

# Inbuilt Hydraulic Jack in Automobile Vehicles

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**Abstract-** An inbuilt hydraulic jack system is attached to automobile vehicle on front and rear part of the chassis. An automobile hydraulic jack system can be easily attached to all currently manufacture automobile chassis and frames. There is a front suspension hydraulic jack that is mounted centrally to the front suspension of an automobile between its front wheels. There is also a rear suspension hydraulic jack that is mounted centrally to the rear suspension of the automobile between its rear wheels. The system operates from a compressed fluid reservoir tank that has connections for the front and rear car jack outlets. Additional outlets can be added to the compressed fluid reservoir tank for connecting a hydraulic lug wrench and another for a tire inflating hose.

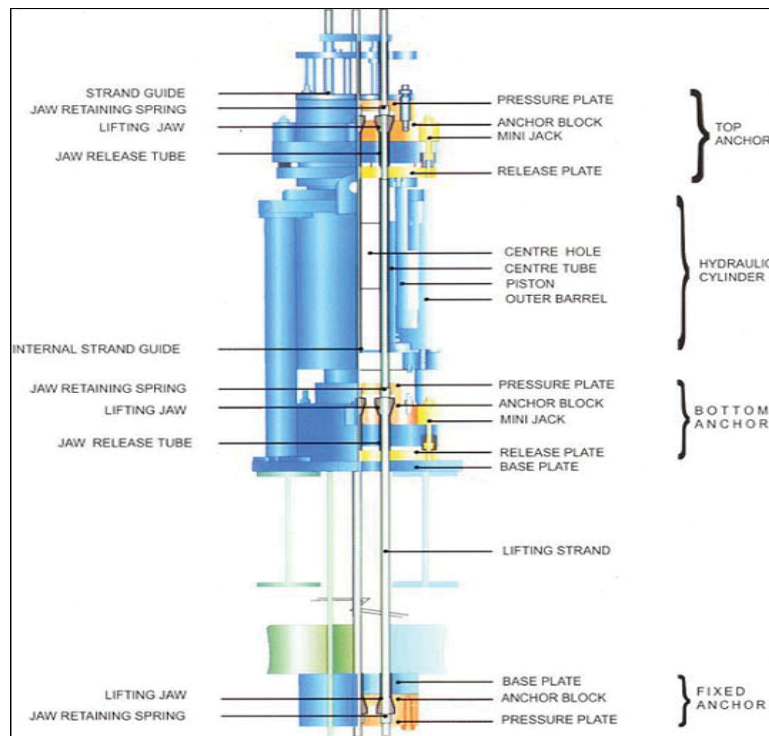
The Major Project entitled “Inbuilt hydraulic jack in automobile vehicle” Worked on the principal of hydraulic power and operated by 12 Volt DC current, solves the all major problem of maintenance of all automobiles specially the heavy vehicles like truck and bus.

This work, if implemented, would definitely help in the maintenance of automobiles and also in saving of time.

## I. INTRODUCTION

Hydraulic jacks work on the basis of Pascal's Principle, named for Blaise Pascal, who lived in the seventeenth century. Basically, the principle states that the pressure in a closed container is the same at all points. Pressure is described mathematically by a Force divided by Area. Therefore if you have two cylinders connected together, a small one and a large one, and apply a small Force to the small cylinder, this would result in a given pressure. By Pascal's Principle, this pressure would be the same in the larger cylinder, but since the larger cylinder has more area, the force emitted by the second cylinder would be greater. This is represented by rearranging the pressure formula  $P = F/A$ , to  $F = PA$ . The pressure stayed the same in the second cylinder, but Area was increased, resulting in a larger Force. The greater the differences in the areas of the cylinders, the greater the potential force output of the big cylinder. A hydraulic jack is simply two cylinders connected. An enclosed fluid under pressure exerts that pressure throughout its volume and against any surface containing it. That's called 'Pascal's Principle', and allows a hydraulic lift to generate large amounts of FORCE from the application of a small FORCE. For lifting cars in car service station hydraulic jacks are used. High pressure liquid is filled in the jack cylinder by hydraulic pump, due to the pressure the piston moves up. To lower the piston valve is provided by which the liquid returns to the hydraulic tank. Hydraulic Jacks are portable devices used for raising heavy objects by means of force applied with a lever or

screw. The hydraulic jacks are compact and lightweight units that are used for lifting capacities. They offer easy operation and are fast acting components. The hydraulic jacks come with inbuilt release pedal for rapid lowering and lugs that make it easy to mount. The heavy duty chassis prevents the jack from twisting or bending and foot pump provides fast lift to the load. It also has a safety overload valve that prevents overloading beyond rated capacity. Unlike the traditional screw type jack which has to be turned with a long handle, the hydraulic jack uses oil pressure to displace (lift) the vehicle by mere moving a lever or handle up and down. This is very easy to operate and with this even a child can operate and lift a vehicle using the hydraulic jack.



