



Things that Work! The Folk Ram Pump



Things that Work!
tested by *Home Power*

Michael Welch

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Tested by Michael Welch, Cara Smith and classmates of Humboldt State University's International Development Program (Susan Brinton, Christopher Herbst, Christine Parra, David Potter, Jon Raybourn, Dav Camras, Daniel Oros, Mike Orr, and Wallapa Wongsuwan).

The Site

Cara Smith of Fieldbrook, California had a problem. Every year in August, her spring flow reduces to a mere trickle. As the Northern California drought got worse year after year, so did her spring's ability to supply her household needs. She needed a permanent solution to her problem.

Fortunately, a nice creek crosses Cara's property, and it flows year round. But, it is 360 feet in elevation below

her water storage tank, which gravity feeds to her home. I had been looking for a site to adequately test the Folk ram pump, and this seemed like it would work. I had been attempting to test the pump on my own system at my home. While it worked well enough for me, my flow was too small to really put the pump through its paces.

So what is a ram pump anyway? Ram pumps use a downhill water pressure to pump a portion of that water even higher uphill to a holding tank. No other source of power is needed.

We enlisted the help of HSU's International Development Program to design, build and test the ram pump system. But that's a story in and of itself that we may tell in a future *HP* article. For now, suffice it to say that this academic program prepares students to help third world countries with their development requirements, and strongly emphasizes appropriate technology to meet these countries' needs.

The Pump Arrives

When I received the Folk ram, I was surprised to see that it was in pieces. Normally, Jim Folk ships his pumps completely assembled, ready to install. But, Jim knew that I was very interested in the workings of his pumps, so he sent it to me disassembled, with a labeling tag on each component explaining the why's and the how's of its design and use. I really appreciated that, but any other customer can expect the pump to arrive well-packed and already assembled.

His largest pump, however, is too heavy to ship by UPS, so it comes in two pieces easily bolted together.

This pump is heavy-duty. Its body is thickly cast and machined from high-grade aluminum alloy, and the inner components and the bolts make use of stainless steel. The internal "valves" are made of thick, bonded rubber seals.

A feature of the Folk ram not found in most ram pumps is a strong rubber diaphragm which separates the delivery water from the pressurized air chamber. This diaphragm keeps the air from mixing and exiting with the delivery water, thus eliminating the need for a "snifter valve" to replenish the air chamber.

Other features of the Folk ram pump include larger-than-usual impetus and check valves for faster reaction time and a large air dome to minimize delivery water pressure pulsations and thus decrease friction loss. The impetus valve stroke length is easily adjustable to change the frequency of pump cycles, which changes the amount of water the pump uses and delivers.

Installation

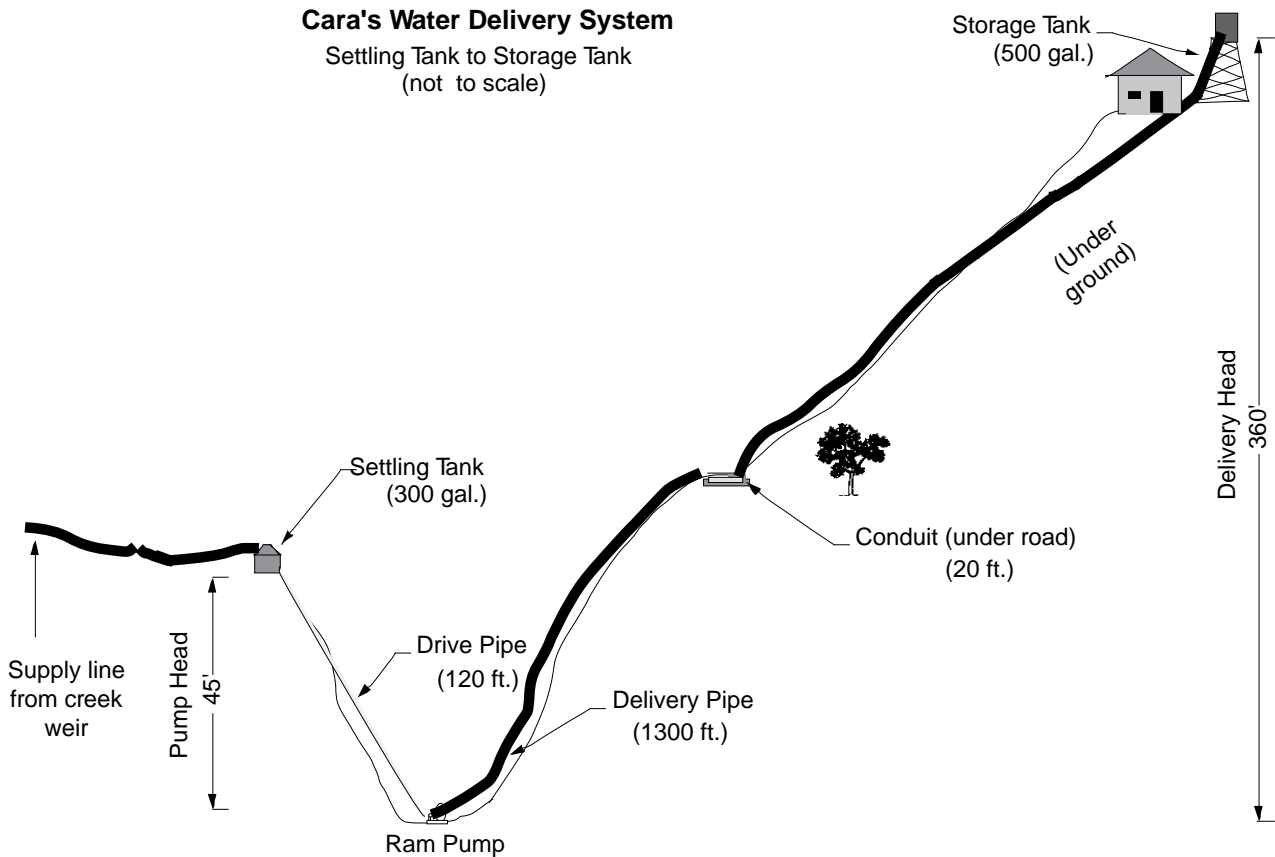
The Folk ram arrived with adequate instructions on how to install, maintain and run it, but there is some room for improvement. Jim Folk told me that he wanted to do a better and more detailed manual for the pump.

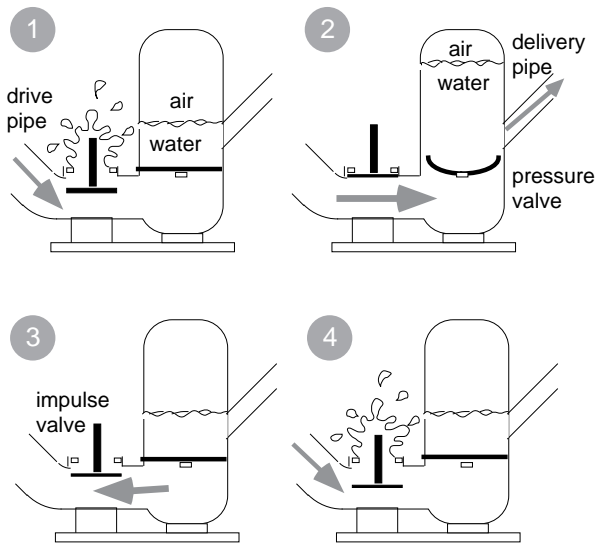
One great thing about Jim Folk is that it is as important to him that the pump works well as it is to sell the pump in the first place. If you have problems with your installation or operation, he will work with you in detail. It's just how he is, and most people can really appreciate it. For example, there was a problem with the bonded rubber the pumps used in their valves. When Jim discovered the defect, he automatically sent every pump owner a new set of valves, using improved materials, and he did it free of charge.

