PORTABLE VEHICULAR ELECTRO-HYDRAULIC JACK

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Abstract:

The disabling of a vehicle due to flat tires is always a constant concern for vehicle operators. In dealing with the problems, operators are often faced with the complexity of car jacks, not to mention the traffics hazards and other forms of damages that can occur under the inexperience hands. Standard mechanical car jacks are known as a screw jack, which is sturdy and cumbersome to handle. Other than that, operators can opt for hydraulic jacks that are commercially available in the market with variety of lifting capacities.

A research was conducted on improving the portable vehicular hydraulic jack. An effort was made in converting manual operated hydraulic jack into a powered actuation. A reciprocating linkage was introduced in between the hydraulic jack and an electric motor, and thus removing the manual actuation handle. A hand-held controller was also introduced in controlling the lifting process of the jack. The result had shown that with proper engineering analysis, the improved electric powered portable hydraulic jack manage to lift any vehicle with ease, using available power provided by the vehicle battery.

Keywords:

Hydraulic Jack, Fluid Power

1 Introduction

The uses of car jacks are standards issues for all car operators in the world. In many application, they are subjected to a standard mechanical "screw" jack, which is positioned next to the spare tires located somewhere behind or hidden under the car trunk. This paper however, will be discussing on the use of another car jack, known as a hydraulic "bottle" type jack. In fact, the focus is more on improving the mechanical actuated hydraulic jack into a motorized jack. This so-called motorized or powered jack should be able to be operated by a hand-held controller, with power supply from the vehicle battery itself. [Figure 1]

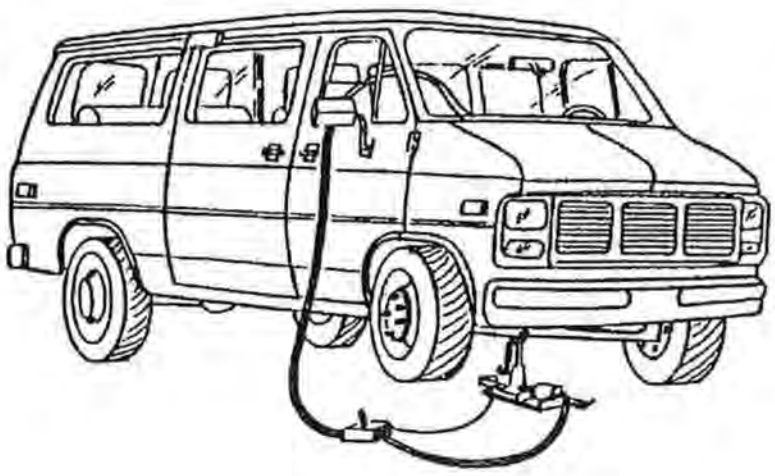


Figure 1. The concept of motorized jacks.

Previous improvement had been done by numerous researchers on designing a simplified version or mechanized car jacks. The earliest idea on designing a motorized hydraulic jack had been patented by Clifford Carman in May 13, 1935 [1]. The invention [Figure 2] is related for hydraulic jack that is electrically actuated by an electrical motor, which obtained the electrical energy from the vehicle itself.

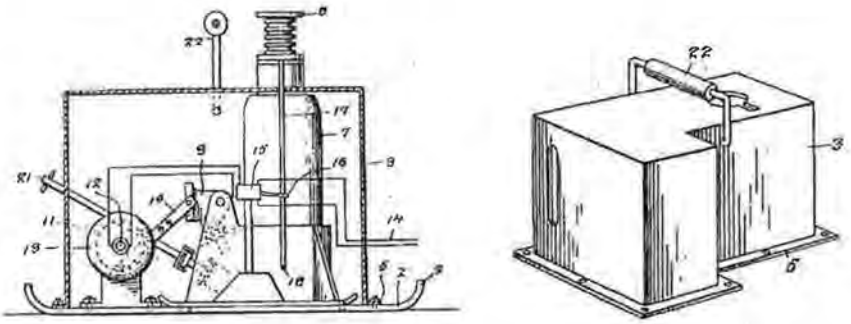


Figure 2. Motorized Hydraulic Jack [1]

The ingenious design comprises of metal base plate, metal cover, a hydraulic jack, and an electric motor mounted with electrical connection to control the elevation of the jack. The jack was all covered with metals and the opening for the elevation of the jack. The design however did not prevail into reality as the design of hydraulic jack was still new at that time, and the bulky overall jack cover seems quiet complicated to be kept in cars. Wen Chen Hsu patented a more realistic motorized hydraulic jack in July 1986. [2]. The improved electrical hydraulic jack had a telescopic lift structure with manually adjustable crown rod. [Figure 3]. The base plate was integrally formed to the jack body, with a motor assembly matched into a fixed housing body in an ingeniously upright position.

