Automatic Hydraulic Jack Inbuilt In A Four Wheeler

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Abstract: With increasing levels of technology efforts being put to increase the comfort and safety. These can be done by implementation of better design. This paper describes Implementation of Automatic hydraulic jack Mechanism in a four wheeler itself. The jack will be powered by the battery. So at a time of puncture to replace the wheel one has to just press the button and the jack which is fitted in the car itself will lift the car.

Index Terms: Hydraulic Jack, 4-wheeler, Lifting Mechanism, Pascal Law, flat tyre

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1 INTRODUCTION

A jack is a mechanical device used as a lifting devices to lift heavy loads or apply great forces. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. The hydraulic jack is the most common form of jacks used for lifting. Various innovations have been done in the hydraulic jack with different electronic devices. With the help of technology the priorities are given to safety, luxury and comfort. The hydraulic jack is based on the pascal's law. The available jacks in the market are time consuming and also require much efforts which makes use of jack very difficult. As the jack is also required to set at "jack point" which further increases the complications in its application. So need of automatic inbuilt jack in automobiles is inescapable. can be vastly used in light weight to medium weight cars. It can also be used as maintenance purpose. The project can be made highly feasible if considered while designing the vehicle.
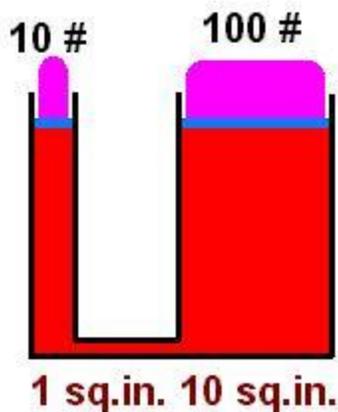

Figure 1 : Pascal's Law

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The pascal's law gives us the fundamentals of mechanics that works with hydraulics. The figure above shows that we can lift a large amount of weight with a small amount of effort.

2. DESIGN OF HYDRAULIC JACK

2.1 Design Parameters
- Inner diameter of cylinder   = 45 mm
- Outer diameter of cylinder   = 53 mm
- Thickness of the cylinder   = 4 mm
- Pressure inside the cylinder = 9.43 N/mm²
- Maximum tensile strength   = 210 N/mm²
- Factor of safety   = 3
- Yield strength   = 210/3
                                                =70 N/mm²

2.2 Design calculation
Assuming internal diameter = 45mm
Area = $\prod r^2$
$\quad$ = $\prod * (22.5)^2$
$\quad$ = 1590.43 mm²
Pressure P = F/A

Assuming pressure force (F) = 15000 N
$\qquad\qquad\qquad$ P = 15000/1590.43
$\qquad\qquad\qquad\quad$ =9.43 N/mm²
Applying Lame's theory
Px = b/x² – a……………..Radial Pressure
σx = b/x² + a……………..Hoop stress
$\quad$ Where a and b are constant.

Px = b/x² – a
9.43 = b/(22.5)² – a………………(1)
σx = b/x² + a
70 = b/(22.5)² + a………………(2)
By solving this equation
$\qquad$ b = 20105.72
$\qquad$ a = 30.28

For external radius of cylinder Px = 0
Px = b/x² – a
0 = 20105.72/x² – 30.28
x² = 664
x   = 25.77 mm

Therefore, thickness of cylinder = 25.77 – 22.5
$\qquad\qquad\qquad\qquad$ = 3.27 mm

Therefore, we take the thickness of cylinder is 4 mm.

