Design & Development of Button Operated Electro Hydraulic Jack

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Abstract - Car jack is an important element in the maintenance and removal of car tyres. The conventional jacks in use are toggle jack, hydraulic jack, screw jack etc. Normally the jacks are operated manually. In case of commercial cars use the toggle jack for lifting the car for removal of tyres. The toggle jack is manually operated although motorized toggle jack are also available. The toggle jack is a spare element which can be placed under an individual tyre location that needs to be replaced. The toggle jacks are cuber some to operate especially to female drivers and hence a more simple to operate motorized hydraulic jack that will be compact, handy, with low storage space is required.

The need of an integrated hydraulic jack in the motorized form is needed where in the lifting capacity of the jack be at least 1 ton, the drive motor be suitable connected via linkage to the operating handle of the hydraulic jack pump and the power be delivered to the motor through suitable electric circuit with 12 volt DC power that can be taken from the car battery through the cigarette lighter socket below dash board.

The design of the hydraulic jack, motor drive and kinematic linkage to operate the pump is done using theoretical method and the 3-d model is developed using Unigraphix NX-8 and the analysis of the parts is done using Ansys 16.0

The testing has been done in suitable manner to demonstrate the capability of jack.

***Key Words*:** Electro Hydraulic jack, Pascal Law, etc…

1. INTRODUCTION

OVERVIEW:

A Screw jack is a device which is used to raise part of a vehicle in order to facilitate vehicle maintenances or breakdown repairs. In normal Jack system a mechanical jack is used for lifting the vehicles. The most common form is a car jack, garage jack, floor jack which lifts vehicles so that maintenance can be performed. Car jacks generally used to increase mechanical advantage while lifting the vehicle. In general the weight of the vehicle is near about the 1 tons. A specified jack can hold up to 1000 kilograms, but tests taken by Consumer Affairs has revealed that is fails to work after lifting 250 kilograms and may physically break when it has a weight close to its 1000 kilograms capacity. Tests have proven that the jack has the tendency to buckle under the weight it is promoted to withstand. For this reason, we have to developed the system which can used with toggle jack is automatic in operation. That means with the help of the electric motor. For this motor we have to use the vehicle battery is as source. In this, vehicle battery should be a 12V DC motor with some torque which is required to overcome the thread friction and to raise the load.

1.1 NEED OF INVENTION:

In the world, the fact is that „necessity is the mother of invention" and the necessary condition is that, large effort is required for the manual operation of jacks, so for that reason, it is the need of invention. In the repair and maintenance of automobiles, it is often necessary to raise an automobile to change a tyre or access the bottom of the automobile. According to that, various car jacks have been developed for lifting an automobile from a ground surface. In that case, they are categorised as; Standard jack, pneumatic jack, farm jack, hydraulic jack. Normally the standard jack uses the power screw for lifting. This standard jack has limited degree of freedom with corresponding link members. In Hydraulic jack, incompressible fluid is used instead of screw for lifting. This is achieved by increasing the fluid pressure in cylinder to uplift the load. Available jacks are typically large, heavy and also difficult to store, transport, carry or move into underside of an automobile. Doing work in a bent or occupying position for a period of time is not ergonomic to human body, i.e. it is not completely desirable in ergonomics point of view. It may give back problem while continuous working with same. Engineering is preferred for making things simpler or improving and effective, for that Car jacks must be easy to use for pregnant women. The general purpose of the project is to minimize the human effort while operating the jack.

1.2 PRINCIPLE OF WORKING:

1.2.1 Standard Jack:

Standard jack is a mechanical device which is used to lifting device. Standard jack employs a screw thread for lifting heavy equipment. The most common used in cars as car jack, floor jack or garage jack which lifts vehicles for purpose of vehicle maintenance. Standard Mechanical jacks are usually rated for a maximum lifting capacity (for ex., 1.5 tons or 3.0 tons). For maximum load hydraulic or pneumatic power is used to lift the Vehicle.