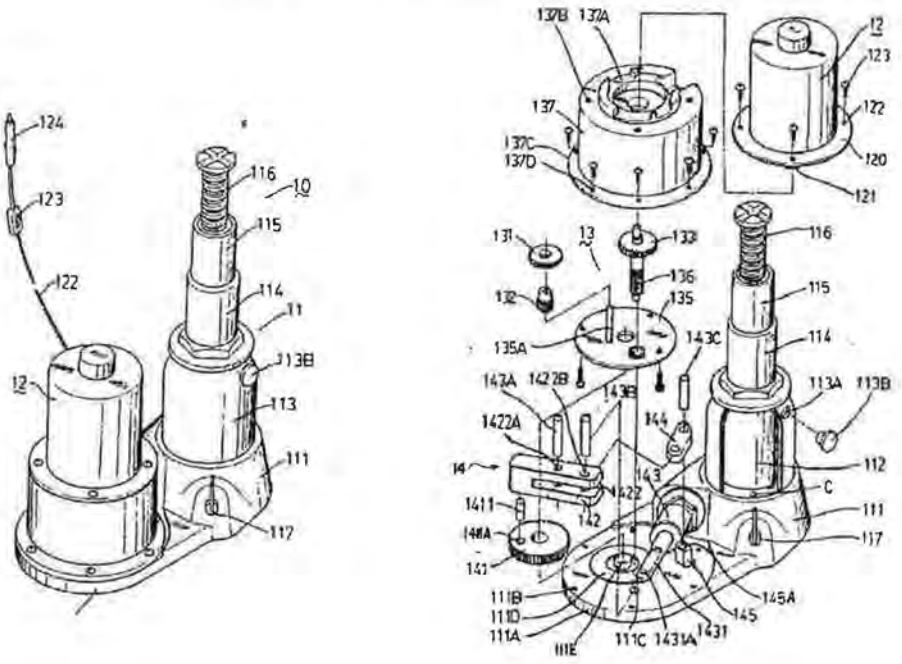


Figure 3. Electrical Hydraulic Jack [2]

This was made possible by the use of transmission devices installed in the upper portion of the housing body in connection with the motor assembly, and an electrical motor mechanically coupled between the transmission device and the jack body. With these assemblies, the high revolution of the motor was reduced and the revolving motion will be converted into straight-line movement to pump the hydraulic jack into action. The design however, with its predecessor, did not prevail into a real product.

The only patented motorized jack that managed to be produced was the motorized screw jack [3], which was patented by Joseph Pickes in Jun 1988. The design, which is called the portable powered screw jack actuator unit comprises of an electric motor coupled to the rotating element of the screw jack, which was used to lower and raise the jack platform. A power cord for the actuator had a plug adapted to be received in a cigar lighter socket of a vehicle. The design even equipped with a back-to-back elements that could create the effect of reversing the jack movement without reversing the motor. The improved jack had been marketed worldwide [4] and named as Easy Lift Power Pack. [Figure 4]

Figure 4. Easy Lift Power Pack [4]

2 Problem Statement

The design of a portable vehicular electro-hydraulic jack is based on the improvement of a 2 ton hydraulic "bottle" jack, which is coupled to a 12 volt electrical motor, and powered by the vehicle battery itself. In the early steps of the research, the original idea is to have a hydraulic jack that is actuated by a rotational mechanism, linked to the rotational movement of an electric motor. This, however, is impossible as almost all hydraulic jack found in the markets is actuated by a reciprocating mechanism, where the jack is sort of mechanically pumped into lifting the vehicles.

