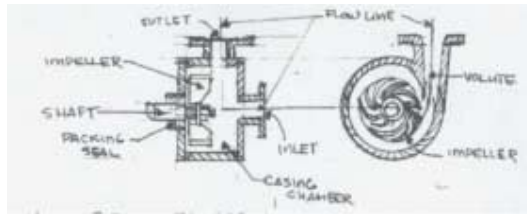


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The team-9 concept design describes a human powered water pump that can be used for irrogational purposes. This design will met all the following criteria: 1) it will vertically displace water a distance of eight feet; 2) it will be operated by one person at a time for a length of five minutes per person; 3) the pump will be operated by three different team members, one female and two males; 4) the cost of the prototype development and fabrication will not exceed \$125; 5) the assembly time for the pump and its components will be no more than 15 minutes, and the disassembly time will be not more than 10 minutes.

The team-9 concept design incorporates systems for drawing water from a holding tank and delivering that water to the required destination, in this case 8 feet to another holding tank.



First, the type of pump will be discussed. This group has decided to proceed with a centrifugal pump. The centrifugal pump is a pump that incorporates rotary motion and energy to propel a liquid with great force and volume. (Figure 1, above) Water is supplied to the pump near its axis of rotation. Then the water is caught and channeled by vanes on the impeller of the pump to the outside of the pump where it is flung out of the pump casing. This process creates a vacuum that draws additional water to replace the leaving water. This provides for a constant flow of water out of the pump. This particular pump was chosen because of its simplicity to adapt to different drive systems as well as its high output. We determined the pump output by performing the calculations outlined in the lecture of Ray Bryan. The following formula gives us the flow rate of the centrifugal pump: $Q = C_Q w D^3$ where Q is the flow rate in gallons per minute, C_Q is a given constant of 0.0625, w is the spin rate and D is the diameter of the pump, found to be .3 feet or about three and a half inches. Also, through other calculations it is found that wD or the product of spin rate and diameter is 37ftHp. Thus the equation can be rewritten $Q = (0.0625)(37)(.3)^2$. This gives us a flow rate of 0.21 ft³/sec or about 95 gallons per minute. This however is operating at one hundred percent efficiency. We have estimated that the pump, because of friction and other losses will operate at fifty percent efficiency and thus, at 0.4 horsepower, we will pump 45 to 50 gallons per minute. This flow rate will be more than adequate for the purpose of the pump.

The drive system that has been chosen is one that matches the rotational motion of the pump itself, (Figure 2, below) and also the effective use of leg power in a human powered pump. The system is comprised of a primary gear, about eight inches in diameter; the person in the seat to the left will power this. This gear is used to power a smaller gear, approximately 1.5 inches in diameter, which is directly connected to the

main impeller shaft of the pump. A standard bicycle chain will connect the two gears. Using this gearing system the pump shaft will turn at a rate of 5.3 times the speed of the primary gear. As long as the operator can pedal at an average rate of 2 to 3 cycles per second, we can produce between 650 and 950 rpm. This speed is needed in order to run the pump effectively. One great difficulty in the concept of this pump is that in order for a pump to run at such high rpm, the precision of the components is essential. Pieces that are not correctly machined run the risk of breaking under such high strain, rendering the pump useless. For this reason, we have decided to subcontract the job of manufacturing the pump itself. This will insure precision in the product and give it a good foundation on which to be built.

The pump design allows the user to operate the pump from a horizontal position. (Figure 2, below) By utilizing a simple movable seat and a steel pin the seat may adjusted to many different distances to accommodate those of varying heights. While this feature allows people to adjust seat depth for optimum performance, it also allows users to adjust the seat to close settings in order to utilize upper body strength to power the pump. This gives the pump great versatility in the field by having the ability to be powered both by legs and the upper body.

The water will be delivered to the pump via a 1-inch flexible rubber hose. This allows the pump to be used in varying venues and situations and also provides for an airtight seal between the hose and the pump through the use of a hose adapter. This pump will have to be primed prior to use for the centrifugal pump will not draw water unless the impeller is submerged in water. Therefore, the pump will be primed by pouring water down the inlet hose until the air is eliminated from the system, then the end of the hose will be capped and sealed until it is submerged in the water source.

Water leaving the pump housing will also pass through flexible tubing, again to ensure flexibility not only of the hose but also of the unit as a whole. In order to measure to flow as it leaves the hose, a simple float gauge will be utilized. As water leaves the hose, it will be released into a channel. Near the end of this channel will be a plastic float that will be attached to a pivot by a wire. On the other side of the pivot will be a calibrated scale, the flow rate can read as the float rises and falls by an indicator wire as it moves in front of the calibrated scale.

