used when the supply of water from a spring is too small to operate a single-acting ram and a stream nearby can be dammed up to obtain sufficient fall.

