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DIY Plans to Make an O-ringer PVC Manual Lift Pump for Your Well Cap

By Lee Hochstetler Vs 1.13 June 2016

These instructions can help you build a hand operated "lift pump" all from pvc pipe. I've been told that economic recession happens about every 7 years, so I figure the next one could result in no electricity for a while, nor gas to run a generator. That's why I decided to make a manual water pump. The outer pipe (riser) is 1¼ inch pvc, and the lift rod is ½ inch pvc. The water is most restricted when passing through the two check valves which are made of ¾ inch pvc fittings. Those are the largest size fittings that will fit into a 1¼ inch pvc pipe. (Yes, a 1 inch pipe will fit inside, but not 1 inch fittings.) The piston is made by sawing 2 grooves into several inches of 1 inch pvc pipe to accommodate o-rings. Clever construction makes it possible to extract all the innards including the lower check valve (if ever service is needed) without having to remove the cap on your well casing. The pump delivers 2 gallons of water per minute at a sustainable pace, and 2½ when I pump more vigorously. The design was inspired by the SlapShot pump and Thompson pump.

TOOLS NEEDED

Hack saw or pvc cutter
Table saw (for making 2 grooves in pvc pipe for o-rings)
Half round file (or 1 round & 1 flat)
Sandpaper
Drill bit the diameter of an ink pen tube
Drill bit approximately 3/16 or 1/4 inch
1&5/8 hole saw (for cap)
2 pipe wrenches (for existing pipe fittngs)

PVC PIPE THAT I USED

1¼ inch Sch 40 370 psi in 10 foot lengths
1 inch Sch 40 450 psi
¾ inch conduit pipe (gray), but white pvc should work too
½ inch Sch 40 600 psi (370 psi seemed too flimsy) in 10 foot lengths

ABBREVIATIONS

OD = outside diameter ID = inside diameter
F = female M = male S = socket (slip) T = threaded
(e.g ¾FT&¾MS = a fitting having a ¾ inch female end with threads & a ¾ inch male smooth slip end.)

N.B. Use **pvc primer** just before cementing joints. Use **all-purpose pvc cement** if you use different kinds of pvc.

Will this work in my situation?

I am assuming that you've done due diligence to determine if a hand pump can be installed on your well casing seal or cap, in addition to existing plumbing. If you're not sure, several references at the end of these instructions should help you figure that out. These plans are more about making a hand pump than addressing all the potential problems you may encounter in the process of installing it (e.g. electrical, modifying existing plumbing, sanitizing, short cycling, etc.). In cold climates there are pitless adapters. In warmer places, like where I live in NC, we have well seals with plumbing coming out the top before going underground. (All is sheltered by a small pump house or insulated fiberglass "rock".) Regardless of whether you have a seal or cap, here are three preliminary questions to consider:

(1) Is my well casing seal or cap large enough in diameter to accommodate a hole 1&11/16 diameter (OD of 1¼ inch pvc pipe)? This question is relevant whether you drill the hole yourself, or intend to purchase a new cap with rearranged hole placement. (e.g. I thought I would have to buy a rearranged seal until I realized that raising my 1¼ pvc pipe above the steel coupling (on the upper side of the seal), and thereby necessitating raising the steel pipe as well, would provide enough space to put a fitting on the pvc.)

If there's not enough room on your cap to put a 1¼ inch pvc pipe through it, perhaps you could scale down these instructions by using ½ inch cpvc fittings for check valves in a 1 inch (1&5/16 OD) pvc riser. Or perhaps you could gain just enough room by substituting one continuous length of poly pipe (like is used on submersible pumps) for the riser instead of coupled sections of pvc pipe. But figuring out a way to secure the head assembly (the pvc with the spout) might be challenging, unless you give up the option of being able to remove all innards without removing the well cap.

(2) Is my electric water pump inside the well casing? If so, are there centering spacers around its ascending water pipe? If yes, are they solid disks or plus shaped? Can I modify them or do I need to purchase different ones? Is there a bulging torque arrestor around the pipe, near the pump? Is it far enough below the water level that it won't interfere? (All submersible well pumps use some kind of method to keep the water pipe and electrical wires free from chafing when the pump torques on start-up.) How do you find out what's down there? Well..., in my case I pulled up the pump to assess the situation the day I prepared the seal. My water pipe had two plus shaped spacers that didn't need to be modified, and no torque arrestor. The riser would only need to pass through one spacer. Now will my riser get chafed--I don't know. Maybe I should have added a torque arrestor.

