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# Designing of Hydraulic Ram Pump

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***Abstract*—This paper describes the techniques and guidelines to successfully install the modern hydraulic ram pump. The proposed technique illustrates the methodology that can be used for the primary design considerations and applications in various ways. This Hydraulic ram pump plays an important role in areas which are not connected to national electricity grid. This method provides means of continuous water supply. Basic principle of working is ramming action of air inside pressure vessel.**

***Keywords*—ram, pump**

## I. INTRODUCTION

Recognizing that the hydraulic ram pump(hydram) can be a viable and appropriate renewable energy water pumping technology in developing countries, it has been used for over two centuries in many parts of world due to their simplicity and reliability made them commercially successful, in the days before electrical power and the internal combustion engine become widely available. As technology advanced and become increasingly reliant on sources of power derived from fossil fuels, the Hydraulic Ram Pump was neglected. It was felt to have no relevance in an age of national electricity grids and large-scale water supplies. Big had become beautiful and small-scale Hydraulic Ram Pump technology was unfashionable.

In recent years an increased interest in renewable energy devices and an awareness of the technological needs of a particular market in developing countries have prompted a reappraisal of Hydraulic Ram Pump. In hilly areas with springs and reliable pumping device is large. Although there are some examples of successful ram pumps installation in developing countries, their use to date has merely scratched at the surface of their potential. The main reason for this being, lack of wide spread local knowledge in the design and manufacture of Hydraulic Ram Pump. Hence, the wide spread use of Hydraulic Ram Pump will only occurs if there is a local manufacturer to deliver quickly; give assistance in system design, installation and provide an after-sales service. Our project team decided to design and manufacture more efficient and durable so that it could solve major problems by providing adequate domestic water supply to scattered rural agriculture, as it was difficult to serve water to them by conventional piped water systems due to unavailability of continuous electricity.

It was in this context that a research project for development of an appropriate small scale prototype of hydraulic ram pumps for those particular conditions.

## II. PREVIOUS WORK

Ram pumps have been used for over two centuries in many parts of the world. Their simplicity and reliability made them commercially successful, particularly in Europe, in the days before electrical power and the internal combustion engine become widely available. As technology advanced and become increasingly reliant on sources of power derived from fossil fuels, the ram pump was neglected. It was felt to have no relevance in an age of national electricity grids and large-scale water supplies. Big had become beautiful and small-scale ram pump technology was unfashionable. In recent years an increased interest in renewable energy devices and an awareness of the technological needs of a particular market in developing countries have prompted a reappraisal of ram pumps.

*A. History*

The first ram pump was created by John Whitehurst of Cheshire, U.K. in 1972. He raised water up to height 16 ft in 1783. He installed another in Ireland. He did not patent it, and details are obscure, but it is known to have had an air vessel. The first self-acting ram pump was invented by the Frenchman Joseph Montgolfier in 1797 and used it in his paper mill at Voiron. His son improved design in 1816.The modern water pump is designed to supply the water for farms, houses and village communities.

*B. The Modern Design*

It is a unique device that uses the energy from a stream of water falling from a low head as the driving power to pump part of the water to a head much higher than the supply head. With a continuous flow of water, it operates automatically and continuously with no other external energy source.

It's a structurally simple unit consisting of two moving parts: refer fig: the waste valve and delivery (check) valve. The unit also consist an air chamber and an air (snifter) valve. The operation of a is intermittent due to the cyclic opening and closing of the waste and delivery valves. The closure of the waste valve creates a high pressure rise in the drive pipe. An air chamber is necessary to prevent these high intermittent pumped flows into a continuous stream of flow. The air valve allows air into the replace the air absorbed by the water due to the high pressures and mixing in the air chamber.

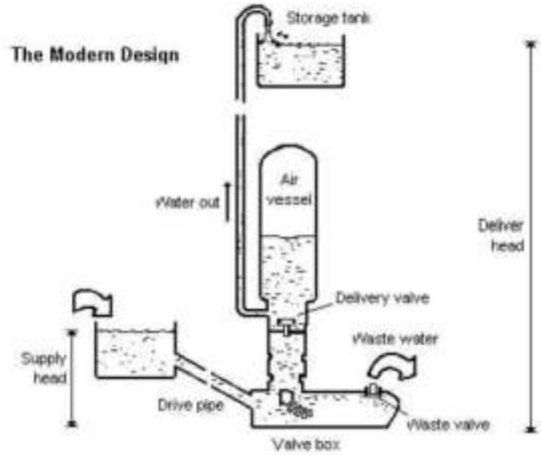


Fig.1.Diagram of modern pump.

III.DESIGNING OF HYDRAULIC RAM PUMP

*A. Part List*

Fig 2. Disassembled Automatic Water Pump

**Air Chamber Parts Schedule 40 PVC:**

1. 4" x 12" (or longer) Schedule 40 PVC Pipe.
2. 4" PVC Pipe Cap. (Rounded high pressure, not
3. 4" slip to 2" female pipe thread PVC reducer / adaptor.
4. 12" Wheel Barrow Inner Tube.

