The Ohio Pump

A deep-well pump designed for maximum simplicity of manufacture, installation, and maintenance.

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Introduction

The Ohio pump is a deep-well pump that is fundamentally similar to most other deep-well pumps, but with several major differences geared toward simplicity. Reports from the developing world say that ease of maintenance by village people using materials and tools available in villages is one of the constraints to successful use of a water pump. The words Village Level of Operating and Maintenance are often used.

Like other deep-well pumps the Ohio pump consists of a rising main which slips inside the well casing, and a piston which moves up and down to pump the water. In a deep well pump the piston is near the bottom of the pump, below the water table. There is also a foot valve (check valve) below the piston. Water can flow up through the foot valve and through the piston, but not down.

The unique aspects of this pump are:

1. The pump rod is not a rod but a steel cable. This eliminates the difficulty of using rigid pump rods with threaded or hooked connections, eliminating their cost and their difficulties in maintenance. The upstroke is performed normally, while the downstroke is accomplished by attaching a weight (a section of pipe) near the bottom of the cable just above the piston.

2. The sections of the rising main are not threaded or cemented together, they are help together at couplings by compression. The weight of the pump is not suspended from the top as with most pumps, but is supported by a steel cable between the rising main and the well casing. One end of this cable is attached to the lowest part of the pump, while the other end of the cable is attached to the ground at the top of the casing. This technique makes construction of the rising main simpler, eliminates the chance of loosing the pump down the well, and makes it easier to pull the pump out of the well for maintenance.

3. The piston can be pulled out of the pump at any time for maintenance while leaving the rising main in place.

4. No difficult manufacturing operations are needed to make the parts of the pump, and no tight tolerances are needed. Simple machine tools such as a drill and band saw were used in making the pump parts.

5. All maintenance of the pump can be performed with only one tool, a hammer, used for taking the pieces of the rising main apart.

Of course, the ideas proposed above could be adapted to other pump designs. For example, the original Ohio pump used leather piston seals, but if someone had good experience with another material, the same ideas could be applied to a pump with those types of seals. Or, a piston design from another pump could be incorporated into the new design. The original Ohio pump was a direction action pump, but the ideas could also be incorporated into a lever-action pump.

Pump Performance and Cost

The performance of the pump is similar to other deep well pumps. It was designed for water depths from 20 feet to perhaps 100 feet (6 to 30 meters). The prototype was tested at a depth of 40 feet (12 meters). The mechanical efficiency under these conditions was 72%, volumetric efficiency was about 100%. Leakage was minimal. The upstroke force for a depth of 40 feet (12 m) is about 48 lb (22 kg). This could be reduced through a variety of lever arrangements.

The cost of the pump will vary with depth but would be about $110 US for 40-foot (12 meters) depth . The most expensive parts are the rising main parts and the 2 steel cables. The cables would typically be stainless steel to prevent corrosion. With some practice it might take 6 hours to make the parts with simple machine tools, and about 2 hours for 2 people to install the pump. The pump could be installed by one person, though this would take more effort.

Details of Construction

The following is how the pump would be built for 40 feet of lift. For greater or lesser lift, some changes may need to be made to the details.