Figure 1 Standard screw jack

1.2.2 Pneumatic Jack:

A pneumatic jack is a part of hydraulic jack that is actuated by compressed air - for example, air from a compressor - instead of human work. It saves the effort which excludes the need of the user to actuate the hydraulic mechanism, with potentially increasing speed. In certain circumstances, these jacks are also capable to be operated by normal hydraulic actuation mechanism, by that keeping possession ability, even when source of compressed air is not available

Figure 2 Pneumatic jack

1.2.3 Farm Jack:

The farm jack is also known as a Hi-Lift Jack. It is composed of a steel beam with a chain or series of equally spaced holes continuous with its length and a mechanism with hand operated which is moved from one end of the beam to the other through the use of a pair of climbing pins. The farm jacks are categorised as 1.2m, 1.5m and 1.8m.

Figure 3 Farm Jack

1.2.4 Hydraulic Jack:

Incompressible Fluid is uses in hydraulic jack that is forced into a cylinder by a pump plunger. Oil is used which is self-lubricating and stable. At the time, when the plunger goes into the reservoir, it get return with oil by means of a suction check valve into the pump chamber. When the plunger goes toward the reservoir, it presses the oil into the cylinder by means of discharge check valve. Due to action of suction valve ball, the valve is open by to and fro motion of plunger which is fitted inside the chamber and same action also done when is moved out but in that condition discharge valve ball is fitted out of the chamber. At this stage the suction ball inside the chamber is pressurized by external work which helps to increase pressure in the cylinder.

Figure 4 Hydraulic Jack

2. PROBLEM STATEMENT:

The conventional jacks in use are toggle jack, hydraulic jack, screw jack etc. Normally the jacks are operated manually. In case of commercial cars use the toggle jack for lifting the car for removal of tyres. The toggle jack is manually operated although motorized toggle jack are also available. The toggle jack is a spare element which can be placed under an individual tyre location that needs to be replaced.
The toggle jacks are difficult to operate especially to female drivers and hence a more simple to operate motorized hydraulic jack that will be compact, handy, with low storage space is required
The need of an integrated hydraulic jack in the motorized form is needed where in the lifting capacity of the jack be at least 1 ton, the drive motor be suitable connected via linkage to the operating handle of the hydraulic jack pump and the power be delivered to the motor through suitable electric circuit with 12 volt DC power that can be taken from the car battery through the cigarette lighter socket below dash board.

3. OBJECTIVES

- To design and develop motor drive for operating jack system.
- To minimize human effort.
- To save time.

4. DESIGN METHODOLOGY:

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy &efficiency.

Hence a careful design approach has to be adopted. The total design work, has been split up into two parts

- System design
- Mechanical Design.

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.

In mechanical design the components are listed down and stored on the basis of their procurement, design in two categories namely,

- Designed Parts
- Parts to be purchased

For designed parts detached design is done & distinctions thus obtained are compared to next highest dimensions which are readily available in market. This amplifies the assembly as well as postproduction servicing work. The various tolerances on the works are specified. The process charts are prepared and passed on to the manufacturing stage

The parts which are to be purchased directly are selected from various catalogues & specified so that anybody can purchase the same from the retail shop with given specifications.

5. SCOPE OF THE PROJECT

- The developed automatic car jack must be operated on a flat surface.
- The developed jack car is only a prototype and not readily functioning as commercial product.
- The developed automatic car jack can only withstand below.
- The design is based on current hydraulic jack & cars in the market.

6. SCHEME OF IMPLEMENTATION

PHASE 1: DATA COLLECTION

Data collection phase involves the collection of reference material for project concept; the idea is taken from book HMT handbook.

PHASE 2: SYSTEM DESIGN

The system design comprises of development of the mechanism so that the given concept can perform the desired operation. The mechanism is basically an inversion of four bar kinematic linkage, hence the mechanism is suitably designed using Grashoff's law and the final outcome is shown in the figure shown before.

