Screw This: A Study of a Simple Positive Displacement Pump

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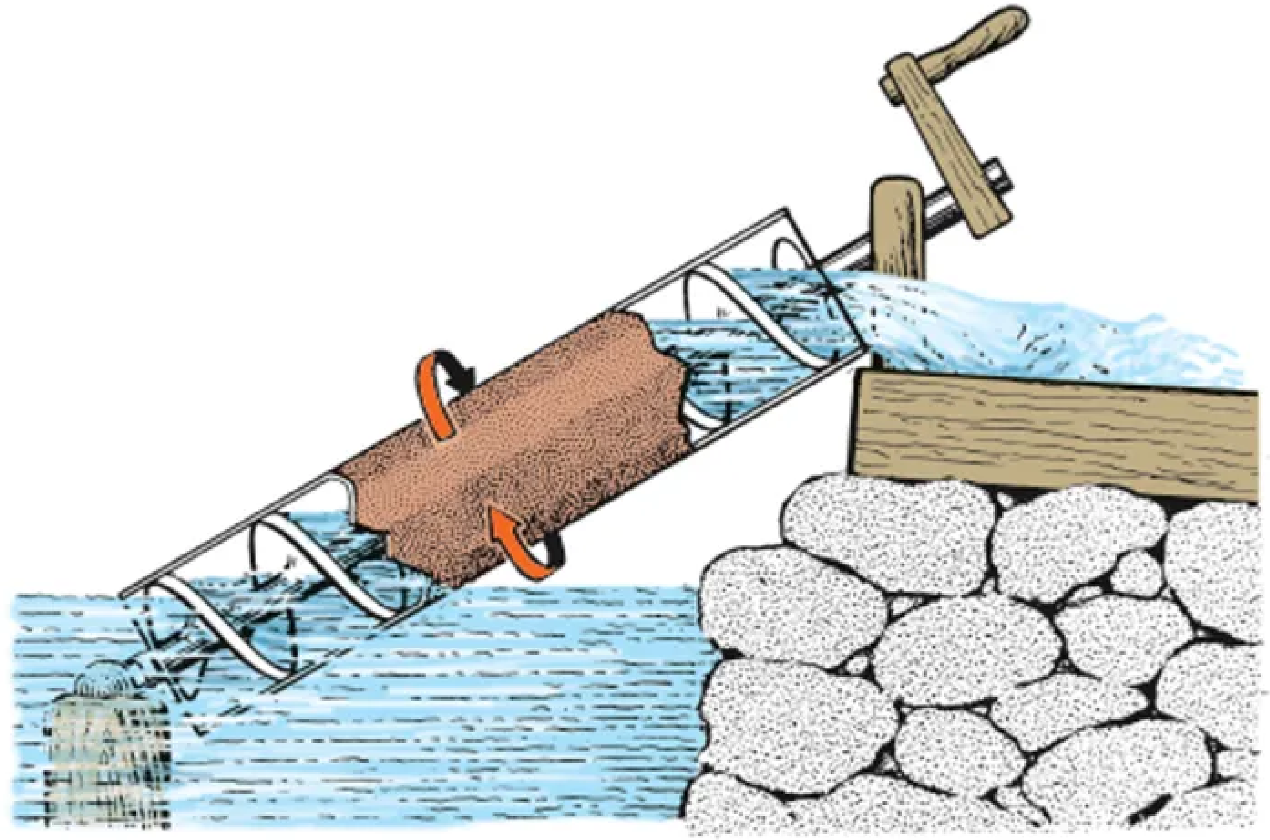

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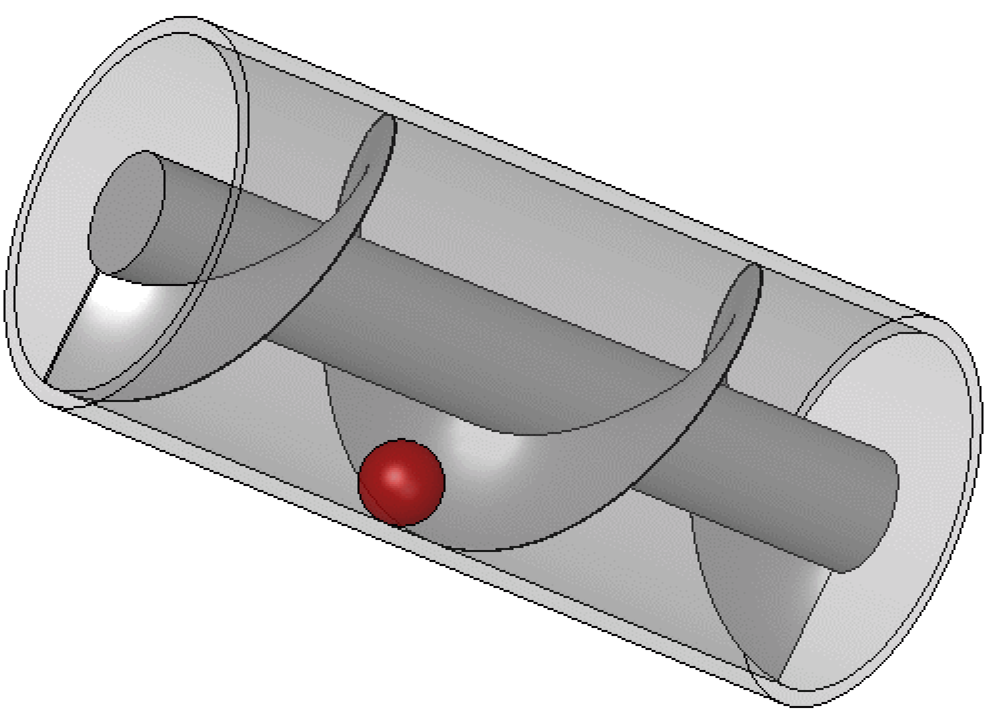

