

An Experimental Investigation of Performance of Multicylinder Reciprocating Pumps

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Abstract :

Tests have been carried out to determine discharge, suction head and human efforts needed for operation of three-Cylinder and four-Cylinder reciprocating Pumps. It has been found that a 3-Cylinder Pump can deliver 13 gallons of water per minute at a suction lift of 10 feet. A 4-Cylinder Pump can deliver 23 gallons of water per minute at a suction lift of 5 feet.

Introduction :

The oldest type of pumping known to mankind is the principle of action of a reciprocating pump. Hand tubewell, diaphragm pump and the recently available indigenous pumps fall under the same type. This kind of pump is widely used for drinking water in our country and it is also used for small scale irrigation. This kind of pump plays a very important role in our society. So, proper attention should be given for its development or improvement. The pumps should be developed for better pumping efficiency and high discharges, and they should be convenient for operation. Many works have been carried out (1) -with multicylinder (2 to 5 cylinders) pumps. A multicylinder pump makes the flow continuous, gives higher discharge, reduces the acceleration head and needs more power. A pump with more than five Cylinders is not advisable as this creates interference in the flow and also increases the acceleration head (1).

In this study two versions of pumps were fabricated. One version of these is a 3-Cylinder system and the other is a 4-cylinder system. On each of the pumps, changes were made in crank, bearing and type of drive. The pumps were tested to find out discharge, suction lift and human effort.

Further research on the development of the reciprocating pump together with the determination of the human effort in terms of horse power is continuing (2).

Fabrication Procedure :

The 3-cylinder version of the pump was fabricated using commercially available G. I. pipes, hand tubewell bucket and flap valve, bearing, M. S. sheet and M. S. rod. The inside diameter and length of stroke for each cylinder were 3.19 inch and 2.75 inch respectively. The fabrication consisted of machining, welding and fitting. A picture of the pump is shown in Figure 1. There were provisions to drive the pump either by hand or by foot. The pump was

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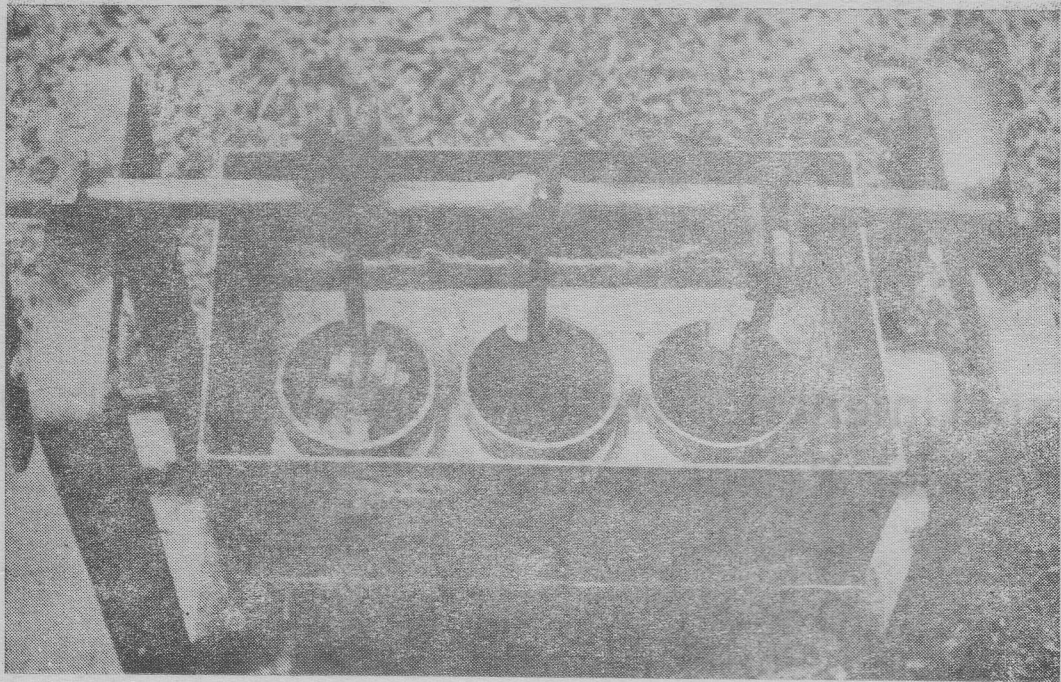


Fig. 1. Top view of the three cylinder pump.

operated by different men and the average discharge was 13 gallons per minute. The pump could be comfortably operated when the suction lift was within 10 feet. There were no appreciable changes in discharge as the suction

lift was increased. The maximum suction lift which could be attained was 23 feet. But at this suction lift, the physical effort needed was tremendous and it was not possible to run the pump for more than ten minutes by a common man.