PHASE 3: MECHANICAL DESIGN

The parts mentioned above in the part list will be designed for stress and strain under the given system of forces, and appropriate dimensions will be derived. The standard parts will be selected from the PSG design data handbook.

PHASE 4: PRODUCTION DRAWING PREPARATION

Production drawings of the parts are prepared using Auto Cad, with appropriate dimensional and geometric tolerances. Raw material sizes for parts are also determined.

PHASE 5: MATERIAL PROCUREMENT & PROCESS PLANNING

Material is procured as per raw material specification and part quantity. Part process planning is done to decide the process of manufacture and appropriate machine for the same.

PHASE 6: MANUFACTURING

Parts are produced as per the part drawings.

PHASE 7: ASSEMBLY –TEST & TRIAL

Assembly of device is done as per assembly drawing, and test and trial is conducted on device for evaluating performance.

7. TEST AND TRIAL

AIM: -To conduct trial on button operated electrical jack

Figure 5 Test Vehicle

TECHNICAL SPECIFICATION

Body Type	All Steel Chassis Cab with customer specified flat bed drop side / tipper / box van load body options
Number of Seats	2
Maximum Speed (mph and kph)	25 mph (40 kph) electronically limited
Estimated Maximum Range	25 miles (40 km) – European Combined Drive Cycle 30 miles (50 km) – Constant 20mph (32 kph)
Overall Length x Width x Height	3,800 x 1,500 x 1,830 mm
Load bed Dimensions Length x Width	2,200 x 1,500 mm
Payload (kg)	500 kg
GVW	1,550 kg
Motor – Maximum Power (10 sec)	25 kW
Motor – Maximum Torque	75 Nm
Drive System	Rear wheel drive Permanent Magnet DC Motor and Drive
Gears	Single Speed e-Drive
Battery Type	10 x 8 Volt Gel – filled Lead Acid
Battery – Total Energy Capacity	85 Ah @ 75 A
Time to Charge from Flat to 100%	Approximately 8 hours

Procedure of Trial:

Lifting Stroke:

1. The jack was placed under the vehicle.

2. Connect the cable to the power source. (12V Supply)

3. The primary motor for the lifting jack is operated and the gear drive is operated

4. The motion of the gear drive operated the drive lever which makes the jack linkage to operate.

5. The motion of the jack linkages results in the vehicle being lifted

Lowering stroke:

1. The primary motor for the primary lifting jack is stopped

2. The relief valve is opened

3. The motion of the jack linkages in downward direction results in the vehicle being lowered

Figure 6 Test Vehicle

8. RESULT & DISCUSSION

1. The literature review showed that majority of the research work has been limited to design of the motorized toggle jack or screw jack, few or no researchers have designed the motorized hydraulic jack. The need of an integrated hydraulic jack in the motorized form is needed where in the lifting capacity of the jack be at least 1 ton, the drive motor be suitable connected via linkage to the operating handle of the hydraulic jack pump and the power be delivered to the motor through suitable electric circuit with 12 volt DC power that can be taken from the car battery through the cigarette lighter socket below dash board.

2. The design of spur gear was done and analytical stress was found to be 58.27 Mpa, both below permissible limit hence part is safe.

3. The design of crank shaft was done theoretical stress was found to be 7.8Mpa and analytical stress was found to be 9.56 Mpa, both below permissible limit hence part is safe.

4. The design of crank was done theoretical stress was found to be 0.212 Mpa and analytical stress was found to be 4.1591 Mpa, both below permissible limit hence part is safe.

5. The design of crank pin was done theoretical stress was found to be 1.63 Mpa and analytical stress was found to be 5.79 Mpa, both below permissible limit hence part is safe.

6. The design of Drive lever was done theoretical stress was found to be 0.88 Mpa and analytical stress was found to be 33.729 Mpa, both below permissible limit hence part is safe.

7. The design of Pump lever was done theoretical stress was found to be 2.136 Mpa and analytical stress was found to be 1.736 Mpa, both below permissible limit hence part is safe.

