

Hand Powered Water Pumps

Bush Pump

Keith Hendrick's Hand Pump

Rope and Washer Pump

Roundabout Pump

Rower Pump

Treadle Pump

Bush Pump, Zimbabwe Pump

Summary:

The Bush pump can be made locally with ease; the parts can be modified to what the local village carries. Over the years the bush pump has become the world's most robust and widely used locally made hand pump. "The Bush pump is built around a down-hole cylinder containing a piston. It is called a "positive displacement pump" because it displaces an amount of water equal to the distance the piston travels" ("Bush Handpumps for clean drinking water").

Pump Type:

Manual hand pump; can be used by anyone

Locations for Use:

In general, the bush pump is suitable for use in communities of up to 500 people so for large communities.

Pumping Depth:

Bush pumps can be used for depths up to 100 meters. Pumping ease is maintained by counter-balancing the weight of the water column by putting concrete or sand inside the hollow pump handle.

Amount Pumped Over a Period of Time:

For a 10 meter head it can pump about 1200 liters/hour, for a 20 meter head it can pump about 900 liters/hour. This also depends on the operator's strength and duration of pumping.

Benefits of the Bush Pump:

- Creates needed local jobs
- Low cost
- Ease of maintenance because it is locally built therefore it can be locally repaired
- Removable parts have minimal resale value (looting)

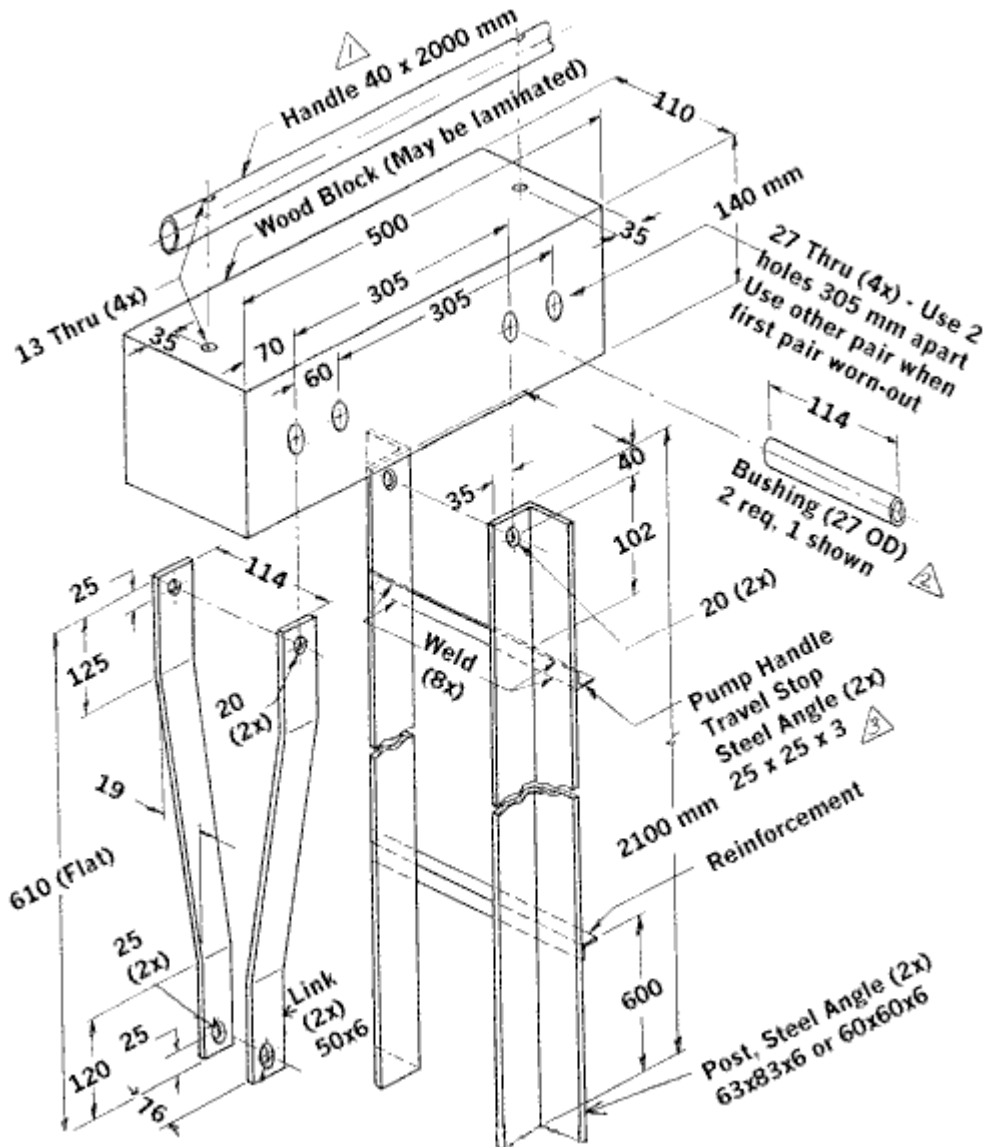
Tools:

- Thread Cutter
- Hack Saw
- Two Adjustable Wrenches or a set of Open-end Wrenches
- Cement working tools (trowels, shovels etc)
- Carpenters level
- Measuring Tape
- Blueprint

Instructions:

