Design and Fabrication of Pendulum Operated Pump

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Abstract- *This paper discusses the importance of a pendulum pump which can be used as a supplementary device for pumping water and is made to replace hand pumps. Our objective is to save electricity consumption to pump the water and to reduce human work in hand pump. By link mechanism and spring force, we can attain linear motion from oscillatory motion and can use that to operate a pump or compressor. So the energy consumption of this system will be lowest. It can be used to spray pesticides.*

Keywords- Reciprocating pump, Basic Pendulum, springs

I. INTRODUCTION

The ever increasing demand for energy has led to the formation of various advanced resources which produces a certain part of the required energy. One principal consumer of a large amount of energy is our household itself. Large amount of electrical energy is wasted in pumping water irrigation purposes etc. In this context the importance of pendulum pump arises, by the use of which a large amount of energy can be conserved and the conserved energy can be used for various other purposes. A pump is a device that moves fluids (liquids or gases), or sometimes slurries, by mechanical action. Pumps can be classified into three major groups according to the method they use to move the fluid: direct lift, displacement, and gravity pumps. Pendulum is a simple body which moves freely until any damper is present. Hence, if the oscillation is forced, then it is possible to gain continuous movement. Our objective is to save electricity consumption to pump the water and to reduce human work in hand pump. By link mechanism and spring force, we can attain linear motion from oscillatory motion and can use that to operate a pump or compressor. So the energy consumption of this system will be lowest.

Typical hand pumps require sufficiently large effort and an average person can use the pump continuously only for a short time, but the pendulum pump requires only minimum of the effort, because it is only required to oscillate the pendulum and can maintain these oscillation for several hours, without any fatigue. The advantage of this invention compared to present hand pump solutions are: less force to start the pump, less water consumption, and both arms can be used to fetch the water.

II. LITERATURE REIVEW

R. Ortega [2013] from Depto. De Matemática Aplicada, Universidad de Granada, 18071 - Granada, Spain presented the stability of the equilibrium of a pendulum of variable length in terms of the third approximation. In contrast, the traditional linearization procedure is not always faithful. Alternative characterizations of stability are also presented. They are based on degree theory and on the algebraic structure of the symplectic group.

Violaine et al.[2014] from UMR 6233 ISM Marey, Université de la Méditerranée, 163, avenue de Luminy, Francemade analysis of the mechanical constraints operating suggested that the gymnast should be considered as a pendulum of variable length. Increasing and decreasing pendulum length at appropriate phases of the swing effectively allows energy to be injected into the system, thereby compensating the energy lost to friction.

Tao Hana et al.[2013] from Department of Mechanical and Industrial Engineering, University of Illinois at Chicago, United States observed a pendulum-like motion of the usually straight electrified jet experimentally and theoretically modeled. Pendulum-like motion arises due to repulsive Coulomb force between the straight electrified jet and the charges accumulated on the collector. This electrical force repels the similarly charged landing jet segment in the collector plane. The motion is transferred to the whole jet via elastic stress sustained by the jet.

W. Szyszkowski and D.S.D. Stilling [2014] of Mechanical Engineering Department, University of Saskatchewan, 57 Campus Drive, Saskatoon, Canada studied the damping effects that are generated in a frictionless oscillating physical pendulum by a continuous motion of an auxiliary mass. The analysis presented shows how a mass sliding in a periodic pattern along the rotating member affects the system oscillations. The resulting rotational motion of the pendulum is not exactly periodic. Therefore, the mass motion should be continuously synchronized to control the phase angle. If the mass motion period is not adjusted properly (if kept constant, for example) then undesired “beating” effects would result over extended oscillations of the pendulum.

Rahul Singh and Vijay Kumar [2014] from Dept. of Electronics and Communication Indian Institute of Technology, Roorkee, India presented an approach for the swing up and stabilization of a rotary inverted pendulum (RIP).

III. OBJECTIVES

- To reduce the effort made by the farmer for supplying fertilizers.
- To reduce the effort of farmer for supplying of water for drip irrigation.
- To reduce the work of supplying of water for gardening.
- To save the electricity consumption.

