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DESIGN AND FABRICATION OF PNEUMATIC LIFTING TABLE OPERATED BY HYDRUALIC JACK

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Abstract: This project was created to allow people to lift any weight with the use of air pressure. A tank is used to hold high-pressure air. A zig-zag pattern connects a cylinder with piston arrangement. The air tank and the cylinder are linked by two pipelines with ball valves. The air rushes out of the cylinder when one of the valves is opened. As a result, the piston travels in a single direction. The piston-connected rod pulls the zig-zag frame up, causing the lift to rise. The air inside the cylinder is released when the other ball valve is opened. As a result, the lift descends.

I. INTRODUCTION

A jack is a very common mechanical device to lift heavy weights or to apply great forces. While mechanical Jack uses screw thread, hydraulic jacks use hydraulic cylinder to apply very high liner forces. Their most well-known application is raising and supporting an automobile to facilitate the replacement of a flat tire. Auto Mechanics use jacks all the time to raise cars up and down when working on them. Even individuals who work on cars out of necessity use jacks for lifting cars up. The easier it is to use a particular jack the better. While ordinary car jacks use mechanical advantage to help lift a vehicle for maintenance, more powerful car jacks use hydraulic cylinder to provide capacity for lifting higher loads over a greater capacity [1]. These jacks are rated on the basis of maximum lifting capacity and generally mentioned in tons i.e. 1.5 tons, 3tons etc [2].

Some researchers have worked on hydraulic jack. Sainath et al. [3] developed a mechanical hydraulic jack. The existing bottle hydraulic jack is a very common device used in this part of the world by different categories of people - auto mechanics, vulcanizers, and individual motorists among others. One and most of its application is in the raising and supporting an automobile to facilitate the replacement of a flat tire. But the problems with this type of jack include- hand use which is laborious in operation, spine and arm aching etc. some other existing jacks of the type described here (floor jacks) have so far been made with a rigid frame and solid wheels, without compensation for flexing under load to transmit the effect to the floor. Ikechukwu et al. [4] developed a foot operated hydraulic lifter for automobile workshops. They designed a hydraulic jack that greatly reduced human efforts from 2050.4 N to 136.7 N. They also incorporated compression springs which allows for flexing under load to transmit the effect of the load to the floor.

Therefore, there is urgent need to design a jack such that human effort will be reduced (although may be manually operated) to the barest minimum. The use of jack to lifting heavy objects, precisely an automobile in order to change a flat tire, is very helpful. It relieves the user out of the primitive method of using a lever for lifting which is more laborious and require greater effort [5]. The screw jack type, requires stressful and vigorous spinning of the screw while (the user) bending, curling or stooping down before lifting can be achieved. However, the better type of Jack with greater efficiency is the hydraulic jack [6]. But the common type in the market today is the cylindrical type with a lever or plunger that is used to pump the liquid that moves the piston.

This study only covers the design and fabrication of an accessory that can be connected to a 3 tonne hydraulic jack to operate it by pedaling while standing upright at a convenient position. Weights of hydraulic jack beyond 3 tonnes are not considered in this design.

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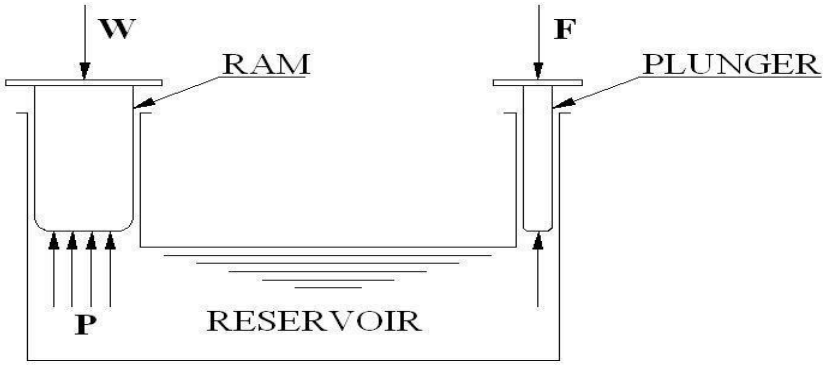
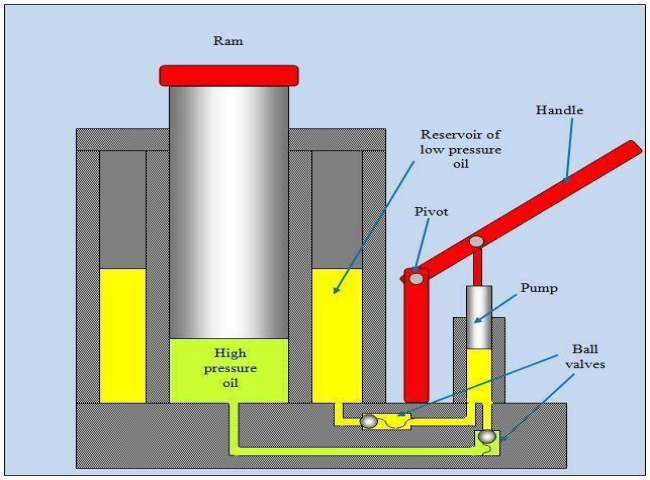