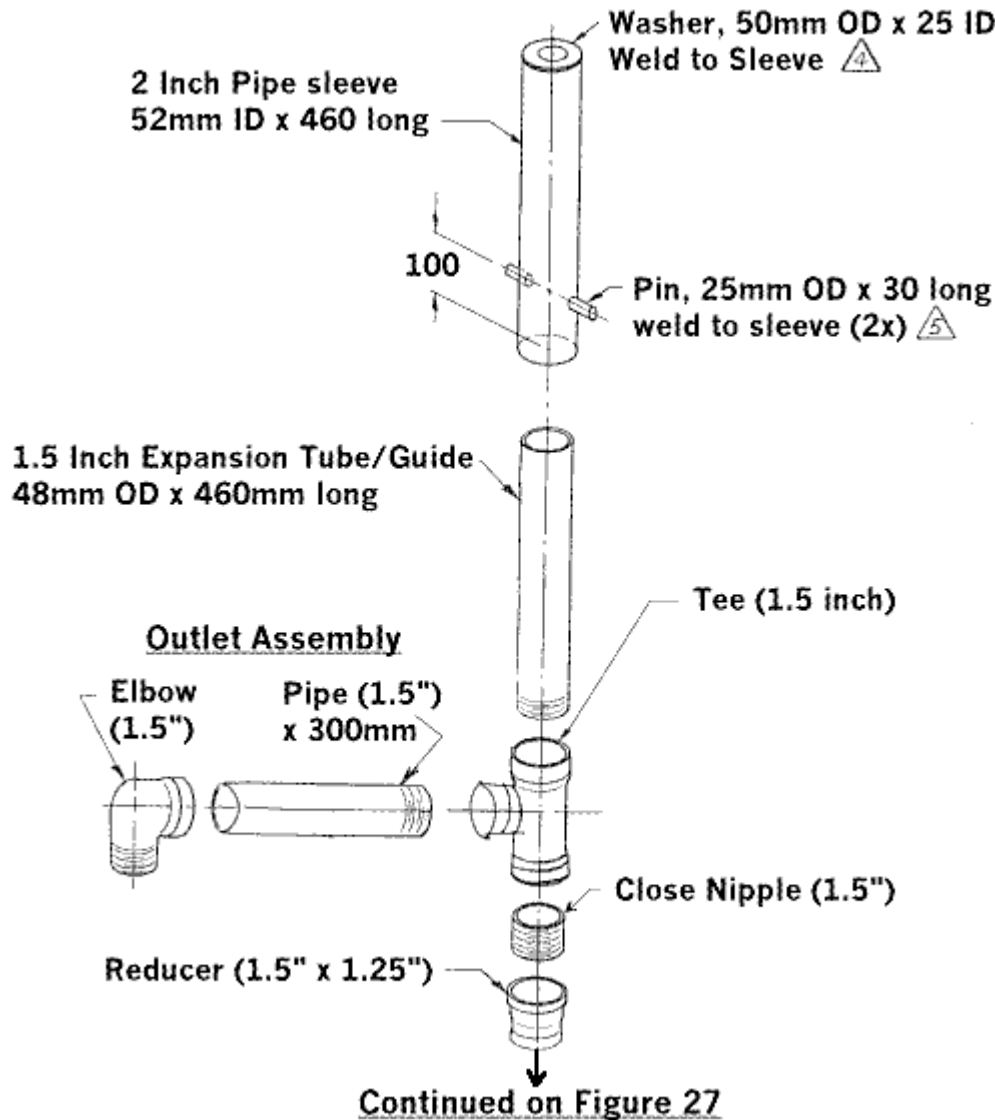
1. The main pump bearing is made of wood. It can be one solid wood block or can be made from three laminated pieces. The wood bearing works best if it is first soaked with oil
2. The handle may be made of wood, but a steel pipe is usually used for strength. Attach the handle to the wood block with 12 or 13 mm diameter bolts, 200 mm long ([see Item #1 on Figure 25](#)). Use large-area washer (45 OD x 13 ID) and lock washer (13 ID) between each nut and block.

Figure 25: Bush Pump Fabrication



3. The bushings should be 3-4 mm longer than the width of the block of wood ([see Item #2 on Figure 25](#)). This will allow bolts (20 mm dia, 150-165 mm long) to be completely tightened without the block being stuck tight between the steel pump supports. If the bushings are the correct length, the block will freely rotate up and down without significant sideways movement. Before assembling, soak the holes in the wood liberally with oil. Used engine oil may even be used. Use 20 mm ID lock-washers behind each nut
4. The aft handle bolt should hit the "pump handle travel stop" angle iron bar when the end of the handle is all the way down ([see Figure 25](#)).
5. Use one or two large-area washers (#1, 2 or 3 with 1/2 inch ID) on top of the 25 mm ID washer which is welded to the top of the pump sleeve ([see Item #4 on Figure 26](#)). Alternatively, instead of using a 50 mm OD x 25 ID washer, use steel plate (3 mm thick or more) cut to fit with a center hole the diameter of the pump rod. If the end of the 5 cm (2 in) pipe is threaded, screw-on a 5 cm (2 in) cap with a hole (diameter equal to the pump rod diameter) drilled in the center. When the pump rod is inserted through the top of the pump sleeve, secure it in place using two nuts, tightened against each other.

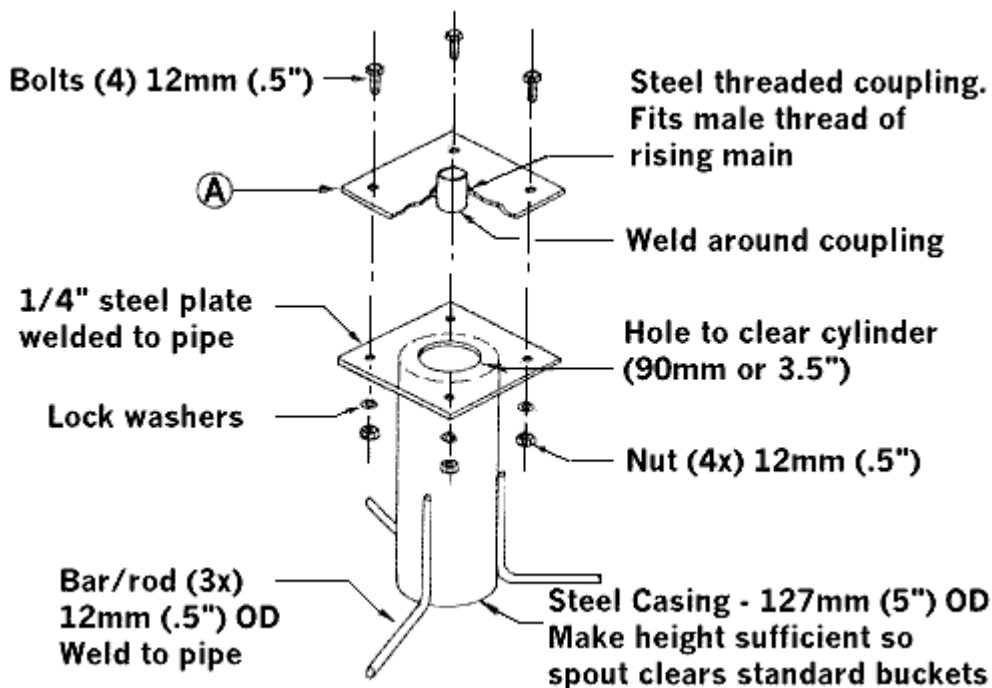
Figure 26: Bush Pump Outlet Assembly Detail