## II. HYDRAULIC JACK

### 2.1 HYDRAULIC FLUID

Hydraulic fluids are a large group of fluids used as the motive medium in hydraulic machinery. Fluid types include synthetic compounds, mineral oil, water, and water-based mixtures. The fluids are found in machinery and equipment ranging from brakes, power steering systems, and transmissions to backhoes, excavators, garbage trucks and industrial shredders. Hydraulic systems are very common in aircraft flight control systems.

Hydraulic fluids can contain a wide range of chemical compounds, including: oils, butanol, esters (e.g. phthalates, like DEHP, and adipates, like bis (2-ethylhexyl) adipate), polyalkylene glycols (PAG), phosphate esters (e.g. tributylphosphate), silicones, alkylated aromatic hydrocarbons, polyalphaolefins (PAO) (e.g. polyisobutenes), corrosion inhibitors, etc.

### 2.2 HYDRAULIC CYLINDER

A Hydraulic cylinder (also called a linear hydraulic motor) is a mechanical actuator that is used to give a linear force through a linear stroke. It has many applications, notably in engineering vehicles.

### 2.3 OPERATION

Hydraulic cylinders get their power from pressurized hydraulic fluid, which is typically oil. The cylinder consists of a cylinder barrel, in which a piston connected to a piston rod is moving. The barrel is closed by the cylinder bottom and by the cylinder head where the piston rod comes out of the cylinder. The piston has sliding rings and seals. The

piston divides the inside of the cylinder in two chambers, the bottom chamber and the piston rod side chamber. The hydraulic pressure acts on the piston to do linear work.

A hydraulic cylinder is the actuator or "motor" side of this system. The "generator" side of the hydraulic system is the hydraulic pump that brings a fixed or regulated flow of oil into the system. Mounting brackets or clevises are mounted to the cylinder bottom as well as the piston rod.

By pumping hydraulic oil to the bottom side of the hydraulic cylinder, the piston rod starts moving upward. The piston pushes the oil in the other chamber back to the reservoir. If we assume that the oil pressure in the piston rod chamber is zero, the force on the piston rod equals the pressure in the cylinder times the piston area. If the oil is pumped into the piston rod side chamber and the oil from the piston area flows back to the reservoir without pressure, the pressure in the piston rod area chamber is  $\text{Pull Force}/(\text{piston area} - \text{piston rod area})$ . In this way the hydraulic cylinder can both push and pull.

Parts of a hydraulic cylinder

- (1). A hydraulic cylinder consists of the following parts:
- (2). Cylinder barrel
- (3). Cylinder bottom
- (4). Cylinder head
- (5). Piston
- (6). Cylinder bottom connection
- (7). Piston rod connection
- (8). Feet for mounting of the barrel

A hydraulic cylinder should be used for pushing and pulling and no bending moments should be transmitted to the cylinder. For this reason, the ideal connection of a hydraulic cylinder is a single clevis with a ball bearing.

#### 2.4 ADVANTAGES OF HYDRAULIC

- fluid does not absorb any of the supplied energy.
- It is capable of moving much higher loads and providing much higher forces due to the incompressibility.
- The hydraulic working fluid is basically incompressible, leading to a minimum of spring action. When hydraulic fluid flow is stopped, the slightest motion of the load releases the pressure on the load; there is no need to "bleed off" pressurized air to release the pressure on the load.

#### 2.5 DESIGNING OF INBUILT HYDRAULIC JACK IN AUTOMOBILE

The research project is carried out for Maruti-Alto car, where two hydraulic jacks are fixed on the front and rear portion of chassis. Figure 4.1 shows the model of project in details. Jacks work on the principle of hydraulic power and operated by a battery.