PRINCIPLE OF HYDRAULIC JACK

WORKING OF HYDRAULIC JACK:

Hydraulic jack works on the principle of ―Pascal‘s law
When the handle is operated, the plunger reciprocates then the oil from the reservoir is sucked into the plunger cylinder during upward stroke of the plunger through the suction valve. The oil in the plunger cylinder is delivered into the ram cylinder during the downward stroke of the plunger through the delivery valve. This pressurized oil lifts the load up, which is placed on top plate of the ram. After the work is completed the pressure in the ram cylinder is released by unscrewing the lowering screw thus the pressure releases and the ram is lowered, then the oil is rushed into the reservoir.It consists of plunger cylinder on one side and ram cylinder on the other side. These two cylinders are mounted on base which is made of mild steel. Plunger cylinder consists of plunger which is used to build up the pressure by operating the handle. Plunger cylinder consists of two non-return valves i.e. one for suction and other for delivery. Ram cylinder consists of ram which lifts the load. The ram cylinder connected to delivery valve of plunger cylinder. It is also consists of lowering screw this is nothing but a hand operated valve used for releasing the pressure in the ram cylinder for get down the load.



II. METHODOLOGY

DESIGN OF RAM CYLINDER

It is a cylinder in which produces a slide way to the ram. The ramcylinder is made up of mild steel with density of 7.868 gm/cc. Itis mounted on the base plate

Let,
d = inner diameter of ram cylinder D = outer diameter of ram cylinder
P = pressure acting on cylinder =25 MpaW = load =60kN T = thickness of ram cylinder

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DESIGN OF PLUNGER CYLINDER:

The plunger cylinder is made up of mild steel and is mounted on thebase plate. It provides slide way to the plunger in order to build up the pressure.
Let
d_p = inside diameter of plunger cylinder = 8 mmD_p = outside diameter of plunger cylinder
t_p = thickness of plunger cylinder

Assume the thickness of plunger cylinder (t_p) = 5 mm Tensile strength of mild steel (σ_t) = 120 N/mm^2
By LAME'S equation
t = 5+ 5.0625(25 - 1) 126.5625 – 5.0625 +5.0625
= 126.5625 – 25
6.0625 = 101.5625
= 16.752 N/mm^2

Hence the induced tensile strength of M.S. is less than permissible value. So, the design is safe. By using thickness and inside diameter, we can calculate the outer diameter of plunger cylinder
$D_p = d_p + 2t$
= 8+2(5)
= 18 mm
Outer diameter of plunger cylinder (D_P) = 18 mm

DESIGN OF PLUNGER:

Let the plunger is made up of mild steel which reciprocates in plungercylinder to increase the pressure of the oil.
Let,
W = load acting on plungerd_p = diameter of plunger
P = pressure developed in plunger cylinder

From standard table inside diameter ofplunger cylinder is fixed i.e. 8 mm Load acting on plunger = pressure × area
= 25×10^6 = 1256.63 N
= 128.09 kg
We taken Load acting on the plunger =130 kg

Performance Evaluation:
The component was tested using different kinds of automobiles, this was carried out to determine the effectiveness of the component and to determine its longevity being a new component.
For effective evaluation, the following were ensured to be in place:

- The vehicle selected was properly packed and well chocked.
- The release valve of the jack was securely locked into position in the clockwise direction.
- The right place under the vehicle was located in order to place the jack.
- The jack was rolled under with the aid of the tyres and placed in the proper place.
- In case of cars with higher height, the ram of the jack was unscrewed from the piston up to the point of carriage.
- The pedal was used to actuate the pump to raise the main piston and to establish a firm grip with the vehicle.
- After these, the pedaling was continued, noting the number of strokes and also timing it, till it lifts the tyre of the ground.

Table 1 represents the performance evaluation of pedal operatedhydraulic jack while Table 2 represents the performance test of hand operated hydraulic jack. Weight of each car was considered, the time to lift the tyre off ground was also considered together with the number of strokes. The pedal operated hydraulic jack was compared with the hand operated hydraulic jack without the accessory as represented below. It takes lesser time to lift the vehicle off ground using the pedal operated hydraulic jack compared to the hand operated hydraulic jack

Fig. 3 gives the representations of the time in which the tyre leaves the ground against the weight of the vehicle while Fig. 4 represents the number of the strokes to lift up the tyre off the ground against the weight of the vehicle. Looking at both graphs, it was realized that normal jack is a little bit faster than the Pedal operated jack, this is due to the loss caused

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by the link when jacking and also the stiffness of spring used. But the major aim of this design is to add an accessory that will facilitate the ease of jack use, the safety of use and the friendliness/convenience of operation of the equipment which has been achieved.