8. The design of Pump Link was done theoretical stress was found to be 4.789 Mpa and analytical stress was found to be 6.24 Mpa, both below permissible limit hence part is safe.

9. The design of Pump piston was done theoretical stress was found to be 1.13 Mpa and analytical stress was found to be 4.51 Mpa, both below permissible limit hence part is safe.

10. The design of body was done theoretical stress was found to be 19.9 Mpa and analytical stress was found to be 3.323 Mpa, both below permissible limit hence part is safe.

9. ELECTRIC JACK ADVANTAGES & DISADVANTAGES

Electric car jacks are equipment used to lift your vehicle. How many times did you suffer from a flat tire or a leaking pipe and wished you had a car jack on you? I bet it's a number of times. Many people just in case of an emergency, buy and store portable electric jacks for times of needs in their vehicles.

These inventions help you lift your car in a matter of minutes. They help you get underneath your car to do what you've got to do with all the support you need. For you to own these devices doesn't oblige you to be a handyman. Anyone can own an electric car jack just in case of any problem with their vehicles.

Pros: They're easy to use, they sometimes come with a kit that includes pump and wrench, they include a durable case for tools, they aren't heavy and they can be portable, they don't take much space and can be stored in your vehicle.

Cons: They can be quite pricy, most of these car jacks don't have great longevity, some don't handle heavy weight, some have short heights and they can even experience leaking.

10. COST ANALYSIS

BILL OF MATERIALS:-

SR NO.	DESCRIPTION	QTY	MATERIAL
1.	SHAFT	1	EN24
2.	DRIVER LINK	1	EN9
3.	CRANK PIN	1	EN24
4.	CRANK	1	EN9
5.	MOTOR	1	STD
6.	GEAR	1	STD
7.	MOTOR BKT	1	MS
8.	JACK	1	STD
9.	JACK BASE	1	MS
10.	BEARING HOUSING	1	EN9
11.	BEARING 6005	1	STD
12.	DP/DT SWITCH	1	STD

RAW MATERIAL COST

The total raw material cost as per the individual materials and their corresponding rates per kg is as follows,

Total raw material cost = Rs 2450/-

MACHINING COST

OPERATION	RATE	TOTAL TIME	TOTAL COST Rs/-
	Rs /HR	HRS	
LATHE	90	10	900
MILLING	105	5	525
DRILLING	50	3.2	160
TAPPING	5 Rs/hole	10	50
TOTAL			1635

Total machining cost= Rs. 1635 /-

MISCELLANEOUS COSTS

OPERATION	COST(Rs)
Sawing	110
Fabrication	800
Total	910

Total miscellaneous cost= Rs. 1635 /-

COST OF PURCHASED PARTS:-

PART NAME	QTY	COST
JACK	1	2850
MOTOR	1	1850
GEAR	1	850
BEARING	1	350
SWITCH	1	150

The cost of purchased parts = 6050

TOTAL COST

Total Cost = Raw Material Cost +Machine Cost + Miscellaneous Cost + Cost of Purchased Parts +Overheads = Rs 11250

Hence the total cost of machine = Rs 11250/-approx.

11. CONCLUSION

The conventional jacks in use are toggle jack, hydraulic jack, screw jack etc. Normally the jacks are operated manually. In case of commercial cars use the toggle jack for lifting the car for removal of tyres. The toggle jack is manually operated although motorized toggle jack are also available. The toggle jack is a spare element which can be placed under an individual tyre location that needs to be replaced. The toggle jacks are cuber some to operate especially to female drivers and hence a more simple to operate motorized hydraulic jack that will be compact, handy, with low storage space is required

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The testing has been done in suitable manner to demonstrate the capability of jack.

A simple, compact, high efficiency, low cost device will be developed, so also a new technology of motorized design has been learnt through the project. The project will provide the industry with a new device to solve lifting problems in many vehicles in many applications.

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