

How to make a Simple Rope Pump

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Introduction

Rope pumps and chain pumps, can be powered by hand, wind or animal power. They work best with shallow wells (ie. less than 6 metres) where the water is intended for irrigation. This is because it is difficult to make the pump to a hygiene standard suitable for drinking water.

The pump is constructed from an endless rope or chain which passes over a pulley, down into the well, and back up through a pipe. By securing washers to the rope or chain, water is drawn up the pipe. Obviously the pipe end must be below the water surface and the rope (or chain) and its attached washers must not touch the bottom of the well otherwise they would stir up mud. In practical terms, this means that there must be a water depth of at least half a metre at the bottom of the well.

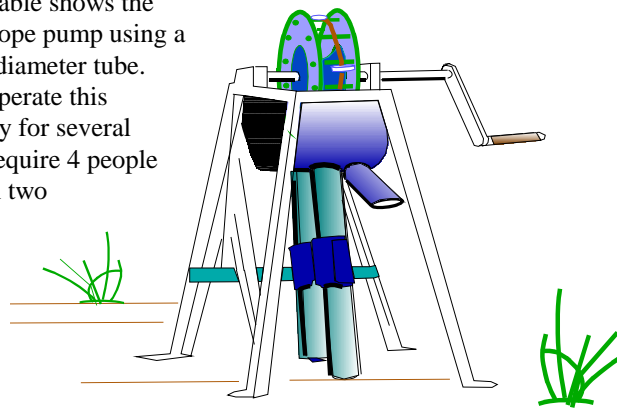
There are several commercial models of this sort of pump available (see illustration)

For a school or university project, a commercial pump is expensive and cannot be modified by the students: This Project Outline describes a low-cost Rope Pump which can be built by students and modified to meet local requirements. It can be used for small scale irrigation projects in the school or village environment.

The Rope Pump

The pump capacity and the power required to work the pump are proportional to the square of the diameter of the tube.

The attached table shows the capacity of a rope pump using a 10 cm (4 ins) diameter tube. However, to operate this pump manually for several hours would require 4 people to operate it in two shifts. This is equivalent to perhaps 0.5 kW.



Commercial Chain Pump

Tools & Materials needed

- 1) Welding and brazing equipment;
- 2) Metal cutting equipment;
- 3) Woodworking tools;
- 4) Plastic or steel pipe:
 - 10 cm (4 ins) outside diameter, length as needed;
 - *5 cm (2 ins) outside diameter, length as needed;
- 5) Nylon or polyester rope about 8 mm in diameter, length as needed;
- 6) *Steel sheet:

Lift	Quantity
6 m (18 ft)	11 m ³ /hr (2906 galls/hr)
3 m (9 ft)	20 m ³ /hr (5284 galls/hr)
1.5 -2 m (4.5 - 6 ft)	25-30 m ³ /hr (6605-7926 galls/hr)

- 3 mm (1/8 ins) thick;
- 6 mm (1/4 ins) thick;

7) Steel rod:

- 8 mm (5/16 ins) in diameter;
- *12.7 mm (1/2 ins) in diameter;

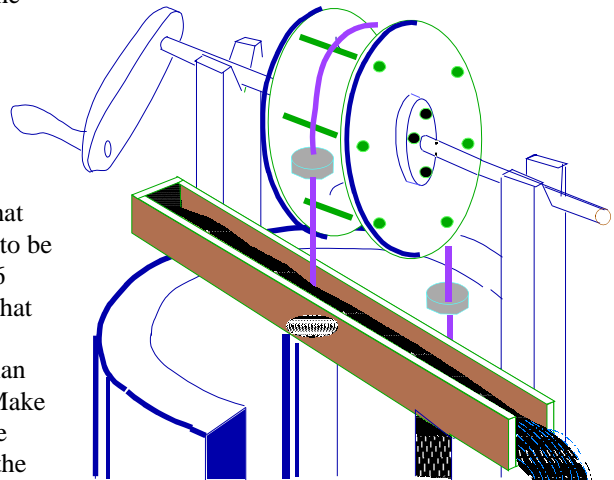
Note: A car wheel without a tyre and running on its own bearings makes a perfect pulley for this pump and replaces items listed above and marked with *);

- 8) Round plastic drinking-water bottles to make pistons;
- 9) The plastic caps to the water bottles to reinforce the thin plastic bottle pistons.

and a metal pipe can be used in place of the plastic pipe.