IV. METHODOLOGY

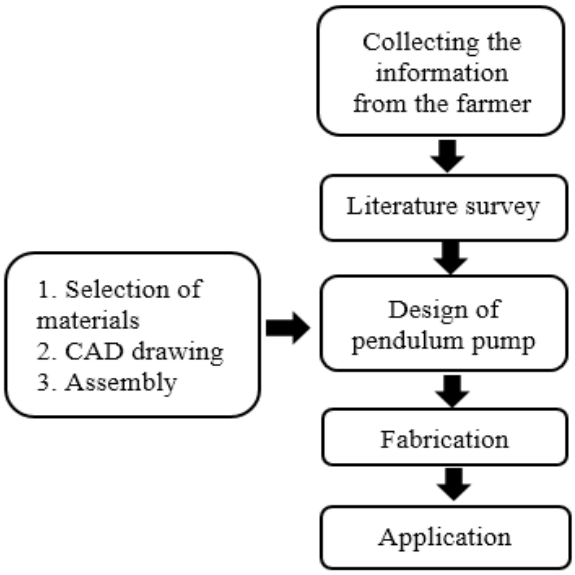

Figure 1. Flow chart of methodology.

V. WORKING PRINCIPLE

The parts of Hand water pump with pendulum are: 1- Load of the pendulum,2- Handle of the pendulum,3- Axis of the pendulum,4- Axis of the two-leg lever, 5- two-leg lever, 6- Water pump, 7- Piston of the pump. The pump is made of pendulum, two-leg lever and cylinder with the piston which pumps the water. Oscillation of the pendulum is maintained by periodical action of the human arm.

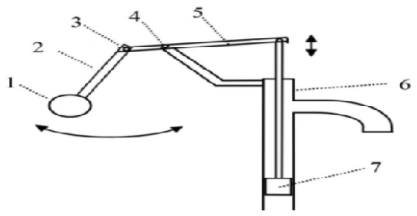

Figure 2. Schematic representation of working principle.

Oscillation period of the pendulum is twice bigger than the period of the lever oscillation. Piston of the pump has reverse effect on the lever and damps its oscillation. Damping of the lever motion causes damping of the pendulum, but the work of the force damping the pendulum is less than the work of the forces which damp the lever. Equilibrium position of the lever is horizontal, and the equilibrium position of the pendulum is vertical. Oscillation of the lever and the pendulum takes place in the same plane, vertical in reference to the ground.

VI. PRINCIPAL COMPONENTS

Frame

It is the main component of the pump system and is made up of steel. The frame consists of several rigid links. Frame is base part which holds another parts like pump, lever, ball bearing etc.

Reciprocating Pump

This is a positive displacement pump. This is closely fitted with cylinder by the principle of actual displacement or a plunger which executes a reciprocating motion.

Springs

The spring is an elastic object used to store mechanical energy. Here in the pendulum pump both tension and compression springs are used. It is the function of these tension and compression springs to stretch and compress according to the load applied.

Lever

It is also the main component of the pump system and is made up of steel. Lever converts the oscillating movement of the pendulum on one side to the reciprocating motion of the piston to the other side.

Ball bearing

Ball bearings are the elements which uses balls between bearings. These are used to reduce rotational friction and support axial loads.

Pendulum

The weight which is used to hold the weights and it is the oscillating part of the system and thus it acts like a pendulum.

Nylon tubes and non-return valve

Nylon tubes are connected to the delivery and suction ends of the reciprocating pump for the passage of water from the sump and the delivery hose. A non-return valve or one-way valve is a valve that normally allows fluid (liquid or gas) to flow through it in only one direction.

