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Design And Development of Inbuilt Car Jack System

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ABSTRACT

The main objective of this paper is to reduce the human effort and when operating the hydraulic lift hydraulic jack is to provide a safe and simple. The proposed mannequin is a choice answer which reduces each human effort and car lifting time. To carry the vehicle, the person wants to exert a mild push over the lever, that actuates the preferred hydraulic jack to the favored height. In a variety of proposals carried formerly involving lifting the automobile extra quantity of jack systems, a number strength supply terminals and requires an extra actuating means, which is redesigned with optimized conditions. The proposed gadget will increase the alleviation of the mild motor automobile customers which brings them extra nearer to the technological upgradation.

1. INTRODUCTION

A jack is a mechanical device used to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply very high linear forces. A mechanical jack is a device which lifts heavy equipment. The most common form is a carjack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. More powerful jacks use hydraulic power to provide more lift over greater distances. Mechanical jacks are usually rated for a maximum lifting capacity (for example, 1.5 tons or 3 tons). 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 there are 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 stations hydraulic jacks are used. High pressure liquid is filled in the jack cylinder by hydraulic pump, due to the pressure the piston moves up. Hydraulic Jacks are 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 the foot pump provides fast lift to the load.

2. LITERATURE REVIEW

Mayank Agrawal et al. This paper represents a study over inbuilt hydraulic jack systems and shows its benefits over traditional mechanical jack systems. The design of inbuilt hydraulic jack is also studied and modified to the extent which can be seen by analyzing the design of the prototype. An Inbuilt hydraulic jack system can be easily operated by buttons provided on the dashboard of the vehicle. The jack will be installed on the chassis of the vehicle. 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 [1].

Mohammed Abuzaid et al. (2013) In this research paper they have focused on an inbuilt hydraulic jack system which is attached to automobile vehicles on the front and rear part of the chassis. 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.[2]

Parth M. Patel et al. 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.[3] P.S. Rana et al. In this research paper they have come up with the idea of Integrated Automated Jacks for 4-wheelers in which the jack is provided on both the sides of the vehicle and can be easily operated with the help of a button placed at the dashboard of the vehicle. This jack is specially designed to overcome the difficulties faced by the senior citizens and ladies who find it difficult to manually operate the jack.[4]

The conceptual thought of lifting the vehicle using jacks has emerged earlier at the period of late 1920's [5]. Pneumatic jacks were initially prescribed for this scenario since it can be compressed; it was believed that it had a far better scope than any other working fluid in nature to lift the vehicle. But as time emerged it was found that the better and efficient means of lifting vehicles was hydraulics which is still in practice in lifting the heavier loads, since hydraulics are provided with accumulators so the rate of getting injured due to failure is considerably reduced. Usually, a jack consists of a cylinder and a piston in most of the cases the guiding medium is stationary and the sliding piston [6] is restricted in it which would result in the uplifting of the components connected to those structures. There are many other methods to constrain the cylinder piston arrangement and even their execution is carried out using many numbers of methods. When a novel hydraulic system is provided for the vehicle jacks whereby the various jacks attached to a vehicle can be quickly and easily controlled [7] from a common central point and one or more of the jacks may be extended or collapsed as desired. Regarding assembly and positioning of the cylinders there are various methods that are being implemented, placing the cylinder in both the front and back of the car [8] it requires a more accurate and a precise design comparatively because it is placed beneath the engine which comprises a lot of difficulties within for space requirements and mass balance. The other notable method is using hydraulic jacks in all the four wheels of the car to lift the car [9] when need arises. But this method again adds even more complications by adding weight to the car and also it is not cost effective because the fabrication of each single cylinder is an extra burden on their back for both the manufacturer and the consumer, the manufacturer will not be able to hike his cost over a certain level either the consumer will not be affordable enough to buy that particular product which is so expensive.

