

Inbuilt Hydraulic Jack System for Four Wheelers:-A new trend in automobile sector

Mayank Agrawal¹, Minti Gehlot Thakur², Deepanshu Mahajan³, Tejveer Singh Chahar⁴

^{1,2,3,4}Department of Mechanical Engineering, Dayalbagh Educational Institute, Agra, India

Abstract:- This paper represents a study over in-built hydraulic jack system and shows its benefits over traditional mechanical jack system. The design of inbuilt hydraulic jack is also studied and modified to require extent which can be seen by analyzing design of prototype.

An Inbuilt hydraulic jack system can be easily operated by buttons provided on the dash board of the vehicle. The jack will be installed on chassis of the vehicle. The system gets power by and this system consists of three main parts: master cylinder, hydraulic jacks and manifold. When car gets lifted with this system, load gets distributed on four points i.e., plunger or ram of hydraulic cylinder and three tires except the tire which is getting lifted. This system will be very useful for all the persons who are unaware regarding conventional mechanical jack or those who find it extremely difficult to operate the jack manually in any breakdown condition. The motive behind using this system instead of a conventional mechanical system is the more power produced by the system and simple in design as compared to a conventional design. As the hydraulic oil is incompressible so the lifting capacity is more in comparison with the pneumatic system which operates on air which is compressible.

I. INTRODUCTION

Hydraulics is the science of transmitting force or motion through the medium of a confined liquid. In a hydraulic device, power is transmitted by pushing on a confined liquid. The transfer of energy takes place because in a hydraulic device, power is transmitted by pushing on a confined liquid.^[1]

• Pascal's law-

Blasé Pascal formulated the basic law of hydraulics in the mid 17th century. He discovered that pressure exerted on a fluid acts equally in all directions. His law states that pressure in a confined fluid is transmitted undiminished in every direction and acts with equal force on equal areas and at right angle to a container's walls.^[2]

• Hydraulic Jack-

A hydraulic jack is a jack that uses a fluid to push against a piston. This is based on Pascal's law.

In the recent past there has been a significant increase in the use of hydraulics in our industries. The use of oil hydraulic systems as a means of power transmission in modern machines evolved a few decades earlier in the western world. But its applications in Indian industries are of comparatively recent choice and hence, there is great deal of urgency and importance to master the art of its applications and maintenance.

This system works by takes power from the engine of the vehicle in which it is used. Master cylinder takes power from engine and pressurizes the oil inside it. This pressure is transferred to manifold and distributed into four hydraulic cylinders.

II. LITERATURE REVIEW

P.S. Rana, P.H. Belge, N.A. Nagrare, C.A. Padwad in their case study of Integrated Automated Jacks for 4-wheelers have concluded that An Automobile hydraulic jack can be easily operated by a single push button provided on the dash board. The jack will be installed on both the sides of chassis according to the weight distributions of the car. Similarly it will be installed on the other side of the car. The system operates on hydraulic drive which consists of three main parts: hydraulic pump, driven by an electric motor, hydraulic cylinder to lift the vehicle. The hydraulic jacks actuate separately for either side of car as per the breakdown condition. The car gets lifted and load gets distributed on three point i.e., plunger or ram of hydraulic cylinder and two tires opposite to side which is lifted. This jack will be very useful for all the senior citizens and especially for females (ladies) who find it extremely difficult to operate the jack manually in any breakdown condition. The motive behind using hydraulic system instead of a pneumatic system is the more power produced by the system and simple in design as compared to a pneumatic design.