In dealing with the problem, a simple and yet practical improvement had been developed whereby the rotational movements from the electrical motor have been transferred into a reciprocating movement using a reciprocating linkage. This would simulate the pumping input for the hydraulic jack in lifting the vehicles. Three designs had been evaluated, and only one is chosen as it has been mathematically proven in this research. Apart from mathematical analysis, the design consideration would also include the extra storing space and the compactness of the new improved jack.

2.1 First Design Evaluation

The first improvement suggested during the research involved the positioning of the electric motor facing the front of the jack. The motor is mounted on mild steel, which is welded on the main fame of the jack. The design however had created few flaws. One of the problems is that the positioning of the motor had caused extra storing space for the whole jack itself. At the same time, more empty space had been created on the jack. In this design, the available torque from the pump the jack is transferred directly through the mechanical linkage.

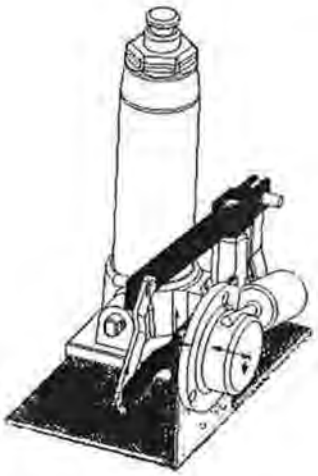


Figure 5. First Design Evaluation

2.2 Second Design Evaluation

The second improvement suggested for the electro-hydraulic jack is the positioning of the mounted electric motor at the back of the jack. The motor is mounted on the middle of welded mild steel. The mounting of the motor is located at the back of the jack and was positioned parallel to the jack. This type of mounting proved to be space-efficient as it reduces unnecessary space on the main base plate. The torque produced is placed to a free lever before pumping the small piston. In this research, the second design has been chosen in designing the first prototype for a portable vehicular electro-hydraulic jack.

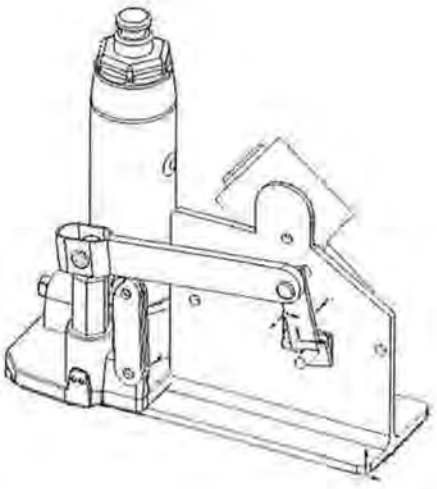


Figure 6. Second Design Evaluation

2.3 Third Design Evaluation

The third improvement also implemented the positioning of the mounted electric motor at the back of the jack. The motor is also mounted on the middle of welded mild steel and mounted in parallel to the jack. The only different is that the torque produced is mounted on a fixed lever before pumping the pump plunger.