6. It is really important to line-up the two pins which are to be welded onto the pump sleeve ([see Item #5 on Figure 26](#)). This can be done by drilling a 2 cm (1 in) hole right through both walls of the pump sleeve, inserting a pin into the hole until it is flush with the inside of the pipe wall and then welding. An even better way to align the two pins is the make a "jig" using the two flat-bar links shown on figure 25. Attach the links to the wood bearing block and then lay the links on their long edge on a flat surface straddling the 5 cm (2 in) pipe. Make sure the pipe is parallel to the two links and raise the links 6 mm (1/4 in) so that the pins will be centered on the pipe wall. Insert the steel pins in the 2 cm (1 in) holes at the end of the links and position the pipe so that the pins will be located at the specified distance from the bottom end of the pipe. Tag-weld the pins, remove the links and finish welding. After the pins are attached to the pump sleeve, install 2 steel washers (50 mm OD x 25 mm ID x 3 mm thick), on each pin - one on each side of the flat bars which link the wooden bearing block to the pump sleeve (total of 4 washers required).
7. The outlet assembly should be supported on a reinforced casing base ([Figure 27](#)). Install the reinforced casing base as follows:
8. Place the steel base over the PVC casing before pouring the concrete pad. Allow concrete to dry 2-3 days.
9. After installing the cylinder and rising main, attach the rising main to the welded coupling in the casing base plate, position the plate on the base and secure with 4 bolts ([see item "A" on Figure 27](#))

10. Install outlet assembly (figure 26) to welded coupling (item A).

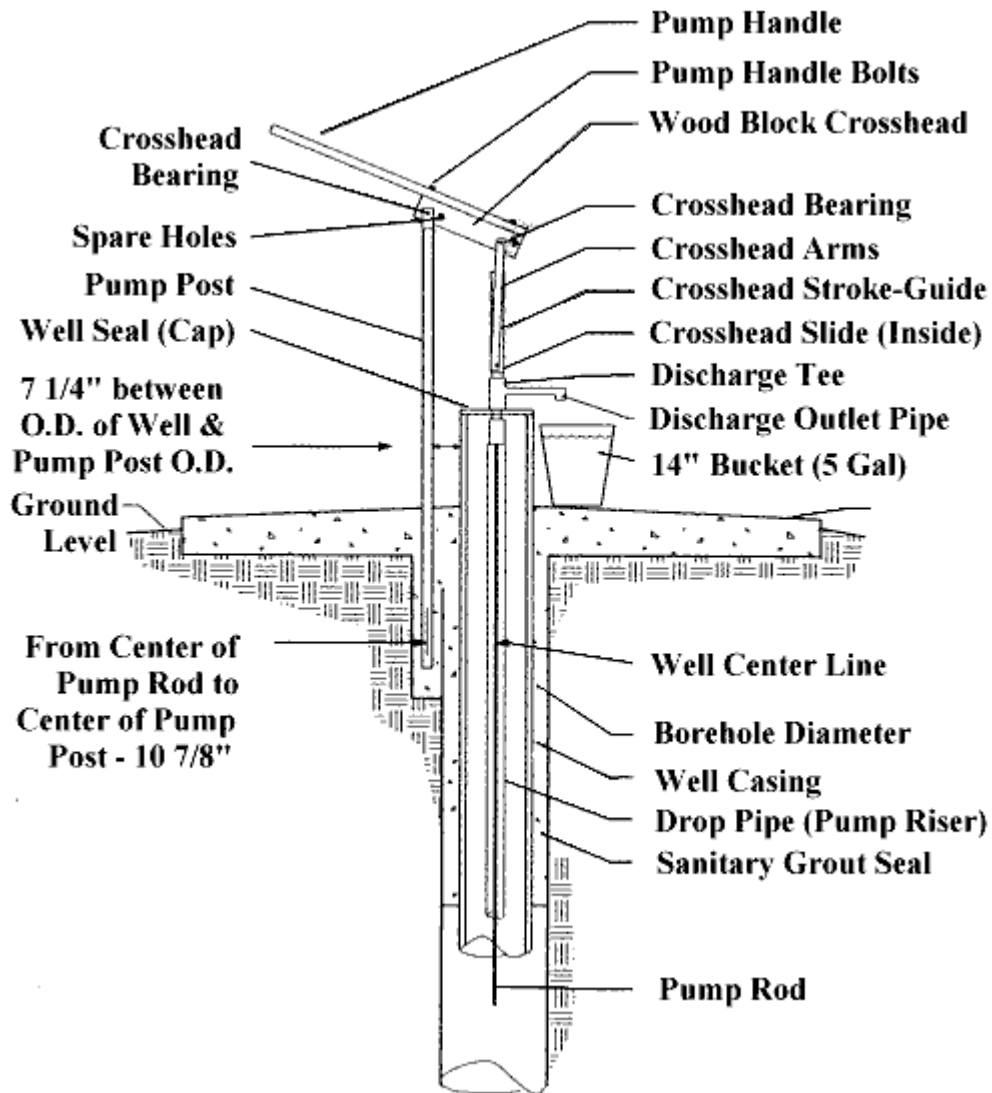
Figure 27: Bush pump casing reinforcement



Pump Post Installation: Installing the pump post and the casing reinforcement base is the hardest part of installing Bush pumps because these two parts must be precisely aligned to each other. To install the pump post:

1. Dig a hole (90 cm deep and 25 cm diameter) centered 30 cm from the middle of the casing reinforcement base.
2. Position pump post in hole (using braces & rocks) so that:
3. The bottom end is 85 cm (2.79 ft) below the projected surface of the finished pump pad, AND
4. The distance of the center of the fulcrum holes to the center of the casing is 30 - 31 cm, AND
5. The horizontal reinforcement angles face 90 degrees away from the casing, AND
6. The post is vertical in two directions 90 degrees from each other. Tolerance: leveling bubble not more than 1/8 bubble outside the markings.
7. Dig around the casing so that the pump base (Figure 27) will fit over the casing. Rest the base anchors on small rocks so that concrete can flow underneath them. The top of the base should be 16 inches above the finished pad surface (ensure that commonly used containers will clear the spout).
8. Pour concrete in the hole around the post and the pump base, leaving sufficient room at top to allow for the thickness of the pad.

Figure 17: Zimbabwe Hand Pumps Configuration





("Bush Hand Pumps for clean drinking water")

Keith Hendrick's Hand Pump

Summary:

The hand pump was designed, built and donated by Keith Hendricks who lives in Ohio. He made his easy-to-assemble pump available for anyone. Although this pump was intended for home use in America it will be very beneficial for those in Africa because of its low cost and ease of use. There are many in Africa who use water-wells to get their drinking water and to get the water from the wells they are still using the bucket and rope concept which can easily contaminate the water. The efficiency of getting the water with this hand pump will also help the people of Africa. ("How to get water from a drilled well when the power is off")

Pump Type:

Manual; can be pumped by anyone from water-wells, lakes, rivers and or ponds.

Locations for Use:

It is used for individuals and their families. It can be easily taken out and transported.

Pumping Depth:

It is suitable for up to 50 feet but works best at about 20 to 35 feet.

Amount Pumped Over Period of Time:

After it gets going, it takes about 1.5 minutes to pump a gallon of water but it depends on the speed of the operator.