Long distance water pumping systems have so many variables that every installation is different. In our case, the terrain was very steep and somewhat rugged. In order to get adequate vertical drop to run the pump, we had to snake the supply pipe 420 horizontal feet from the source to a settling tank, and then go steeply down the hillside to the pump site with the drive pipe. The cost of having to run such a long horizontal distance was a reduced supply available to the pump. While Cara's creek flows at about 72,000 gallons per day, our 420 feet long, two inch diameter supply pipe with five feet of head between the creek inlet and the settling tank would make 5,400 gallons per day available to the pump.

Most installations will be more straightforward than ours, and less expensive as a result. The price of the

Cara's Water Delivery System





How a Ram Pump Works

All ram pumps work on the principle of momentum which is controlled by a cycle set up by the interaction of two valves in the pump.

When the impetus valve is opened (this must initially be done by hand to start the pump cycling), water begins to flow down the drive pipe and through the impetus valve as in Figure 1. When the drive water reaches a certain velocity, water friction slams shut the impetus valve as in Figure 2. The momentum of the water carries past the closed impetus valve, forcing open the flapper valve and pushing water past it to pressurize the air chamber above the water level. In Figure 3, the water pressure above the flapper valve overcomes the spent momentum below it, forcing the flapper closed again. The water that made it past the flapper in Figure 2 is then forced by the extra air pressure up the delivery pipe. Since the momentum of the water coming down the drive pipe was stopped, the impetus valve falls open, allowing the water to flow down the drive pipe again as in Figure 4 (just like Figure 1), starting the cycle over again.

This process occurs over and over again until something happens to stop the cycle. Ram pumps can cycle anywhere from 25 to 300 times per minute. The frequency of the cycle is adjustable by changing the length of the stroke of the impetus valve. A longer stroke produces a lower frequency. This means more of the supply flows to and through the pump and more is pumped up the delivery pipe.

The stroke is adjusted to restrict the amount of water used to the amount available, or if supply is unlimited, to regulate the amount delivered to match the amount needed.

pump remains a fixed cost for everyone, but the installation costs can vary widely. Because of the long supply line and the uncommonly high delivery elevation, Cara's installation costs were about double the average installation. I estimate the average to be about \$1,000 for system components including the Folk ram pump which runs about \$695. Labor is not included in these approximations.

A typical installation includes a 1.5 inch steel drive pipe from the source to the ram pump, a poured concrete foundation to secure the pump, a one inch poly delivery pipe to the household supply tank, and valves and unions to control flow and allow access to the various components of the system.

Pump Performance

Because the Folk ram's capabilities could easily outstrip our supply, we choked it back so it wouldn't run out of water. When a ram pump stops cycling, it needs to be restarted by hand. Once we had the pump properly set, it just kept running on and on for months without the need for further attention. This reminds me of a ram pump story I heard:

Friends were hiking near the New River in the Trinity Mountains of Northern California. This river is peppered with old gold mining claims. Far away from any other form of civilization, the hikers were surprised to come to an otherwise pristine spot where they heard a muffled "ka-chunk ka-chunk ka-chunk...." Taken by surprise, they were unable to discover the source of the mechanical noise until they dug down several inches through the forest humus finding a rotten board covering a hollow box. The box contained an old ram pump that had been operating on its own, unattended for as long as it took the box cover to become buried under many layers of duff.

Commercial ram pumps are known to provide years of trouble-free service. We expect that the Folk ram will furnish Cara with water for decades to come.

Even with the pump choked back for the decreased supply, we obtained delivery rates of 600 gallons per day. This is a far cry from the 2,400 gallons per day that this pump could achieve under the same drive and delivery heads with unlimited access to the creek's supply. However, it was more than adequate for Cara's needs which max out at 475 gallons per day. Jim Folk states that, under ideal supply, drive, and delivery conditions, this particular model of his pump will produce up to 5,000 gallons per day. He has a second model that will produce up to 25,000 gallons per day.

For you folks with super low flow situations, this pump may still work for you. For several months, I had this

pump installed on my own spring which was flowing at about 1,500 gallons per day, with 26 feet of drive head, and 158 feet of delivery height. This is really running the pump on the low end of its capabilities, yet it still was able to provide my home with about 190 gallons of water per day.

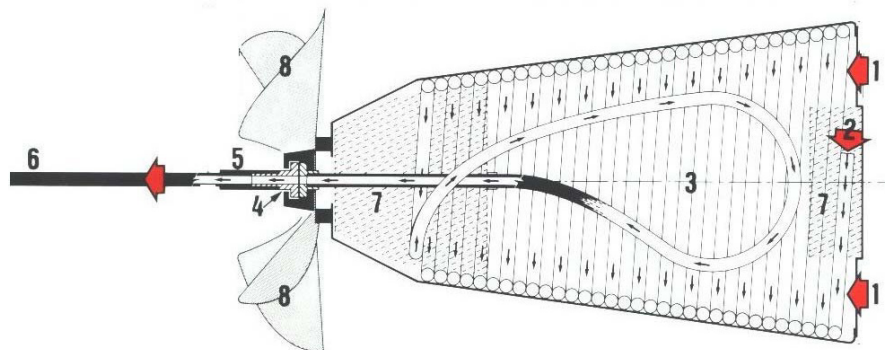
Conclusion

Folk ram pumps are well-made, dependable, and work as promised. While there are other ram pumps available, the Folk has features that are unique and proven. At \$695 for a pump that will likely outlast its owner, it is an excellent buy. A larger model is available that lists for \$995. These pumps are handmade in Conyers, Georgia.

Access

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Ram Pump Maker: Folk Water Powered Ram Pumps, 2770 White Court N.E., Conyers, GA 30207 • 404-922-4918



Things that Work! Alternative Energy Engineering's High Lifter Pump

Test Conducted by Michael Welch



Things that Work!
tested by Home Power

Let me start by saying that I am completely sold on the High Lifter pump for my application. My High Lifter is pumping 240 gallons per day from a 6 gallons per minute spring that is 132 feet downhill from my water tank. The High Lifter is located 26 vertical feet below my spring.

Shipping Container and Documentation

The High Lifter comes well wrapped in a 6 in. x 6 in. x 28 in. cardboard box. Alternative Energy Engineering uses recycled materials for packaging their products. The shipping weight is 10 pounds. Included with the pump itself is an inlet filter, an inlet pressure gauge, a hose for between the filter and the pump, an output pressure gauge, and a ball valve with a check valve for the outlet.

The Owner's Manual that comes with the pump is one of the best written pieces of documentation that I've ever seen. It is 23 pages long and includes: an introduction, typical applications, how it works, how to install it for various situations, an in depth section on maintenance and troubleshooting, performance curves, a trouble shooting flow-chart, an exploded view showing all the pump parts, and a specifications table.

The Test Site

My water system is comprised of a spring which flows into a large 480 gallon settling tank. From there, the water flows at 6 gallons per minute through 3/4 inch Schedule 40 PVC pipe 26 vertical feet to my pump site. The pump then pushes the water up 158 vertical feet through 1" black rolled drinking water pipe (only 1/2 inch pipe is required). The 250 gallon tank at the top is suspended between two sturdy conifers about 20 feet above the taps in my home to obtain sufficient indoor water pressure.