**Pump Body Parts Galvanized:**

5. 2" "T", Female, (2 each required).
6. 2" Street Elbow
7. 1" Street Elbow
8. 2" X 1" Bushing

9. 2” x ¾” Bushing
10. 2” Close Nipple
11. 2” X 2 1/2” Nipple
12. 1” Close Nipple
13. ¾” Close Nipple
14. 1” Check Valve (2 each) 2" valve for HRP1-2.

**Impetus / Waste Valve Conversion Parts:**

15. Stainless Steel Coupling Nut
16. Stainless Steel Bolt
17. Stainless Steel Nuts & Washers (valve weights)
18. Faucet Washer

**Construction Material:**

19. Fiberglass resin and hardener
20. 11/4" Lavatory Washer
21. 5" stub of 1" threaded pipe
22. 100 grit sandpaper
23. PVC Primer and Cement
24. Black Paint (Spray and liquid rust inhibiting).
25. Teflon Thread Tape

All connectors between the fittings are threaded pipe nipples - usually 2" in length or shorter. This pump can be made from PVC fittings or galvanized steel. In either case, it is recommended that the 4" diameter fittings be PVC fittings to conserve weight.

## IV. DESIGNING OF HYDRAULIC RAM PUMP

### *A. PRACTICAL ASPECT OF DESIGN*

*Parameters:* The detailed mechanics of operation are not well understood. Several parameters relating to the operations are best obtained experimentally. These parameters include:

Drive pipe length (L);· Cross-sectional area of the drive pipe (A);· Drive pipe diameter (D) and thickness;· Supply head (H); Delivery head (h);Friction head loss in the drive pipe; Friction head loss through the waste valve; Friction head loss at the delivery valve; The velocity in the drive pipe when the waste valve begins to close (V0);The steady flow velocity (VS) through the waste valve when fully open; Valve weight (W); Valve stroke (S); Valve opening orifice area (A0); Valve cross sectional area (AV); and · Size of the air chamber.

*1) Drive Pipe Length (L):* The drive pipe is an important component of a installation. The drive pipe must be able to sustain the high pressure caused by the closing of the waste valve. Empirical relationships to determine the drive pipe length are:

***6H< L <12H (Europe & North America)***

***L = h + 0.3 (h/H) (Eytelwein)***

***L = 900 H / (N2 * D) (Russian)***

***Where N is the Number of Beats/min***

***L = 150 < L/ D< 1000 (Calvert)***

Many researchers have indicated that Calvert’s equation gives better guidelines

*2) Air chamber:* It is recommended that the volume of the air chamber be approximately 100 times the volume of water delivered per cycle.

*3) Air Valve:* Experiments with different sizes indicate that the air valve size has negligible effect on a operation. A small hole, less than 1 mm, is sufficient.

*4) Waste Valve:* The flow area (A0) through the waste valve should equal to or exceed the cross-sectional area of the drive pipe to avoid "chocking" of the flow.

*5) Delivery (Check) Valve:* 1.45 cm2 of area for every liter of water to be delivered through the valve is recommended.

*6) Supply Head (H):* With simple weighted impulse valves, the supply head should not exceed 4 m, otherwise the valve will be closing so rapidly and frequently that no useful work will be done. In such a case, the valve should be assisted by a spring to regulate its closure.

## V.WORKING OF RAM PUMP

Once we have found your source of flowing water you will need to be able to collect it through a screened intake and route it preferably into a settling tank before sending the water to the ram pump through a drive pipe.

**STEP 1**: Water starts flowing through the drive pipe and out of the "waste" valve, which is open initially. Water flows faster and faster through the pipe and out of the valve.

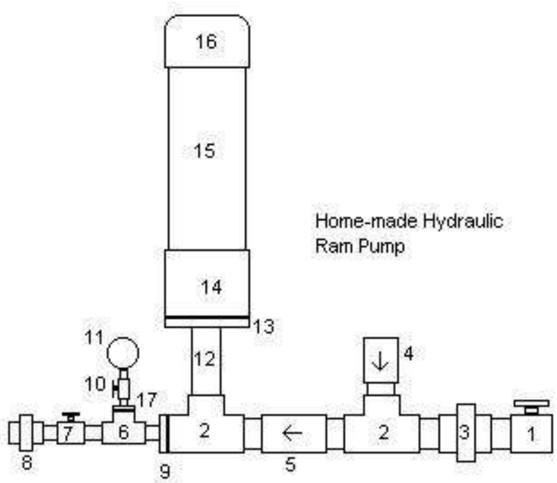


Fig.3.Working of Ram pump.

**STEP 2:** At some point, water is moving so quickly through the brass swing check "waste" valve that it grabs the swing check's flapper, pulling it up and slamming it shut. The water in the pipe is moving quickly and doesn't want to stop. All that water weight and momentum is stopped, though, by the valve slamming shut. That makes a high pressure spike at the closed valve. The high pressure spike forces some water through the spring check valve and into the pressure chamber. This increases the pressure in that chamber slightly. The pressure "spike" the pipe has nowhere else to go, so it begins moving away from the waste valve and back up the pipe It actually generates a very small velocity backward in the pipe.