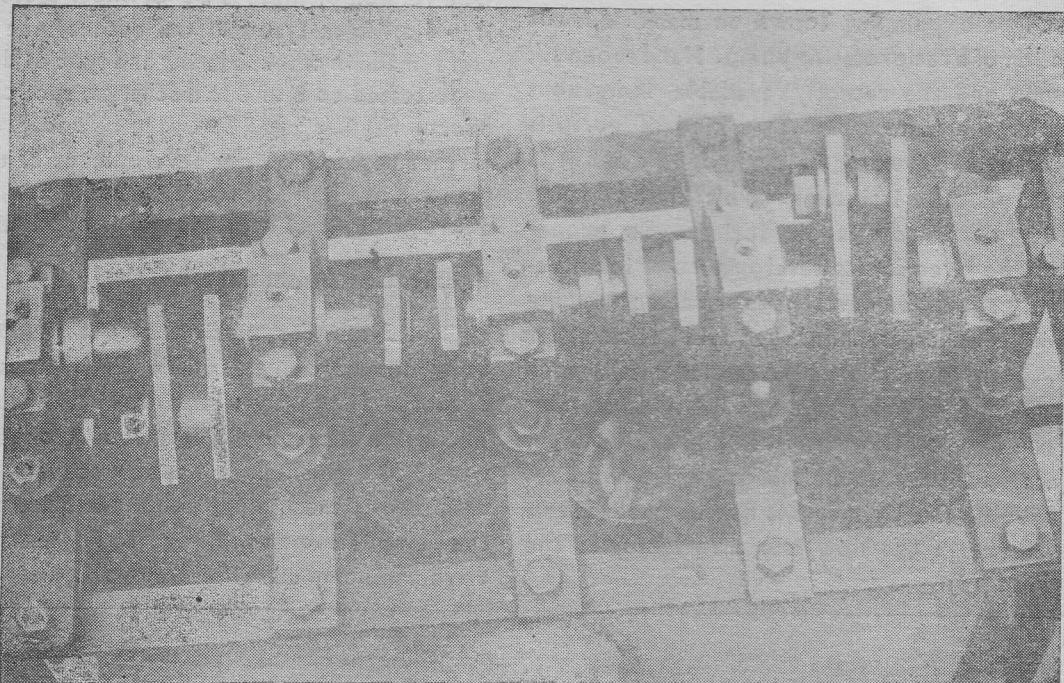


Fig. 2. Top view of the four cylinder pump.



Fig. 3. Four cylinder pump. (Foot operated)



Fig. 4. Four cylinder pump. (Hand operated)