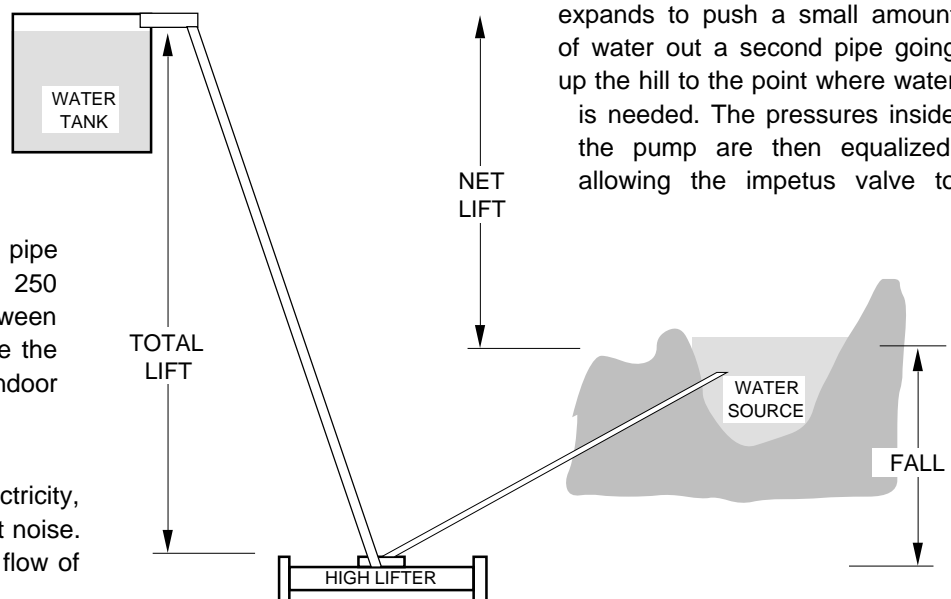
Pumping water without electricity

This pump works great without electricity, without internal combustion, and without noise. This pump will take a steady but small flow of

water, and, with a short drop, pump a significant part of the water way up hill to the place it is needed.

Oh, if only all our water supplies were located above the point of use. Alas, it is an imperfect world. Well, then, if only we could afford some of the fine solar water pumping systems that are available. By the time you purchase the pump, wiring and the fair number of PV panels needed, your cookie jar will look like a bottomless pit.

I know two ways to use a downhill flow of water to pump a portion of the water further uphill. One is with the time-tested ram pump. The ram pump lets a flow of water in a pipe build up momentum until the flow causes an impetus valve in the pump to slam shut. The water, still wanting to exert its moving energy, is channeled into a chamber containing air, which is compressed by the force of water. The compressed air bubble in the chamber then expands to push a small amount of water out a second pipe going up the hill to the point where water is needed. The pressures inside the pump are then equalized, allowing the impetus valve to



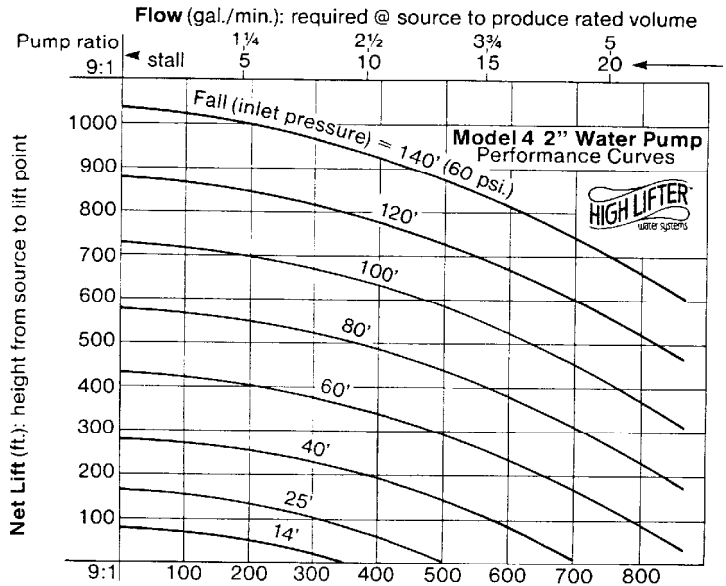
open again thus starting the downhill flow moving again, and the cycle repeats.

The second method is with the relatively new High Lifter. The High Lifter uses head pressure instead of momentum in a downhill pipe. It uses a larger volume of low-pressure water to pump a smaller volume of water at a higher pressure. A larger piston acts with a smaller one to gain mechanical advantage, a kind of "hydraulic lever." A collar inside the pump controls the inlet valve. As the pistons reach the end of their stroke, they contact this collar, pushing it until it directs a small amount of "pilot water" to the end of the spool in the pilot valve, thereby shifting it and changing the direction of the water flow in the pump. The flow moves the two-way pistons in the opposite direction until they again contact the collar, which shifts the pilot valve again, and the process repeats. Thus the pump's innards travel back and forth as it pushes water way up the hill.

High Lifter Specifications

The cylinders are made of stainless steel, the valve body and head materials are machined from acrylic, and the pistons are made of high quality nylon. The total width is about 4 inches, length 26 inches, and the pump itself weighs about 5.5 pounds. The High Lifter is obtainable in two volumetric pump ratio models, 4.5:1, and 9:1, and changeover kits are available to switch back and forth. The higher the volumetric ratio, the greater the pumping pressure and the lower the output flow.

FOR 9:1 VOLUMETRIC RATIO PUMPS



1 psi = 2.3' Delivery (gal./day): assuming adequate water @ source

Typical applications

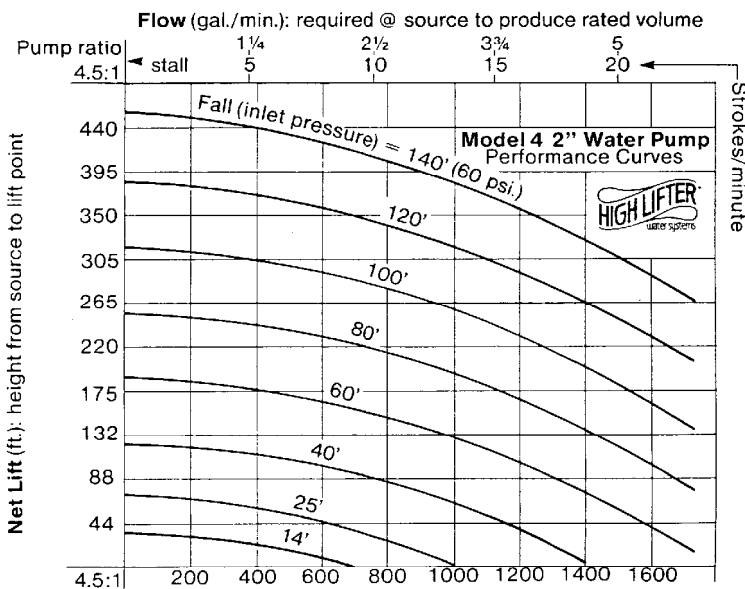
According to the Owner's Manual, the High Lifter can deliver up to 750 or 1500 gallons per day, depending on the model. It can be used with flows as little as one quart per minute. It can achieve net lifts of up to 1,100 feet, depending upon the circumstances. In situations of low fall and high lift, two High Lifters can be used in series.

High Lifter Performance

When I took delivery of my High Lifter, I had nothing but problems. I thought I would be unable to recommend the pump in "Things that Work" because my test site seemed to put to much of a strain on the pump, causing it to stall out with regularity. After trying "everything in the book", and some things that weren't in the book, I took the pump back to Dave Katz's pump experts at Alternative Energy Engineering. (I like going there anyway because they have so much neat renewable energy stuff to look at.) There we discovered that some of the earlier pumps had been assembled with too much silicone glue between the barrel and the valve body. The excess silicone had slopped over to partially plug the pilot valve holes. They gave me a recently rebuilt pump since they didn't have a new one ready to give me.

I installed the newly rebuilt pump, and 30 hours later I checked my previously empty tank. I was totally amazed to discover that the 250 gallon tank was completely full! At that point I began keeping track of the flow: it was an remarkable 240 gallons per day. Two weeks later the

FOR 4.5:1 VOLUMETRIC RATIO PUMPS



1 psi = 2.3' Delivery (gal./day): assuming adequate water @ source

Things that Work!

flow had decreased to 218 gallons per day so I cleaned the inlet filter. Now that the pump was broken in and the filter cleaned, my flow increased to 294 gallons per day! It seems to have settled in at between 220 and 300 gallons per day, depending on how clean the input filter is.