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3. EXPERIMENTAL SETUP

Figure 2 : *Experimental Setup*

3.1 Motor Specification
Motor is of 12 v D.C
Motor power = 300 W
               = 0.4 HP
Motor rpm   = 3000 rpm
Motor torque = 1 N.m

3.2 Pump Specification
Pump type = Gear pump
Flow rate = 15 litre/m³ and
Pressure = 250 bar

Reasons Behind using gear pump
High speed
High pressure
No overhung bearing load
Relatively Quite Operation
Design accommodates wide variety of materials

3.3 CONROL VALVE

Need for hydraulic control valve
A hydraulic valve properly directs the flow of a liquid medium, usually oil, through your hydraulic system. The direction of the oil flow is determined by the position of a spool. A hydraulic system can only function - as per requirements - by using valves. Thus, you should always look for the correct type of hydraulic valve to serve your intended purpose. Hydraulic valves are available in a variety of sizes. The size required is determined by the maximum flow of the hydraulic system through the valve and the maximum pressure in the hydraulic system. Hydraulic valves are available with different mountings: e.g. mounting in pipe lines, threaded connection as cartridges, sub plate mounting, etc.
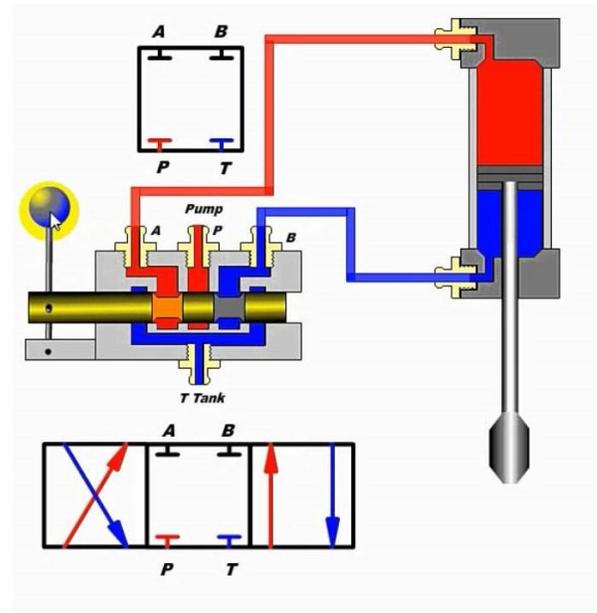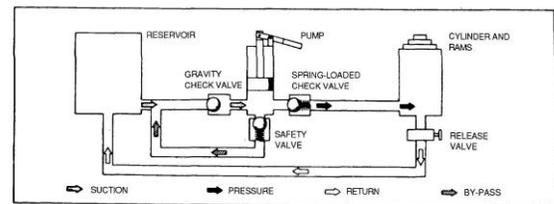

Figure 3: *Control valve*

Figure 4 : *Schematic Diagram of setup*

4 METHODOLOGY
Our mechanism is mainly used for lifting the car. The mechanism is powered by the battery. The control of the mechanism will be provided at the user hand. When the operator presses the switch, the battery will run the hydraulic pump. The pump will press the oil from the reservoir to the control valve. The flow of oil to the double acting hydraulic cylinder can be controlled with the help of this control valve. When control valve directs the oil to the cylinder for a lifting stroke the pressure will be imparted to the piston and the stroke will take place. Then the piston will start lifting the car on reaching the ground level. For the down movement of a lifted car the user can again operate the control valve which will direct the flow of oil to the other side of cylinder and the stroke will be imparted with pressurized oil. After operation the user will press the off button and that will cut-off the electrical power to the motor. This will stop the pump and the circulation of oil in the system.

5 Expected Outcome
- Automobile with an inbuilt hydraulic jack requires less to no efforts and saves time.
- As the jack is automatically operated the complications of finding the jack point is neglected. so,it can be easily operated by a rookie and women.
- It will also make the maintenance of the vehicle easy.
- User can easily use the jack in any environmental condition.

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- Oil wastage is eliminated.
- Light loaded vehicle can be easily lifted.
- Here, the cooling operation of moving parts is done by oil itself so no separate cooling is required.
- Hydraulic systems are smooth and quite in operation.
- Vibration is kept to minimum level.

6 Conclusion

With some design consideration an inbuilt car lifting mechanism can easily be fitted in all light weight automobiles. The project works on hydraulic power provided by battery. Maintenance and service of the vehicle can be easily done by this project. With this project the usage of automobile can be made easy for women and old people. Some extra automation like solenoid control valve can add great value to the project. The inbuilt jack is operated by battery so it can also be used when the vehicle engine is not started.

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