

October 2, 2000

The Irrigator - Team 1 Design Concept

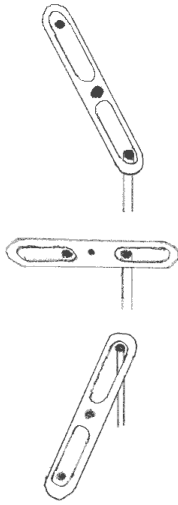
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The team one design concept describes a double acting human powered piston pump. The concept will meet the following criteria: 1.) Prototype development and fabrication will cost no more than \$150; 2.) The prototype assembly time will be no more than fifteen minutes, the disassembly time will be no more than ten minutes; 3.) The pump will accommodate at least three different people, one of whom will be female; each person will have a five minute interval to use the pump; 4.) Human energy will be the only power supply for the pump; 5.) A flow measurement device must be adapted for use on the pump, and may use AA or 9V batteries; 6.) The pump should create a maximum flow rate, with minimum leakage; 7.) The pump should be easy to manufacture and use; 8.) The pump should be able to move water to a minimum of 8 feet above the original height of the 55-gallon container.

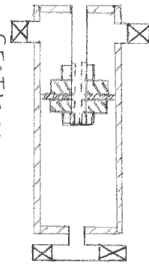
A dual acting piston pump will be used because piston pumps are commonly used for irrigation, they are positive displacement pumps, maximum flow rate will be achieved by producing water on each stroke of the piston, minimum leakage, ease of priming, and ease of use and repair. The piston pump will use oscillating movement to move water on both sides of the piston in the cylinder. The cylinder will be 4" PVC or acrylic, based on the calculation $r = \sqrt{(F)/(P * \pi * D)}$ where r = radius, F = force on the piston (about 50 lbs), P = pressure (4psi, as found in Dally, pg 81), D = distance of piston travel (about 1ft). The piston will be attached to a steel shaft (with one threaded end) using a piece of waterproof material squeezed between two circular pieces of piston material using nuts to make an adjustable seal (a plumber's plug design). The design will use two one-way check valves on each side of the piston to create a directed flow. Each set of valves will contain an "in" valve and an "out" valve (see drawing, Section A-A). On the side opposite of the shaft, the check valves will be attached to a threaded T-fitting, placed in the center of the cylinder. This position is most practical since the resistance to the pump will be distributed most evenly there. Water in the pump is forced to exit to one side; therefore, if the valves are to be placed on the peripherals of the housing, one side of the piston will encounter more resistance than the other. The piston will begin to rotate, causing a break in the seal between the piston and the cylinder resulting in a loss of efficiency (see drawing, Section A-A). On the shaft side, the valves will be run 90° to the shaft, as close to the cap as possible. Tubes will run toward the center of the cylinder from the check valves on the exterior. Rubber stoppers will be used to limit the movement of the piston.

The pump will maximize power by using lower body strength to move the piston. A person's lower body will create more force and will have more endurance than the upper body. Bicycle pedals will be used to push the shaft (see drawing, Detail B). Only one foot will push directly in line with the piston shaft. The opposite foot will operate a lever that moves the (in-line) pedal to its original position. The pedals will be supported by legs with rollers, which will glide along a track attached to the baseboard. The lever will be lubricated to prevent loss of work due to friction.

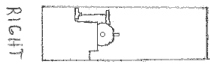
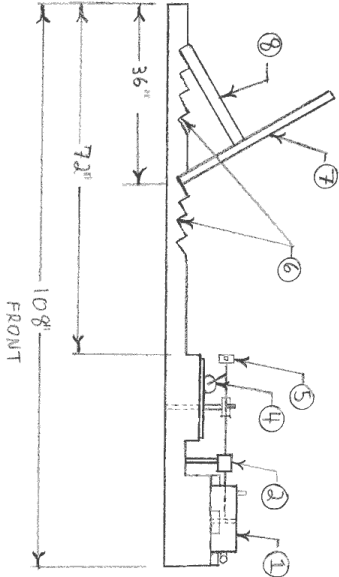
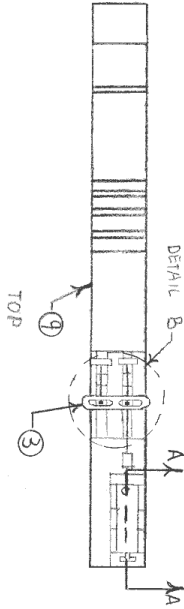
The baseboard will be set up to hold all of the components together. An adjustable seat will be located at one end of the baseboard, and the pump located at the other. The seat will be designed to utilize the maximum strength of human legs, by providing an optimal distance between the pedals and the operator. Additionally, this distance will create optimal angles for the operator's hips and knees. Bicycle pedals that rotate around a central axis will provide optimal ankle angles by allowing the foot to apply a direct force to the horizontal plane of the shaft. The pump will be elevated above the baseboard, to a level equal with the pedals. This will maximize the force applied by allowing the operator to push directly and comfortably on the piston. By raising the pump, the appropriate hip and leg angles will be applied to create a direct motion instead of losing effort to a downward motion. The pump will be attached to wood blocks to stop unwanted motion. Band clamps will be used to secure the pump and the wood to the baseboard. The flow of the pump output will be measured by the Bourdon pressure gauge because of its low cost and accuracy.



LEFT FOOT FORWARD FEET EVEN RIGHT FOOT FORWARD
DETAIL B



SECTION A-A



RIGHT

ITEM	DESCRIPTION
9	BASE BOARD
8	SEAT SUPPORT
7	SEAT
6	ADJUSTABLE CHAIR NOTCH
5	PEDALS
4	LINKAGE ROLLERS
3	PEDAL LINKAGE
2	SHAFT SUPPORT BEARING
1	WATER PUMP

CONCEPT DRAWING

PART:			
Group #1	WATER	PUMP	
DATE:	SCALE:	UNITS:	
9/23/00	NTS	INCHES	
DR. BY: BRYAN RILEY			