Benefits of the Keith Hendrick's Hand Pump:

- creates needed local jobs
- low cost around 30 US dollars
- easy to transport
- simple to make

Material:

PVC solvent
PVC glue
Rags
Pipe tape or compound
Drill
Drill bits for weep hole
Eye hook hole
Sleeve bolt holes
Crescent wrenches
Pipe wrenches
Allen wrench for well caps

These parts are for this model only. You can vary the parts and adapters. The only thing necessary for a working pump is a foot valve, a weep hole (cold climates), a stiff hollow shaft above the foot valve and a hose or side pipe discharge for the water as it comes out.

Instructions:

The 1-1/2" interior diameter PVC guide sleeve should have a cap glued on the bottom end and 1/2" holes drilled through the bottom pipe section above the end cap. The holes allow water to flow freely into the 1-1/2" interior diameter sleeve when it is submerged into water. The sleeve separates the hand pump from feed lines, wiring or submersible pumps so they do not rub during pumping. It also keeps the water clearer by keeping the hand pump off the bottom of the well. The guide sleeve can be bolted

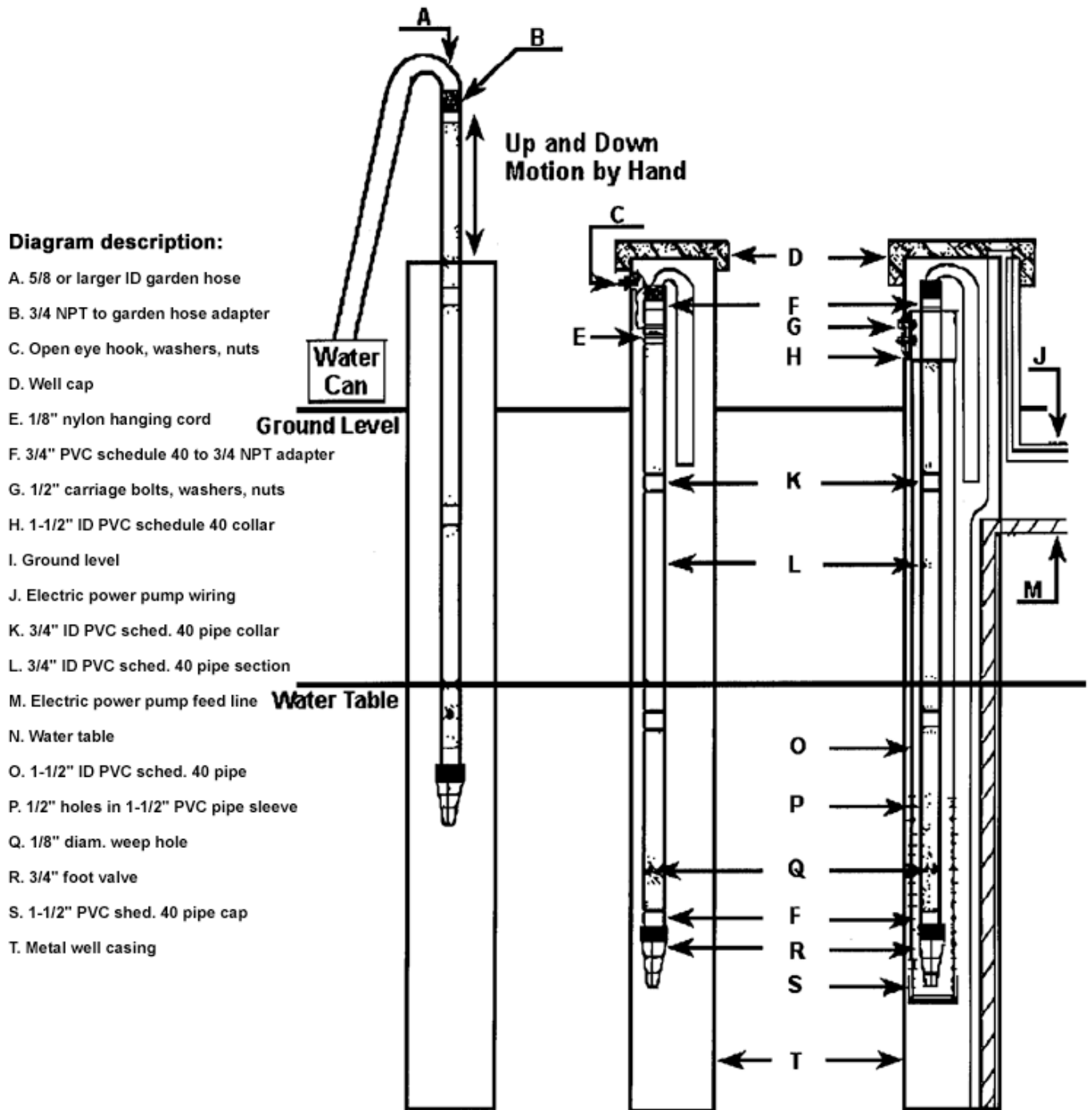
to the above ground well casing area with 1/2" carriage bolts and nuts. Be sure to seal the bolt holes with rubber washers or caulking. The guide sleeve and pump should extend down below the water table. As the foot valve of the pump is pushed down below the water table, the water flows up through the foot valve and into the pump shaft above it. The valve is open on the down stroke and closed on the up stroke. Repeated pumping motion shoves the water up the pipe and out the hose by a hydraulic ram effect. The water flows out the hose on the down stroke only.

Pump length is based on well depth and the water table height in it. The pump should be long enough to stay submerged in at least 3' - 5' of water so the pump remains in the water during the pumping motion cycle. Remember that water tables may change with seasonal conditions.

You must disinfect your hands before using the well. Keep all the pump parts off the ground and disinfect them before placing them in the well. Sick persons must not have any contact with the well area, pump or water containers. Leaving the pump in the well and keeping the well cap on when not in use will help keep the well sanitary.

A plunger action check valve can be used but you should put a 1/8" screen over the intake end and secure it with a ring clamp to help keep any well debris out of the valve. Foot and check valves have a closure spring which may need to be trimmed down or removed to get the best flow rate from pressures generated by hand pumping.

The weep hole is about 1/8" diameter. It should be drilled through one side of the pump shaft above the foot valve but a good distance below the frost line in your area. This allows the water in the pump shaft to slowly drain back down into the well when the pumping stops. This helps keep the well from freezing in cold weather off-the-shelf foot valve and some PVC pipe and fittings. The only tool needed was a saw, to cut one section of pipe to length. (The water level in the well was at 20 feet. We made the total length of the pipe, including foot valve and fittings, about three feet longer, so the foot valve would be under water and there would still be a foot or so of pipe above the top of the well casing.) We uncapped the well and inserted the pipe and foot valve. It went past the electric pump with room to spare.