(3) What is the distance from the well cap to the water (static level)? Firstly, it enables you to determine the total length of riser that you will need. (My well is 105 ft deep, with water at 40 ft and submersible pump at 51 ft, so I made my riser 46 feet long.) Secondly, you can estimate the weight of that riser that will be hanging from your well cap. Can the cap support that much weight? But if your electric pump is outside of the well casing, you could consider cementing together and lowering (both done incrementally) sections of 1 inch pvc pipe, so that after everything is cemented together, the far end (with a foot to prevent digging in over time) will be sitting on the bottom of the well, supporting the weight of the riser.

Prepare the well casing seal / cap

My well seal (6&1/4 inch ID) is composed of three pieces: a 7 inch upper pvc disk, a smaller rubber center disk and a lower pvc disk. Tightening four bolts running through all three pieces expands the rubber disk so it securely grips the inside of the casing.
(1) Remove the well cap. (If you have a seal AND a submersible electric well pump, beware that a steel coupling on top of the well cap probably holds the pump suspended in the well! I've heard stories of pumps being inadvertently dropped to the bottom of wells, with no way to fish them out, thus requiring the purchase and installation of a new one.)
(2) Drill a 1&5/8 inch hole through your well cap. You'll probably need to file the hole slightly until a 1¼ inch pvc pipe fits through it. (For my 3-piece cap, I drilled a pilot hole through all 3 pieces together, then drilled the larger hole in each piece separately.)
(3) Decide how much 1¼ inch pipe needs to extend above your well cap so that you can put a MT fitting on it that will accommodate a FT fitting from the bottom of the head assembly.
(4) Calculate the total length of 1¼ inch pipe that needs to pass through the well cap. This should be the length you decided you need above the cap, plus the thickness of the cap, plus 3-6 inches below the cap. Allow enough below the cap so that a FT fitting will not interfere with any other fittings just under the cap. Cut **1¼ inch pipe** to the total length you calculated. Push it through the corresponding hole in your well cap to the amount that you calculated.
(5) Cement the MS end of a **1¼FS&1½MS** into the FS end of a **1½FS&1½FT** fitting. Then cement the 1¼FS end to the 1¼ inch pipe extending from the underside of your well cap.
(6) Cement the MS end of a **1¼FS&1½MS** into the FS end of a **1½FS&1½MT** fitting. Then cement the 1¼FS end to the 1¼ inch pipe extending from the top side of your well cap. This will provide a threaded joint between the cap and a FT fitting at the bottom of the head assembly. If you choose to store the head assembly and innards until they are needed, you can cover the 1½ MT fitting at your well cap with a **1½ pvc cap**.

The instructions below purposely avoid the terms "adapter, bushing, and reducer." They look good on paper, but people unfamiliar with plumbing parts can easily confuse them while shopping for supplies.

Build the lower valve seat assembly (d)

(1) Cut a piece of 1 inch pvc pipe 2 ¾ inches long **(a)**.
(2) File out the inner lip of **1FS&1¼MS (b)** so that the male end can be cemented flush with one end of (a). That should leave at least 1 inch of the 1 inch pipe extending behind the female end of (b), which provides a way to add-on to the riser (if you ever want to extend it deeper into the well casing) sometime in the future.
(3) Cut a piece of **¾ inch pvc pipe 2 inches long (c)**. File it slightly so that half of it can be inserted and cemented into the end of the 1 inch pipe (a) that is flush with (b). The portion of ¾ inch pipe that protrudes will serve to seat the lower check valve. This seat must remain a slip joint without cement.
(4) Before installation, the MS of (b) needs to be cemented into a 1¼ coupling at the lowest end of the riser.

Build the lower check valve (j)

A check valve only allows water to flow in one direction. This valve will allow water to be sucked into the riser on the upstroke, but will close on the downstroke, thus forcing the trapped water up the riser. The valve will work without a rubber washer, but less effectively (i.e. will produce lower pressure).