High Lifter Advantages

The advantages of the High Lifter over the ram pump are numerous. The pump is more efficient in that it uses less water to pump a given amount uphill. Additionally, it is a far piece quieter than the constant and very noisy KA-CHUNK of the ram, and it is quite a bit lighter and easier to move around than the ram. Last, but not least, the High Lifter will operate with relatively thin wall pipe in the input, whereas a ram, because of the intense and constant hydraulic hammering caused by the sudden closing of the impetus valve, requires solid mounting and steel pipe to keep from breaking apart joints.

The High Lifter is not without its disadvantages, though. It has a complex array of pilot valves and check valves, and relies heavily on close tolerance seals. Unlike the ram pump, water must be completely free of sand and grit lest

the barrels and seals become scored allowing leakage. The High Lifter comes with a filter which takes out much of the harmful sized particles which may flow from your water supply. The filter must be cleaned regularly to avoid loss of inlet pressure. If a lot of foreign matter flows with your water, then the High Lifter may not be for you.

The Owner's Manual states that there is a danger that a hard knock to the valve body could cause a misalignment, but personal experience proved that it takes 2 large, strong people to successfully dislodge the glued and strapped valve body from the barrel.

Conclusions

The High Lifter has far exceeded my expectations, and definitely lives up to its promises. It is worth the \$750. price tag, which includes access to the manufacturer who is willing to go the extra distance to help their customers.

Access

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Hydraulic Ram Pump



adapted from *A Manual for Constructing and Operating a Hydraulic Ram Pump* by Kurt Janke & Louise Finger

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Here's a design for a hydraulic ram pump that requires readily available materials and few tools to construct. Ram pumps are commercially available that are potentially more efficient and durable, but are also more expensive. This pump can be built for under \$75, and is capable of pushing 130 gallons per day 150 feet high, with a drive head of 20 feet.

A ram pump uses the potential energy of falling water to lift a fraction of that water to a higher elevation. (See Figure 1) Water accelerates through the drive pipe and open waste valve. Its velocity increases until the flow and upward force causes the waste valve to shut suddenly. The momentum of water produces a short-lived pressure, called the "ram", which is greater than that in the pressure tank. This causes a small amount of water to be released through the check valve into the tank. After the exerted energy is transferred into the pressure tank, the pressure below the check valve is less than that in the tank. The check valve shuts and the waste valve falls open, allowing the cycle to repeat continuously. The compressed air in the tank acts like a spring to drive the water that had passed through the check valve into the delivery pipe and on to a higher elevation.

The output volume of a ram pump is determined by the drive head, delivery head, amount of available water, and stroke length of the waste valve. The greater the drive head, the greater the acceleration in the drive pipe, and thus the potential energy at the pump. A longer stroke length also allows a greater velocity to reach the pump. Similarly, the greater the flow, the greater the mass of the moving water, and thus greater the potential energy. The greater the delivery head, the greater the energy required to pump a given volume of water.

Tools required for this homebrew ram pump are: two 24 inch pipe wrenches, two 7/16 inch wrenches, utility knife and/or circle cutter, drill and metal bits, #8 tap, and a screwdriver. For materials, see the list on right.

Waste Valve Assembly

Figure 2 illustrates the waste valve assembly. Use only half of the 1 1/4 inch union for the base/seat of the valve. It will be necessary to drill a 3/8 inch hole through the 1 1/4 inch male plug and a 5/16 inch hole in the shoe heel material. Attach the shoe heel disk to the bottom of the all-thread by securing the lock nuts and washers around it. The rubber washer at the top of the valve serves to reduce the stress induced on the adjustment nuts by the continuous pounding of the ram. The relatively soft all-thread used in the waste valve might stretch (or even break occasionally), so we recommend

Materials Required

Pump
10 liter fire extinguisher (1" thread [®])
1/2" gate valve
Two 2" tees
1" tee
2" 90° elbow
2" x 4" nipple
1" x 4" nipple
Two 1" close nipples
1/2" x 4" nipple
1/2" x 2" nipple
Two 2" x 1" reducer bushings
2" x 1/2" reducer bushing
1" x 1/2" reducer bushing
Teflon tape
Waste Valve
1/4" tee
1/4" close nipple
1/4" male plug
1/4" union
5/16" x 10" all-thread*
Two 5/16" nuts
Two 5/16" lock nuts
3/4" ID x 7/8" OD flat washer
5/16" ID x 3/4" OD flat washer
5/16" ID x 1" OD flat washer
rubber washer
7/8" diam. x 3/8" shoe heel material ⁺
Check valve
Two 2" x 3/4" reducer bushings
3/4" close nipple
#8 x 1/4" machine
tractor tire rubber or leather ⁺

[®]Other types of tanks or larger diameter pipes may work better, as fire extinguisher bodies are often made from soft aluminum with a potential for thread failure.

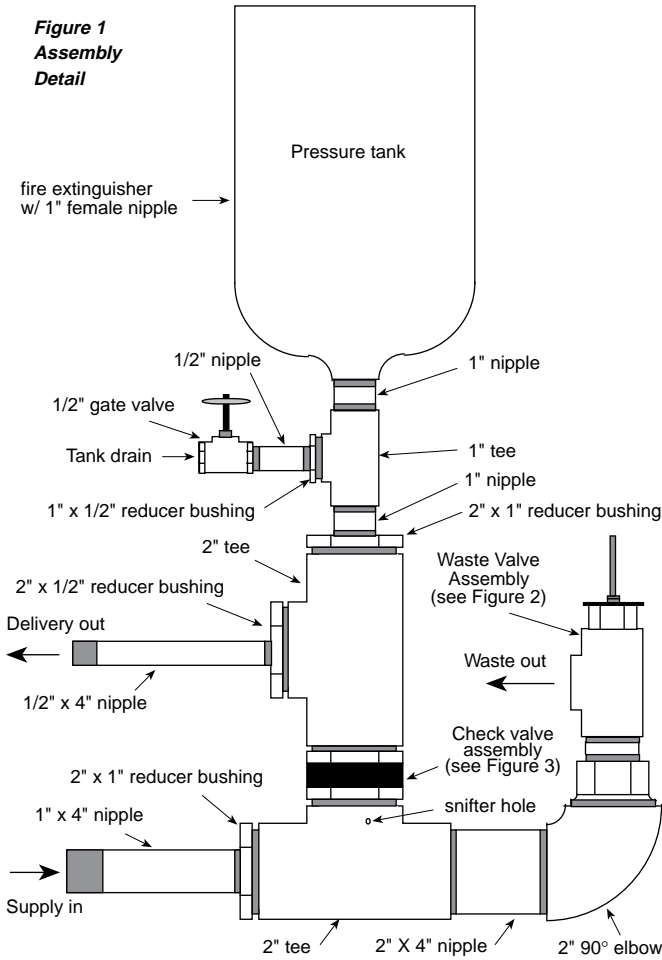
*A steel bolt with threads over its full length will also work and may be more durable.

⁺Available at shoe repair or leather-working shops.

having replacements on site, or using a more durable material.

Be as accurate as possible with the tolerance between the all-thread and the plug. Cut the shoe material accurately round, and center the holes carefully. The success of the pump depends on the waste valve running up and down precisely as well as how it seats on the union.

**Figure 1
Assembly
Detail**



ability of the valve. This washer should be centered over and cover the width of the seat, and can be secured with a short bolt and locknut, with a small washer on the underside.

Pump Assembly

Valves, fittings, and pipes are assembled together as shown in Figure 1, using two pipe wrenches. In the same fashion as the check valve, all threaded pipe should be Teflon taped and tightly secured.

A very small snifter hole may be drilled in the tee below the check valve. This will allow air to be sucked into the pressure tank to replace the air that inadvertently mixes with water and exits through the delivery pipe. Many homemade pumps just leave this hole open, but efficiency can be lessened as water squirts out during the ram. Without a snifter, the pressure tank will eventually fill with water and need to be emptied regularly.

