The Irrigator – Team 1 Design Description

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Team 1's goal is to design a double-acting human-powered piston pump, according to the specifications given (see Table 1). The Team 1 design is simply a pump, crank, and a chair attached to a baseboard. The adjustable seat is located at one end of the baseboard, and the pump located at the other, while the crank is in between (see Drawing, pg. 3). The seat is made of wood and is held down with bolts that go through a 90-degree bracket, with holes 6 inches apart (see Item 5). This makes an adjustable distance between the pedals and the operator. A bicycle crank and pedals provide motion to the piston shaft, linked by a steel rectangle. The pump is elevated above the baseboard, equally level with the pedals. This maximizes the force applied by allowing the operator to push more directly to the piston. The pump is attached to stacked wood blocks to stop unwanted motion. Band clamps secure the pump and the wood to the baseboard.

CHARACTERISTICS	SPECIFICATIONS
Cost	Less than $150
Power	Human Power and/or 9V or AA Batteries
Assembly/Disassembly Time	15/10 Minutes
Kit Size	Minimize
Accomodations	3 Different People, 1 Female
Flow Rate	Maximize
Performance	Move Water 8 Feet High
Measurement Method	Accuracy of Measurement at Instantaneous Flow Rate

Table 1 -- Design Requirements

The pump uses oscillating movement to move water on both sides of the piston in the cylinder. The cylinder is 4" PVC, where the size is based on equation 1:

Equation 1: $r = \sqrt{(F)/(P*\Pi)}$

where r = radius, F = force on piston (about 50 lbs), P = pressure (3.47 psi, as found in Dally, pg 81), The piston is attached to a steel shaft (with one threaded end) using a piece of rubber squeezed between two circular pieces of piston material with nuts to make an adjustable seal (See Detail B). The piston travels approximately 14 inches. The design uses two one-way check valves on each side of the piston to create a directed flow. Each set of valves contains an "in" valve and an "out" valve. On the side opposite of the shaft, the check valves attach to a threaded T-fitting, placed in the center of the cylinder. On the shaft side, the valves run 90° to the shaft, as close to the cap as possible (See Section A-A & Item 6). The pump will be placed on wooden blocks stacked on the baseboard and held down with band clamps.

The pump is designed to use lower body power to move the piston. A person's lower body can create more force and tires out much more slowly than the upper body. A bicycle crank and pedals push the shaft (see Items 2 & 8). The link piece to the shaft consists of two pieces of rectangular steel welded into a T-shape (for strength). The link is attached to a bicycle pedal on one end, and the piston shaft at the other end (see Item 3). A bearing prevents the piston shaft from any unwanted motion (see Item 7).

The Team 1 parts list (see Figure 2) consists of twenty-four parts, totaling $114.58, which is well below our maximum expenditure of $150. The parts should all be relatively easy to fabricate and assemble, with the exception of the piston assembly and the linkage from the pedal to the shaft, which will both involve welding.

Team 1's preliminary testing consist of building prototypes out of straws and paper plates, to see how the mechanics of the linkage system work.

A clicker that will count the number of strokes will facilitate flow rate calculations. A leg press at Lombardi gave data regarding strokes/min. of the three people pumping. The lowest average strokes /min. is 16. This information is used in equation 2, which gives q as 2814.867.

Figure 2 -- Team 1 Parts List

Part #	Part Name	Description	Dealer or Loc.	Quan.	Unit Price	Total
1	Baseboard	2"x10"x10'	Home Depot	1	$ 9.24	$ 9.24
2	Chair Back	2"x10"x3'	Home Depot	1	$ 4.92	$ 4.92
3	Chair Strut	2"x8"x2.5'(6')	Home Depot	1	$ 4.92	$ 4.92
4	Brass T	.75" dia.	W. Nev.Supply	1	$ 4.76	$ 4.76
5	Brass Nipple	.75" dia.	W. Nev.Supply	5	$ 2.21	$ 11.05
6	Check Valve	.75" dia.	W. Nev.Supply	4	$ 3.95	$ 15.80
7	Shaft	.5"dia x 3.5'~4' steel	Home Depot	1	$ 6.95	$ 6.95
8	Shaft Cap	.5"dia.Cap	Home Depot	1	$ 0.59	$ 0.59
9	Bicycle Pedals	From Bicycle	Garage Sale	1	n/a	n/a
10	Bolts	.75"dia x 6"	Home Depot	6	$ 0.60	$ 3.60
11	Nuts	.75"dia	Home Depot	6	$ 0.06	$ 0.36
12	Washers	.75"dia	Home Depot	12	$ 0.06	$ 0.72
13	Nuts for Shaft	.75"dia	Home Depot	2	$ 0.06	$ 0.12
14	Wood(Pump Stops)	2"x1"x8'	Home Depot	1	$ 0.96	$ 0.96
15	Plumbers Plug	4" dia	W. Nev.Supply	1	$ 3.88	$ 3.88
16	Crank	From Bicycle	Garage Sale	1	$ 5.00	$ 5.00
17	Packing Material	.25"dia x 2'	Home Depot	1	$ 1.98	$ 1.98
18	Packing Ring Flange	3"o.d.,!"I.d.,rp(6)@2"	Home Depot	1	$ 2.95	$ 2.95
19	Pump Housing	PVC #40 4"x2'	W. Nev.Supply	1	$ 11.66	$ 11.66
20	End Housing Cap	4"x Schd.40	W. Nev.Supply	1	$ 4.62	$ 4.62
21	Shaft Housing Cap	4"x Schd.40	W. Nev.Supply	1	4.11	$ 4.11
22	Shaft Housing Plug	4" Threaded Plug	W. Nev.Supply	1	$ 2.98	$ 2.98
23	Band Clamps	.75" x 3'	Home Depot	2	$ 1.35	$ 2.70
24	J B Weld	Two Part Cold Weld	Home Depot	1	$ 2.96	$ 2.96
					Subtotal	$ 106.83
			Nv Sales Tax @ 7.25%			$ 7.75
					Total	$ 114.58