Rope and Washer Pump

Summary:

The design of the Rope and Washer Pump has evolved over time to fit each location of use. This pump has been successful in places such as Tanzania, Zambia and Zimbabwe. The pump is cheap and easy to make and can be operated, maintained and repaired on a very small scale. In addition, the materials needed for manufacture are widely available at market places in most parts of the world.

Cost by Piece for Pump:

The pump, in total, can cost between \$30.00 and \$50.00 USD depending on what part of the world it is purchased in. However, the pump can actually be made from existing scrap materials such as an old tire and old pipe that has been discarded. The rope, if not available from scrap materials will need to be purchased. The amount for the rope varies depending on locality. The pump is generally manufactured locally and operation and maintenance for the pumps are low in comparison with other low cost hand pumps.

Pump Type:

Manual, hand operated

Locations for Use:

Water can be pumped from sources such as a dug well, river, perennial pocket at different land contours. The Rope and Washer Pump is capable of lifting relatively large volumes of water from a water hole or well to its own height but no higher.

Pumping Depth:

The Rope and Washer Pump can pump water from 20 meters in depth.

Amount Pumped Over Period of Time:

“The water output rate for an adult at a 20 meter depth is 20 liter per minute. An output of 1 liter per second at 5 meters can be sustained, enough to irrigate 1/4 hectare if pumped 20 hours a week.”

Benefits of the Rope and Washer Pump:

- Low cost
- Can be made from parts that are made and available locally
- Can be constructed from scrap and discarded materials so in some cases cost is next to nothing
- Enables farmers to increase productivity of their farming and crops
- Creates self-sufficiency of the farmer and family which leads to increased self-esteem and respect
- Easy to use
- Easy to repair
- Low maintenance
- Easy to build
- Produces a substantial amount of water with minimal effort

Instructions:

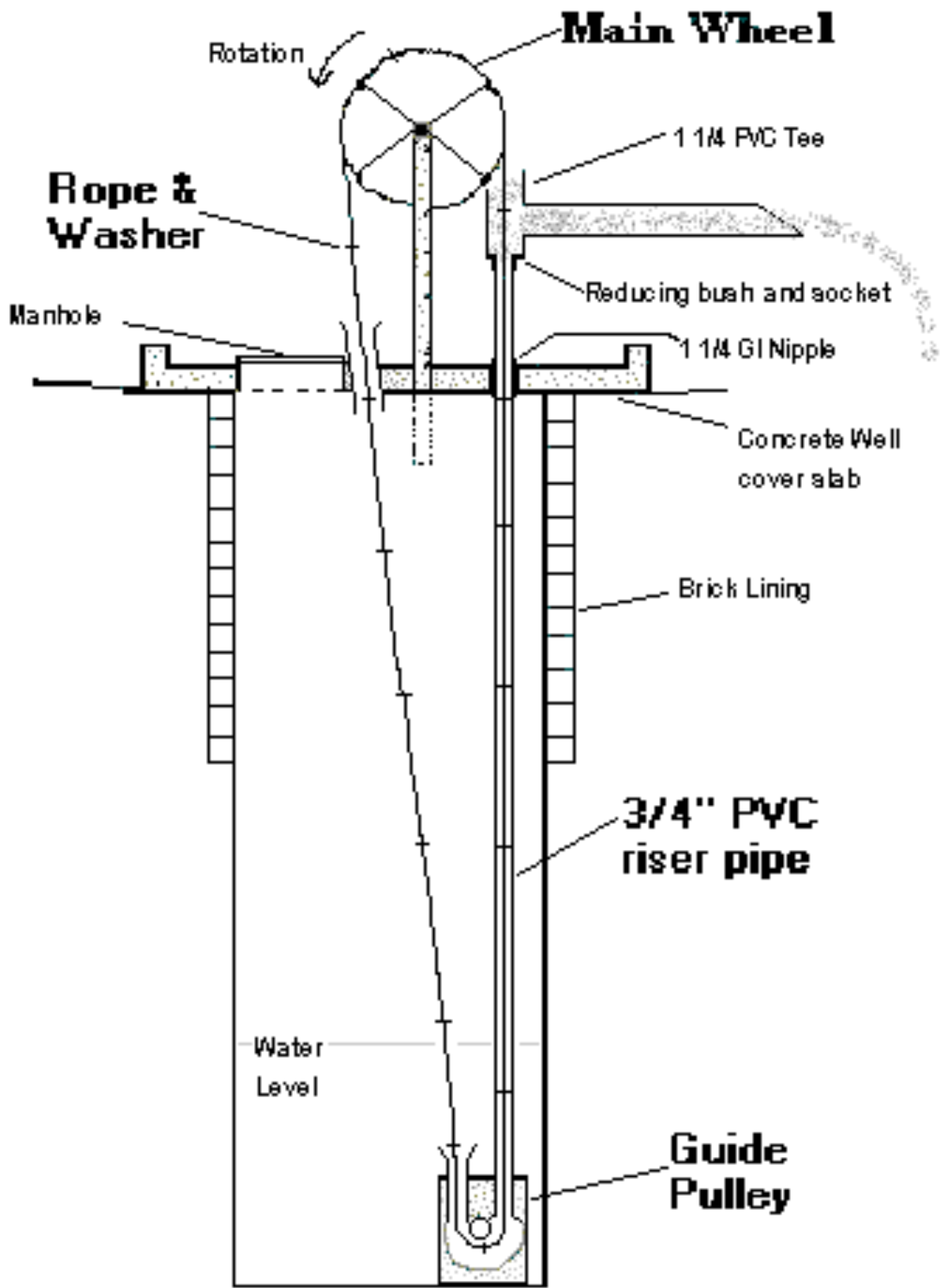
The washers are an exact fit with the riser pipe and force water up towards the surface. A rope is pulled up through a pipe by means of a pulley wheel which can be as simple as an old tire. Fixed to the rope are flexible rubber washers which can also be cut from a tire whose diameter is slightly less than the internal diameter of the pipe. This creates a tight fit which creates a vacuum that will draw the water up. Tight fitting washers also prevent water from seeping by down at other points of the pump. As the washers are pulled up through the pipe water is drawn up and discharged at the top. The rope and washers make there way around the pulley as it is turned, which causes the washers to produce suction inside the pipe. This in turn pulls the water upward toward the spicket.

