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Research Article

Design and Modification in the existing model of Bottle Jack QYLS5

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Abstract

A Bottle jack is a jack which works on the principle of hydraulics (hence falls under the category of hydraulic jacks) and resembles a bottle in its shape. It can be used for lifting vehicles to undergo repair work or dealing with flat tires. It can also be used in interconnection with more bottle jacks for lifting structures and for some household purposes. With the use of bottle jacks short vertical heights can be achieved. The former model was carefully studied in terms of the design features, specifications, capacity and with the help of new methodology an attempt was made to fabricate a new design that can work horizontally, producing same capacity within the economic range. The work consists of the fabrication of the new model and projects the advantages of the new method over existing methods. The new design was successfully made and was able to fulfill all the required objectives. The following work can be a new eye opener for the design engineers dealing with making the jack work horizontally.

Keywords: *horizontal bottle jack, hydraulic jack, fluid mechanics, automotive hydraulic jack, bottle jack.*

1. Introduction

A bottle jack consists of a cylindrical body and a neck. The hydraulic ram, which makes contact with the object to be lifted, emerges from the neck of the bottle jack. Pierre Louis George Du Buat, 1734-1809 not only conducted a wide variety of experiments but also wrote an excellent textbook on hydraulics which -- in spite of his being forced to flee during the revolution -- went through three successively enlarged editions. Du Buat formulated perceptively the resistance of closed conduits and was the first to show that the drag of immersed bodies resulted more from the suction produced at the rear than from the pressure exerted at the front. (http:// www.lib.uiowa.edu/scua/bai/hydraul.htm)

Leonardo da Vinci, 1452-1519 was the one who first emphasized the direct study of nature in its many aspects.
Leonardo's hydraulic observations extended to the detailed characteristics of jets, waves, aud eddies, not to mention the flight of birds and comparable facets of essentially every other field of knowledge. In particular, it was Leonardo who first correctly formulated the basic principle of hydraulics known as continuity: the velocity of flow varies inversely with the cross-sectional area of a stream.(http:// www.lib.uiowa.edu/scua/bai/hydraul.htm)
People have started feeling the need of having a bottle jack that works horizontally to move heavy objects on a horizontal plane or to spread an opening. However, in order to make the bottle jacks work horizontally it requires that the pump be placed lower than the piston so that the hydraulic fluid does not leak into the piston reservoir thereby causing a loss of pressure.

Richard Dudgeon 1819-1869 the owner and inventor of hydraulic jacks started a machine shop. In the year 1851, he was granted a patent for his hydraulic jack. In the year 1855, he literally amazed onlookers in New York when he drove from his abode to his place of work in a steam carriage. It produced a very weird noise that disturbed the horses and so its usage was limited to a single street. Richard made a claim that his invention had the power to carry near about 10 people on a single barrel of anthracite coal at a speed of 14 m.p.h. Dudgeon deserves a special credit for his innumerable inventions including the roller boiler tube expanders, filter press jacks, pulling jacks, heavy plate hydraulic hole punches and various kinds of lifting jacks. (http://EzineArticles.com/886634)

2. Materials and Methods

Inside the Bottle jack is an operating arrangement that is comprised of a reservoir, a main cylinder, a main piston, a pump piston, pump cylinder, check valves, a release valve, oil, oil ports and many seals to prevent air or oil leakage in the pressurized system. The check valves are the important parts of the arrangement and deliver the main function of preventing oil within the ports from traveling in the wrong direction. The pump piston is connected to a lever that is moved up and down with a long handle provided when the bottle jack is placed under the vehicle. The up-and-down action of the lever moves the pump piston up and down within the pump cylinder. As the pump piston is moved upward in the pump cylinder, it creates a suction that pulls

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open the first check valve and draws oil from the reservoir through the oil ports and thereafter into the pump cylinder. As the lever is brought downward, the pump piston pushes the oil, closing the first check valve and opening a second check valve.

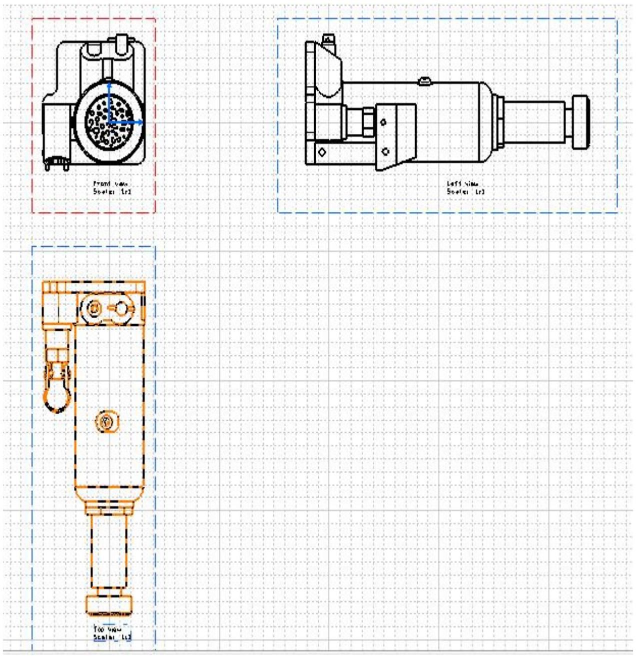

Fig.1: 2-D drawing of the bottle jack –Model No. QYLS5

The pump piston is pushed upwards with force of oil. The pressurized oil pushes through another o il port to the main cylinder where it lifts the main piston upward. As the lever is lifted upwards again, the second check valve closes and the first check valve reopens to draw more oil into the pump cylinder. The process is repeated until the piston reaches the desired height.

