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Review On Development Of Motorized Hydraulic Jack

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Abstract

The purpose of this project is to modify the design of existing car jack (hydraulic) in terms of its functionality by addition of 12 volt battery operated motorized gear box to oscillate the operating link of hydraulic jack . General idea of the project is to minimize the human effort while operating the jack. To provide an electrical hydraulic jacking system that is directly lifting vehicles one wheel.it reduces human hectic efforts reduces injury risk also like sleep of jack.

Keywords: Hydraulic jack, Cylinder, axial direction, reciprocating motion

1.Introduction

Bottle or hand jacks, came into wide spread popularity during the early part of the 20th Century, paralleling the boom of the automobile industry. They filled the immediate need of a small convenient device requiring only one person to operate that could lift an automobile off the ground for servicing - It quickly found hundreds of other uses in the modern world, as well.

Jack is used for power transmission or transmission of force. A **Hydraulic Jack** is a cylinder on whose surface is cylindrical .The cylinder will have specified width and depth, which bear some ratio with the diameter of the cylinder. The piston rotates in a cylinder on the internal surface. Thus a piston and a cylinder make a connected pair in which one remains stationary while other rotates and translates axially. If an axial force acts on, say cylinder moving inside stationary piston, the point of application of the force will move as the cylinder advances in axial direction. This will result in work being done and hence power being transmitted. Both types – one in which piston rotates and advances in a stationary cylinder or one in which piston rotates between fixed support and piston is free to move axially – are used in practice. In the latter case the force acting on piston will move as piston translates. However, the friction between the surfaces of contact will require some power to be overcome. Hence the power delivered by the cylinder-piston pair will be less than the power supplied.

The contact surfaces of cylinder and piston are made perpendicular to the outside and inside cylindrical surfaces. They are sometimes given a small inclination. Such provision keeps coefficient of friction to a reasonable low level. The coefficient of friction may be further reduced by lubrication. However, by creating considerably inclined surfaces in piston and cylinder the effective coefficient of friction is very low.

Need of Electro-Hydraulic Jack

A revolutionary change has taken place in the field of Fluid Power Technology due to the integration of electronics as a control medium for hydraulic components and systems. Due to sophistication of hydraulics and allied fields of power and higher accuracy in speed, force and position control. Efforts have been made to include the latest possible trends in the field of hydraulics and allied control areas to keep the ever changing state of the technology in hydraulics. Now a day more stress is given to LUXURY, COMFORT and SAFETY as much as possible with money and TECHNOLOGY available with the mankind. In that way to help those who are physically challenged this project is been made. That is a case of lifting a jack to an automobile, is troublesome to physically challenged human being. And we are using oil, hence the jack as a means of power transmissions. Hydraulic systems are now extensively used in almost all the engineering fields in varied applications. So we tried to grab the opportunity. Energy can neither be created nor be destroyed but it can be transformed from one form to another. The energy associated with human beings will decrease as he becomes older resulting unable to challenge physically. To overcome we have provided alternate source of energy by taking the power from wiper motor to drive the hydraulic jack loading subsequently and automatically, which substantially reduce the burden. Our project works on the mechanism of converting rotary motion of the wiper

motor into reciprocating motion of the hydraulic jack plunger. A cylinder cage structure of wiper motor ensures maximum power delivered by consuming the available battery power which can be easily generated. Important thing is that the power is available at any instant and anyone can withdraw easily, without any hazard.

Realizing that the engineers are more concerned with the applications than with theory, we have woven the subject-matter with this practical application in engineering and achieved the objective. Addition of number of figures, tables and examples is in proportionate to the addition of written word because they offer better visual appreciation and mental grasp.

2. Literature survey

Screw Jack

A screw jack is a portable device consisting of a screw mechanism used to raise or lower the load. The principle on which the screw jack works is similar to that of an inclined plane. There are mainly two types of jacks-hydraulic and mechanical. A hydraulic jack consists of a cylinder and piston mechanism. The movement of the piston rod is used to raise or lower the load. Mechanical jacks can be either hand operated or power driven.

Jacks are used frequently in raising cars so that a tire can be changed. A screw jack is commonly used with cars but is also used in many other ways, including industrial machinery and even airplanes. They can be short, tall, fat, or thin depending on the amount of pressure they will be under and the space that they need to fit into. The jack is made out of various types of metal, but the screw itself is generally made out of lead. While screw jacks are designed purposely for raising and lowering loads, they are not ideal for side loads, although some can withstand side loads depending on the diameter and size of the lifting screw. Shock loads should also be avoided or minimized. Some screw jacks are built with anti-backlash. The anti-backlash device moderates the axial backlash in the lifting screw and nut assembly to a regulated minimum.