(Step by step instructions are to follow. The manual by Robert Lambert has been purchased and am awaiting delivery)

Inter-changeable Parts with Parts from other Types of Pumps:

Due to the simple design, the pump can be constructed by the users themselves from spare parts. An old tire can be used as the pulley and the washers can be made from an old tire. The pipes can be found from other retired equipment or even made from hollowed tree trunks, bamboo, or reeds as long as they have a thick enough diameter to carry the water supply that makes the pump efficient when used. Parts from the treadle pump and any other pump that uses a rope and pulley system can be interchanged with parts from the rope and washer pump.





CROSS SECTION VIEW of Well

Roundabout Water Pump

Cost:

\$7,000 USD

Justification of Cost:

1. The idea is so well received and the pump is so effective that U.S. donors are willing to subsidize the cost of the pumps. For example, in 2006 at the Clinton Global Initiative, First Lady Laura Bush announced a \$16.4 million public-private partnership to install more PlayPumps. This was the beginning of an effort to install 4,000 pumps to provide water to up to 10 million people in Africa by 2010. The announcement includes \$10 million from the U.S. government, \$5 million from the Case Foundation, and \$1.4 million from The MCJ Foundation.
2. The cost to maintain the pump is minimal due to the pump having only two working parts.
3. The pump is used to generate funds that are funneled into maintaining the pump. The sides of the pump are used as billboards that are rented by advertisers. The money received from that pays local people to maintain the pump and also covers the cost of parts.
4. The money raised by advertising can also go toward paying back a lender of money for the pump or to purchasing additional pumps.

Pump Type:

Manual; generally used by children as a merry go round.

How Effective is the Roundabout Pump for Producing Water?

The pump is much more efficient than a traditional hand pump and can move up to 1400 liters of water per hour, depending on the depth of the borehole. This means that the storage tank can be filled in just two to three hours. After this, it can be topped up as necessary. If more water is pumped up when the tank is full, it is diverted back to the borehole so that none is wasted. As both the tank and the pumping system are sealed units, the water supply is protected from the risk of contamination.

Benefits of the Roundabout Pump:

1. The play pump runs on energy created by children playing – free, fun, productive and environmentally safe.
2. The play pump allows children to spend their time in school instead of collecting water from the rivers. As water collecting is typically a woman's job the pump allows for more educational gender equality. In addition, the roundabout is usually the only piece of play equipment the schools or villages own.
3. Local families can collect water by turning a tap instead of having to spend time pumping it up from the borehole. This leaves women more time to earn money, and their children more time for education.
4. Contamination of the water is avoided because the tank and pump are sealed units.
5. The drive mechanism is strong and there are so few moving parts that they do not break often. The pumps can be maintained by local people.
6. Money generated by advertisements on the side of the water tank is used to train local people and keep the equipment working well.
7. The advertising is also used to raise awareness of HIV and AIDS, and is set to play a part in wider community action programs to prevent the spread of disease.
8. PlayPump International has enlisted the work of Outdoor Fabrication and Steelworks, a local South African company in Johannesburg, to manufacture the pumps.
9. Roundabout Outdoor is the South African company contracted to hire and train local villagers on how to construct and maintain the pump. This provides the village with useful and tradable knowledge that will help in sustainability.

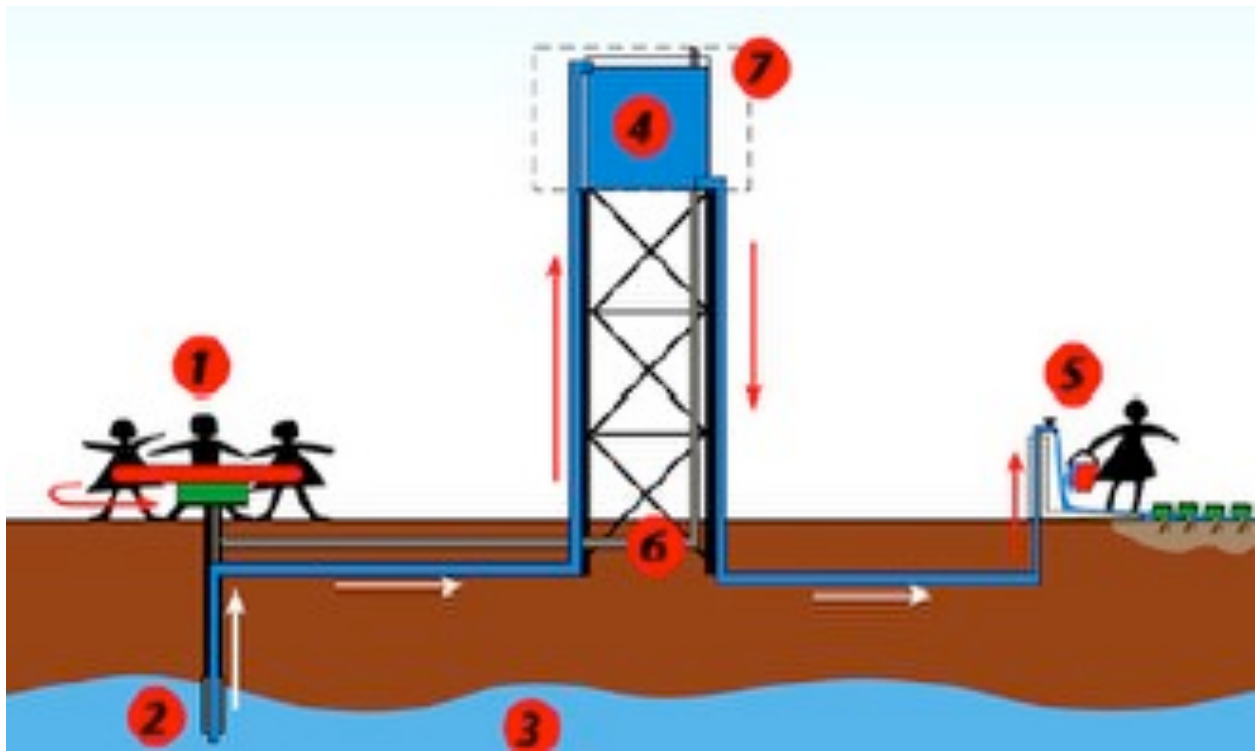
How the Roundabout Pump Works:

Kids spin the large wheel which causes the water to be pumped. A drive mechanism below the roundabout is used to power a displacement cylinder that pumps water up the borehole to the storage tank. It is designed to be a conventional borehole pump and is powered by a tool that entertains children. The revolutionary pump design converts rotational movement to reciprocating linear movement by a driving mechanism consisting of only two working parts.