Rajmohan G, Jazim Haris, Mohamed Shafin K, Sabah Salam, Santhosh Kumar in Inbuilt Lifting Arrangements for Heavy Vehicles said that an inbuilt lifting and safety arrangements for a Four Wheeler with a hydraulic bottle jack system is attached to automobile vehicle on front and rear part of the chassis. During puncture or some repairs without lifting externally drop the hydraulic bottle jack

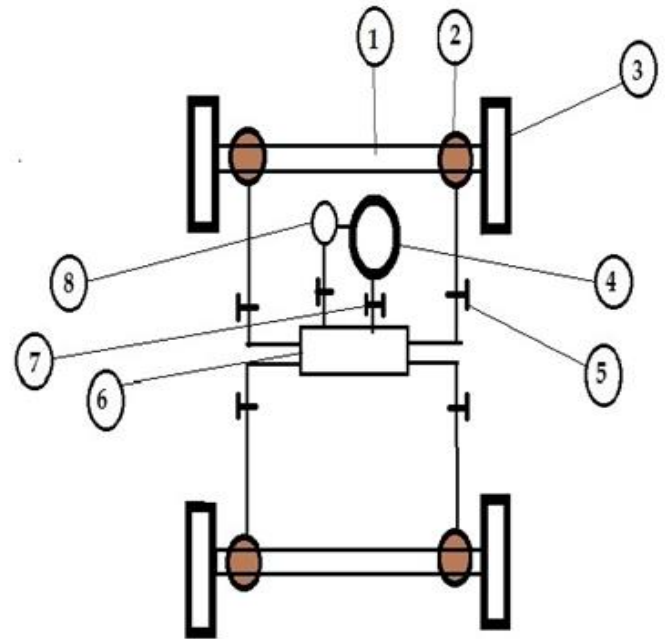
with a single button. For heavy vehicles like truck, lorry etc., it will be easy to we are fixed a mechanism to lift the vehicles for the four sides and by operating the motor in single switch. The hydraulic jack is operated by a cam which works under the mechanism of single slider crank chain. It consists of one sliding pair and three turning pair, the lever is connected with a return spring rod.

Professor. Mali P.K., Dept. of Mechanical, SGREF's G H Raisoni college of Engineering, Ahmednagar in DESIGN AND DEVELOPMENT OF AUTOMATIC PNEUMATIC JACK FOR FOUR WHEELER have said that fabrication is based on pneumatics which deals with the study and application of pressurized air to produce mechanical motion. Pneumatic jack is a fabricated model which when installed in four wheeler, will ease in the problems arising in the conventional operated jack. This fabricated model consists of a small size reciprocating air compressor which is driven by the battery used in four wheeler, an air tank to store the compressed air, and a pneumatic control valve used as a jack which performs lifting. Thus the car is lifted using jack and the problem related to tyres such as puncture tyres, tyre replacement and wheel balancing can be resolved with less effort and time.

Parth M Patel , Sunil M Shah in their case studies have also said that implementation of better design of hydraulic jacks will improve the comfort level and security to a great extent.

III. NEED OF INBUILT HYDRAULIC JACK

It is believed that 'Necessity is the mother of invention'. Here the necessity lies in reducing the human effort applied during manual operation of the jacks and hence the need of the invention. In day to day life it is very tedious job to operate the jack manually and it is also a very time consuming work as well. So to make it easier for everyone especially for aged person and for lady drivers. To provide a safe and simple automatic hydraulic jacking system without manual effort. To provide a novel jacking system that can be operated from within the vehicle by means of a dashboard control panel. There are certain mechanisms already available for the same purpose which has a definite capacity to lift the car on 2 wheels viz. a screw jack. But the general idea of the project is to minimize the human effort while operating the jack. To provide a novel hydraulic jacking system that is directly and permanently incorporated into the vehicle frame in such a way as to prevent the additional risk of damage or weathering.^[3,4,5].