One marginal remedy is to put a nail through the hole with the head on the inside, bending the shank on the outside to prevent the nail from being sucked into the pump. Shoot for a loose back and forth fit so that air can be sucked in, yet the head of the nail can close off the inside of the hole during the ram.

Installation, Operation and Maintenance

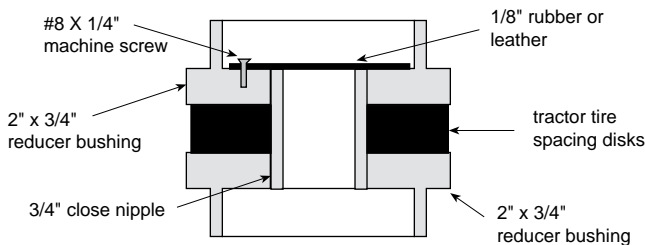
Both the drive and delivery pipes should have a shut-off valve and union on the pump end of the pipe. The only mounting apparatus needed is a stable pad for the pump to rest (i.e., a board). The pump should be held upright and installed so that the waste valve unit is clear of water and obstruction.

Check Valve Assembly

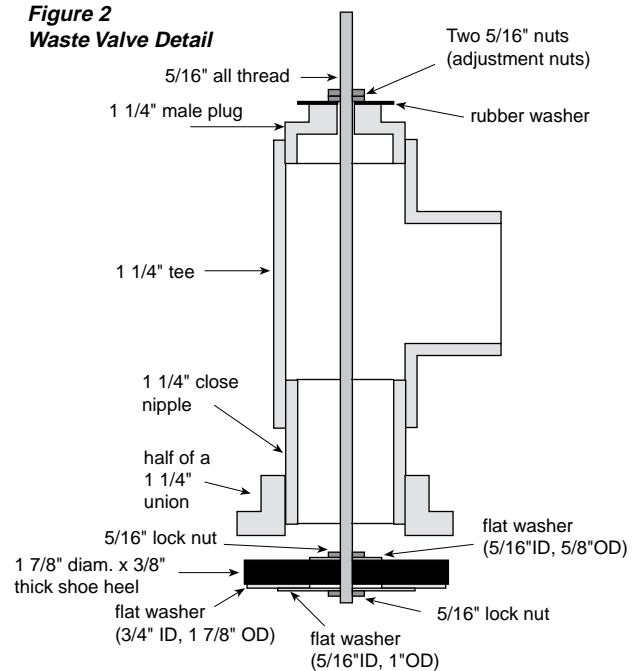
Figure 3 illustrates the check valve assembly. A reducer bushing is used as the valve seat. Drill a 1/16 inch hole in the bushing flange and thread the hole with a #8 tap. From tough rubber, such as a tire, cut a disk approximately 1/8 inch thick so that it fits loosely inside the bushing. Secure the disk with a screw. Cut additional disks to be used as spacers and support between the two bushings. Use Teflon tape on the nipple threads to prevent leakage.

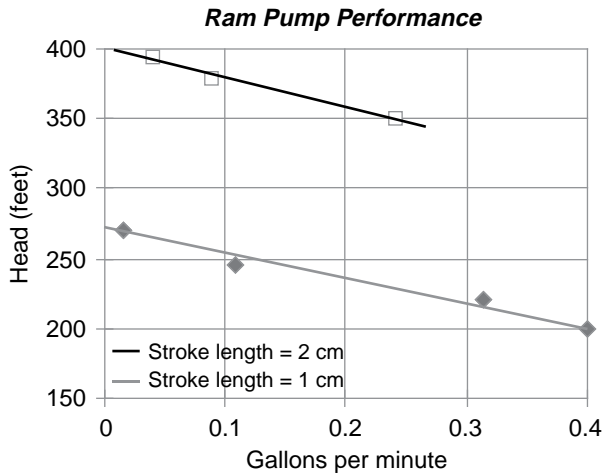
Thick leather makes excellent check valve material, as well. Putting a heavy washer acting as a weight on top of the valve material may also increase the sealing

**Figure 3
Check valve detail**



**Figure 2
Waste Valve Detail**





Access

Louise Finger & Kurt Janke developed this pump through Humboldt State University's International Development Program (see page 78). For information, call 707-826-3619.

Contact authors through Michael Welch, c/o Redwood Alliance, PO Box 293, Arcata, CA 95521 • 707-822-7884 (voice) • 707-822-8640 (Computer BBS)



To start the pump, set the stroke length between one and two centimeters and open the inflow valve, keeping the outflow valve closed. Manually open and close the waste valve until it will operate on its own. Wait approximately one minute and then crack open the outflow valve a little at a time. If the pump fails to continue operating, repeat the process, lengthening the lag time prior to opening the outflow valve.

The stroke length can then be experimentally varied to optimize pump output. Shorter stroke lengths work better at lower flows and longer stroke lengths are better for higher flows. A longer stroke length provides a greater velocity in the drive pipe, thus increasing the potential energy in the falling water at the pump. However, more water is "wasted" which may result in possible source depletion.

If the pump is operated continuously without a snifter valve, it should be drained, via the tank drain, before the pressure tank becomes full of water. One should expect to drain the tank approximately once a month, unless you have a working snifter valve. The rubber used in the valves should withstand continuous use for several years. Periodic inspections will help determine when replacement is necessary.

This homemade ram pump is a "folk project", with improvements by each person who built it. If you find new solutions for keeping the waste valve in better alignment, or a good snifter design, please share them.