#### 2.6 SPECIFICATION OF COMPONENTS USED

*Battery:*

Voltage: 12V

Type: D.C. Generator

*Jacks:*

No.: Two hydraulic jacks

Capacity: Depends on the vehicle type (for Maruti-Alto, 500 Kg each)

Type: Hydraulic

Principle of operation: Hydraulic Power

*Paddle:*

- No.: Two
- Shape Rectangular (may be circular also)
- Size: Depend on vehicle type (for Maruti-Alto, 30cm X 30cm)

Weight

Depend on vehicle type (for Maruti-Alto, 15 Kg)

Cost: 15,000/- for Maruti-Alto

## 2.7 DESIGN OF HYDRAULIC JACK

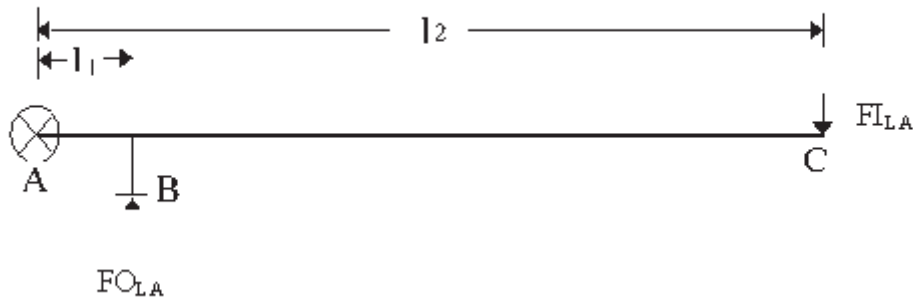
This work describes a procedure for determining the mechanical advantage and efficiency of a small hydraulic jack. The testing procedure and required calculations demonstrate how the efficiency of a simple machine can be determined, and how multiple mechanical advantages in a simple machine have a multiplying effect, rather than an adding effect. The cost to set up the experiment is relatively low, yet very informative for the students.

Hydraulic jacks provide a means of lifting loads that otherwise could not be lifted by conventional mechanical (screw and scissors) jacks. A common hydraulic jack with a lever arm and pump has two Mechanical Advantages (MA) built into it. One MA is due to the lever arm and the other is due to the ratio of the ram piston diameter squared ( $D^2$ ) to the pump piston diameter squared ( $d^2$ ),  $D^2 / d^2$ . The two MA's combine in a manner that results in a multiplying effect rather than an adding effect, which yields a much larger overall MA. The efficiency of a jack can be determined from the basic definition of efficiency, which is output / input.

A hydraulic jack has a relatively large overall MA due to the lever arm and the ratio of the ram piston diameter squared to the pump piston diameter squared.

The MA due to the lever arm can be demonstrated and determined by analyzing the simple lever arm shown in Figure 4.1.

Point A is the lever arm pivot point, Point B is where the lever arm applies an output force ( $FO_{LA}$  = force out, lever arm) to the jack's pump and Point C is where the input force ( $FI_{LA}$  = force in, lever arm) to the system is applied, usually by hand.



## 2.8 HYDRAULIC JACK LEVER ARM

Summing moments about Point A yields;

$$\sum M_A = 0 = (FO_{LA} * l_1) - (FI_{LA} * l_2)$$

or

$$(FO_{LA} * l_1) = (FI_{LA} * l_2)$$

or

$$FO_{LA} / FI_{LA} = l_2 / l_1$$

The mechanical advantage due to the lever arm is either of the above ratios, or

$$\text{MA lever arm} = \text{FO}_{LA} / \text{FI}_{LA} = l_2 / l_1.$$

**Eqn. (1)**

It is usually difficult to determine FO<sub>LA</sub>, but easy to measure l<sub>1</sub> and l<sub>2</sub>, and therefore possible to calculate MA lever arm.

The mechanical advantage due to the ratio of the ram diameter squared to the pump diameter squared can be developed by analyzing the basic fluid principles of the jack. A simplified hydraulic jack is shown in Figure 4.2.

Point A is where the force into the system is applied (FI<sub>LA</sub>) and Point B is where the force out of the system (FO<sub>HS</sub> = force out, hydraulic system) is used to lift a load. In the case of a jack the force out of the lever arm (FO<sub>LA</sub>) is equal to the force into the hydraulic system (FI<sub>HS</sub>) at the pump.