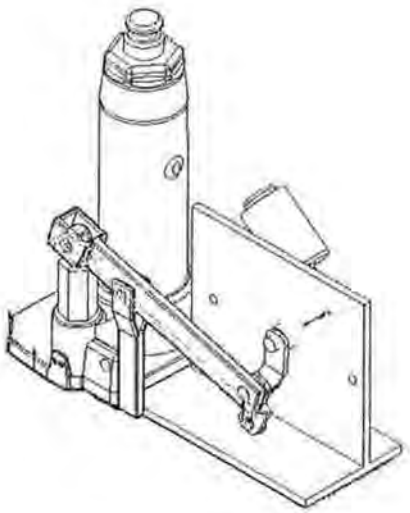


Figure 7. Third Design Evaluation

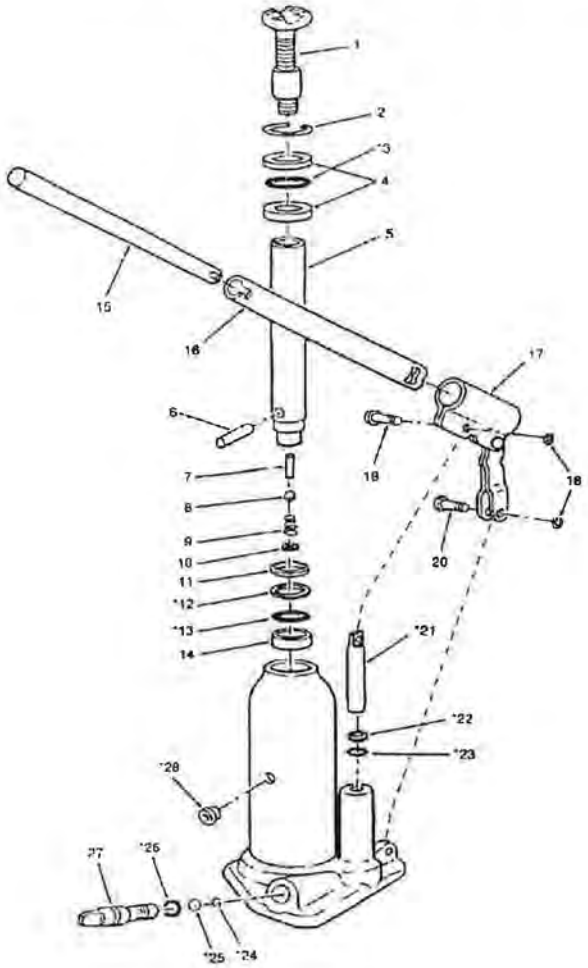
3 Design Components of Portable Vehicular Electro-Hydraulic Jack.

3.1 Hydraulic "Bottle Type" Jack.

The hydraulic "Bottle" Jack is used in this research due the compact design of the jack itself. Like the typical mechanical "screw" jack, the hydraulic "bottle" jack is usually manually operated by using small rod in pumping the hydraulic jack. The complete exploded view of the hydraulic "bottle" jack and the hydraulic circuit for the jack can be observed in Figure 8 and 9. Figure 8 shows complete loading control by using built-in non return valve, lever lingkage assembly and rod handle. Table 1 shows the specification of the hydraulic jack used in this research.

Table 1. Major Specifications of Hydraulic Jack.

Type	Hydraulic "Bottle Type" Jack Ram Type Cylinder.
Pushing Force	2 ton.
Minimum Height	181 mm
Maximum Height	297 mm
Lifting Height	116 mm
Adjusting Height	48 mm
Base size	80 mm x 95 mm
Weight	2.9 kg



INDEX NO.	DESCRIPTION
1	Extension screw assembly
2	Snap ring
*3	O-ring
4	Upper bearing
5	Ram
6	Limit pin
7	Valve pin
8	Check ball, limit pin .250 dia.
9	Spring
10	Retainer
11	Ram bearing (A)
*12	Back-up ring
*13	O-ring
14	Ram bearing (B)
15	Handle section, solid
16	Handle section, tubular
17	Lever linkage assembly
18	Snap ring
19	Pin, link
20	Pin, link
*21	Pump plunger
*22	Back-up ring
*23	O-ring
*24	Check ball, cyl injection port .219 dia
*25	Check ball, release valve
*26	O-ring
27	Release valve
*28	Plug, oil filler

Figure 8. Exploded View of the Hydraulic Jack.[5]

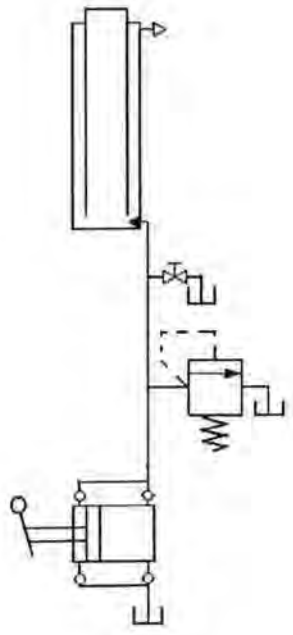


Figure 9. Hydraulic Jack Circuit.[6]

3.2 Electric Motor

A 12 volt electric wiper motor is used in redesigning the hydraulic jack. Such electric motor is important in the improvement of the jack since it manage to produce the necessary torque required in pumping the hydraulic jack and at the same time having a suitable car voltage requirement. The electrical motor will be mounted on the main based plate of the hydraulic jack.

