

REVIEW ON DESIGN AND DEVELOPMENT OF AUTOMATED HYDRAULIC JACK

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ABSTRACT

The purpose of this study is to create an automated hydraulic jack system. A jack is a mechanical lifting device used to apply greater force to lift heavy loads. A mechanical jack employs a screw thread for lifting heavy equipment. A hydraulic jack uses hydraulic power. It is a tool that raises and lowers the automotive vehicle. The automated hydraulic jack will be useful to elderly people and women who find it extremely difficult to physically operate the jack during any car breakdown. Whenever the tire failure occurred in the automotive vehicle, lifting the vehicle from ground surface is very difficult, it also involves intense human effort and it is a more time taking process. For rectifying, this kind of problem an automated hydraulic jack system helps to lift the vehicle automatically from the ground instead of conventional mechanical jack, which can save the time and excess effort. The motive behind this work is instead of using an automated jack system which is the more power produced and simple in design as compared to a conventional design. When compared to a pneumatic system, which runs on compressible air, hydraulic systems have a greater lifting capacity since the hydraulic oil is incompressible. Major components of this work include hydraulic jack, DC motor, hydraulic oil.

Key Words: Hydraulic jack, Automotive vehicles, motor, Automated operation, hydraulic oil, pascal law, ground clearance.

INTRODUCTION

In this work we are replacing normal conventional jack as automated hydraulic jack for lifting purpose in automotive vehicle. In hydraulic device, power is transmitted by pushing the confined liquid. It is a mechanical function that operated through force or liquid pressure. It is based on the principle of pascal's law. The application of hydraulic system is usually used in various fields like food industry, beverage industry, machinery industry, automotive industry, robotic arms, it can withstand and lift heavy loads.

Normally we use bottle hydraulic jack, scissor jack for lifting vehicles. The ground clearance of a car should be considered mainly during this operation. In this system they have replaced conventional hydraulic jack as inbuilt hydraulic jack and they have integrated in the vehicle [1]. Following studies can also analyses the advantages of an integrated hydraulic jack system over a conventional mechanical jack system. By examining the design of the prototype, it is possible to see that the design of the built-in hydraulic jacks and also automated hydraulic jack is also investigated and adjusted to the necessary extent [2]. The built-in self-jacking component is started by pressing the designated button on the dashboard. The built-in hydraulic jack will be helpful to elderly people and ladies who find it extremely difficult to physically operate the jack during any car breakdown. This hydraulic jack will have the ability to lift the wheels in accordance with our requirements; for example, if we just need to lift two wheels, the cylinder will be moved as necessary on the rack with the help of the DC motor [3].

Field Activity Survey

This kind of concept will be very useful in society, so our team interacted and questioned some types of peoples to know what are the problems that they are facing while their tyre gets punctured in certain circumstances. A lady stated that, if my car gets punctured, I face many difficulties and inconvenience. Also, she said that it is very difficult to operate lever bottle hydraulic jack or some any kind of mechanical jack. We also interacted with one car driver. He stated that "we are using cars for commercial purpose. so that the tyre quality will get depreciate day by day. Because of that many times car will get puncture at out of city limit areas and remote areas, on that time, it is very difficult to find workshops, mechanic shops. Many times, we changed the tyres in dark places. It will be very easy if any product is there for us to replace tyres in a faster and automated manner". Our team visited some car garages and workshops to discuss that if they are having any

devices, instruments or any ideas to rectify the above problem. Through this field survey our project team got some useful inputs for project ideas.