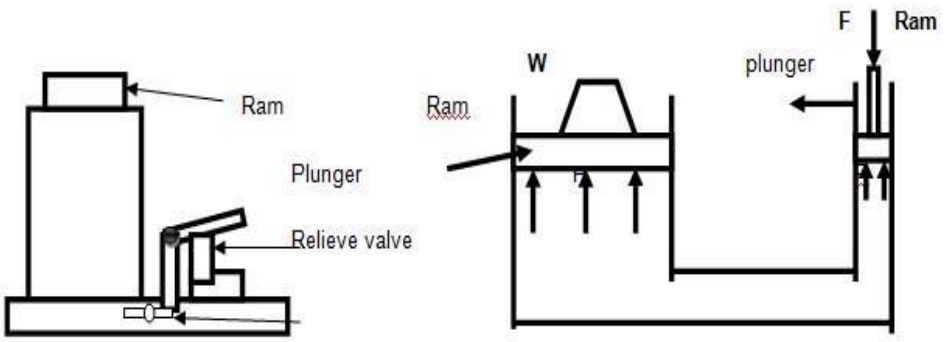


Fig 1(a) A Bottle Hydraulic Jack (b) Principle of Hydraulic Jack

Detail Drawing and Assembly of the whole Machine

The assembly of the pedal operated hydraulic jack is shown Fig. 5. The assembly contains rear pipe, T-nut, bolt, compression spring frame, metallic wheel, compression spring, hydraulic jack handle, hydraulic jack, return spring, connecting bar, foot pedal frame, foot pedal guide, foot pedal bar, foot pedal support and foot pedal.

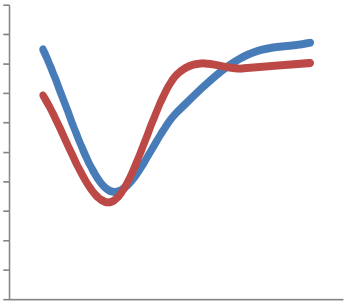
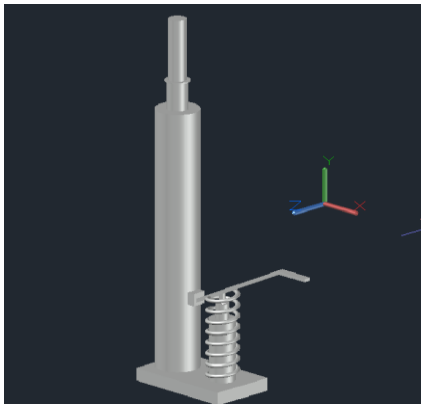


Fig. 4. Graph of times (seconds) against weight (Kg)

Hydraulic jack:

A hydraulic jack is a mechanical device used as a lifting device to lift heavy loads or to apply great forces. A hydraulic jack uses a liquid, which is incompressible, that is forced into a cylinder by a pump plunger.
Oil is used since it is self-lubricating and stable.



Final Assembled figure:

It is the assembled figure in which the model is being fabricated with all the above mentioned parts.

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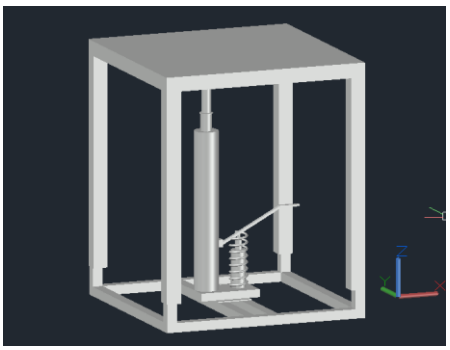
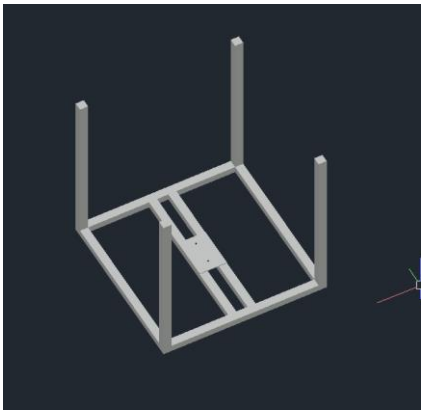


Base frame:
It is the main supporting part of our project. The hydraulic jack, shear cutter, fulcrum rests on the base frame. It is made up of mild steel square bar and plate. The spring is attached to the base frame.



III. CONCLUSION

This work looked at the possibility of controlling a hydraulic jack using a pedal operated linkage mechanism. This modification greatly reduced stress and allows for comfort during usage in an automobile workshop, and the effort required is also very minimal. The test results showed that this pedal operated hydraulic lifter for automobile workshops performed much more efficiently than the hand operated hydraulic lifter. The designs made are in terms of lifting effectiveness, usage, occupied space, easy transportation, easy maintenance, and method of operation by foot pedal. This is more convenient than hand use. In terms of cost, it is affordable to the common users of hydraulic jacks.

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