Building a Homemade Ram Pump

Scott Lee

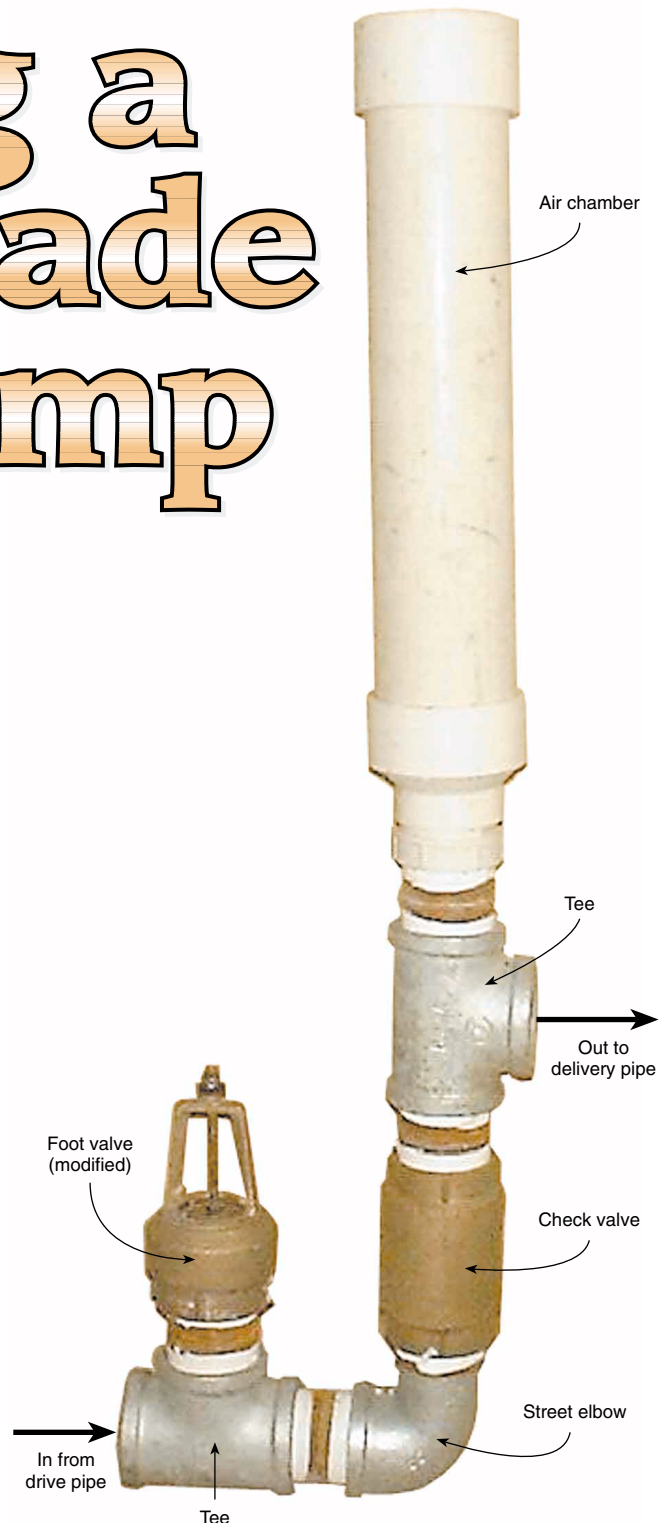
©2000 Scott Lee

During the mid 1970s, I first encountered the hydraulic ram water pump. A friend of mine was interested in a water pump for irrigating a garden. I had also purchased some land with a stream and a nice garden spot, but no electrical service. The combination of a stream below my garden spot and no electrical power seemed to be a perfect situation for a hydraulic ram.

Three Tries

The manufactured rams back in the '70s were fairly expensive—US\$250 and up. Some publications had home-built designs. One in particular was by an organization called VITA (Volunteers in Technical Assistance). Based on the cost of the manufactured rams, I set out to construct a home-built ram pump. The first two versions of my ram were based loosely on VITA's descriptions and plans. They weren't followed

Scott Lee's ram pump in operation.



exactly, due to the difficulty in obtaining some of the parts that were mentioned.

I recently went to the local hardware store to check out the cost of these parts. The 2 inch version of my homebrew ram will cost about US\$130 (see parts list). A 1 inch ram will be cheaper, and might cost a little more than half that amount. The cost of the pipes needed to hook up the ram may exceed the cost of the ram itself.

Ram Pump Parts List

Qty	Item
1	2 inch foot valve (brass)
1	2 inch check valve (brass)
2	2 inch tees (galvanized)
6	2 inch close nipples (galvanized)
1	2 inch street elbow (galvanized)
1	2 by 1 inch bushing (galvanized)
1	1 inch close nipple (galvanized)
1	3 inch pipe cap (PVC)
1	3 inch pipe, 18 inches long (PVC)
1	3 by 2 inch reducer (PVC)
1	2 inch PVC to IPT adapter (PVC)
1	1/4 inch threaded rod (stainless)
6	1/4 inch nuts (stainless)
2	1/4 inch washers (stainless)
1	Faucet washer
1	14 gauge copper wire, 2 inches

The first version of my ram was built entirely out of galvanized steel pipe and fittings. The waste (or impetus) valve proved to be the hardest to construct. The first version's valve was constructed from a 1 1/2 by 1 inch bushing. While this valve worked after a fashion, it was very leaky. I figured that the ram would perform better if this valve would seal tightly. My second version had a valve that was constructed from a 1 1/2 inch pipe plug. The plug was bored with a 1 inch hole, and had the inside surface of the plug machined smooth. This resulted in better ram performance.

I never used the first two versions in working applications, though I did test them. Shortly after the second one was operational, an article appeared in *The Mother Earth News* (May/June 1979, #57, page 120) with instructions on how to build a ram mainly out of PVC pipe fittings. Using this design as a guide, I developed a third version. This version was also built from galvanized steel pipe fittings, with the exception of the air chamber, which was constructed from PVC pipe

and fittings. This version still required machining of a sort—cutting threads on the outside of a 1 1/2 inch hose barb, so that it would thread into a 2 by 1 inch bushing.

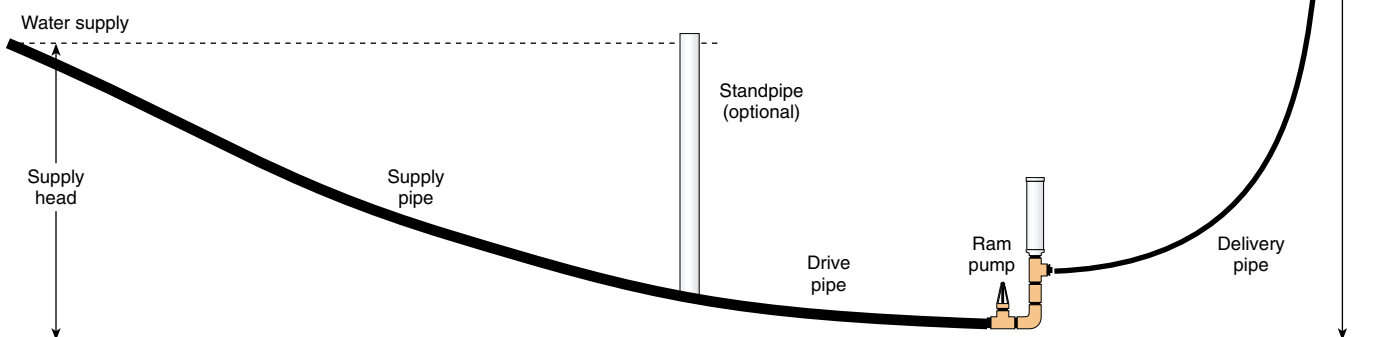
Although this was a workable system for constructing the waste valve, it still was not as simple as I wanted. For a time, this ram was used to pump water to my garden. The water was also used to provide showers, with the use of 200 feet (60 m) of 3/4 inch black poly pipe for a solar water heater. This pump was installed with a 4 foot (1.2 m) fall (head) to the ram, developed over the distance of 100 feet (30 m). It had a delivery lift of 30 feet (9 m) to a 3 by 12 foot (0.9 x 3.7 m) pool used as a storage tank. The point of use was 15 feet (4.5 m) lower than this storage pool.

Standpipe

When the ram was first put into service, it operated very slowly—about 15 to 20 cycles per minute. Everything that I'd read stated that rams of this size should operate at about 45 to 60 cycles per minute. I fabricated a standpipe and inserted it in the drive line about 30 feet (9 m) from the ram. This is within the recommended 5–10 times ratio of head to drive pipe length. This allowed the ram to operate in the 45 to 60 cycles per minute range. The flow of water delivered to the tank increased from 0.25 to 0.75 gallons (0.9 to 2.8 l) per minute.

Ideally, the length of the drive pipe should be in the range of 5 to 10 times the head. So for a head of 3 feet (0.9 m), the length of the drive pipe should be in the range of 15 to 30 feet (4.5–9 m).

If the drive pipe is too long, the cycle frequency that the ram can operate at will be limited to some low value. The standpipe provides a closer location for the ram pump's supply. This means that there is less resistance in the drive pipe, and the flow can reach full velocity more



How a Ram Pump Works

The energy required to make a ram lift water to a higher elevation comes from water falling downhill due to gravity, as in all other water-powered devices. But unlike a water wheel or turbine, the ram uses the inertia of moving water rather than water pressure, and operates in a cycle.

1. When the waste valve is opened, water flows from the source, through the water inlet (drive) pipe, and out the waste valve.