How to make the rope-pump

First make sure that the well which is to be used is less than 6 metres deep and that the water in the bottom is more than 50 cm in depth. Make sure that you have permission from the owners of the well to put the pump in place and point out that water from the pump will be best used for irrigation: Just because the pump is made from drinking-



water bottles does not purify the water it pumps!

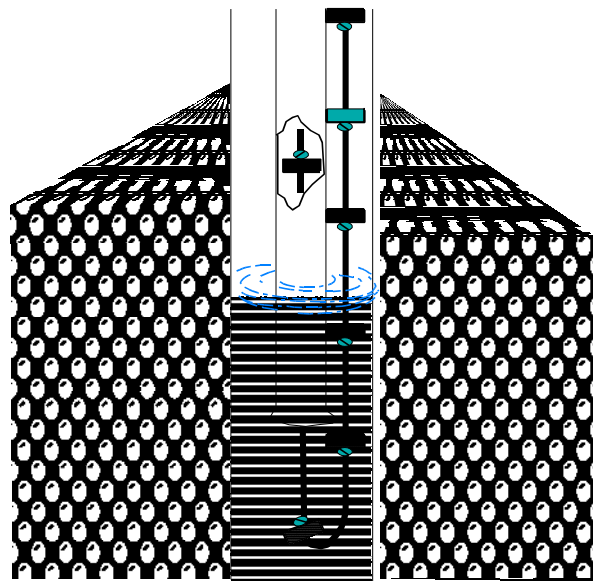
Assemble the various components:

Well depth	Bottles	Bottle-caps
2 m	20	40
3 m	28	56
4 m	36	72
5 m	44	88
6 m	52	104
7 m	60	120

* The rope should be about 8 mm in diameter and be twice as long as the well is deep. Add an allowance of up to 4 metres for the rope that goes round the pulley and runs below the water surface at the bottom of the well and to allow for the knots.

* The pistons will be placed at 20 cm spacing along the rope so you will need about 8 times the well depth (in metres) plus four (for the ends) bottles. (The attached table shows roughly how many bottles and bottle caps you will need).

A diagram of the finished rope pump is shown in the attached illustration. Essentially it is an endless rope with pistons on which pulls water up through a close-fitting pipe. A pulley at the top takes the weight of the pipe and its contents and makes it possible to move water to the top of the well. The large pipe should be about the same diameter as the plastic water bottle ends used as pistons. If this cannot be arranged, pistons made from leather or rubber washers can be used instead. Similarly a natural fibre rope can replace the synthetic one, a steel spool can be made to form the pulley



* Assemble the pulley and make sure that it is working. If you use a car wheel, weld twelve equally spaced rods as rungs across the rims. Alternatively, drill holes in the rims on a radius of 20 cm and 10 cm apart (for a 40 cm diameter wheel) and weld rods in the holes. This makes it possible to spin the wheel by hand without the use of a crank. If you do not use a car wheel, bend a simple crank-handle from the steel rod and weld it to two steel 40 cm diameter disks which have been cut from 6 mm thick sheet. The two disks should be about 20 cm apart and have steel rungs welded across the rims in the same way as the car wheel.

* Two hardwood blocks with "V" notches cut in them will act as bearings for the shaft although you might like to secure the shaft with blocks of wood or metal, or perhaps a strap across the top of the "V".

* A car-wheel has its own bearings so that all that is necessary is to cut two support plates from the steel sheet to hold the wheel across the well. Alternatively, the wheel can be supported with wood.

* The pistons are made from three parts:

1) The piston disk which is made from the bottom of a circular plastic drinking-water bottle. This should be cut to fit tightly inside the plastic pipe. (If you use a leather or rubber washer, perhaps with a larger diameter pipe, the washer should have an outside diameter about two thicknesses of the washer larger than the inside diameter of the pipe);

2) A reinforcing disk above the piston disk;

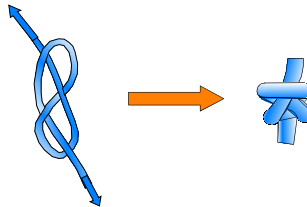
3) A support disk below the piston disk.