The disadvantages and defects of the models mentioned above in this chapter are discussed in the following passages. First the model which has the hydraulic jack in the front and rear end [10] of the car is discussed. For the efficient placement and for achieving better mass balance effects [11]

the engine assembly has to be rearranged and the placement of the cylinders are to be done if not the available space should be used efficiently which is not possible in practice. Other disadvantages are the mass balance feature that is achieved only when the placement axis attains symmetric nature, if not then the mass balance will not be up to the expected level which will lead to the wobbling of the vehicle at once when it gets lifted.

The actuation is also a tougher task because the cylinder in front of the car would experience more loads than the rear because of the weight of the engine so the cylinders have to be manufactured for two different specifications, if it was for the same specifications then the rear cylinder would have more lifting force than required. This particular function will demand more oil or the working fluid which would ultimately increase the capacity of the reservoir tank and the weight of the whole setup. The setup requires more clearance from the ground level since lifting it from the midplane of the car is also a tedious action to perform and achieve the required result.

3. PROBLEM STATEMENT

Driving a car is quite common and easy nowadays, but the problem arises when it comes to its maintenance and replacement. The world of technology has seen a great change in the automobile industry but people still today face a lot of difficulties in replacing the tyre when it gets punctured in a deserted location and it becomes hard to find a mechanic nearby.

In this situation the driver is left with only one solution i.e.- step down from the car, get the tools and manually replace the tyre which becomes quite hectic and tiring and even time consuming.

The concept of tubeless tyres has overcome this problem to some extent but not completely. If punctured, the tubeless tyre also needs to be replaced after running the vehicle for a few kilometers. But with the idea of inbuilt hydraulic car jack one can change the punctured tyre of the vehicle not only with less effort but also within less time being consumed. The inbuilt hydraulic car jack involves an initial onetime cost which is going to give benefits in the long run to the driver of the car by simplifying his job during the time of puncture.

4. OBJECTIVE

1. On service stations both manual hand operated and automatic hydraulic jacks are used to lift the vehicles. But on the road, for tyre replacement, drivers have to put efforts with conventional hand operated jacks present in the vehicle.
2. The objective is to make the mechanic's job easier and safer than before.
3. This project should also reduce the users' hassle during emergencies like a flat tyre on the road.
4. It reduces human effort at a large limit and also this type of system is very useful for ladies and old people since during the problem of puncture of tyre, they can easily change the wheel.
5. A single person can go on a long drive without worrying about getting stuck in the way.
6. The servicing of the vehicle will be easy and cheap and it can be operated even when the vehicle is not in starting condition. This is also suitable for uneven surfaces.

5. SCOPE

The arrangement of inbuilt hydraulic jack is used for lifting of heavy vehicles like trucks by making more modification this arrangement can be used in real life for lifting of heavy loaded vehicles. 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. 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 just next the wheel to the front also a rear suspension hydraulic jack that is mounted equal distance from center to the rear suspension of the automobile between its rear wheels. The system operates on hydraulic power. This arrangement has many advantages such as maintenance and servicing of vehicles.

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 a 12 volt DC battery; hence jacks will also work, when the vehicle is not in starting condition. Both jacks can work simultaneously at a single time also.

6. METHODOLOGY

Hydraulic jacks and much other technological advancement such as automobile brakes and dental chairs work on the basis of Pascal's Principle, 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.

This 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's 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.

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) move down and as the piston of the hydraulic cylinder touches the ground then after further strokes of the master cylinder that tire starts raising. 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 the 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. 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.

7. CONVENTIONAL JACKS

A. Screw Jack

A jackscrew is a type of jack which is operated by turning a lead Screw. It is also known as a screw jack, and is commonly used as car jacks. A jackscrews compressive force is obtained through the tension force applied by its lead screw. An acme thread is most often used, and this thread is very strong and can resist the large loads imposed on most jackscrews while not being dramatically weakened by wear over many rotations. These types are self-locking, which makes them intrinsically safer than other jack technologies like hydraulic actuators which require continual pressure to remain in a locked position as shown in Figure.