How to Get a PlayPump in Your Community:

- When PlayPumps goes into a new country, they must first conduct a full scale assessment of the needs and capabilities of the area. Once the country has been approved a pilot program is launched including the installation of 100 pumps in a 150km radius. They are currently in South Africa, Mozambique, Swaziland, Zambia, Kenya, Lesotho, Malawi, Tanzania, and Uganda. The plan is to be in Ethiopia by 2009. In order to ensure all around consistent assistance to the 10 previously designated countries, PlayPumps will not be taking on any new countries until pumps have been established in all.
- If one would like to suggest a village in a pre-designated country, or another after target countries are met, they are welcome to contact PlayPumps at info@PlayPumps.org with the following information:
 - Village Name
 - District/Province/Region Name
 - Size of the community
 - Current water source for the community
 - Do boreholes exist in the community and if so where
 - Any other organizations working in the area
 - Name and contact information of someone in the community





The Rower Pump

Summary:

The action required for using the rower pump is a push and pull handle that pumps the water through a tube into the container above ground.

Cost:

\$15-\$30 USD

Pump Type:

Manual; two handed

Locations for Use:

The design of the rower pump is ideal for uphill pumping and can be used in lakes, rivers, streams, wells, etc.

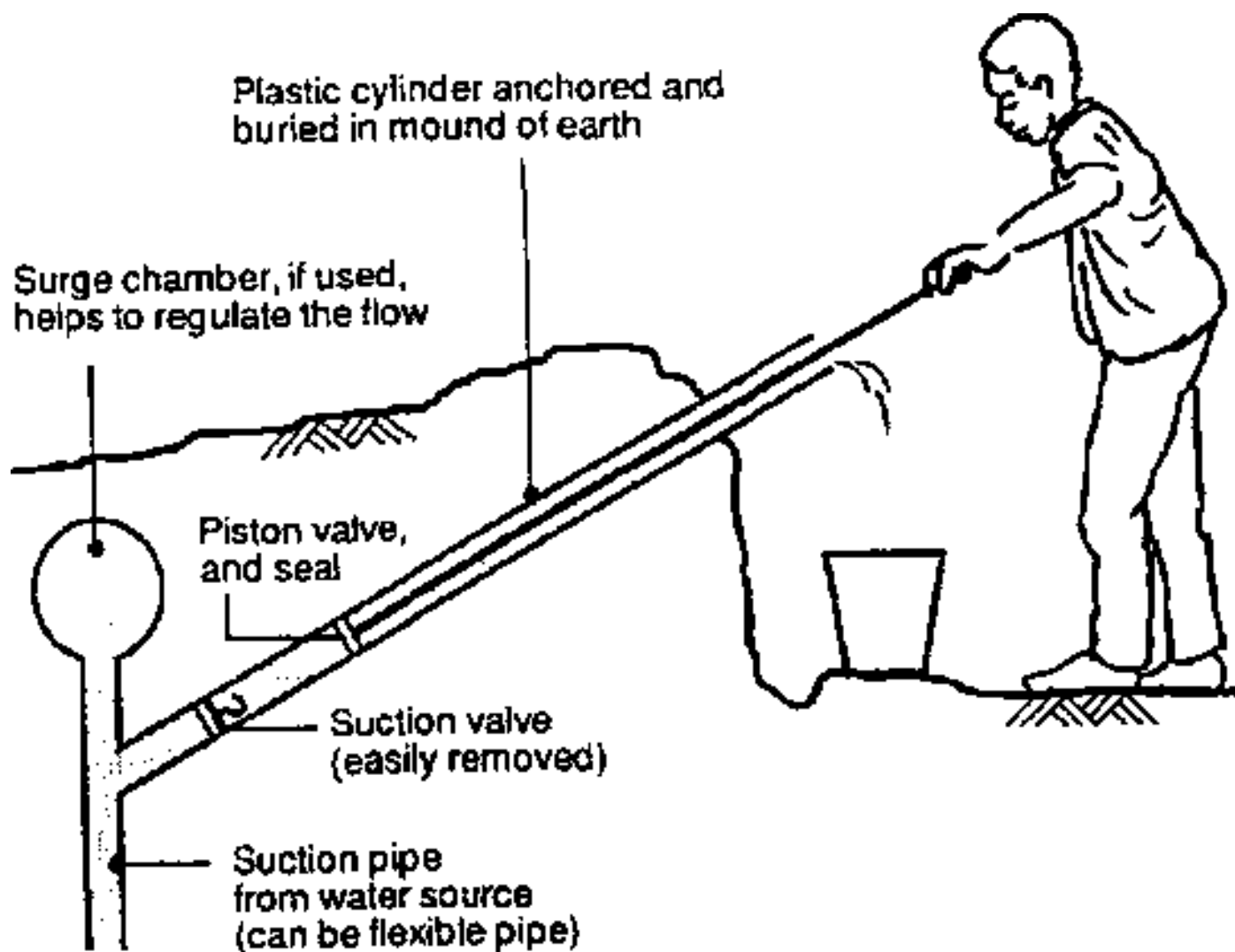
Pumping Depth:

Can lift water from depths of 7 meters.

Amount Pumped Over Period of Time:

The Rower Pump can produce 27 liters per minute.





As with the previous pump how to instructions are still to come and will be included in the final draft.

I have found a group that creates these pumps and holds workshops to show people or other groups how to make them. They will also sell them at a low cost. This group could be essential in an effort to distribute pumps to villages in Africa. Taken from their website:

SWS can either sell complete pumps or help you set up assembly workshops if there is sufficient demand. SWS Filtration also has a charity account which allows us to give some pumps and water filtration equipment free of charge to bona fide development projects. Funding for this account is limited but we would be very pleased to help you if we can. Alternatively, if you would like to support this work, your donations would be gratefully appreciated by those we are seeking to help.

The link is provided below:

<http://dSPACE.dial.pipex.com/swsfilt/index.htm>

Treadle Pump

Summary:

Human pumper stands on the pump holding on to handle. User is generally elevated a few feet above ground and will step down and up similar to the use of a stair master. Pump hose will be located below ground and will pump water into bucket or other water storage container.

Cost:

\$50-120 USD

Justification of Cost:

The inherently low cost of the Treadle Pump allows many the ability to obtain and maintain the pump.

Pump Type:

Manual: Nontraditional manual pump powered by the stair stepping motion of human pumper.

Locations for Use:

The Treadle Pump is ideal for pumping water from wells. Its vertical design is not very conducive to pumping water from rivers or lakes. It is however extremely suitable for varying environmental locations.

Pumping Depth:

The Treadle Pump can pump effectively up to 7 meters in depth.

Amount Pumped Over Period of Time:

The treadle pump is highly effective in producing water relative to other small scale pumps. It can produce in the range of 0.6 to 0.8 l/sec with a lift of 4.5 m, This pump can easily pump 15 gallons per minute in moderately low elevations and less in higher elevations, though the pump still remains effective at these altitudes. When compared with other single manned, human operated pumps the treadle pump is comparatively better.