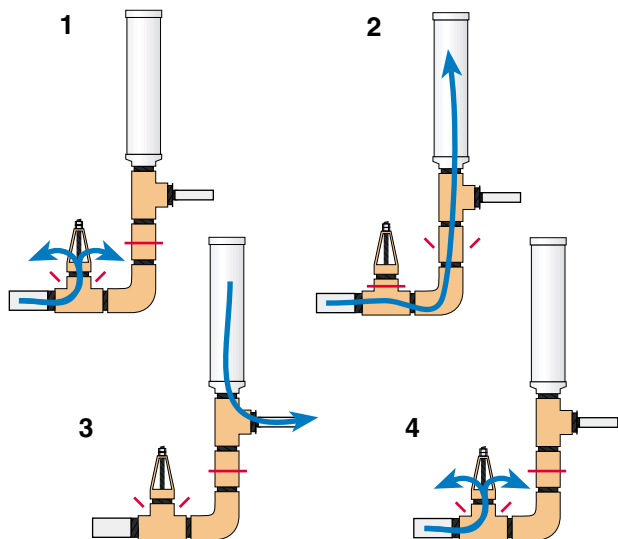
2. After a short time, the velocity of the flow is high enough to force the waste valve closed. The water, due to its inertia, wants to continue moving past the valve. The pressure inside the ram will rapidly increase enough to force the check valve open. This forces some water into the air chamber, compressing the chamber's air bubble. The pressurized bubble forces that water through the delivery pipe to the point of use.

For a ram pumping one gallon (3.8 l) per minute, and cycling 60 times per minute, each cycle pumps one-sixtieth of a gallon—about two ounces (60 ml). The compressed air in the air chamber helps smooth out the flow on the delivery side of the ram, so the flow tends to be more continuous, rather than a small spurt during each cycle of the ram.

3. Soon after the check valve has opened, the pressure surge (generated by the waste valve closing) is spent. Flow will try to start backwards, but the check valve will close, preventing this from happening.

4. At about this time, the pressure in the drive pipe will be low enough so that the waste valve can open, allowing water to start flowing from the source to the ram, beginning a new cycle.

The cycle that the ram goes through can occur 30 to 120 times per minute, depending upon conditions such as head, flow, and the size of the ram.



quickly than without the standpipe. Basically, a standpipe allows the ram to operate as if it had a shorter drive pipe.

The diagram on page 43 shows a standpipe inserted between the supply pipe and the drive pipe. The critical distance is now only the distance between the standpipe and the ram, not the total distance to the source of supply.

A standpipe can easily be constructed out of PVC pipe and fittings. The pipe needs to be long enough so that it is a few inches higher, in its installed location, than the elevation of the water source. Consider screening the top of the standpipe to keep out birds, insects, and detritus if you are pumping potable water.

The standpipe is usually inserted at a distance from the ram that is 5 to 10 times the supply head. This will vary from installation to installation. Since my installation had 3 feet (0.9 m) of supply head, I inserted the standpipe 30 feet (9 m) from the ram. This allows the ram to cycle properly, which results in more water pumped.

It's also important to consider the diameter of pipe on long drive runs, to minimize flow loss due to pipe friction. When in doubt, go up in size. It's recommended that the standpipe be at least two full pipe sizes larger than the drive pipe. I've used 4 inch standpipes with 2 inch rams, and 2 inch standpipes with 1 inch rams. It's also recommended that the pipe from the supply to the standpipe be one full pipe size larger than the drive pipe. This will insure that the flow to the standpipe will be able to keep up with the ram pump's usage.

Drive Pipe

This configuration operated for about six months, after which it was dismantled for the winter. It was later installed at a new location with 3 feet (0.9 m) of head and 12 feet (3.7 m) of lift. Most of the time it supplied garden soaker hoses, with an old 52 gallon (200 l) hot water tank being used for a small storage volume, operated as a pressure tank.

One day, we were operating the ram with the discharge valve shut, and we noticed that the 2 inch black poly drive pipe was actually expanding visibly with each closing of the waste valve. We concluded that a portion of the energy was being wasted expanding the drive pipe, rather than pumping water. We also noticed that the max discharge pressure was 21 psi.

So I replaced the 30 feet (9 m) of black poly pipe between the standpipe and the ram with schedule 40 PVC pipe. With this pipe in place, I noted that the maximum discharge pressure was now 57 psi. This meant an almost threefold increase in the amount of water delivered. With a 12 foot (3.7 m) lift, we

measured the flow at 2 gpm after the installation of the PVC drive pipe.

Based on these observations, I suggest that you don't use black poly pipe or other flexible pipe for the drive pipe. If you are using a standpipe, the pipe from the standpipe to the ram is the only section that needs to be rigid. The supply pipe from the source to the standpipe can be flexible. If your drive head is higher than a few feet, steel drive pipe is recommended, since high pressures can blow out plastic pipe joints.

Versions Four & Five

Although this ram was successful, it still was not completely satisfactory. The waste valve needed a lot of maintenance, and also required a pipe threading machine to make it.

In light of these shortcomings, a fourth version was built using a standard plumbing check valve for the basis of the waste valve. This worked well, but required a lot of work to cut discharge ports into the check valve.

In a matter of days after version four was put in operation, it was discovered that a foot valve would serve the purpose as well as a check valve, with very little work required to convert. This valve was built and put into operation successfully and performed well. The fifth version is still in use. I think that it was first used in 1980 or '81. This ram continues to provide irrigation for a garden, and water for keeping a compost pile moist enough for proper decomposition.

It should be noted that this is not a year-round installation. Before winter weather starts, the ram and standpipe are removed from the stream to prevent freezing. They are reinstalled the following spring. This has worked well, since there is no demand for the water during the winter.

I built and installed another ram of this size for a neighbor, to supply water from a spring to two houses. This ram was a slightly improved version. The main differences were that I used a larger check valve and foot valve, which improved the performance slightly. This ram was supplied by 4 feet (1.2 m) of head and lifted the water 30 feet (9 m) to a 1,500 gallon (5,700 l) storage tank about 1,400 feet (425 m) away.

At the storage tank, separate centrifugal pumps and pressure tanks were used to supply water to both



The foot valve on its way to becoming the waste valve—the stem is cut off the valve disc and the lower crosspiece has been cut away from the casting.

houses. The ram delivers almost 1 gpm to the storage tank, which has proved to be plenty of water for all normal household uses. This ram installation is freeze-proof, with the delivery line buried and the ram in an enclosure. The ram has proved to be superior to trekking to the spring and running a gasoline engine-driven pump every two to three days to fill the storage tank.

How to Build The Ram

All of the parts for the ram were obtained from a local hardware store's plumbing section. The foot and check valves were Simmons brand, but any other good quality valves should work as long as they are of the same general configuration.

Begin the fabrication of the waste valve by removing the screen that is supplied as part of the foot valve. Then use wrenches to remove the valve disc from the foot valve, and cut off the supplied stem from the valve.

Now take the disc and drill a 1/4 inch (6 mm) hole in the center of it.

Use extreme care in drilling this hole to make sure that it is straight and centered. Use a drill press if you can. It is possible to get this right by hand if you are careful.

Now cut a 6 inch (15 cm) piece of 1/4 inch (6 mm) threaded stainless steel rod for the new valve stem. Thread on one of the 1/4 inch nuts, far enough to allow the valve disc to be placed on the threaded rod with room for another 1/4 inch nut. Lock the disc to the threaded rod by tightening both nuts against the disc.



The valve disc is reassembled with a 6 inch long piece of 0.25 inch stainless steel threaded rod, and locked in place with nuts top and bottom.

Now take the valve body and enlarge the threaded hole in the top crosspiece to 1/4 inch with a drill. Again, use care to get this hole straight. Using a hacksaw, remove the lower crosspiece.

After these modifications have been made, take the modified valve disc and insert it up through the valve body. After you have inserted it, put on a 1/4 inch washer, a faucet washer with its hole enlarged to 1/4 inch, and another 1/4 inch washer. The faucet washer provides some cushion to help quiet the waste valve when it falls open. Then thread on two 1/4 inch nuts, adjusting them so that they allow about 1/2 inch (13 mm) of movement of the valve disc and stem within the body. This is a good starting point—further adjustments can be made later, after the ram is operating. Your assembled valve should look like the diagram at right.