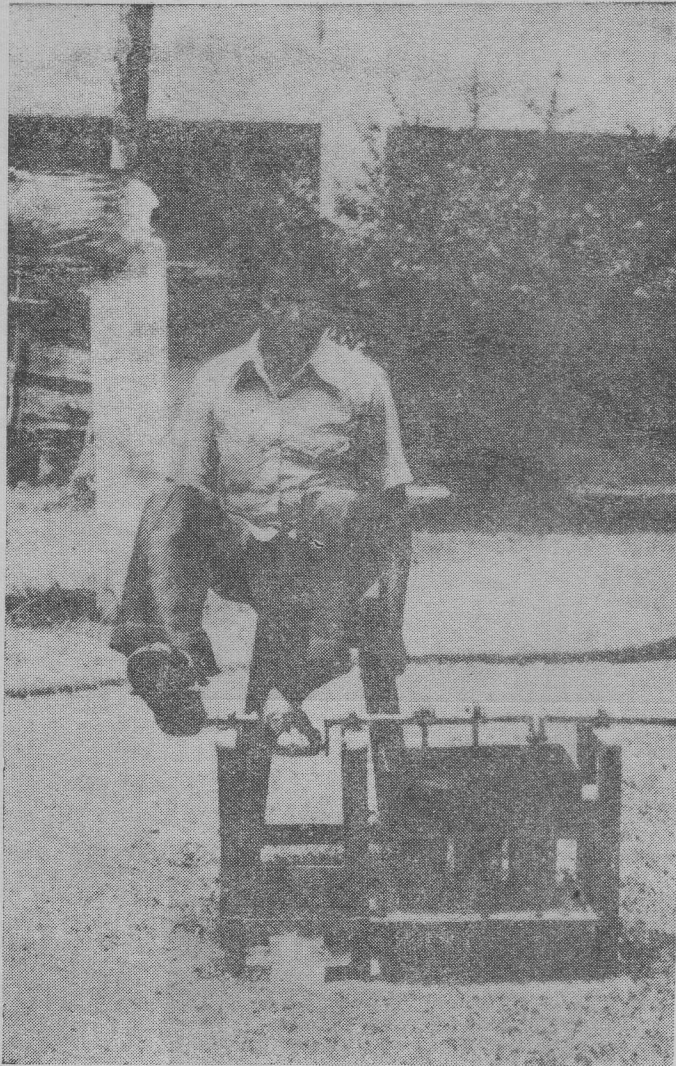


Fig. 5. Three cylinder pump. (Foot operated)

The four Cylinder version (Fig. 2) was also made from similar commercially available materials. The inside diameter and length of stroke for each cylinder of this pump were also 3.19 inch and 2.75 inch respectively. It was driven by both hand and foot, with and without a flywheel. The average discharge was 23 gallons per minute when the suction lift was about 5 feet. Higher human effort was needed for higher suction and it was extremely difficult to operate the pump beyond a suction lift of 6 feet. A continuous running of the four-cylinder pump by a person for even an hour was not possible.

One crank shaft was fabricated with all the cranks welded to it, thus making it an integral crankshaft. Another crankshaft was fabricated with slots in the cranks which allowed the piston to be connected or disconnected without dismantling the crank shaft. The repair and maintenance would be simpler in this case, but there will be more friction resulting in lower efficiency. The integral crank shaft would offer less friction, but the repair and maintenance would be a little difficult as the whole crank shaft must be dismantled before a bucket or a piston can be changed.

The pumps were driven both by hand and foot (Fig. 3, Fig. 4 and Fig. 5) and the foot-drive was more convenient. It was found that the flywheel had virtually no-effect on the performance of the pump. In all cases the delivery head was zero.

Conclusion :

The 3-cylinder and 4-cylinder pumps were tested for discharge, lift and human effort. The 4-cylinder version of the pump needed a very high human effort making it unsuitable for continuous operation (1 to 2 hours) when the suction lift is more than 6 feet. So, the manual operation of the 4-cylinder pump is not possible.

The 3-cylinder pump can be driven for more than 2 hours by a common man, and it will deliver 13 gallons per minute under a head of 10 feet. The head can be raised to 23 feet with more human effort. For this high head a common man cannot drive the pump for more than 10 minutes. But the discharge is approximately constant. A well-built and durable 3-cylinder pump would cost Tk. 3,000/-. The cost can be reduced to some extent by putting less number of bearings and using a crank shaft with slots in the cranks. But this would increase friction during the drive and need frequent repair and maintenance making it difficult for convenient and economic operation.

A comparison of these two pumps with other manually operated water lifting devices is shown here.

Device	No. of Operator required	Approximate discharge gpm.	Cost in Taka	Suction lifting height Ft.	Delivery head Ft.
4-Cylinder pump (stroke-2.75 inch, dia. 3.19 inch.)	1	23	4000	5	0
3-Cylinder pump (Stroke-2.75 inch, dia. 3.19 inch.)	1	13	3000	10	0
Hand Tubewell (MOSTI) Stroke 6 inch, dia 3.5 inch.	1	5	1500	22	0
Local DHONE Standard	1	10	300	8	0
Local Swing Basket Standard	2	15	100	6	0
Local Dug-Well Standard	1	4	100	15	0

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