(1) Start with a coupling **¾FS&¾FS (e)** (prefer conduit [gray] because inside hole is larger than white one).
(2) Place a garden hose **flat rubber washer (f)** in one end of the coupling.
(3) Cut a piece of **¾" pipe at least 1½" long (g)**.
(4) Measure 5/8 inch from one end of (g) and drill a hole there the diameter of an ink pen tube through one side and out the other side.
(5) Insert a piece of empty **ball point pen ink tube (h)**,straight through the drilled holes of (g), flush with the outside of (g), to limit ball movement. (A nail would eventually rust out.)
(6) Place a **5/8 to ¾ inch acrylic or glass or SS316 ball** (e.g. a marble) in the rubber washer.
(7) Cement drilled end of (g) against the rubber washer (f) (but don't compress washer) to trap the ball. Cement can slightly cover the ends of the ink pen tube.
(8) File ribs off **conduit ¾FS&¾MT (i)** so it will slide easily through 1¼ pipe. Cement FS end to (g).

Do NOT cement this check valve to anything. The FS end of (e) will press fit onto the ¾ inch pipe (c) of the lower valve seat assembly. The ¾FT (l) of the lift assembly can be lowered to thread onto the MT (i) end of the check valve so that it can be removed it if it ever stops functioning properly.

Build the lift assembly (v)

(1) Make the o-ring piston **(n)** from **1 inch pipe**. Use a length you can safely hold on to and rotate while using a table saw, and then cut it to the correct length after cutting both grooves. Set the blade to cut half way through the wall of the pipe. Make first groove 1/4" to 3/8" in from one end. Make a second groove about 1½" to 2" away from the one you just cut. Cut off the pipe at approximately the same space beyond the second groove that matches the space from the other end to the first groove. (The grooves are close to the ends so that when a fitting will be cemented into each end, those areas will be reinforced.)
(2) Get **two o-rings 1 3/8 OD x 1 3/16 ID x 3/32 thick (o)** [e.g. Danco #45] or 35mm OD x 30mm ID x 2.5mm thick.) Place an o-ring in each groove of the piston.
(3) Take ¾ inch pipe and lightly file the last inch of outer surface so it will fit into one end of the piston. Then saw off that **¾ inch pipe at 2 inches length (m)**.
(4) Cement unfiled end of (m) into FS end of **conduit ¾FS&¾FT fitting (l)**. Slightly file ribs on fitting until it slides easily through a 1¼ pipe.
(5) Cement filed end of (m) into one end of the piston so that (l) butts against the piston.
(6) File ribs off **conduit ¾FS&¾MT (p)** so it will slide easily through 1¼ pipe. Cement the MT end into the other end of the piston.
(7) Place a garden hose **flat rubber washer (q)** into the FS end of (p).
(8) Measure 5/8 inch from one end of a **¾ inch pipe (s)** and drill a hole there the diameter of an ink pen tube, through one side and out the other side.
(9) Insert a piece of empty **ball point pen ink tube (r)** straight through the drilled holes of (s), flush with the outside of (s), to limit ball movement. (A nail would eventually rust out.)

(10) Drill several holes approximately 3/16 inches in diameter in the next 2 inches of (s). (These holes will allow water to pass through the lower lift assembly and into the riser above the piston on a down stroke. On an up stroke, the lift check valve will close and cause the water above the piston to be lifted up the riser.)
(11) Cut off the ¾ inch pipe (s) about ¾ of an inch beyond the last pass-through hole.
(12) Place a **5/8 to ¾ inch acrylic or glass or SS316 ball** (e.g. a marble) in the flat rubber washer.
(13) Cement (r) end of (s) against the rubber washer (q) to trap the ball. Cement can slightly cover the ends of the ink pen tube.
(14) Find or **make a solid disc (t)** that fits into the FS end of a **conduit ¾FS&¾FT fitting (u)**. The disc will prevent water from traveling up the lift rod and will instead force it out the pass-through holes of (s). (A 25 cent coin fits perfectly, but if you have slightly acid water, the copper will gradually dissolve into your water. Consider making a disc from a plastic jar lid, or the cap of a hydraulic hose.)
(15) Cement FS end of (u), with disc in it, over remaining end of (s).
(16) File ribs off (u) so it will slide easily through a 1¼ pipe.