Figure 1: Screw Jack

B. Scissor Jack

A scissor lift (jack) or mechanism is a device used to extend or position a platform by mechanical means. The term “Scissor” comes from the mechanism utilized which is configured with linked, folding supports in a crisscross “X” pattern. The extension or displacement motion is achieved by applying force to one of the supports resulting in an elongation of the crossing pattern. The force applied to extend the scissor mechanism may be hydraulic, pneumatic or mechanical (via lead screw or rack and pinion system).

Figure 2: Scissor Jack

C. Floor Jack

An automotive floor uses hydraulic fluid to raise and lower heavy vehicles, usually personal cars and trucks. This type of floor jack is placed on the flat ground during use. Every automotive floor jack is rated for different weights, generally ranging from two to twenty tons. The hydraulic lift system can be used to easily lift heavy vehicles simply by pumping the long arm extending from the jack's body. In this way, the automotive floor jack allows the mechanic to change tires or to remove tires in order to check brake systems, examine undercarriage damage, or check exhaust pipes, among other applications.

Figure 3: Floor Jack

4) Drawbacks of Conventional Jack

- Requires more effort to operate.
- Wear of parts is more.
- Difficult to place the jack at the exact point of operation.
- Apparatus is heavy.
- Work is done relatively slowly in conventional jacks.
- Risk of the jack getting slipped is involved.

D. Need for automotive inbuilt hydraulic jack system

Today in this world of speed and motion, man's movement from place to place has been very rapid. Numerous ways of transport and travel have emerged owing to the needs of human beings. This idea behind many of the innovations and inventions is to make humans more comfortable and enable them to cope up with the pace of a rapidly changing world. When such is the emphasis laid by man on time and comfort, it is of almost importance to reduce breakdowns and unnecessary halts during travels. A person acquainted with driving problem will certainly understand the difficulties and frustration due to breakdown of vehicles during the journey. In automobile breakdown, not only is our precious time affected but also a great amount of money is wasted due to many factors that lead to breakdown. A few of them are suspension ill effects, engine problems and tyre damages. The most frequently encountered problem is that of tyre damage be it under inflated tyres or punctured tyres. Due to god's grace, one may be fit enough to handle the conventional jack and change the tyre. But one fact remains that all are alike in matters of strength. Today a chunk of the fair is doing a lot of driving. The change of tyres requires the use of jack, the most commonly adopted is the conventional screw jack.

One has to place the jack under the vehicle and operate the lever i.e. physical efforts are required to operate the jack and lift the car. One could overcome these hardships,if he has provided himself with a lifting device that would operate automatically with least or no physical effort being put into it and is time saving.

E. Design of Inbuilt Hydraulic System

Hydraulic systems rely on the fact that liquids are virtually incompressible and pressure applied where in the fluid is transmitted in all directions as in fig. Operated by pressure, it exerts a force which is proportionally greater than that applied to the first piston but distance moved by the second piston will be correspondingly less. If, for instance, the second piston has three times the area of the first piston, it will exert three times the force through one third of the distance traveled by the first piston. All present-day cars are equipped with a hydraulic brake system. Using the master cylinder of the hydraulic brake system,

an inbuilt hydraulic jack system. Here four hydraulic jacks are provided at suitable places near the four wheels of the car.

A manually operated non return valve is provided on the fluid line from master cylinder to five-way plug valve can be operated Manually, ball valve is provided so the fluid does not return back into the master cylinder. The master cylinder is being used in the hydraulic brake system of the car; the non return check valve is manually opened so that it allows the fluid to go back into the master cylinder when the pedal of the brake is released.

