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ijirset@gmail.com



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# Design and Analysis of Hydraulic Jack

Mr M.Sangeethkumar, Saranrajaperumal R, S.B.Rinith, U.Sabari, L.P.S.Suriyaprakesh,

Assistant Professor, Department of Mechanical Engineering, Sona College of Technology, Junction Main Road, Salem,  
Tamilnadu, India.

Department of Mechanical Engineering, Sona College of Technology, Junction Main Road, Salem,  
Tamilnadu, India.

**ABSTRACT:** A jack is a device that uses force to lift heavy loads. The primary mechanism with which force is applied varies, depending on the specific type of jack, but is typically a screw thread or a hydraulic cylinder. Jacks can be categorized based on the type of force they employ: mechanical or hydraulic. Mechanical jacks, such as car jacks and house jacks, lift heavy equipment and are rated based on lifting capacity (for example, the number of tons they can lift). Hydraulic jacks tend to be stronger and can lift heavier loads higher, and include bottle jacks and floor jacks. HYDRAULIC JACKS depend on force generated by pressure. Essentially, if two cylinders (a large and a small one) are connected and force is applied to one cylinder, equal pressure is generated in both cylinders. However, because one cylinder has a larger area, the force the larger cylinder produces will be higher, although the pressure in the two cylinders will remain the same. Hydraulic jacks depend on this basic principle to lift heavy loads: they use pump plungers to move oil through two cylinders. The plunger is first drawn back, which opens the suction valve ball within and draws oil into the pump chamber. As the plunger is pushed forward, the oil moves through an external discharge check valve into the cylinder chamber, and the suction valve closes, which results in pressure building within the cylinder.

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

## I. INTRODUCTION

A hydraulic jack is a jack that uses a liquid to push against a piston. This is based on Pascal's Principle. The principle states that pressure in a closed container is the same at all points. If there are two cylinders connected, applying force to the smaller cylinder will result in the same amount of pressure in the larger cylinder. However, since the larger cylinder has more area, the resulting force will be greater. In other words, an increase in area leads to an increase in force. The greater the difference in size between the two cylinders, the greater the increase in the force will be. A hydraulic jack operates based on this two cylinder system.

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].



Fig 1: hydraulic jack

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.

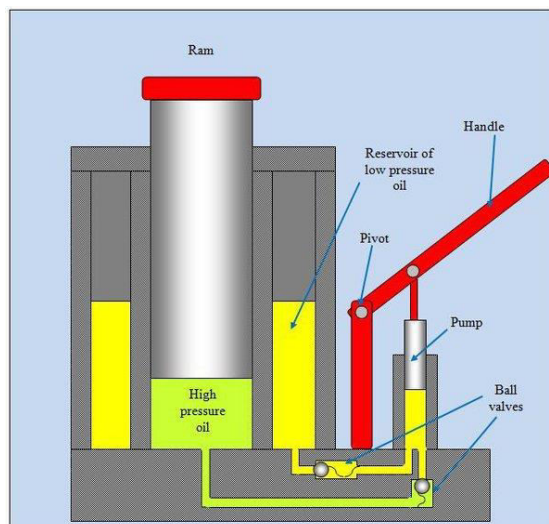


Fig 2: hydraulic jack is a mechanical device

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.

## II. LITERATURE SURVEY

The research survey revealed that few methods were adopted to lift the vehicle for reconditioning, repairing and others. This hydraulic jack has mainly focused on this difficulty. Therefore, a suitable device has been designed for lifting the vehicle without apply any impact force. The device has been considered for simple and economy therefore it is one of the important and essential equipment in automobile service center's which required minimum skilled technician are. In many auto service center's vehicles are lifted by using screw jack, to avoid this automatic hydraulic jack may be utilized in lifting the vehicles easily without impact force. This can be operated by even unskilled operator.

A hydraulic jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. A hydraulic mechanical jack employs the mechanism of a hydraulic power system in the lifting of heavy equipment (Brian, 2006). The most common form is a car jack, floor jack or garage jack which lifts vehicles or trucks so that maintenance can be performed. Hydraulic jacks are usually rated based on its maximum lifting capacity which could include: 1.5 tons, 3 tons, 20 tons or 30 tons (William, 2001).

A remote controlled hydraulic jack is a type of jack designed to incorporate a d c motor control and link mechanisms having an infra-red transmitter and receiver circuits which processes and decodes the control signals for the upward and downward movement of the hydraulic jack (Oshevire, 2014). This works in such a way that it can be used to lift heavy duty trucks very smoothly without any impact force and also a simple operation so that even unskilled labour can use it with ease. This is an era of automation where it is broadly defined as the replacement of manual effort with mechanical power in all degrees. The mechanical automation remains to be an essential part of the system although it comes with some physical changes on the jack; the degree of mechanization is greatly increased.