Prepare the lift rod

(1) The lift rod is made of 10 ft sections of **½ inch pvc pipe** to facilitate storing them along with the other innards until you want to use your hand pump. The bottom-most section needs a **¾MT&½FS (w)** fitting cemented on the lower end so the rod can screw into the top of the lift assembly (u) and a **½FS&½FT** on the upper end.
(2) The top-most rod section will have a **½MT&½FS** on both the lower and upper end, but leave one of these two uncemented until after the head assembly has been installed onto the well cap. (Until you are sure the overall rod length is correct, and the rod has passed through h7, h8, and h9.)
(3) All other rod sections will have a **½MT&½FS** cemented on one end and a **½FS&½FT** on the other end. The combined length of all the lift rod sections must stop at least several inches short of hitting the lower check valve seated at the bottom of the riser. If you ever need to remove the lower check valve, unscrewing the head assembly should allow the lift rod to descend far enough to screw onto the check valve to fetch it out.

Prepare the riser

The riser is the 1¼ pvc pipe that will descend from the bottom side of your well cap into the water in your well. **10 ft lengths of 1¼ pvc pipe** are easier to transport, but it is better to cement them into 20 foot lengths before installation. (Because 20 ft vertical is all you can handle while getting them into the well casing. And when putting them down the casing, you'll need to hold the lower pipe 15 minutes each time you cement sections together, until the cement dries sufficiently. If the joint pulls apart, you'll be left holding the last 20 ft section after the rest falls to the bottom of the well.) The riser normally remains in the well even if you choose to store the lift rod sections and innards until you want to use the hand pump. If you have a submersible pump in the well, I recommend you bevel both outer ends of the 1¼ inch riser couplings to facilitate unfortunate future removal of the riser if ever the electric pump needs to be replaced. This will minimize the problem of a spacer snagging on a coupling as it passes.
(1) The bottom most riser section needs a **1¼FS&1¼FS** coupling on each end.
(2) Each section thereafter just needs a coupling on one end, except for the top most section.
(3) The top most riser section only needs a threaded fitting. Make it by cementing the MS end of a **1¼FS&1½MS** into the FS end of a **1½FS&1½MT** fitting. Yes, this really needs to be a 1½ inch fitting

to allow the pump innards to pass through. Cement the 1¼FS end to the top riser section. This will provide a threaded joint between the riser and a FT fitting on the underside of the well cap.

Build the head (spout) assembly (h10)

(1) Cement the MS end of a **1¼FS&1½MS (h2)** into the FS end of a **1½FS&1½FT (h1)**.
(2) Screw the fitting you just made onto the 1½ MT fitting on your well cap so you can figure out the length of 1¼ inch pipe needed to reach the height you want the spout to be from the ground. Cut that length of **1¼ pipe (h3)** and cement it into the FS of **(h2)**.
(3) Cement one end of a **¾FS&¾FS 45° angle (h5)** into the 1 inch side of a **1¼ x 1¼ x 1 Tee (h4)**.
(4) Screw h1 onto the **1½MT** fitting on your well cap. Set the Tee on the pipe in the direction you want the spout to point. If you're not sure of the direction, or how tight to screw h1, then don't cement the Tee to the pipe yet.
(5) [optional step] Cut off a small piece of **¾ inch pipe ½ inches long (h6)**. File out the ID a tiny bit until a ½ inch lift rod passes through it easily. Cement it into the M end of (h8) to make a seat for an o-ring.
(6) [optional step] Place an **o-ring 27mmOD x 21mm ID x 3mm thick (h7)** into the seat of the FT end of h8.
(8) File out the inner lip of a **1MT&¾FT (h9)** until a ½ inch pipe passes through it easily, and then screw it into the FT end of a **1¼MS&1FT (h8)**.
(9) After the head assembly **(h10)** has been installed, and the overall rod length is correct, pass the top-most rod through h6, h7, h8, h9 so that h8 may be firmly pushed into the top of the T (h4). Do NOT cement h8 into the Tee (because that would prohibit removing the innards).
(10) Cement **14 inches of 1 inch pipe** to a **1 x ½FT snapfit Tee** to make the pump handle. The FT screws onto the MT fitting of the top-most section of the lift rod.

Suggestions

1. Take bags to where you buy the pvc fittings so you can put the components of each assembly into a separate bag.
2. If you don't have a table saw to make the grooves for o-rings, find a friend or ask a public school woodshop instructor to do it for you. Use a longer piece of pipe for safety, then cut it to the desired length after making the grooves.
3. Bevel (i.e. file) all ends of fittings and pipes to facilitate water passage and the insertion / extraction of innards (e.g. as piston o-rings pass joints).