8. WORKING PROCEDURE

• When the DC supply is given to the motor, the motor will start to run where the motor and the vane pump are initially meshed with the help of gear arrangements.
• Which in terms makes the vane pump to rotate.
• The oil from the reservoir is pumped out and passes to the control valve.
• The control valve controls the flow of oil and directs the oil into the inlet of the double acting cylinder.
• The double acting hydraulic cylinder will have one piston within a cylindrical housing.
• When hydraulic will be supplied to its cap end port, hydraulic pressure force will be applied over the piston or plunger.
• Hence, the piston will be extended and this stroke of the cylinder will be termed as forward stroke.
• During extension of the cylinder piston or plunger, hydraulic oil at rod end side will be pushed out and will be directed towards the control valve which actuate or retard the hydraulic cylinder in the basis of manual control.
• Hence a double acting hydraulic cylinder will be operated hydraulically in both directions i.e. during extension or forward direction and also during retraction or return stroke.
• Direction of hydraulic oil will be changed with the help of directional control valve and it is also being used for changing the direction of flow of fluid.
• With the help of the rack and pinion arrangement, the piston will move forward and backward of the chassis.

9. MATERIAL REQUIRED

A. Master Cylinder

The master cylinder can be rigidly named as the heart of the hydraulic braking system, because the pressure necessary for operating the graces as well as the hydraulic jacks is developed in this cylinder.

There are two main chambers in which the piston operates. The fluid in the reservoir compensates for any change in the fluid volume in the pipelines due to temperature variations and to some extent due to leakage. To prevent leakage there are rubber seals on both ends of the piston in the compression chamber. The reduced diameter region of the piston is always surrounded by the fluid. A rubber boot covers the pushrod end of the cylinder to prevent the dirt from entering
inside. Towards the brake lines side of the compression chamber, there is a fluid check valve with a rubber cup inside. It serves to retain the residual pressure in the brake lines even when the brakes are released.

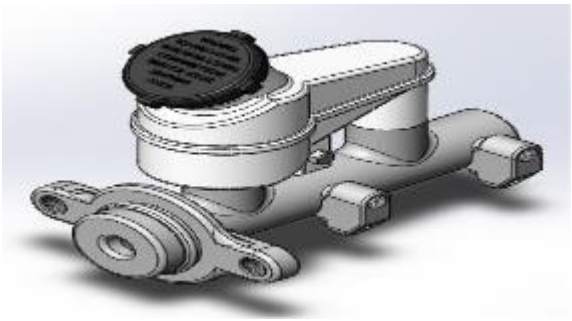

Figure 4: Master Cylinder

B. Double acting hydraulic cylinder

Hydraulic cylinders get their power from pressurized hydraulic fluid [06], which is typically oil. The hydraulic cylinder consists of a cylinder barrel, in which a piston connected to a piston rod moves back and forth. The barrel is closed on each end by the cylinder bottom (also called the cap end) and by the cylinder head where the piston rod comes out of the cylinder. The piston has sliding rings and seals.

Figure 5: Double Acting Cylinder

The piston divides the inside of the cylinder in two chambers, the bottom chamber (cap end) and the piston rod side chamber (rod end). The hydraulic pressure acts on the piston to do linear work and motion. Flanges, trunnions, and/or clevises are mounted to the cylinder body. The piston rod also has mounting attachments to connect the cylinder to the objector machine component that it is pushing.

C. Five Way Control valve

The body of the valve is made of carbon steel or cast iron [7]. The exterior and interior are cylindrical in shape. The interior is well ground for good seating of the plug. A hole is a body cover or plate, which is placed below it and is fastened by screw after the plug is placed in the body. It has an inlet port on its circumference at the top. The body plate has markings indicating the direction of the part lead i.e., right front jack, left front jack, fight rear jack, left jack and brakes. The operating handle is fixed to the plug by threads and a check nut so as to fix the handle in the direction of the outlet part of the plug. This means that when the handle is in the directions of the left front jack marking of the cover plate. It will operate the left front jack, when the brake pedal is operated.