According to ezinearticles.com, the origin of hydraulic jacks can be dated several years ago when Richard Dudgeon, the owner and inventor of hydraulic jacks, started a machine shop. In the year 1851, he was granted a patent for his hydraulic jack. In the year 1855, he literally amazed onlookers in New York when he drove from his abode to his place of work in a steam carriage. It produced a very weird noise that disturbed the horses and so its usage was limited to a single street. Richard made a claim that his invention had the power to carry near about 10 people on a single barrel of anthracite coal at a speed of 14 m.p.h. Dudgeon deserves a special credit for his innumerable inventions including the roller boiler tube expanders, filter press jacks, pulling jacks, heavy plate hydraulic hole punches and various kinds of lifting jacks (Muchnik, 2007).

Hydraulic jacks uses fluid, which is incompressible, that is forced into a cylinder by a pump plunger (Elliot, 2006). Hydraulic oil is used since it is self lubricating and stable. When the plunger pulls back, it draws oil out of the reservoir through a suction check valve into the pump chamber. When the plunger moves forward, it pushes the oil through a discharge check valve into the cylinder. The suction valve ball is within the chamber and opens with each draw of the plunger. The discharge valve ball is outside the chamber and opens when the oil is pushed into the cylinder. At this point the suction ball within the chamber is forced shut and oil pressure builds in the cylinder. In other cases, some hydraulic jacks have horizontal pistons which push on the short end of a bell crank, with the long arm providing the vertical motion to a lifting pad, kept horizontal with a horizontal linkage. The incorporating of castors and wheels allows for the compensation of the arc taken by the lifting pad; this mechanism provides a low profile when collapsed, for easy maneuvering underneath the truck while allowing considerable extension (Fauzi, 2011). The d c motor is coupled with the hydraulic jack by gear arrangement with the rotation of the d c motor determining the lifting speed of the hydraulic jack.

## III. METHODS

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].

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].

#### IV. RESULT ANALYSIS

The origin of hydraulic jacks can be dated several years ago when Richard Dudgeon, the owner and inventor of hydraulic jacks, started a machine shop. In the year 1851, he was granted a patent for his hydraulic jack. In the year 1855, he literally amazed onlookers in New York when he drove from his abode to his place of work in a steam carriage. It produced a very weird noise that disturbed the horses and so its usage was limited to a single street. Richard made a claim that his invention had the power to carry near about 10 people on a single barrel of anthracite coal at a speed of 14 m.p.h. Dudgeon deserves a special credit for his innumerable inventions including the roller boiler tube expanders, filter press jacks, pulling jacks, heavy plate hydraulic hole punches and various kinds of lifting jacks.

JT-15T Performance Tables (Lift Screw Tr52x8)											
Gear Ratio	Lift screw travel (mm), per turn of input shaft	Eff. %	1800 rpm			1500 rpm			1200 rpm		
			Power kw	Load ton	Speed m/min	Power kw	Load ton	Speed m/min	Power kw	Load ton	Speed m/min
H: 1/8	1.0	19	2.00	1.30	1.80	1.86	1.45	1.50	1.75	1.70	1.20
M: 1/16	0.5	18	1.06	1.30	0.90	0.98	1.45	0.75	0.93	1.70	0.60
L: 1/32	0.25	17	0.75	1.75	0.45	0.70	1.95	0.38	0.65	2.25	0.30
Gear Ratio	Lift screw travel (mm), per turn of input shaft	Eff. %	900 rpm			600 rpm			300 rpm		
			Power kw	Load ton	Speed m/min	Power kw	Load ton	Speed m/min	Power kw	Load ton	Speed m/min
H: 1/8	1.0	19	1.62	2.10	0.90	1.57	3.05	0.60	1.24	4.80	0.30
M: 1/16	0.5	18	0.89	2.20	0.45	0.83	3.05	0.30	0.65	4.80	0.15
L: 1/32	0.25	17	0.61	2.80	0.23	0.59	4.10	0.15	0.46	6.40	0.08

Fig 3: multi-speed jack Result analysis

A multi-speed jack, having a pump assembly including a pump block having a first cylinder and a second cylinder defined therein, a piston assembly movable within the pump block, the piston assembly having a first portion configured with the seal ability engage with the first cylinder and a second portion configured to sealable engage with the second cylinder, a reservoir for storing hydraulic fluid and coupled to the pump block so that when the piston assembly is moved in a first direction, hydraulic fluid in the reservoir is supplied to the first cylinder and the second cylinder, a lifting assembly having a ram chamber and a ram rod, the ram chamber coupled to the pump assembly and configured to receive fluid from the first cylinder and the second cylinder when the piston assembly is moved in a second direction so as to raise the ram rod and a bypass check valve provided in the first cylinder. The bypass check valve is configured so that when the piston assembly is moving in the second direction and the pressure in the first cylinder exceeds a threshold pressure, the hydraulic fluid in the first cylinder returns to the reservoir. T

## V. 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.

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