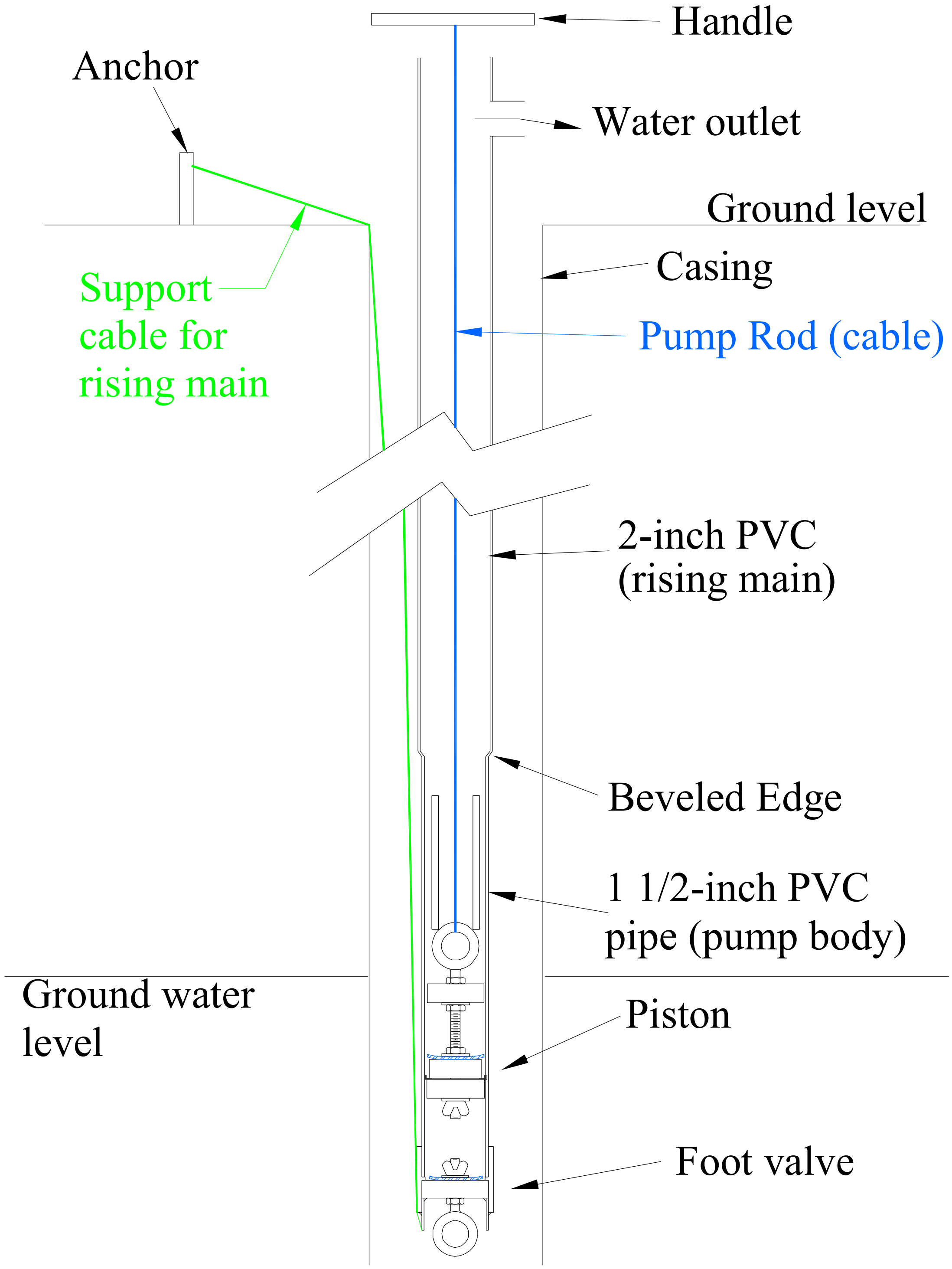

Figure 1: Overall view of the pump (not to scale).

An overall view of the pump is in Fig. 1. There is a rising main made of PVC pipe sections, held together by couplings with no epoxy or threads. The prototype used 2-inch schedule 40 pipe for the rising main. The rising main is held in compression, unlike other types of pumps, and is supported by a 1/8 inch steel cable. Most likely, stainless steel cable would be used for corrosion resistance. The rising main is in compression, and is prevented from buckling by the well casing. If the well casing were considerably larger than the rising main, one might add wooden discs on each section of the rising main to keep it centered in the well casing.

As with other deep-well pumps there is a piston which is pulled up and down. Unlike other pumps, there is no pump rod, instead a steel cable raises the piston and the piston lowers by being pushed down by the steel pipe, which serves merely as a weight.