The definition of fluid pressure is a force per unit area, or in equation form,

$$P = F / A$$

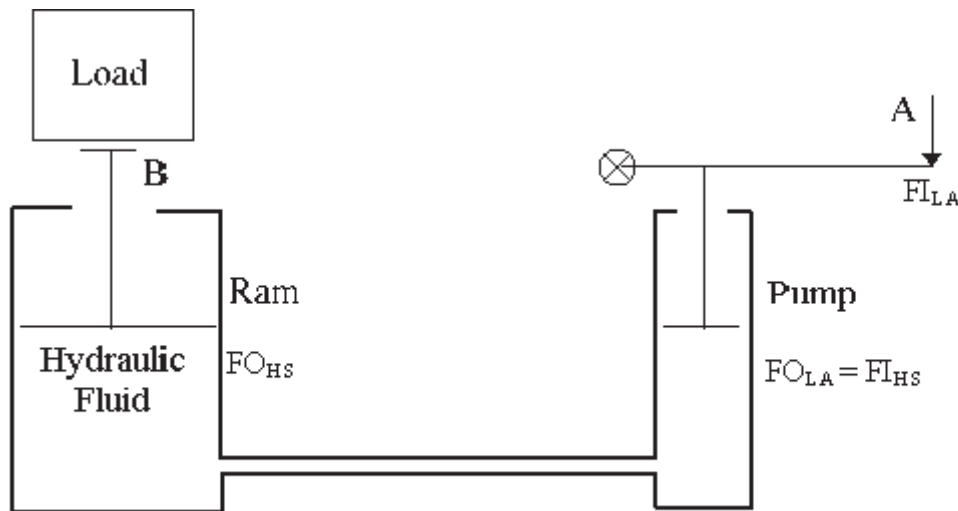
**Eqn. (2)**

Where

P = pressure (N/m<sup>2</sup>),

F = force (N), and

A = area (m<sup>2</sup>)



Simple hydraulic jack system

The pressure throughout the hydraulic fluid is assumed to be constant, and for Figure 2 the following applies,

$$P = FOHS / AD = FIHS / Ad$$

Where

P = the pressure of the hydraulic fluid in the jack (N/m<sup>2</sup>)

AD = the area of the ram piston (m<sup>2</sup>) and

Ad = the area of the pump piston (m<sup>2</sup>)

Rearranging the above yields

$$FOHS / FIHS = AD / Ad = (p D^2/4) / (p d^2/4) = D^2 / d^2$$

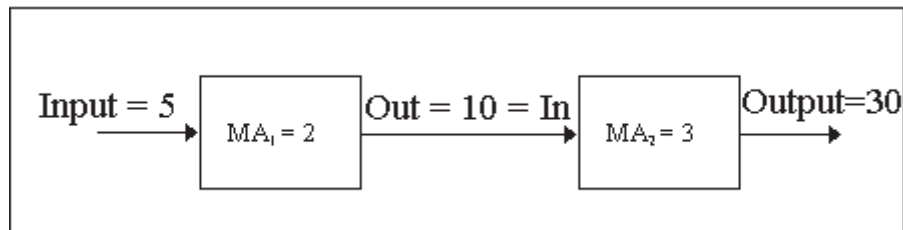
The mechanical advantage of the hydraulic system is any of the above ratios, or

$$MA \text{ hydraulic system} = FOHS / FIHS = AD / Ad = D^2 / d^2 \quad \text{Eqn (3)}$$

Measuring the piston diameters is usually easier than measuring the forces into and out of the hydraulic system.

Total mechanical advantage

Figure 4.3, demonstrates how two MAs, MA1 and MA2, can be manipulated to determine the overall MA total.



One system with two mechanical advantages

$$MA_{\text{total}} = \text{Out} / \text{In} = 30 / 5 = 2 * 3 = 6$$

Figure shows that the total system MA is determined by taking the ratio of the output to the input, or by multiplying the individual MAs.

For the topic at hand, the total mechanical advantage of the hydraulic jack would be determined by multiplying the MA of the lever arm by the MA of the hydraulic system,

or

$$MA_{\text{total}} = MA_{\text{lever arm}} * MA_{\text{hydraulic system}}$$

The efficiency of the hydraulic jack can now be determined from the following,

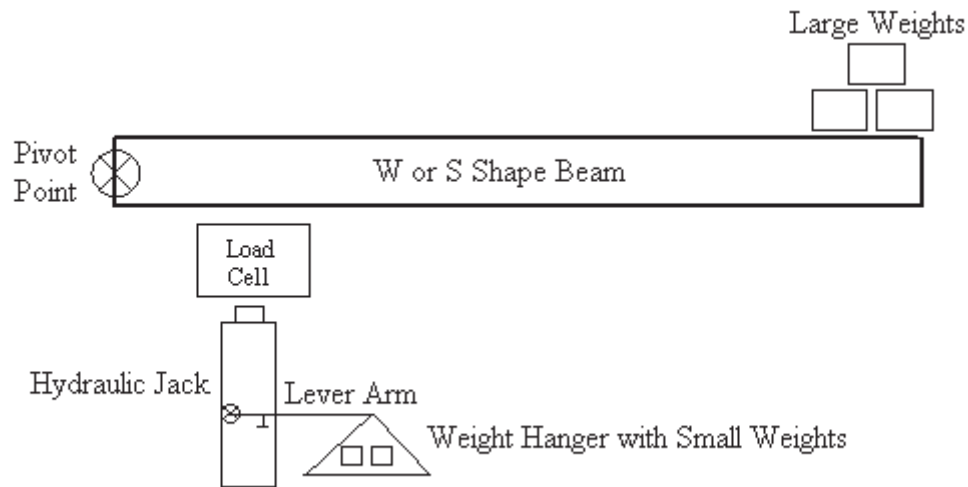
$$\eta = (\text{Output} / \text{Input}) * 100 = (\text{Output Force} / (\text{Input Force} * MA_{\text{total}})) * 100$$