2-D Diagram with Sectional views

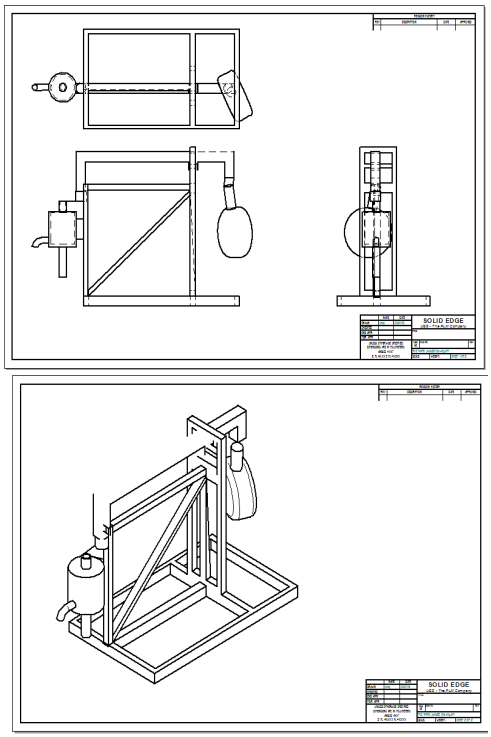

Figure 3. 2D drawing of pendulum operated pump.

VII. DESIGN OF PENDULUM and MODEL

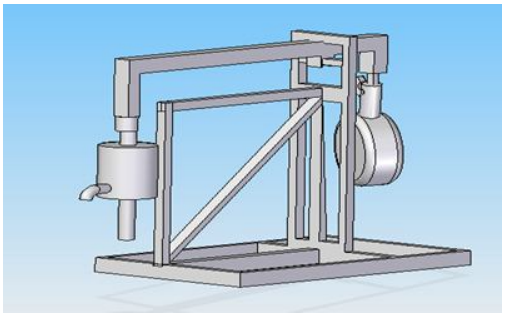

Figure 4. 3D drawing of model.

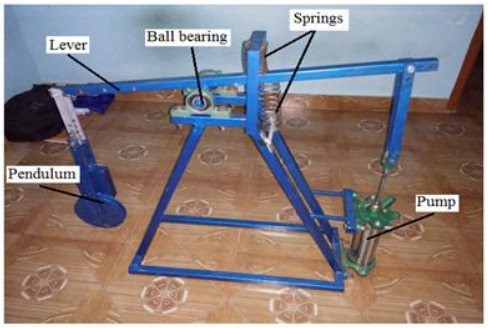

Figure 5. Working model.

VIII. RESULTS AND DISCUSSION

- On increasing the suction head, discharge of the given pendulum system decreases.
- On increasing the mass of pendulum, discharge of the given pendulum system increases.
- On increasing angle of swing, the discharge of the given pendulum system increases.
- It was concluded that the human effort considerably reduced while pumping water by pendulum operated pump compared to the regular pump
- Efficiency of the Pump is 52.11%.

IX. CONCLUSION

From this design and fabrication of pendulum hand pump, we have reduced the human effort by providing the pendulum bob which is attached in the hand lever. While pumping the pendulum oscillates to and fro and provides continuous energy to the hand lever which pressurizes the water and lifts the water from lower head to higher head and provides the continuous flow of liquid. This is one of the methods that help the rural people to access liquid easily for spraying pesticides, gardening purpose and for Drip irrigation.

X. ADVANTAGES & DISADVANTAGES

1. Farmer can supply water and spray pesticides without use of electricity.

2. It is portable.
3. Reduction of farmers work.
4. Improve human health.
5. Uses the minimum of human strength in comparison to present classic hand water pumps.
6. Compact size, easy to relocate, less moving parts, hence less maintenance cost.

Limitations includes,

1. Not suitable for large scale farming.
2. Leakage problems.

XI. APLICATIONS

- Drip irrigation.
- For spraying pesticides
- Gardening purposes.

XII. SOCIAL RELEVANCE

It is essential for us to reduce the consumption of Non-renewable energy resources therefore our project mainly uses human effort intern using electrical energy. The pendulum pump to be used as an efficient mode in the irrigation of smaller lots, water-wells and gardening purpose. By the use of pendulum based water pumping system we can increase the efficiency of the plant and reduce the effort, cost of production, production time, man power requirement.

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