The pump body (cylinder) is built into a smaller diameter section of PVC pipe. In the prototype a 1 ½ inch schedule 40 PVC pipe was used for the pump body. The piston can easily be pulled out of this smaller section of pipe for maintenance. There are 2 reasons why the smaller pipe section is used in the actual pump body; the smaller piston reduces the upward force needed at the handle, and with the smaller section of pipe at the pump body, the piston can be pulled all the way to the surface without jamming the cup seal in one of the couplings.

The junction between the larger and smaller section of pipe is a standard reducer. The top of the piece of 1 ½-inch pipe must be beveled on the inside so that the piston is guided into the smaller pipe when the piston is dropped into place after maintenance.

Below the piston is a foot valve or check valve, as with other pumps of this type. The support cable runs through the lowest section of the entire pump, such that the entire pump is in compression and no part of the pump can be lost down the well, assuming the support cable is intact.

Details of the piston are shown in Fig. 2. There are 3 plastic discs, a rubber flapper valve, and a leather cup. Other materials may be used, other pumps use plastic or rubber for the cup, or a number of other sealing mechanisms. The dimensions shown are for the prototype, other dimensions might be used for a larger or smaller piston. The diameter of the middle disc would also depend on the thickness of the material used for the cup.

Each of the discs has 5 holes around it to allow water to flow through, each hole is 3/8 inch (10 mm) diameter. The prototype used discs made of ½ inch (13 mm) PVC, which worked well. The flapper valve would be minimally smaller in diameter than the inside of the pipe. The top disc is used only to keep the piston straight in the cylinder.