Overview of Hydraulic Jack

A hydraulic jack is a mechanical device used to lift heavy loads. It is a device that uses specific fluids to push against piston. It works on the principle of pascal's law. It states that the pressure applies on closed fluid is transmitted and undiminished in every direction and acts with equal force and same area. In this system the use of oil act as a power transmission. Hydraulic system is a good choice for lifting heavy machineries, it is more efficient compared to pneumatic set up machines. Usage of hydraulic machineries in industries can achieve mass production and more efficiency. There are many types of jacks like scissor jack, floor jack, highlight jack, hydraulic bottle jack. Among these hydraulic bottle jacks is portable, cheaper, easy to use. The incorporated hydraulic car jack that is integrated with the automobile's current braking system and can help in overcoming the drawbacks of the present mechanical jack offered in the vehicle. With the built-in hydraulic jack, we can now lift the punctured side (tyre) of the car using piston cylinder arrangements that are welded to the vehicle's chassis by applying pressure from the braking fluid, which was previously used just for braking [4]. The most typical type of jack used for lifting is the hydraulic jack. With diverse electronic gadgets, the hydraulic jack has undergone a number of changes. Safety, luxury, and comfort are prioritized with the aid of technology [5].

Pascal's law is the foundation for the hydraulic jack. The time and effort required to use the jacks that are currently on the market make using jacks exceedingly challenging. Given below figure 1 and figure 2 represents the working of a simple hydraulic jack.

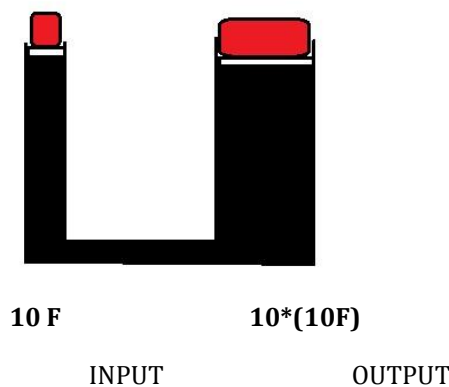


Figure 1

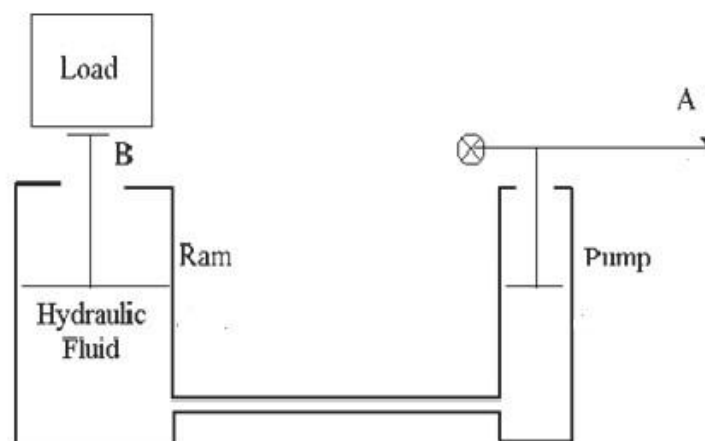


Figure 2 Simple Hydraulic Jack Model

Relation Between Lifting Force and Piston Pump Force

$P_1 = P_2$ (by pascal's law which is pressure will be same at entry and exit)