The plastic bottle caps can be used for both reinforcing disk and support disk. Their purpose is to spread the load and to stop the rope tearing through the thin plastic bottle. Extra

plastic disks cut from the end of water bottles or thick plastic sheet can also be used. Steel or aluminium disks are recommended for use with a large diameter pipe. For use with a leather or rubber pistons, they should have an outside diameter about two piston-washer thicknesses less than the pipe diameter.

Centre all three parts and clamp them together so that an 8 mm diameter hole can be drilled through the centre. The rope can then be threaded through and knotted on either side. A simple knot will do but a "stopping knot" of the form shown in the attached diagram is better.

* Remember that pistons should be placed about every 25 cm along the rope.



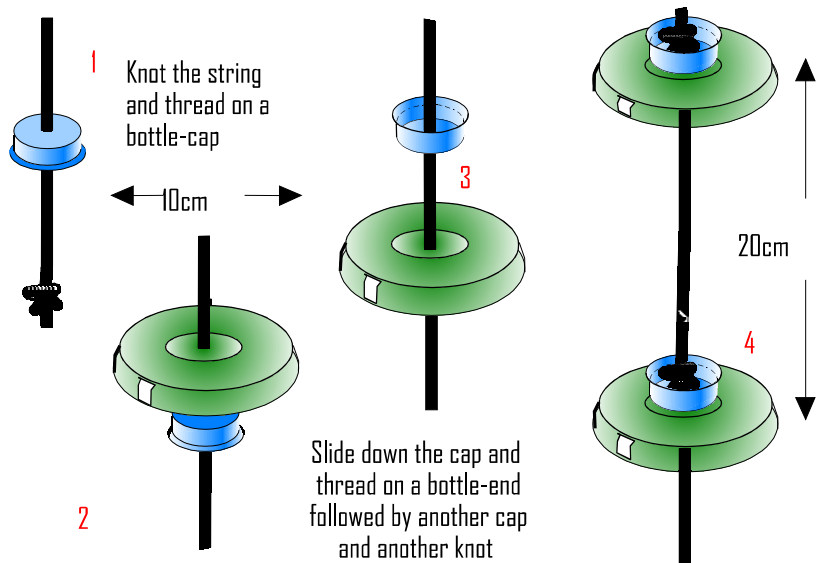
* A simple trough across the top of the well should be made from wood to fit across the well-head. This will need a hole equal to the

outside diameter of the pipe cut in the bottom and the pipe fitted to it. Plastic pipes usually have plastic flanges which can be glued or heat welded to the pipe: Steel pipes may be threaded and a flange plate bolted to the end. The flange should be 8 to 10 mm thick for a steel pipe.

Note that in this design, the full weight of the pipe is taken by the wooden trough so the flange should be on the upper surface of the base. (Hopefully the water will run so deep that the pipe will not need to end precisely on the base of the wooden trough!)

When all components have been made:

- * Assemble the pulley on the well-head.
- * Thread the rope and its pistons through the pipe so that the open ends of the plastic bottles (if used) point downwards. **This is not a bucket-pump!**
- * Lower the pipe into place so that the trough rests across the well-head.
- * Make sure that you keep the two ends of the rope at the well-head otherwise you will have to remove the pipe to recover them! (You can retain the ends by connecting them with string to the pulley support.)



- * Finally knot the rope ends together over the top of the pulley.

Now when the pulley is turned, water should be moved up the pipe and into the trough. The work required to lift water should get less as the surfaces wear. Eventually, as the piston disks wear out, the pistons becomes easy to move but must be moved faster to bring the same amount of water to the surface.

When this happens, make up a new rope with new pistons and join it to the old one to pull it through the pipe. Then cut out the old rope and knot the ends of the new one.

Sometimes the pistons are just too tight in the pipe. This puts a heavy load on the pulley and may damage the pistons themselves. Pouring some water back down the tube may help lubricate the pistons enough to get the pump started but you may also have to dismantle the pump and trim the pistons to a smaller diameter.

Acknowledgements and Further Reading

1) Molenaar, Aldert. *Water Lifting Devices for Irrigation*. Rome, Food and Agriculture Organisation, 1956.

2) VITA Technology Handbook, (1988):Volunteers in Technical Assistance, 1815 North Lynn Street, Suite 200 Arlington, Virginia 22209 USA

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