- 1-Axle
- 2-Hydraulic jack
- 3-Tyre
- 4-Master cylinder
- 5-Valve
- 6-Manifold
- 7-Non-return valve
- 8-Oil reservoir

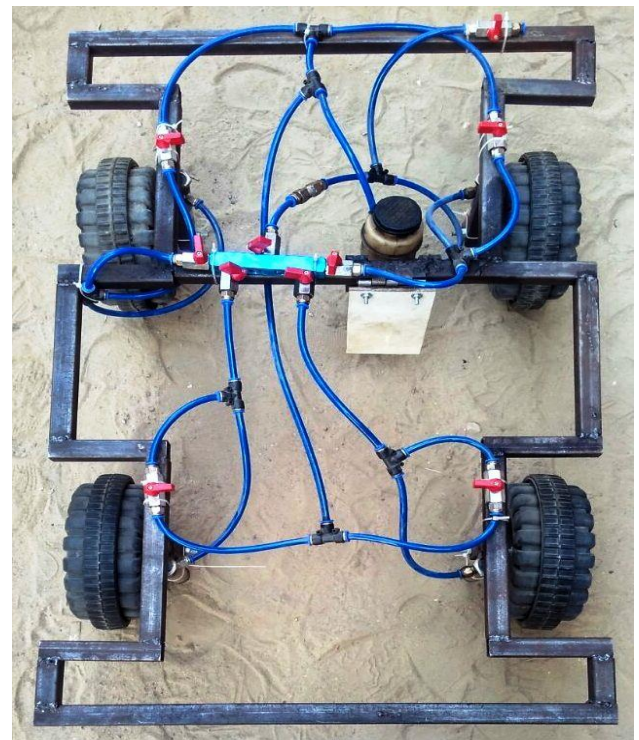


Figure 1

IV. MAIN COMPONENTS PRESENT IN PROTOTYPE

1. Hydraulic cylinder or jack
2. Manifold
3. Master cylinder
4. Non return valve
5. Valves
6. Hydraulic fitting and pipes

V. METHODOLOGY

Hydraulic jacks and much other technological advancement such as automobile brakes and dental chairs 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.^[6,7]

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 as described above. An enclosed fluid under pressure exerts that pressure throughout its volume and against any surface containing it. That's called 'Pascal's Principle.'^[8]

With the help of engine power we give the power to master cylinder with the help of gear arrangement. Master cylinder pressurizes the oil and sends pressurized oil to the manifold via hydraulic pipes. As a vehicle undergoes a tire failure than first we will turn on the valve of Manifold of failed tire jack. It will operate the failed tire jack, when power is given to the master cylinder by engine. Now when power is given to the master cylinder than the fluid from the master cylinder will pass through the master cylinder and make the piston in the hydraulic cylinder(jack) to move down and as the piston of hydraulic cylinder touches the ground than after further strokes of master cylinder that tire start raising.^[9]

This hydraulic jack system has six main parts. These are the Master cylinder, Hydraulic jacks, Reservoir, Manifold, Non return valve and valves. The reservoir holds hydraulic fluid. Master cylinder will draw the fluid up and then create pressure on the down stroke as it pushes the fluid

through the check valve. This valve allows the fluid to leave the reservoir and enter the main cylinder. In the main cylinder, the piston is forced up as the cylinder is filled with the fluid.^[10]

CALCULATIONS AND SPECIFICATION

Jack specification- Let, the weight of car (W) = 10000N and the weight hydraulic jack has to lift (w) =2500N
 Diameter of the piston/ram of hydraulic jack= 8cm=0.08meter
 Stroke length of cylinder (l₁) = 30cm=0.3meter

Area of cylinder (A₁)

$$A = \pi r^2$$

$$= 0.005m^2$$

Swept volume of cylinder (V₁)

$$V = \frac{\pi}{4} d^2 l$$

$$= 0.0015m^3$$

Master cylinder specification- And if the diameter of master cylinder =6cm=0.06meter

Stroke length of master cylinder (l₂) =10cm=0.10meter
 Area of master cylinder (A₂)

$$A = \pi r^2$$

$$= 0.0028m^2$$

Swept volume of master cylinder (V₂)

$$V = \frac{\pi}{4} d^2 l$$

$$= 0.00028 m^3$$

1. Master cylinder's stroke required to lift the jack

$$= \frac{\text{swept volume of jack}}{\text{swept volume of M. C.}}$$

$$= \frac{0.0015}{0.00028}$$

=5 approx.