**STEP 3:** As the pressure wave or spike (red arrows) moves back up the pipe, it creates a lower pressure situation (green arrows) at the waste valve. The spring-loaded check valve closes as the pressure drops, retaining the pressure in the pressure chamber.

**STEP 4:** At some point this pressure (green arrows) becomes low enough that the flapper in the waste valve falls back down, opening the waste valve again.

**STEP 5:** Most of the water hammer high pressure shock wave (red arrows) will release at the drive pipe inlet, which is open to the source water body. Some small portion may travel back down the drive pipe, but in any case after the shock wave has released, pressure begins to build again at the waste valve (#4) simply due to the elevation of the source water above the ram, and water begins to flow toward the hydraulic ram again.

**STEP 6:** Water begins to flow out of the waste valve (#4), and the process starts over once again.

Steps 1 through 6 describe in layman's terms a complete cycle of a hydraulic ram pump. Pressure wave theory will explain the technical details of why a hydraulic ram pump works, but we only need to know it works. The ram pump will usually go through this cycle about once a second, perhaps somewhat more quickly or more slowly depending on the installation. The pump was tested for calculating inlet flow, outlet flow, and other parameters.

Below is our experimental observation table our ram pumps performance.

Table 1. Test results for pump

| **Drive Pipe Diameter** (inches) | **Delivery Pipe Diameter** (inches) | **At Minimum Inflow** | | **At Maximum Inflow** | |
|---|---|---|---|---|---|
| | | **Pump Inflow** (lpm) | **Expected Output** (lpm) | **Pump Inflow** (lpm) | **Expected Output** (lpm) |
| 1 | 1/2 | 10 | 3.3 | 30 | 13.3 |

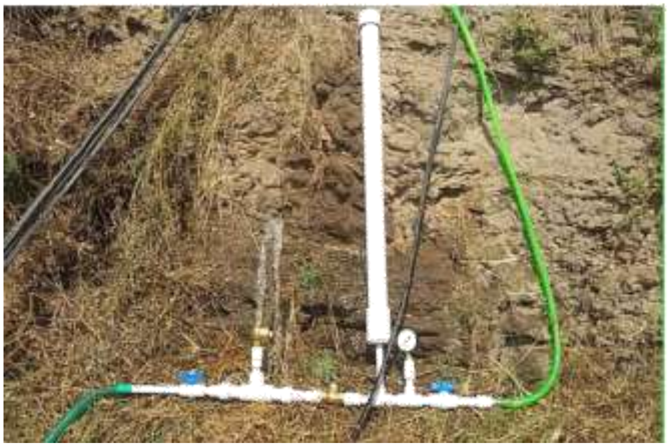

Fig.4.Actual Demonstration of Working Model

VI.APPLICATION

There are three main factors that will determine how much water your RAM can pump. They are the amount (Volume / Quantity) of water available at the source, the distance in vertical feet between the source and the pump called (FALL), and the vertical distance from the RAM pump to the end use area or storage tank called (LIFT). These three factors are inter-related and have the possible changing variable of (Volume / Quantity), therefore, it is very hard to get to an exact figure of gallons or liters per hour that a given pump will provide. The main objective is that we can determine whether or not a hydraulic ram will function in a given location. We have good idea of the amount of water required over a given 24 hour period. This is critical to our location and needs or we are able to build or provide a suitable storage tank of sufficient size to compensate for our average usage. There are formulae by using which we can practically work hydraulic pump efficiently.

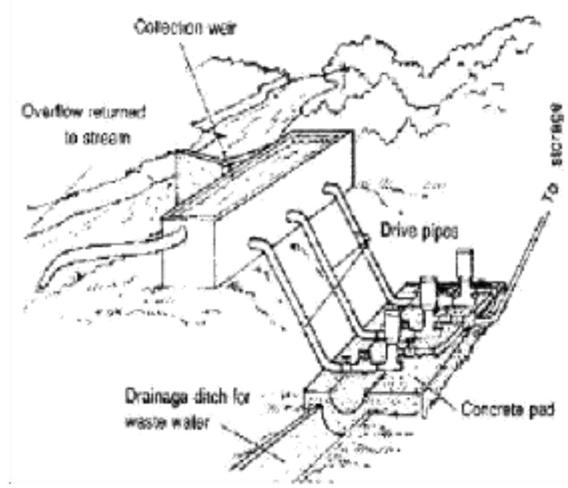


Fig.5. Working at river or Dam

## II. CONCLUSION

Here we would like to conclude on a healthy and warm vote of thanks to all who have made this project a reality.

1) The hydraulic ram pump prototype of good quality and high performance was successfully fabricated and tested.

2) The ram developed is low cost of high performance comparable with commercial models.

3) A weighted waste valve was designed and operated successfully.

4) It eliminates the need of retainer springs which are not available locally.

5) A proven and effective methodology to identify suitable sites for hydraulic ram use was evolved and tested.

6) A locally made was successfully developed and tested. It is recommended that ministry of water and agriculture department to establish small scale water supply schemes using pumps to utilize the this pump so that it would greatly solve water problems for agricultural as well as domestic purpose.

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