Benefits of the Treadle Pump:

Households or farmers who use the treadle pump are able to obtain it cheaply without incurring serious debt which may hinder them financially for a long period of time. The pump has been shown to effectively increase the output of farm production which allows farmers to make a higher income and in turn reduces poverty levels with widespread use. The use of the legs in pumping action decreases human energy and time use while at the same time a higher level of water is obtained. Generally the women in the community are given the task of water collection and must use primitive methods while expending much effort and time. With a more effective pump women can spend this time at home nurturing and teaching their children. Several organizations have utilized this pump in their efforts toward a better Africa. The treadle pump is currently being used in several African countries, mainly Nigeria, and has proven effective for these very same reasons.

Materials:

Wood:

- ½ Sheet (4' x 4') 1/2" exterior grade plywood
- 3 2" x 4" x 8'
- 1 2" x 6" x 6'

Hardware:

- xx 3/8" galvanized steel rod, enough for two 18" long rods and one 5" long rod
- xx 1/4" all thread rod, enough for eight 6" long pieces
- 8 1/4" flat washers

- 8 1/4" nuts
- 8 1/4" "T" nuts
- xx 3/8" all thread rod, enough for two 10" long pieces
- 2 3/8" joiner nuts
- 2 1/4" x 4" eyebolts with hardware (nut and washer)
- 2 1/4" x 2" eyebolts with hardware (nut and washer)
- 2 3/8" x 4" eyebolts
- 10 3/8" flat washers
- 4 3/8" locknuts
- 4ft 1/8" x 1" flat steel
- 4 3/16" x 3/4" cotter pins
- 10ft 1/8" galvanized steel cable
- 2 1/8" cable clamp
- 2 3" diameter garage door pulleys, with hanger strap

Plumbing:

- xx 4" Schedule 40 PVC pipe (two 10" sections and two 5" sections required)
- 2 4" PVC pipe caps
- 2ft 1 1/4" PVC pipe (enough for some small spacers and a strainer)
- 4 1 1/4" PVC solvent union
- 4 3/4" MPT x 3/4" MPT x 1" PVC pipe nipples
- 8 1 1/4" solvent to 3/4" FPT PVC reducers
- 4 3/4" MPT to 1" metal or plastic hose barbs
- 2 1" metal or plastic hose barb tees
- 1 4" of automotive type heater hose
- 8 hose clamps sized to fit heater hose
- 4 7/8" Delrin balls**

Miscellaneous:

- xx Several feet of heavy (14 Ga. – 16 Ga.) galvanized wire
- xx Teflon thread tape
- xx PVC primer and solvent cement

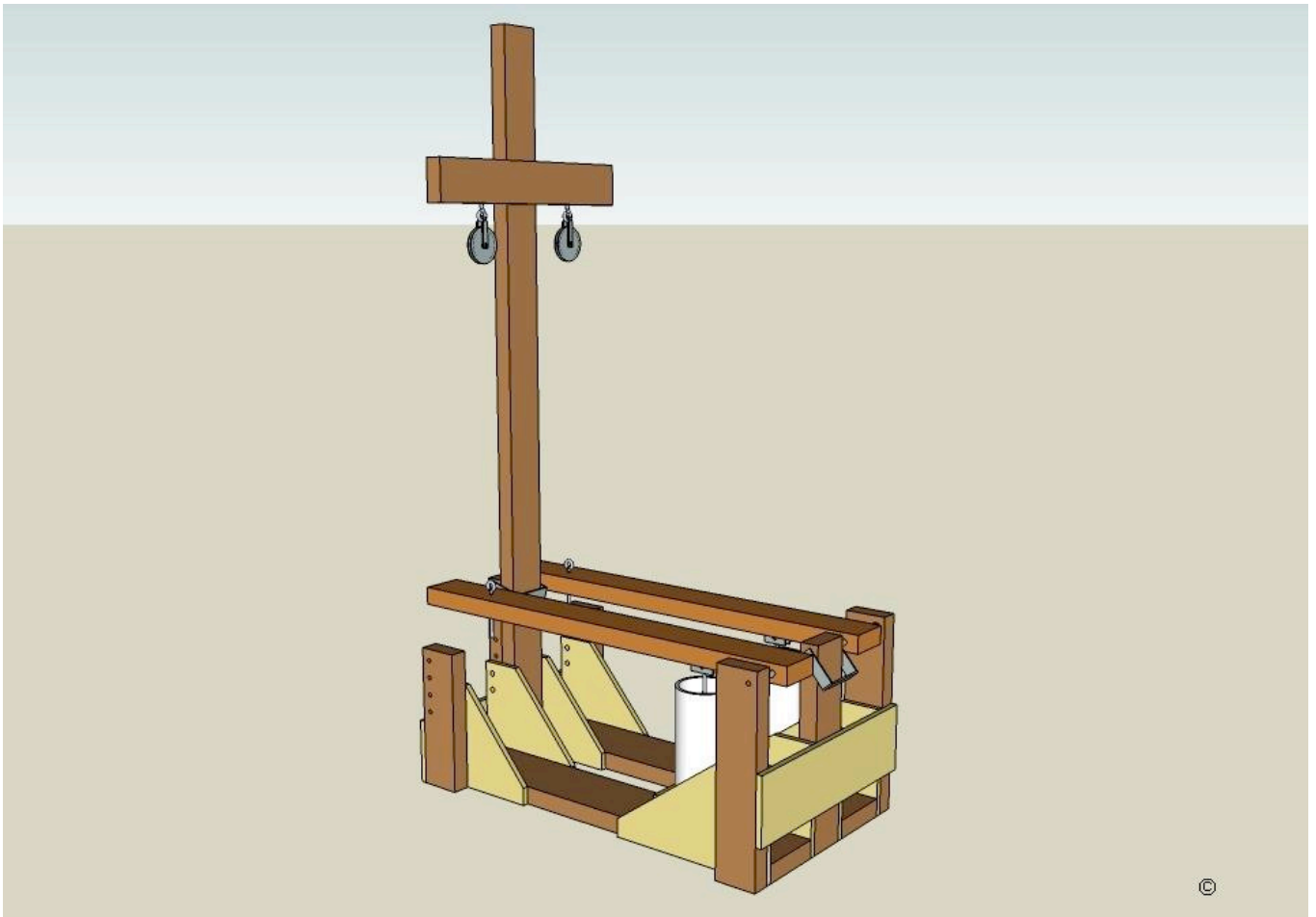
Instructions:

I am currently obtaining a book from which I can give the instructions necessary to manufacture this pump. Until this time (within 1 week) I will be able to list these instructions:

To see a video of a village child using the pump access this link:

<http://www.fao.org/NEWS/2001/010103-e.htm>





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