A large amount of heat is generated in the screw jack and long lifts can cause serious overheating. To retain the efficiency of the screw jack, it must be used under ambient temperatures, otherwise lubricants must be applied. There are oil lubricants intended to enhance the equipment’s capabilities. Apart from proper maintenance, to optimize the capability and usefulness of a screw jack it is imperative to employ it according to its design and manufacturer’s instruction. Ensure that you follow the speed, load capacity, temperature recommendation and other relevant factors for application

The screw has a thread designed to withstand an enormous amount of pressure. This is due to the fact that it is generally holding up heavy objects for an extended amount of time. Once up, they normally self lock so that they won't fall if the operator lets go, and they hold up well to the wear of repeated use. If they are made with a ball nut, they will last longer because there is less friction created with this type of jack. However, they will not self lock. This can be dangerous and handled carefully.

Operation

The jack can be raised and lowered with a metal bar that is inserted into the jack. The operator turns the bar with his hands in a clockwise direction. This turns the screw inside the jack and makes it go up. The screw lifts the small metal cylinder and platform that are above it. As the jack goes up, whatever is placed above it will raise as well, once the jack makes contact. The bar is turned until the jack is raised to the level needed. Although a jack is a simple and widely used device, the use of any lifting device is subject to certain hazards. In screw-jack applications, the hazards are dropping, tipping or slipping of machines or their parts during the operation. These hazards may result in serious accidents. The main reasons of such accidents are as follows:

(i) The load is improperly secured on the jack

(ii) The screw-jack is over loaded.

(iii) The centre of gravity of the load is off centre with respect to the axis of the jack

(iv) The screw-jack is not placed on hard and level surface.

(v) The screw-jack is used for a purpose, for which it is not designed.

Proper size, strength and stability are the essential requirements for the design of the screw-jack from safety considerations.

Construction of Screw Jack

Screw jack consists of a screw and a nut. The nut is fixed in a cast iron frame and remains stationary. The rotation of the nut inside the frame is prevented by pressing a set screw against it. The screw is rotated in the nut by means of a handle, which passes through a hole in the head of the screw. The head carries a platform, which supports the load and remains stationary while the screw is being rotated. A washer is fixed to the other end of the screw inside the frame, which prevents the screw to be completely turned out of the nut.

Function

The basic function of a screw jack is to lift a portion of a vehicle. Typically this is used to change a tire although other maintenance is sometimes performed.

Features

All jacks have safety features to protect the user from accidental injury. Wide bases help to stabilize a jack and prevent tilting or sinking into soft soil. Most car jacks also come equipped with their own handle or cranking mechanism, but alternately many of these also will accept the flat end of a tire tool to jack up a vehicle. When in the extended position, jacks will have a stop point that prevents the user from overextending the jack beyond its rated capabilities. When in the contracted position, jacks that are provided by the manufacturer will have a storage area specially formed or designed for the jack to rest in when not in use.

Benefits

Equipping motorists with car jacks has provided many benefits to those who are on the road. Most importantly, jacks have equipped drivers with the ability to change a tire in an emergency situation without having to call for assistance, which can save service fees and potential towing fees as well. Car jacks also provide the home auto enthusiast with a tool to use in maintenance of their own vehicle with the simpler tasks such as changing brake pads, oil and belts. When used appropriately with safety in mind, car jacks are an essential resource for anyone owning or operating a motorized vehicle.

Mechanical Jacks

A mechanical jack is a device which lifts heavy equipment. The most common form is a car jack, floor jack or garage jack which lifts vehicles so that maintenance can be performed. Car jacks usually use mechanical advantage to allow a human to lift a vehicle by manual force alone. More powerful jacks use hydraulic power to provide more lift over greater distances. Mechanical jacks are usually rated for maximum lifting capacity. There are two types of mechanical jacks:

Scissor Jacks

Scissors jacks are also mechanical and have been in use at least since the 1930s.

A scissor jack is a device constructed with a cross-hatch mechanism, much like a scissor, to lift up a vehicle for repair or storage. It typically works in just a vertical manner. The jack opens and folds closed, applying pressure to the bottom supports along the crossed pattern to move the lift. When closed, they have a diamond shape.

Scissor jacks are simple mechanisms used to drive large loads short distances. The power screw design of a common scissor jack reduces the amount of force required by the user to drive the mechanism. Most scissor jacks are similar in design, consisting of four main members driven by a power screw.