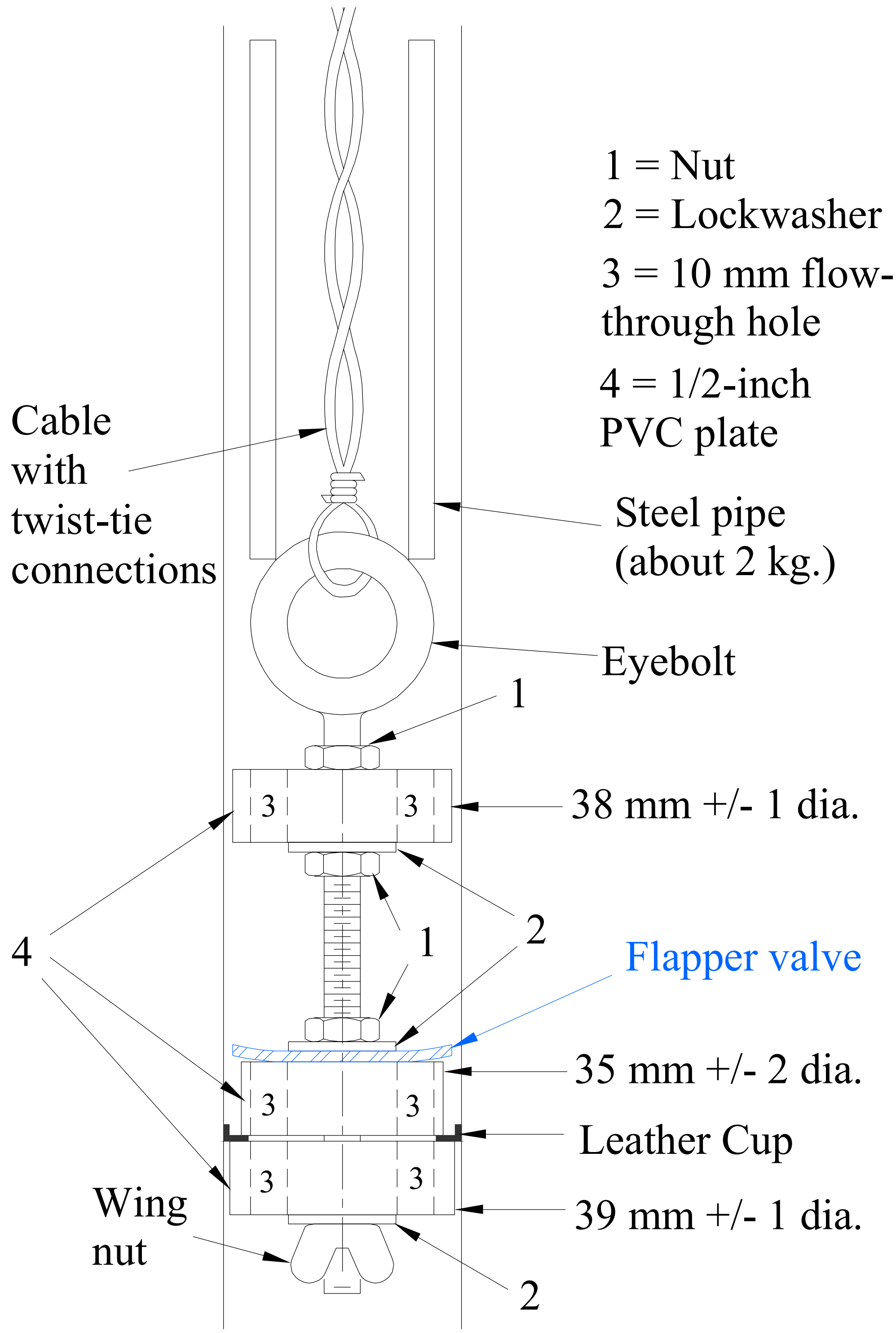

Figure 2: Details of the piston.

The eyebolts on the piston and foot valve would typically be made of stainless steel to prevent corrosion and avoid imparting taste to the water. The nuts and wing nuts could be made of plastic to prevent corrosion, or they could be made of stainless steel. The prototype used plastic wing nuts which worked well, however, stainless steel might hold up better over time. Regardless, by using eyebolts and wing nuts in strategic places, the parts should be able to be disassembled without tools. Only nuts which are intended to remain in place permanently are hexagonal nuts.

The 2 cables of the pump are held in place using a "twist and tie" connection, which is shown in Fig. 3. The cable would be looped through its fixture, then twisted a number of times around itself (10 twists, minimum) then tied in 2 or more places with a wire. Experience has shown that if the twists and ties are tight, this is an acceptable connection that doesn't need tools to apply or remove. Similar twist and tie connections would be used at the top and bottom of the piston cable and in the rising main support cable.

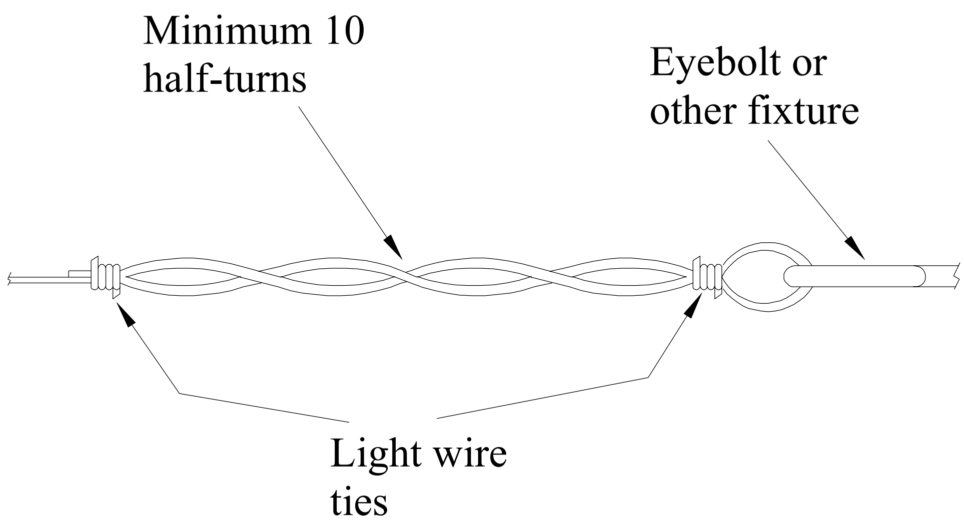

Figure 3: Details of a "twist-and-tie" connection.