$$= (\text{FOHS} / (\text{FILA} * MA_{\text{total}})) * 100 \quad \text{Eqn. (4)}$$

Where

$\eta$  = the jack efficiency (%)

The testing apparatus can be constructed out of readily available materials. A testing apparatus that could be used is shown in Figure 4.4.



Testing apparatus example

### 2.9 PROCEDURE FOR TESTING

- Weigh the weight hanger.
- Weigh the assorted small weights.
- Determine the mechanical advantage due to the lever arm on the jack by measuring the lengths  $l_1$  and  $l_2$ , and calculating the ratio  $l_2 / l_1$ .
- Determine the mechanical advantage due to the ratio of the piston diameters squared by measuring the pump piston and ram diameters, and calculating the ratio  $D^2 / d^2$ . The instructor may choose to disassemble the jack and measure the diameters before the experiment actually takes place to save time.
- Determine the total mechanical advantage of the jack by multiplying the individual MAs together.
- Place the jack in the testing apparatus.
- Place the weight hanger on the end of the hydraulic jack's lever arm.
- Add weights to the weight hanger until the jack just starts to lift the beam. Record the amount of weight on the weight hanger and the load cell force.
- Add large weight(s) to the beam.
- Adjust the position of the lever arm so that it remains horizontal as the hanger weights are applied to simplify the calculations.
- Repeat steps 8-10 eight to ten times throughout the load range of the jack.

### 2.10 PRINCIPLE OF OPERATION

Both hydraulic jacks are pivoted on the rectangular struts. The one end of jack is fixed to frame. The rectangular struts are kept hollow for reducing the weight. The rectangular paddles are also pivoted on the other end of struts. Hydraulic jacks are operated by 12 volt DC battery. At a single time, one and two both jacks can work and vehicle can lift from one side and also from two sides as per the requirement.

### 2.11 APPLICATIONS

The inbuilt hydraulic jacks system can be incorporate in any type of motor vehicle such as:

- In small cars
- In heavy loading vehicle like trucks and buses
- In heavy vehicles like crane and harvester

### 2.12 ADVANTAGES

- The maintenance of vehicle will be very easy.
- The servicing of vehicle will be easy and cheap.
- This type of system is very useful for ladies since during the problem of puncher of tyres, they can easily change the wheel.
- Time saving of maintenance.
- This is also very useful for heavy vehicles such as trucks and buses, since there is a common problem of breaking leaf spring plates, this system will help in changing of leaf spring plates.
- A single person can go on a long drive.
- Since whole system is operated by battery, jacks will also work when vehicle will not in starting condition.
- Both jacks can work at a single time also.
- Vehicle can easily wash at home also.

### 2.13 DISADVANTAGES

- Cost will increase slightly.
- Weight of vehicle will increase slightly.
- System can not work without 12 volt DC current.
- System required maintenance also

### 2.14 FUTURE SCOPE

The arrangement of inbuilt hydraulic jack system is designed for small car in this project work, but this arrangement can be widely use in future for heavy vehicles also by making some small modifications in current project.



### III. CONCLUSION

An inbuilt hydraulic jack system can be easily attached to all currently manufacture automobile chassis and frames. There is a front suspension hydraulic jack that is mounted centrally to the front suspension of an automobile between its front wheels. There is also a rear suspension hydraulic jack that is mounted centrally to the rear suspension of the automobile between its rear wheels. The system operates on the hydraulic power. This arrangement has many advantages such as maintenance and servicing of vehicle. With the help of this system the driving of vehicles will be easy especially for ladies. Arrangement is also very useful for heavy loading vehicles and a single person can go on a long drive. Whole system is operated by 12 volt DC battery; hence jacks will also work, when vehicle will not in starting condition. Both jacks can work simultaneously at a single time also.

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