A scissor jack is operated simply by turning a small crank that is inserted into one end of the scissor jack. This crank is usually "Z" shaped. The end fits into a ring hole mounted on the end of the screw, which is the object of force on the scissor jack. When this crank is turned, the screw turns, and this raises the jack. The screw acts like a gear mechanism. It has teeth (the screw thread), which turn and move the two arms, producing work. Just by turning this screw thread, the scissor jack can lift a vehicle that is several thousand pounds.

Construction

A scissor jack has four main pieces of metal and two base ends. The four metal pieces are all connected at the corners with a bolt that allows the corners to swivel. A screw thread runs across this assembly and through the

corners. As the screw thread is turned, the jack arms travel across it and collapse or come together, forming a straight line when closed. Then, moving back the other way, they raise and come together. When opened, the four metal arms contract together, coming together at the middle, raising the jack. When closed, the arms spread back apart and the jack closes or flattens out again.

Design and Lift

A scissor jack uses a simple theory of gears to get its power. As the screw section is turned, two ends of the jack move closer together. Because the gears of the screw are pushing up the arms, the amount of force being applied is multiplied. It takes a very small amount of force to turn the crank handle, yet that action causes the brace arms to slide across and together. As this happens the arms extend upward. The car's gravitational weight is not enough to prevent the jack from opening or to stop the screw from turning, since it is not applying force directly to it. If you were to put pressure directly on the crank, or lean your weight against the crank, the person would not be able to turn it, even though your weight is a small percentage of the cars.

Bottle (cylindrical) Jacks

Bottle screws may operate by either

(i) Rotating the screw when the nut is fixed; or

(ii) Rotating the nut and preventing rotation of the screw.

Bottle jacks mainly consist of a screw, a nut, thrust bearings, and a body. A stationary platform is attached to the top of the screw. This platform acts as a support for the load and also assists it in lifting or lowering of the load. These jacks are sturdier than the scissor jacks and can lift heavier loads.

Hydraulic Jacks

Hydraulic jacks are typically used for shop work, rather than as an emergency jack to be carried with the vehicle. Use of jacks not designed for a specific vehicle requires more than the usual care in selecting ground conditions, the jacking point on the vehicle, and to ensure stability when the jack is extended. Hydraulic jacks are often used to lift elevators in low and medium rise buildings.

A hydraulic jack uses a fluid, which is incompressible, that is forced into a cylinder by a pump plunger. 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 a bottle jack the piston is vertical and directly supports a bearing pad that contacts the object being lifted. With a single action piston the lift is somewhat less than twice the collapsed height of the jack, making it suitable only for vehicles with a relatively high clearance. For lifting structures such as houses the hydraulic

interconnection of multiple vertical jacks through valves enables the even distribution of forces while enabling close control of the lift.

In a floor jack a horizontal piston pushes 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. Floor jacks usually include castors and wheels, allowing compensation for the arc taken by the lifting pad. This mechanism provide a low profile when collapsed, for easy maneuvering underneath the vehicle, while allowing considerable extension

STANDARD RANGE OF HYDRAULIC JACKS

i. Hydraulic Bottle Type Jack. From 5MT – 100MT Capacity.
ii. Remote control Jack – With a separate pumping unit connected to the main Jack using a 2Mtr Hydraulic Hose. From 5MT – 1000MT Capacity.
iii. Hydraulic Puller Centre Hole Jack Remote type. From 10MT – 100MT Capacity.
iv. Trolley Jack- Primarily for Automobiles & Workshop applications. From 1.5MT – 20MT Capacity.
v. Hydraulic Toe Lift Jack. From 10MT – 50MT Capacity.
vi. Hydraulic Pallet Truck. From 1MT – 3MT Capacity.
vii. Hydraulic Lifting Table. From 1MT – 3MT Capacity.
viii. Hydraulic Mobile Floor Crane. From 1MT – 3MT Capacity.
ix. Hydraulic Pipe Bending Machine. Suitable for pipe sizes ½” to 6”.

STANDARD RANGE OF HYDRAULIC JACKS

The standard American lifting capacities start at 1 1/2 ton and run 3 ton, 5 ton, 8 ton, 12 ton, 20 ton, 30 ton, 50 ton and 100 ton.