References

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ILLUSTRATION OF RISER & INNARDS

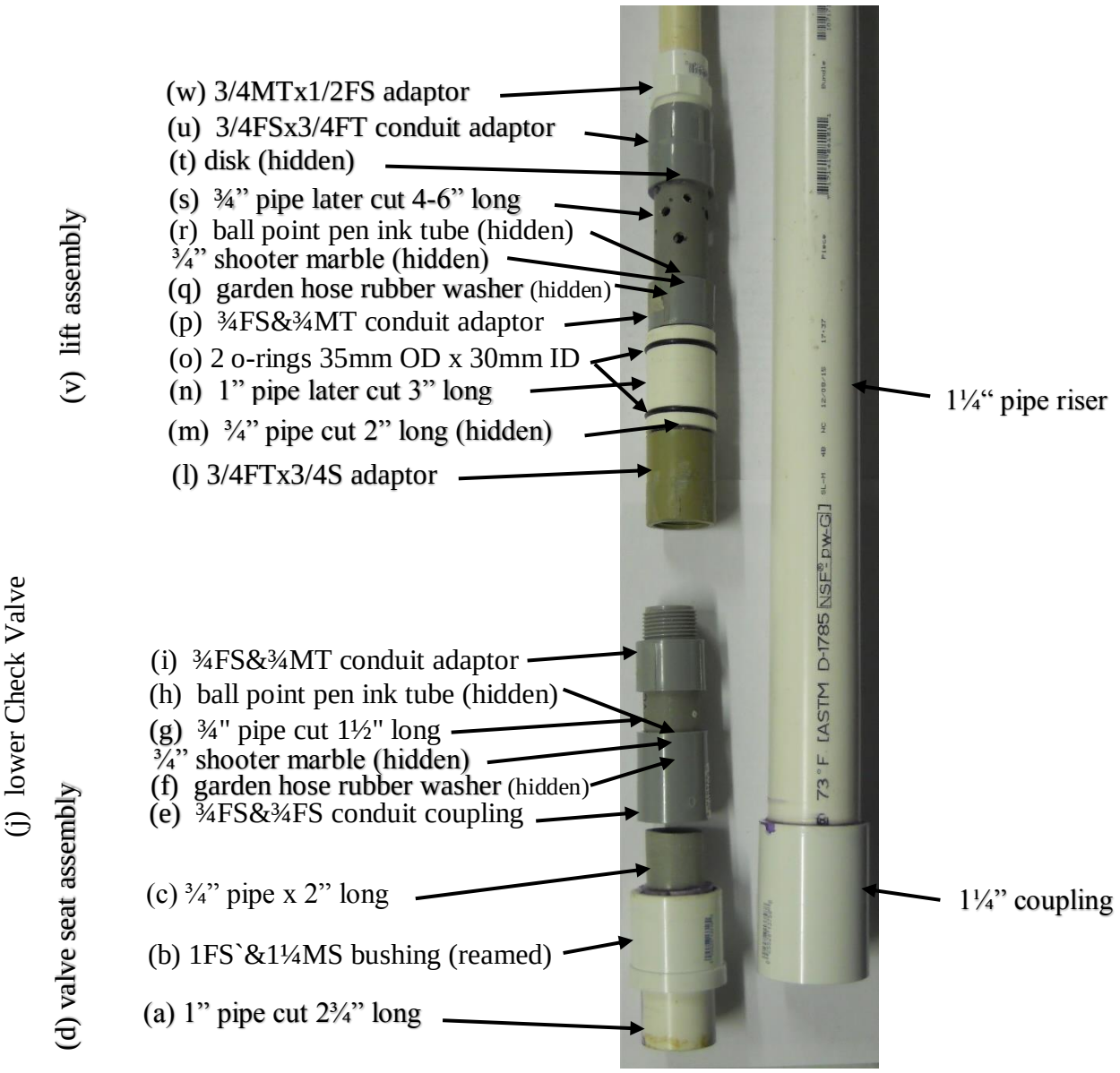

ILLUSTRATION OF HEAD ASSEMBLY AND HANDLE