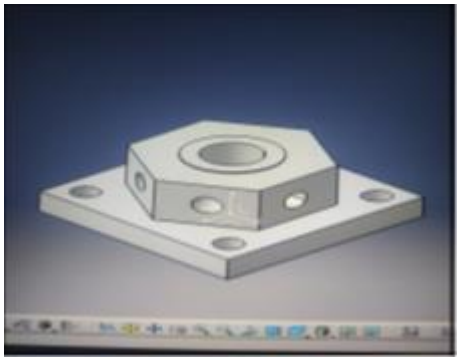

Figure 6: Five Way Directional Control Valve

D. Non-Return Valve

Check valve, clack valve, non-return valve or one-way valve is a mechanical device, a valve, which normally allows fluid (liquid or gas) to flow through it in only one direction. Check valves are two-port valves, meaning they have two openings in the body, one for fluid to enter and the other for fluid to leave. There are various types of check valves used in a wide variety of applications. Check valves are often part of common household items. Although they are available in a wide range of sizes and costs, check valves generally are very small, simple, and/or inexpensive. Check valves work automatically and most are not controlled by1 a person or any external control; accordingly, most do not have any valve handle or stem. The bodies (external shells) of most check valves are made of plastic or metal.

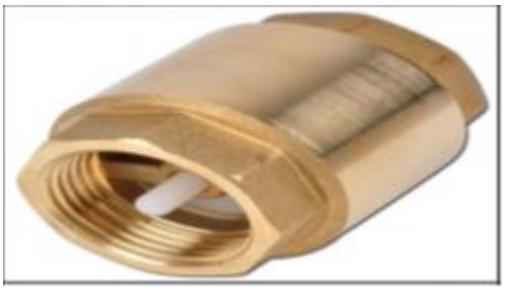

Figure 7: Non Return Valve

EXPERIMENTAL DESIGN

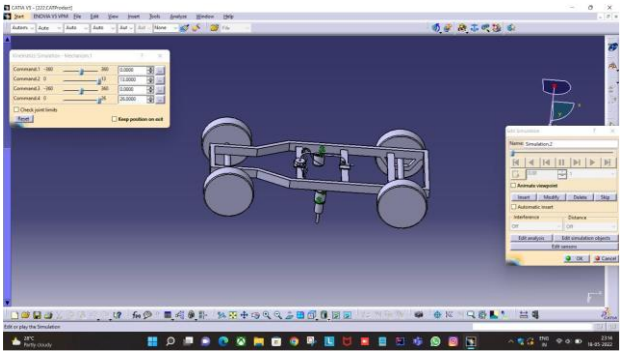

Figure 8 a) Experimental Design

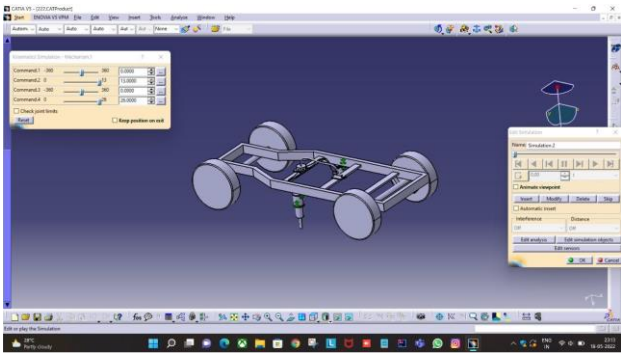

Figure 8 b) Experimental Design

CONCLUSION

An inbuilt hydraulic jack system can be easily attached to all currently manufactured automobile chassis. There is a front suspension hydraulic jack that is mounted externally to the front suspension of an automobile between its front wheels. Automatic inbuilt jacking systems in automobiles will not only save the effort of a person but will also save one's precious time under critical circumstances. 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.

Some extra automation like solenoid control valves 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.

- Automatic inbuilt jacking systems 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 traveling.
- Motor operated mechanical jacks are already in the market but the jack's design is the area of concern. In order to make the built-in jack system practical, the 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 moved 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.
- 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.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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