PHYSICAL ATTRIBUTES

Bottle/hand jacks have the general appearance of an old 1 quart milk bottle and range in weight from a few pounds for the smallest 1 1/2 ton models to more than 200 pounds for a 100 ton jack. Average heights range from about seven inches to 10 inches with a stroke (pushing range) of about five to six inches. Many jacks in the 1 1/2 to 12 ton capacity group offer a convenient extension screw giving an extra 3 inches of utility. Aside from the standard sizes, a few brands offer 'stubby' jacks that start as low as 6 inches. One brand sells a 'telescoping' jack that ranges from a low height of about 5 inches and extends to a height of more than 10 inches. In addition, 1 1/2, 3, 8, 12 and even 20 ton capacity jacks are available in heights from 20 to 24 inches, popular in engine cherry picker/cranes and for special applications; however, the 8, 12 and 20 ton versions are quite expensive.

3.Problem statement:

- For this type of operations we need heavy force. In the case of tyre puncture or replacing wheels lift the car is more important part. This time we use traditional ways to lift the tyre. In that case a physically handicapped person, ladies person or aged person may not lift the car easily .
- They require more time and also require more force to lift the tyre. Automatic hydraulic jack system is more useful for this type of problems.
- Mechanical jack requires more effort moreover not suitable for uneven surfaces. It requires more power consumption also Maintenance is quite high as well as Suitable for small capacity and requires skilled labour.

4.Objectives:

The objectives of the project are to design a system for;

i. To develop a electrical hydraulic jack that helps in easy and quick lifting.
ii. To provide the alternative method for vehicle lifting.
iii. To reduce human efforts.
iv. To reduce the cost anyone can use and easy to operate.

5.Methodology:

i. This project deals with design and fabrication of automatic hydraulic car lifting attachment with the help of hydraulic cylinder.
ii. Study the jack mechanisom
iii. Decide, plan and make rough sketch to operate jack by motorized gear box.
iv. Draw finale sketch
v. Manufacture and assemble jack
vi. Test the model

6.**Method of Jacking and Safety Precautions**

6.1 Method of Jacking and Jacking Points

If you are using the jack that came with the car, it should be designed to fix securely onto specific points under the car, typically here ; There will be a cut out or indentation behind the front wheel and infront of the back wheel that will accept the head of the jack. When the head of the jack is located at the correct points, it should not move about whilst you are operating it and raising/lowering the car. **How do I do it safely then?** For the purpose of this exercise we will assume that you are changing a wheel on your car. If you are performing something else under your car, just stick to the stuff relevant to chocking the wheels, raising the car and securing it.

Step 1. MOST IMORTANT - find a flat and solid surface to jack up your car. Don't jack up any car when it is not on level ground or has an uneven surface. This is just asking for trouble and you could end up in hospital or worse.

Step 2. Make sure that the handbrake is fully on and the car is in gear. Here are a couple more examples of jacking points, your owner's manual or Haynes Manual may help you identify safe jacking points also.

Step 5. The reason for not lifting the wheel fully off the floor is so that we can loosen the wheel nuts slightly and with it on the ground the wheel won't spin around. If you were to jack up the car fully and then try and loosen the wheel nuts, the wheel will most likely just keep turning around. So with the weight of the car on the jack, take your wheel bolt spanner (or wheel brace/spider as shown below) and loosen off all the bolts very slightly.

Step 6. Now raise the car slowly with the jack until the tyre is off the floor.

Step 7. At this point you can now fully remove all of the wheel bolts and put the safely to one side. Now you can remove the wheel by just lifting it off the car, mind your back as large wheels/tyres can be heavy. Place the removed wheel under the car as a back-up to the jack. NOTE - if the wheel is stiff and does not want to come off, put one hand on the top (6 o'clock) and one at the bottom (12 o'clock) and try to rock it loose. It should not require too much force/effort to get the wheel loose but take care not to rock the car off its jack.

Step 8. Now you can fit your replacement wheel, making sure that the bolt holes on the wheel are lined up with the holes on the car wheel hub. Line up the holes and refit the bolts you removed earlier. With the car jacked up, tighten each bolt as much as you can until the wheel starts to turn. Now to ensure that the wheel goes on straight, make sure that when you tighten the bolts, they are tightened up as follows; 4 studs (bolt) wheels 5 stud (bolt) wheels

Step 9. Lower the car to the floor with the jack and remove it. Now perform the final tightening of the wheel bolts using the same sequence as shown above.

Step 10. Remove all tools and equipment to you has used and stores them away safely.

6.2Safety Precautions

1. Regularly inspect and lubricate jack to ensure it in good working order and condition. Does not use the jack if damaged or a fault is suspected-check section 5 troubles shooting. If necessary, immediately repair or replace damaged parts.

2. Use recommended parts only; the use of unauthorized parts may be dangerous and will invalid

3. Use jack on level and solid ground, preferably concrete.

4. Park the vehicle and apply hand brake. Switch off the engine and place chokes under the wheels.

5. Ensure a minimum distance of 0.5 m between vehicle and static objects such ass doors, walls, etc. to allow for tilting during jacking.