Equation 2: $Q = (\Pi r^2)(l)(s)$

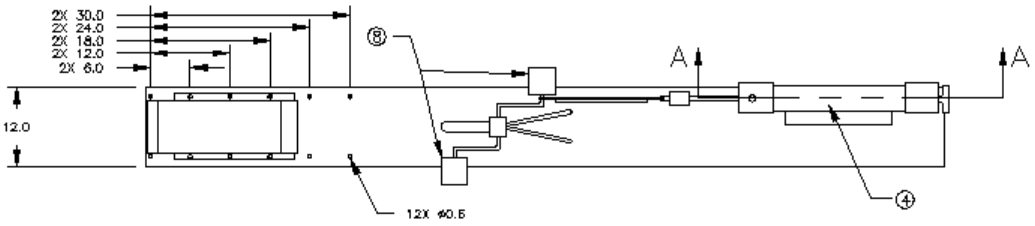
To convert into GPM plug 2814.867 into equation 3 and use 60% efficiency which gives 7Gpm.

Equation 3:
QGPM=Qin^3/min*1Gal./231in^3

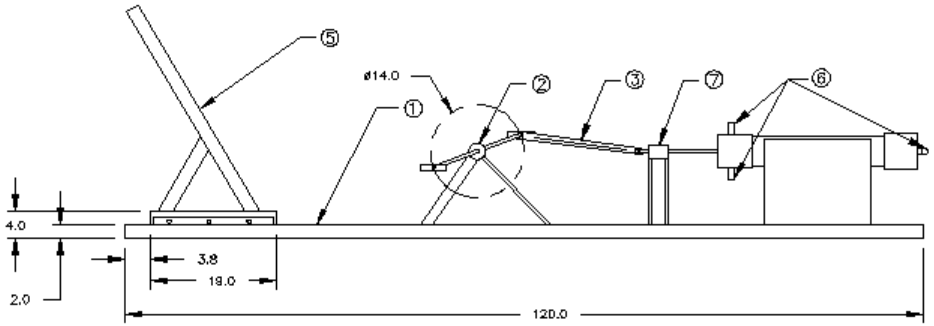
Figure 3
Team Schedule

	September	October	November	December
Concept Development	//////////////////////			
Initial team construction	////////			
Receive specifications	/////			
Original concept generation	//////////////			
Written report	//////////////			
Review original concepts	///			
Detail Design	//////////////////			
Revise original concepts	////			
Design, in detail:	///////			
Piston	////			
Pump	/////			
Drive mechanism	//////			
Flow rate	///			
Design Review	//////////			
Oral presentation	/////			
Powerpoint	////			
Presentation preparation	////			
Written presentation	//////////////////			
Drawings	//////			
Budget	//////////////////			
Parts list	//////////////////			
Testing	///			
Manufacturing	{----------}			
Obtain Materials	{-----}			
Manufacture parts	{-----}			
Inspect for testing	{---}			
Presentation	{-----}			
Pre-assembly	{--}			
Testing	{--}			
Final Report	{--------}			
Oral presentation	{-----}			
Powerpoint	{----}			
Presentation preparation	{-----}			
Written presentation	{--------}			
All aspects of project	{--------}			

Team 1 has excellent teamwork. We meet 1-2 times a week, depending on the necessity of the meeting. Team 1 has met all deadlines without any trouble, and should continue to do so. Some future planning involves building the prototype, putting together two more presentations, along with two more written reports (see Figure 3). Organizationally, Team 1 has put together a team contract, meeting agendas, and an overall agreement has been made on how things should be carried out.



TOP



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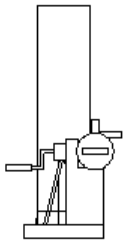

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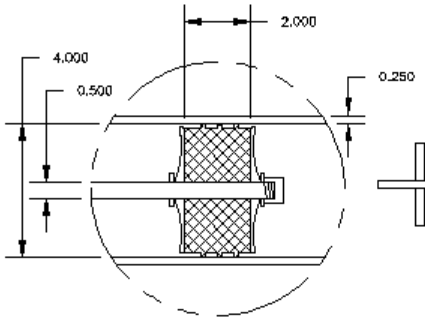
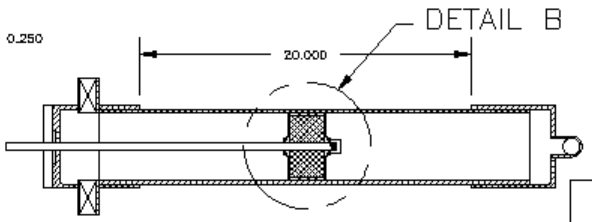


DETAIL B

SCALE: 1:5

"Plumbers Plug"



SECTION A–A

SCALE: 1:10

QNTY	ITEM	DESCRIPTION
2	8	Pedals
1	7	Shaft Bearing
3	6	Check Valves
1	5	Adjustable Seat
1	4	Pump Housing
1	3	Crank Linkage
1	2	Crank Assembly
1	1	Baseboard

PARTS LIST

THE IRRIGATOR

Group 1 Design Project

Tolerances:
X.X ±.1
X.XX ±.05
X.XXX ±.01

Units: Inches

Scale: 1:25 & NOTED

Date: 10/14/00

Drafter: Bryan Riley