$$F_1/A_1 = F_2/A_2$$

$$F_2 = F_1 * A_2 / A_1$$

$$F_2 = F_1 * \pi R_2^2 / \pi R_1^2$$

$$F_2 = F_1 * R_2^2 / R_1^2$$

Whereas,

$P_1 = P_2 = \text{Pressure}$

$F_1 = \text{Force on input piston pump}$

$F_2 = \text{Lifting Force on output piston}$

$A_1 = \text{Cross-sectional area of piston pump}$

$A_2 = \text{Cross-sectional area of piston valve in outlet pump}$

$R_1 = \text{Radius of input piston}$

$R_2 = \text{Radius of output piston}$

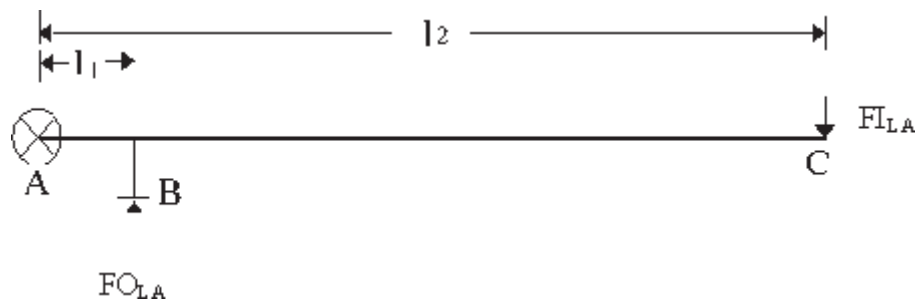


Figure 3 Design Bending Moment Diagram for Hydraulic Jack

Whereas,

$F_{I_{LA}} \rightarrow \text{Force applied by input lever arm}$

$F_{O_{LA}} \rightarrow \text{Output force produced in the piston}$

Summing moments about Point A;

$$\Sigma M_A = 0 = (F_{O_{LA}} * l_1) - (F_{I_{LA}} * l_2)$$

or

$$(F_{O_{LA}} * l_1) = (F_{I_{LA}} * l_2)$$

or

$$F_{O_{LA}} / F_{I_{LA}} = l_2 / l_1$$

Features of Automotive Jacks

There are many types of jacks available in the market to lift heavy load, jacks like floor jack, bottle jack, farm jack, scissor jack, pneumatic jack and strand jack. But mostly many of the mentioned jacks required manual power, most of domestic purpose jacks used man power only to operate. If any of this type of jack that can be work upon by automated manner for domestic purpose it will be very useful.

pneumatic based jacks which will use the pressurised air to generate mechanical motion. A model pneumatic jack was created and mounted on a four-wheeler to address the issue that existed with the traditional jack. This constructed model consists of a small reciprocating air compressor that is powered by a battery used in a four-wheeler, an air tank that is used to store compressed air, a pneumatic control valve that regulates air flow, and a double acting cylinder that serves as a jack for lifting [6].

With the development of technology, we now make sure that any electronics equipment needs less space when in use. We can "rotate" a four-wheeled vehicle, particularly one that resembles a car, to any degree utilising a hydraulic jack support that is kept in the middle of the vehicle. This strategy can be utilised when there isn't enough room for the car to make a "u" turn and when the road or path is too narrow to change directions [7].

Toggle or scissor jacks are straightforward devices used to lift and move heavy weights over short distances. A typical toggle jack's power screw design lessens the force needed by the user to drive the mechanism. To lift the big loads at the stable state under some special circumstances, a Toggle jack with a distinctive design is used. A nut is a stationary part whereas a screw is a moving part. The market available car jacks have some drawbacks, including the need for greater energy to operate, unsuitability for usage by women, and inability to be employed on uneven surfaces. As a result, this design has been altered for the practicality and human factor considerations of the existing automobile jacks [8].

Working Principle

In normal conventional hydraulic jack, the intensity of pressure is transformed uniformly in all directions through a mass of fluid. In this study, Pascal's Law Concept is used to examine the lift force. Also, this study analyses hydraulic system components or hydraulic telescopic capabilities to better the hydraulic jack's capability. The simple automation work of jack can be done with the motor drive mechanism [9]. The goal of this research is to design the hydraulic portable gadget to facilitate the mechanics in car maintenance and repair notably a component of the bottom machine. The data collection can be done by directly assessing the performance test of the portable automated hydraulic jack in automobiles and compared with the original jack [10]. Also, some of the systems can be work by integrating the hydraulic principle to the scissor-based jack, this will work by transferring the hydraulic pressure with the help of hydraulic cylinder to the scissor jack mechanism, this will be useful for lifting the light weight automobiles for servicing or repair kind purpose, it can be handled indoor as well as outdoor [11]. In order to assist the elderly and physically disabled, this project's automatic hydraulic jack mechanism is more beneficial. So, they made an effort to seize the chance. This system can also be integrated with wiper motor as a driving mechanism for operating hydraulic jack [12].