6. Ensure all persons are out of the vehicle before jacking. Do not enter vehicle whilst it is supported on the jack or axle stands.

7. Check lifting point is centered and stable on jack saddle. Positions jack so as to avoid, operating it from under vehicle.

8. Keep hands etc. clear of moving parts during raising and lowering of the vehicle.

9. Road side wheel changing is hazardous. Use hazard warning lights.

10. When changing a wheel, slightly loosen wheel nuts/bolts prior to jacking vehicle. Screw wheel nuts/bolts back before lowering vehicle. Finally tighten when vehicle is fully

11. DO NOT exceed the rated capacity of the jack and do not operate the jack beyond its maximum pump stroke.

12. DO NOT try to move the vehicle, or try to start the engine, when the vehicle is jacked up.

13. DO NOT jack a vehicle if it may result in the spillage of fuel, battery acid, or other dangerous substances.

14. Do not place any part of your body under vehicle whilst it is supported by the jack.

15. DO NOT use jack to support extensions or cradles.

16. DO NOT top up jack with brake fluid. Use hydraulic oil only. Do not adjust the safety overload valve.

6.3 Operating instructions

1. Check that the ground upon which the jack will stand is level and solid.

2. Position the jack saddle under the vehicle manufacturers recommended lifting point.

3. Using the screw extension necessary raise the saddle to the lifting point.

4. Pump the unit until the required height is achieved.

5. Ensure that the suitable axle's stands are provided and removed after and before jacking. The lowering speed is controlled by the amount of release valve is opened. Turn anti-clockwise and lower slowly and carefully

Application:

Power cylinders are used in machines and equipment for lifting loads, applying pull forces, translating loaded machine parts and tools and for positioning devices. It can work in two modes, either with a fixed piston and moving cylinder or with a fixed cylinder and moving piston. The rotary motion can be given to any of the piston s or cylinder. The simplest device one can think of is a cylinder jack, often used for lifting heavy loads. The load can be placed on top of a platform, and with fixed piston the cylinder may be rotated with the help of a lever. However, the load will rotate with the cylinder. The alternative method would be to rotate the cylinder supported in vertical direction and obstruct the cylinder to rotate with the piston.

The lead cylinder of a lathe machine, which moves the tool carriage, is another example of power cylinder in which the cylinder rotates in a piston and cylinder is supported like a shaft between two bearings. The thrust is caused on the piston, which is integral part of the tool carriage. The piston moves along the length of the cylinder taking the carriage. The reaction of the thrust bears on the supports of the cylinder. The cylinder can be used for accurate positioning of the carriage if it is rotated by a separate stepper motor. The cylinder in

transferring of force can also be used in hand operated punching machines, as a lifter of dam gate or as a presser of masses.

If there is a support like a collar, on the top of which the load is placed so that it does not rotate, then the applied torque has to be equal to the sum of the torque required to rotate the cylinder in the piston and the friction torque between the surfaces of the collar and load platform. The friction torque between the supporting bearing surface and stationary surface may be reduced by lubrication or by providing rolling bearing. In any given situation the torque at bearing surface will have to be calculated.

Uses:

In the automotive world the 1 1/2 through 5 ton jacks are popular for cars and light trucks, the 8 and 12 ton models for Recreational Vehicles and medium to heavy duty trucks while the 20 ton bottle jacks are used primarily for 'big rig' tractor trailers. Bottle jacks and variations thereof appear in fields as diverse as medicine (for patient lifts, examine tables, hydraulic stretchers), plumbing (pipe benders), electrical (cable slicers), printing (paper cutters) warehousing (material handling), agriculture (equipment maintenance), construction (pushing, pulling, hoisting or lifting), food industry (from pallet jacks to pressing apple juice or sausages) metal shops (bending, cutting and fabricating) and in dozens of applications too numerous to mention. Jacks, while traditionally used in an upright fashion with the ground as a base to lift a great weight in the air, are quite often mounted inside a framework to do a specific job such as compressing, as in a hydraulic press, or mounted on a vertical beam to push against a horizontal beam making a crane.

Conclusion

It is concluded that the project has been completed successfully as per our objective oriented in the beginning. Being the motive of this object to prepare a project model which is light weight and compact in nature to serve the people of elder civilian, moreover the physically challenged persons. It is also experienced that the wiper motor can be replaced by stepper motor to have more torque and less space consumption resulting in reduction of weight and cost; hence the range of operation can be increased. Also by including further latest technology available it can be implemented and produced in lump sum.

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