Air Sniffer

The next step is to modify the 2 inch check valve by adding an air sniffer hole. This hole will allow a little air to be taken in on each stroke of the ram, replacing air in the air chamber that has dissolved in the water and gone up the delivery pipe. Loss of all the air in the air chamber can result in something breaking. I once saw the bonnet of a 2 inch PVC valve blow off. This valve was used to isolate the ram from the drive pipe. If you choose not to use an air sniffer, you must shut down the

ram every few days and drain some water from the air chamber.

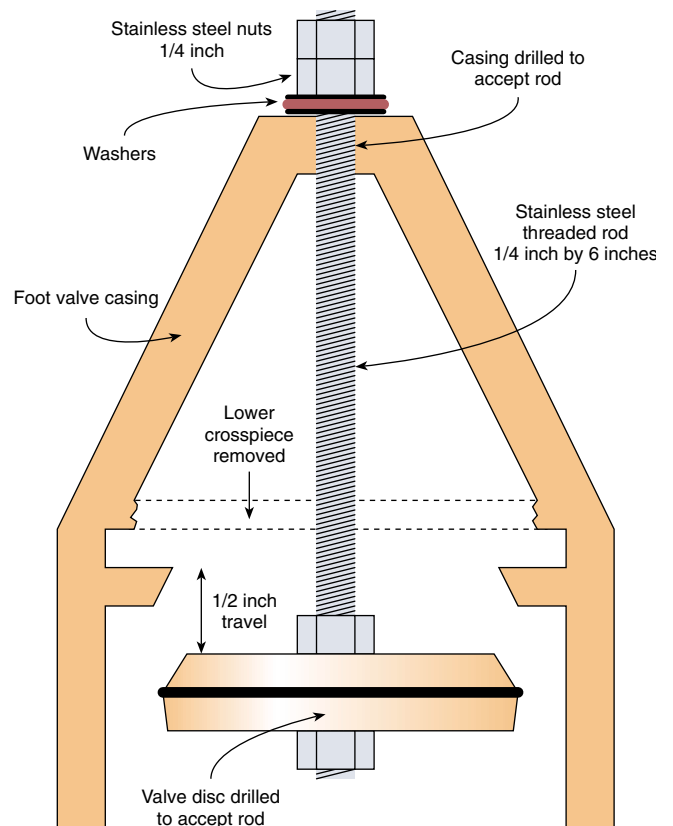
Begin the construction of the air sniffer by stripping the insulation from a piece of #14 (2 mm²) copper wire. Select a drill bit that is just slightly larger than this wire. Use this bit to drill a hole in the check valve as shown in the next sketch.

Make sure that you drill this hole on the correct side of the valve seat, as shown on page 47. After you have drilled this hole, twist a small loop in one end of the wire you have stripped. Insert the straight end of this wire into the hole, and twist another small loop in the wire on the inside of the check valve. If you are building the ram for a low-head installation, you may want to remove the spring from the check valve at this time. Otherwise it can be left in place.

Air Chamber

The air chamber is the last piece you will need to assemble before the ram can be completely finished. A 4 inch diameter air chamber should be okay for up to 10 feet (3 m), while a 6 inch chamber should work for about 15 feet (4.5 m). When in doubt, it's probably better to err on the large side. The air chambers are usually about 18 inches (46 cm) plus the length of the fittings, but could be made longer if necessary.

Assembled Waste Valve Detail





The modified foot valve ready to assemble onto the ram.

To assemble the air chamber, glue a cap to one end of the 3 inch PVC pipe. Then glue the 3 by 2 inch reducer to the other end of the pipe. After these are complete, glue in the PVC to IPT adapter. The air chamber should now be complete, and the final assembly of the ram can proceed.

Assembly

Screw a 2 inch close nipple into one of the end branches, and another into the side branch, of a 2 inch tee. Teflon tape should be used on all of the threaded connections. This will aid in any disassembly that may be required in the future. Screw your waste valve onto the nipple on the tee's side branch.

Screw the street bend onto the nipple on the end branch. Screw the check valve onto the end of the street bend. The flow directional arrow should point away from the street bend. Screw a 2 inch close nipple into the check valve. Screw an end branch of the other 2 inch tee onto the close nipple.

Screw another close nipple into the other end branch of the 2 inch tee. Screw your air chamber onto this nipple. Screw the 2 by 1 inch bushing into the side branch of

the tee. Screw the 1 inch close nipple into this bushing. Go back to the first 2 inch tee and screw in the last 2 inch close nipple.

Your completed ram should look approximately like the photo on page 42. The 3 inch air chamber size on this ram should be adequate for supply heads of up to 5 feet (1.5 m). If the head is greater than this, the air chamber should be larger.

Installation

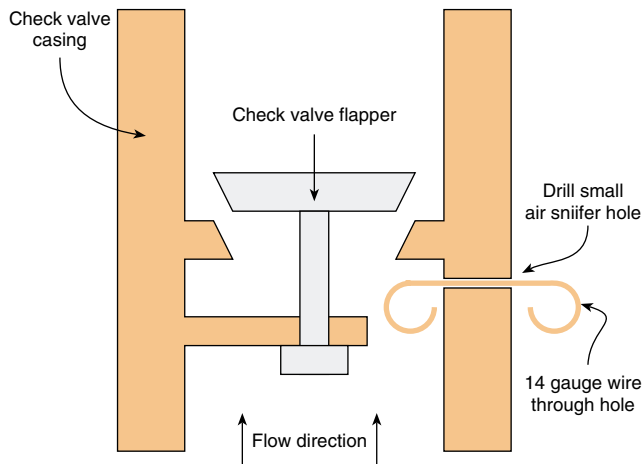
This completes the ram pump construction, but you may find that this is the easiest part of the job. As much or more depends on a good installation. I recommend that you use a union on either end of the ram. A gate valve on both the drive and discharge lines will also facilitate any maintenance that is required on the ram itself. The diagram on page 43 is a typical ram installation, showing head, lift, supply, delivery, and the length of the drive pipe.

To calculate how much a ram will deliver, divide the head by the lift, multiply by the flow, and finally multiply by 0.6. It takes at least 5 gpm to run this ram, with at least 2 feet (0.6 m) of head. In general it is easier to pump more water with more head, so run more drive pipe to get the head you need.

The check valve with the wire poking out of the air sniffer hole.



Check Valve Cutaway



Using this equation, a site with 3 feet (0.9 m) of head, 20 feet (6 m) of lift, and a supply flow of 10 gpm would deliver 0.9 gpm. The same flow and lift, with 4 feet (1.2 m) of head, would result in 1.2 gpm delivered to the point of use. Or the same delivery could be accomplished with less supply flow. The delivered flow of 0.9 gpm could be achieved with 7.5 gpm of supply flow, using 4 feet (1.2 m) of head.

Maintenance on this ram is not very demanding. I've had to replace the faucet washer a couple of times per year. Otherwise the ram is noisy, and tends to wear the metal parts more. The O-rings on the valves will have to be replaced about every five years. The wire in the air sniffer will last two to four years.

Consider a Ram

Hydraulic rams can be very useful in providing a supply of water from a lower to a higher elevation. They can

pump in a remote location, with no other energy required besides the falling water. Don't be discouraged about the small flow of water delivered by a ram, since they can pump 24 hours a day. Remember that one gallon per minute times 1,440 minutes per day will be 1,440 gallons per day delivered to wherever it is needed. It can also be used year-round if the ram and piping are protected from freezing.

The most important step in deciding if a ram is for you is a site survey. This will ensure that you have the flow and head required to operate a ram. Once this has been determined, build a ram to supply the water. Rams are inexpensive, easy to construct, and dependable, so there's no reason not to use one, if you have a location that meets the requirements.

Access

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Other *Home Power* articles on ram pumps:

Hydraulic Ram Pump, by Kurt Janke & Louise Finger, *HP41*, page 74.

Things that Work! on the Folk Ram Pump, by Michael Welch, *HP40*, page 44.