3.3 Based Plate

The main base plate is the main plate that is mounting the electric motor. It is made out of mild steel of 230 x 78 x 5 mm. The same base plate is welded with a 90° stand of 138 x 113 x 5 mm. The base plate is design in such a way that it can reduce extra space and provide a strong foundation for the electric motor to actuate the pump plunger in lifting the jack.

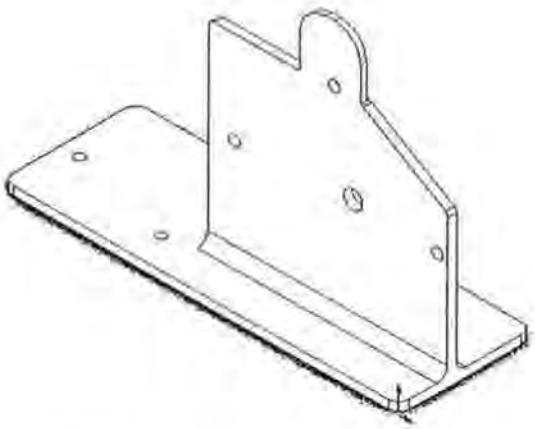


Figure 10. Main Base Plate

3.4 Lever

There are three type of lever used in the design. The main lever, as seen in Figure 11,is used in transfering the torque provided by the electric motor to the hydraulic jack pump pulnger. The main lever is supported by two more small lever that transfer the rotational movement into a reciprocating movement and at the same time maintain the stability of force tranformation.

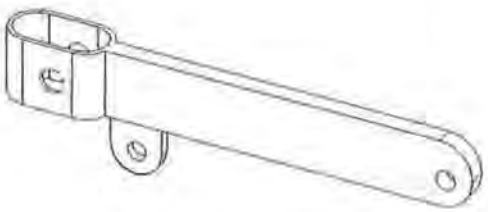


Figure 11. Main lever.

3.5 Electric Wire

The wire is used in the design to transmit electrical power from 12 volt power supply located from within the vehicle. The minimum length used in this research is 4 meter.

3.6 Auto Plug

A conventional auto plug was used in this design. The plug must be able to be adapted to cigar lighter socket of any vehicles.

3.7 Switch Controller

A switch is used in the design which act as a hand-held controller in operating the jack. The controller is used to lift the jack to the necessary height, and at the same time provide two different speed control for the job.

4 Field Test

The lifting of the redesign hydraulic jack had been done in a field test by using 850cc Perodua Kancil car. The weight of the car is about 690 kg. The test was done after all consideration of the force required to raise the car was properly measured and evaluated. Figure 12 shows the position of the hydraulic jack before the car was lifted. As the original minimum height of the jack is 181mm, it was mounted exactly next to the tire. The lifting of the jack is controlled by a controller, which received electrical signals from the lighter socket of the car. In Figure 13, it was observed that the redesigned jack managed to lift the car in a minimum time of 2 minutes.

Figure 12. The positioning of the electro-hydraulic jack

Figure 13. The position of the jack during the lifting of the car.

Conclusion

In this paper, an improvement of a manual actuated hydraulic jack is proposed and tested in the field. The redesign process includes mounting of a 12-volt electric motor to actuate the pump plunger, thus creating the lifting effect on the jack ram cylinder. A hand-held controller has been introduced into the electro-hydraulic jack to control the lifting of the jack with ease. The design is able to handle heavy load up to 2000 kg, as the original specification of the hydraulic jack is not tampered. Ongoing research will been done in designing portable vehicular electro-hydraulic jack which should be able to withstand more than 2000 kg of load with the same linkage design.

Acknowledgement

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References:

[1] Carman C. (1936). Hydraulic Jack. (U.S. Patent 2,034,605).
[2] Easy Lift Power Jack.(2005). Citing Internet Sources. URL http://www.hooksetter.com/prod01.htm.
[3] Norco Industries.(2005). Hydraulic Axle Jack. USA: Specification Brochure.
[4] Pickles J. (1988). Portable Powered Screw Jack Actuator Unit. (U.S. Patent 4,749,169).
[5] Priences M.J. and . Ashby J. G. (1988), "Power Hydraulic", Prentice Hall. U.K.
[2] Wen Chen Hsu. (1986). Electrical Hydraulic Jack. (U.S. Patent 4,598,898)