Conclusion

Automated jack system is a simple and compactable design, some of them can propose miniature inbuilt jack models, and some of them can propose automated jack models. the reason why inbuilt jack system doesn't have the tendency to perform well is due to its additional weight in automobile and also ground clearance issues. These problems can be simply rectified by installing a automated system in conventional hydraulic jack. A typical locomotive mechanism that can be able to convert the output into reciprocating motion that will able to drive the jack into automated manner. Since it takes power from car battery itself, so no any additional power source is required. it reduces man power, time saving, easy to operate and able to lift the vehicle. By altering and improving the design modification and testing in future we can integrate this system to power brakes also, so the hydraulic fluid will circulate for car brakes and also for power lifting.

References:

- [1] Dr.Ramachandra C G, Krishna pavana, Shivraj Shet, Venugopal Reddy, Virupaxappa B (2013). Design and fabrication of automotive hydraulic jack system form vehicles.
- [2] Mayank Agarwal, Minti Geholt Thakur, Deepanshu Mahajan, Tejveer Singh Chahar (2018). Inbuilt hydraulic jack system for four wheelers.

- [3] Shivangi Patidar, Shivam Patel, Naman Mehta, Vikas Ojha, Suveer Chandra Dubey (2021). Mechanism of inbuilt automatic hydraulic jack used for light and heavy vehicles.
- [4] Aditya Masiwal, Aman Kanungo, Ishan Rawlley, Devendra Jha, Ashutosh Singh, Dhruv Kumar, Ram Jatan Yadav (2018). Design and fabrication of hydraulic jack system for four wheelers.
- [5] Parth M Patel, Parth S patel, Vaibhav H Shah, Suril R Shah (2016). Automatic hydraulic jack inbuilt in a four-wheeler.
- [6] Atul A Dhawale, Rohitkumar R Gupta, Shubham A Gawande, Yogesh D Bate, V.S. Nikam (2017). Design and fabrication automatic pneumatic inbuilt jack system by using fifth wheel parking system.
- [7] D.Bhattacharya (2018). Hydraulic jack mechatronics for any angle rotation in four wheelers.
- [8] Dhamak C.S., Bajaj D.S., V.S.Aher, G.S.Nikam (2015). Design and Standardization of toggle jack.
- [9] Rinasa Agistya Anugrah, Putri Rachmawati (2021). Analysis of hydraulic system on portable electric hydraulic jack.
- [10] P Rachmawati, I R Kurniawan (2019). Design of portable electric hydraulic jack for improving the productivity.
- [11] Charlie J. Cano, Warlito M. Galita, Elmer I. Samoranos, Aloy Alino De Leon, (2022). Design and Fabrication of a hydraulic motorcycle lifter.
- [12] Durvesh Rohidas More, Aditya Arun Patil, Adesh Ananta Thakare, Nishank Rajesh Vartak, Md Saqib Ansari (2022). Design and fabrication of motorized hydraulic jack system.
- [13] Parameshwar Durge, Nitesh Thakur, Abhishek Ghawalkar, Sunil S.Patil (2019). Inbuilt motor operated screw jack and automatic tyre inflation system.
- [14] Shinde, Aishwarya B, Daphal, Pranitaa B, Nilange, Pratiksha S. Nanwatkar, R.K. (2016). Design and fabrication of mechanical lift for transportation.
- [15] Dhiraj P.Bhuwad, Roshan S. Kodare, Prathamesh R.Shetye, Priyanka P.Pawaskar (2016). Design and fabrication of brake pedal operated hydraulic jack.
- [16] Rakesh Y.Suryawanshi, Pranay S.Ramteke, Niraj Patil, Deepak Kumar, A.V. Vanalkar (2015). Design and fabrication of hydraulic bearing puller and pusher.
- [17] D Ramesh, A Thirumoorthy, K Kandasamy, S Suresh (2019). Hydraulic compartment puller.