2. Pressure required inside the master cylinder (P_m)

$$= \frac{\text{force or load on hydraulic jack}}{\text{area of jack's cylinder}}$$

$$= \frac{2500}{0.005}$$
$$= 500000 \text{ Pascal}$$

- After successful implementation of the above idea in small passenger cars, future developments can be made in design to apply the same in heavy duty automobiles also

RESULT AND CONCLUSIONS:

An inbuilt hydraulic jack system can be easily attached to all currently manufacture automobile chassis. There is a front suspension hydraulic jack that is mounted externally to the front suspension of an automobile between its front wheels.

There is also a rear delay hydraulic jack that is mounted externally to the rear suspension of the automobile between its wheels. The system operates on the hydraulic power. This arrangement has many advantages such as maintenance and servicing of vehicle. It reduce the security tension and easy to implement. Quick lifting is possible and Suitable for heavy load for about 100 kg or 1000N. The force to be applied at the working piston is 10 times lesser than the weight to be lifted. With the help of this system the driving of vehicles will be easy. Arrangement is also very useful for heavy loading vehicles and a single person can go on a long drive.

Automatic inbuilt jacking system in automobiles will not only save the effort of a person but will also save one's precious time under critical circumstances.

- This concept will eliminate the need of carrying a conventional mechanical jack while travelling..
- Motor operated mechanical jacks are already in the market but the jack's design is the area of concern. In order to make built-in jack system practical, jack's shape and type need modification.
- Mechanical jacks are pretty easily operated but their effectiveness and maintenance may become an issue as they will be move with chassis, constantly underneath hence, chances of rusting and damage is high.
- Hydraulic jacks look convenient to use and can also prove quite effective and easy to maintain (as completely closed) in long run, they will provide more power too but there are also some challenges like keeping low production cost and designing of jack which can be carried with the chassis given, common ground clearance level of an automobile, and keeping in check the increase in weight of automobile.

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BIOGRAPHIES:

Mayank Agrawal born on 10th April 1987 received degree of B. Tech. in Mechanical Engineering from Dayalbagh Educational Institute, Agra, India. He received most prestigious award of the institute Founders Medal for best all-rounder

among the first degree student of the institute graduating in the year 2010. He has three years of industrial experience in leading automobile industry of India as a assistant manager of production planning and control department.

Experienced in –

Production: - Scrutinizing and analyzing of key delay zones to enrich forthcoming production.

Planning:-To achieve utmost result with minimum resources concentrating on key result regions to gain optimized resultants.

Control:-Expertization of demanding and controlling of inventory/material /money and man power judiciously. Controlling and balancing the system by vertical and horizontal management.

Now he is dedicating him to endow his time as a Lecturer since March'13 in the department of Mechanical Engineering, Technical College, DEI, Agra. His research interest includes workshop technology, Manufacturing Process and Industrial Management.



Minti Gehlot Thakur born on 15th December 1996 and is a student of final year diploma in engineering with mechanical branch from Dayalbagh Educational Institute, Agra. He has done his internship in Uttar Pradesh State Road Transport Corporation. He has a broad idea of

thermodynamics and mechanics of solids. He has broad idea of internal combustion engines.



Deepanshu Mahajan is a student of final year diploma engineering with mechanical branch from Dayalbagh Educational Institute, Agra. He has a student membership of system society of India. He has done his summer internship from Regional Workshop of Uttar Pradesh Roadways and Parth

Engineering, Agra. He has broad idea of industrial engineering and production technology.



Tejveer Singh Chahar born on 1st February 1997 and is a student of Final year Diploma In Mechanical Engineering from Dayalbagh Educational Institute. . He has done his internship in Uttar Pradesh State Road Transport Corporation. He has a broad idea of

thermodynamics and mechanics of solids and Internal Combustion Engines.