Fig. 2: 3-D drawing of the bottle jack – Model No. QYLS5 before adopted changes

In an existing **Bottle Jack- Model No. QYLS5** an upward stroke of the handle sleeve draws oil from the oil reservoir and the oil goes into the plunger cavity and thereafter downward stroke of the handle pushes the oil from the plunger cavity into the piston and lifts the saddle upwards. When the saddle reaches its maximum height, the release valve is turned anticlockwise and the oil flows back into the reservoir thereby bringing the saddle down.

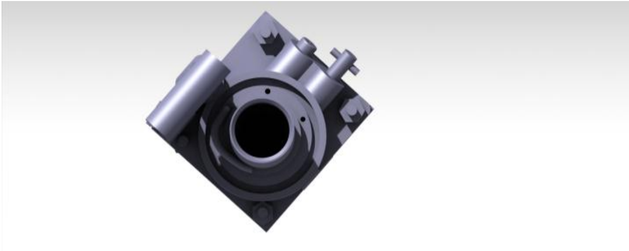

Fig. 3: 3-D drawing of the Bottle jack- Model No. QYLS5

2.1 Methodology adopted for the proposed design

The proposed design had the following objectives:
i. To take the oil from the reservoir in the horizontal position using a copper-nickel alloy pipe of length of approx. 3 inches.
ii. To make the jack work horizontally.
iii. The change adopted should be provident.
To account for the above design a brake pipe of a Suzuki minivan was used. It was cut into a required length of 3 inches. The diameter of the pipe is uniform and is nearly same as that of the suction hole. The cut piece of the pipe is welded over the fluid suction hole using arc welding.

Fig. 4: Inside view of Bottle jack (Model no. – QYLS5) after welding the pipe

Fig. 5: Inside view of Bottle jack (Model no. – QYLS5) after using the adhesive and bending the pipe

For better results a mixture of fast curing epoxy compound adhesive was used. Thereafter, the pipe is bent such that its open end lies in the region where the fluid is situated when the jack is placed horizontally. Given above is the picture taken after applying the adhesive.

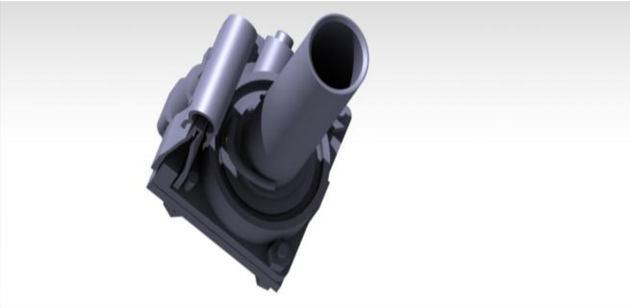

Fig. 6: 3-D drawing of the Bottle jack (Model no. QYLS5) after bending the pipe

2.2 Calculations

Here, the time taken by the fluid to move from the reservoir to piston is taken into account. The piston is lifted immediately with every stroke of the handle sleeve. Therefore it can be concluded that the time taken in a basic bottle jack (Model No. QYLS5) to reach from the reservoir to piston is less than a fraction of a second. Using the formulae given below it can be demonstrated that the time taken by the fluid to go through the pipe attached, which is made of Cu-Ni alloy, differ by 0.3 seconds approximately. Hence the pipe is viable. Applying principle of continuity for incompressible fluids:

$$A_1v_1 = A_2v_2 \quad (1)$$

Where A_1 & A_2 are the areas of the pipe at both the ends and v_1 & v_2 are the velocities at both the ends.

$A_1 = A_2 = 9.6mm^2$

$$V = D/t \quad (2)$$

$$t = D/V \quad (3)$$

Here D = 3inches (length of pipe) + 5inches (distance travelled by fluid to reach from reservoir to piston when the pipe is not attached).
= 8inches
V = 10inches/second

Case 1 (when the pipe is not attached)
Using equation (3)
t = 0.5 seconds.
Case 2 (when the pipe is attached)
Using equation (3)
t = 0.8 seconds.

Table 1 Material used

S. No.	Name of Part	Material
1.	Reservoir	Mild Steel
2.	Oil plug	Rubber
3.	Cylinder	Mild Steel
4.	Piston rod	Alloy Steel
5.	Oil drain valve	Cast iron
6.	Saddle	Mild steel
7.	Handle	Mild Steel
8.	Backing	Cast iron
9.	Oil suction pipe	Cu-Ni alloy

After the changes adopted following were the developments:

- Same fluid was used
- The pipe was successfully attached to the suction hole

Conclusions

Fig. 7: 3-D drawing of the bottle jack – Model No. QYLS5 after adopted changes

1. The capacity of the jack was not affected by adopting the change.
2. The fluid could flow from the reservoir to piston in a negligible time difference as compared to the previous case where pipe was not attached.
3. The jack was working smooth in horizontal position.
4. Less maintenance was required.
5. The change adopted was economical.

Hence, the modified jack can be used anywhere without any limitations whatsoever. With a little change, that was quite economic and viable, one can attain proper working of the jack when kept horizontally. This new finding can find various applications in the field of engineering and can help to tailor the need for a new horizontal bottle jack.

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