Purpose

The purpose of our project is to create a simple positive displacement pump. Positive displacement pumps like this are beneficial when water needs to be moved across an uphill distance and a relatively low incline. An example of this could be needing to move water from a river or a body of resting water over a valley so that a nearby town is able to access it. These pumps are especially appropriate for third-world countries. There is no need to dig underground to install plumbing to access water that way. It is also much cheaper than a pump that uses suction, because of the long distance that the water would need to travel. The pump can even be operated by a person, using a crank mechanism, then no electricity is required. This does lower the efficiency of the pump, but it does also raise its portability. Because, if the pump doesn't require any electricity to run, it can be used even in the most remote of locations. One other benefit of our pump is that it has no limit on the height that the water can reach. Even with a total vacuum a suction pump the water can only be lifted to a height of 34 feet because that is atmospheric pressure at sea level. Our pump has no such limits on the height it can be pumped to. Another benefit of our positive displacement pump is that once you rotate it enough times to get water to the top of the pipe, you will continue to get water with each rotation. So once it is "loaded" it takes a minimal amount of time and effort to continue to transport the water. This means that if it was desired, it could be used as a well, where each rotation would bring water to the end of the pump. On a much larger scale, this could be used in villages where people need to walk long distances to get water from a river or lake, or other sources of water. Of course, one drawback is it would take quite a while to get the water to the end of the pump initially, but once the water got there, it would only take one rotation to get water to come out. If the diameter of the pipe, and of the external tubing was large enough, this could fill up a small bucket in just a few rotations, making it easier for people to get access to water. This pump would have to be on a much larger scale than the one that we have created, but after the materials were paid for, and it was assembled, it would require little maintenance, and cost almost nothing to operate and maintain. If constructed on a large scale, it does provide a real solution to a problem.

Background

A positive displacement pump works by trapping a small amount of water and forcing that water upward. It then traps another small amount of liquid and forces the two upward simultaneously. Once the process has been completed a few times, the pump is "full" and has many separate pockets that are all being forced upward at the same time. The principle started back in Greek times with the inventor Archimedes. He created something that became known as an Archimedes Screw. This consisted of a hollow metal tube, and inside of it was a screw in the shape of a double helix. The screw is fitted precisely so it just touches the inside edge of the pipe. The screw is then placed in water and rotated, while the pipe remains still. The rotating screw creates a pocket of water that is trapped and moved up the pipe. Our project works similarly to this, except it is a simpler, more cost-effective version. Our pump can be operated by hand, or by motor, but it is more effective when operated using electricity.

Procedure

The procedures for this project were mainly in assembling the pump. We tested different diameters of pipe including ¼ inch and ½ inch diameter pipe. We found that ¾ inch was the most effective because the circumference was the greatest, thus the tubing had the greatest length, so there was more space for water to be trapped in. Another thing that we changed was the diameter of the tubing. We initially tried a very small diameter of tubing, thinking that the smaller size would trap the water better because more of the water would be touching the tube, creating more friction, but we found that using a bigger diameter such as ½ or ⅜ inches worked better to capture more water since there was more volume for the water to occupy. Also, the opening of the tub could capture more water when it was submerged. So, after some testing, we found that the optimal pipe diameter was ¾ in and the optimal tube size was ⅝ in. Once we had found this, we set out to attach the motor to the pump. This turned out to be harder than we initially thought. The motor span so fast that it broke the seal created by the hot glue, and begin to spin on its own without the pump. The way that we solved this was by spinning the motor slower so that it would not break the seal that joined it to the pump. To slow it down we reduced the voltage on the power supply, which in turn made the motor spin slower.

Results

The project was not as efficient as we expected, however, the premise still works, and the properties theorized still apply. It is still a valid solution to a problem. One unexpected problem that came up was the motor span too fast, and the heat created by the friction melted the hot glue that held the motor in place. So we had to re-secure it with a mixture of super glue and hot glue. This helped to attach the motor to the cap which was fastened to the pipe and made it rotate. Since the motor was spinning very fast, that's meant that the pump itself was also spinning quite fast, and the centripetal force was pushing it out of the pump, so we had to slow it down so it could operate successfully.

Materials

¼ inch diameter PVC pipe

¾ inch diameter PVC pipe

⅛ inch diameter vinyl tubing

⅝ inch diameter vinyl tubing

¾ inch PVC pipe cap

Hot glue

12V power rotating motor

Power supply with voltage/ amperage control

Duct tape

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