The foot valve is shown in Fig. 4. It is similar in many ways to the piston, using similar hardware and plastic discs and flapper valves. One difference between the piston and foot valve is that certain joints must be sealed with adhesive to prevent leakage in the foot valve.

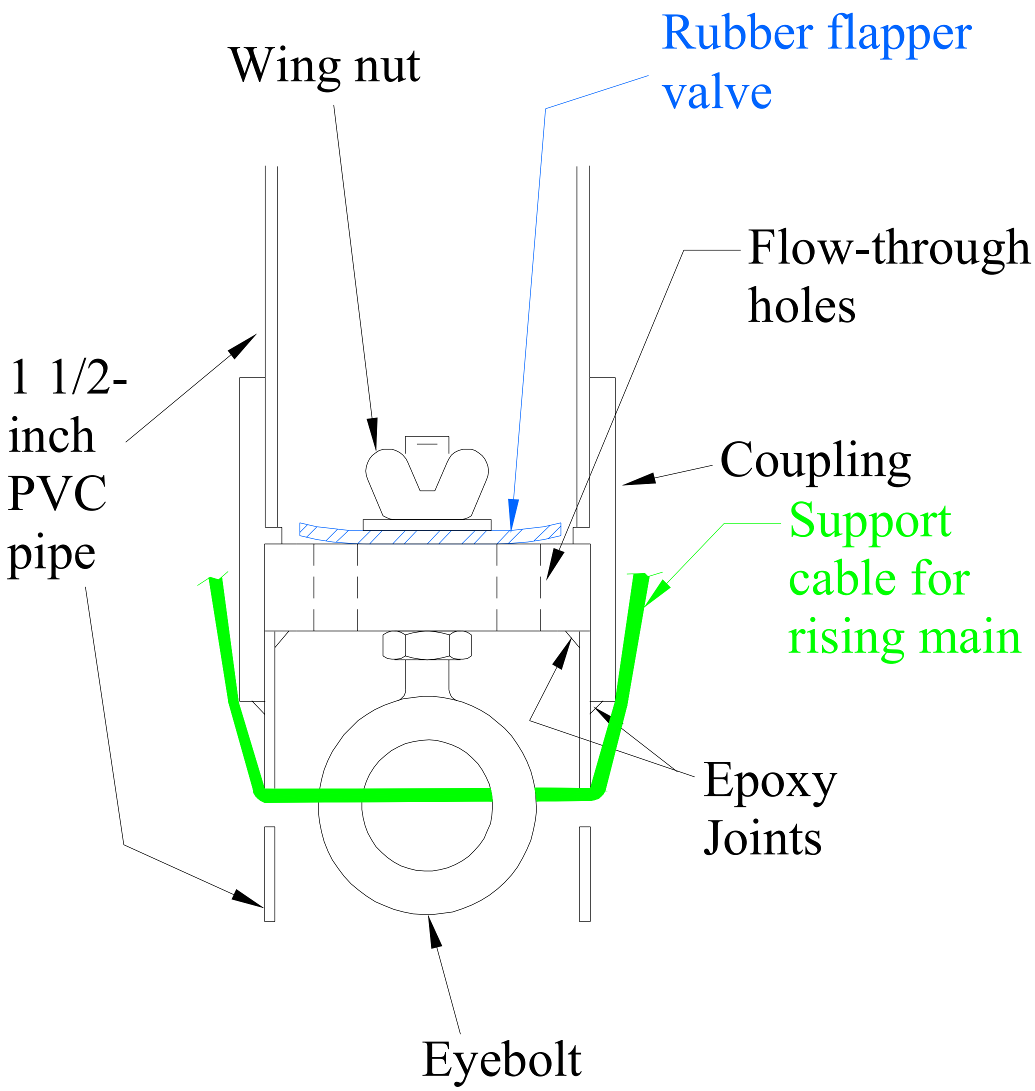

Figure 4: Details of the foot valve.