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Design and Fabrication of Automatic Jack for a Four-Wheeler

[1]Ketan Tonpe, [2]Mahendra Funde,[3]Akash Manekar,[4]Nikhil Sathawane

1Assistant Professor Mechanical Engineering, SCET, Nagpur
[2,3,4,]B.E. students of Mechanical Engineering, SCET, Nagpur

ABSTRACT

Now-A-Days, everybody is aware of the several complications and anomalies that may or may not occur in a simple LMV. These complications include unanticipated breakdown, that tire, etc. or any such complication that renders the vehicle to a halt and unusable. A crude solution 1or such complications that has been implemented since a long time is a manually operated jack. Hence, irrespective of its size and weight a jack that is used to list the vehicle is one o1 the most essential accessories that need to be constantly kept close at hand. Thus, the need to keeping the jack available is undeniable. These days several types of either manually operated or automatic jacks whether lightweight/portable or heavy are widely used to fulfill their purposes in lifting heavy as well as light equipment's. There are only a 1ew types o1'jacks that are consistently used for lifting a vehicle during its repair work or any such purpose viz. manually operated screw jacks, manually operated screw jacks, manually operated hydraulic jacks etc. Even though they fulfill their purpose there is a huge drawback to these kinds of jack i.e. they are manually operated and consume a substantial amount of time and energy for their operation. Thus an alternative for these jacks which is already integrated and automatic would prove to be beneficial to the end user as well as the repairmen. One such alternative is the Integrated Automated Screw Jack. This jack would be permanently mounted on the chassis on the vehicle and will be automatically operated which will evidently eliminate manually operating it to raise the vehicle and would save valuable time.

Key words: Electric car jack, flat tires, crush injuries, improvements in jack, high safety features, car battery, easy to operate.

INTRODUCTION

Due to the difficulty of operating automobile jacks, various forms o1 electric jacks have been proffered. With the development of such electric jacks has gradually come an understanding of some of the problems associated therewith. Due to the torque needed to lift something as heavy as most automobiles, direct drive electric motors are not reliable; therefore, reduction gear drive mechanisms of some sort should be employed, as a severe mechanical advantage must be utilized. Direct motor-to-jack drive, with only two gears, fails to accomplish this task. Electric jacks that are built into an automobile have not been accepted due to expense and the need to at least lilt each side of an auto, if not all corners individually. If a system is chosen to individually lift each corner of the auto, even greater expense in design, production, and cost is encountered. Some have even entertained total encasement o1 a screw jack type device. The invention relates to hydraulic jack and more specifically to an automobile hydraulic jack system. In most o1 the garages the vehicles are 1itted by using screw jack. This needs high man power and skilled labors in the past both hydraulic and pneumatic jack has been utilized in combination with the structure of automobile. They have always utilized a separate jack tor each of 4 wheels by having the jacks permanently installed on the vehicle. They are ready to operation at all time. Lifting device has been installed on vehicle, such as air tilting device. Various types o1 jack or lilt devices has been installed on vehicle which are turned in 1 fashion or another from a horizontal altitude into a vertical altitude and then extended tor the purpose of lilting the vehicle. It is an object of the invention to provide a novel screw jack system that only utilized screw jacks, one that is mounted on chassis on side of car between two wheels and 2 jacks that is mounted on side o1 automobile between its side wheels. It is also an object of invention to provide novel jack system that can be operated by driver inside the car. It is also an object of invention to. Now the project has mainly concentrated on this difficulty, and hence such that the vehicles can be lifted from the floor land without application of any impact force. By pressing the button in the dashboard, it activates the jack automatically.

Jack is one the most widely used accessories for lifting vehicles and light or heavy equipment's. It is relatively cheaper than its counterparts and most widely and readily available. It is made up of' High Carbon Steel and other alloying elements which impart strength and ductility. It is rigid in construction but flexible in its pattern to usage.

PROBLEM STATEMENT

- Available jacks present difficulties for the elderly, women and are especially disadvantageous under adverse weather conditions. These presently available jacks further require the operator to remain in prolonged bent or squatting position to operate the jack.
- Doing work in a bent or squatting position for a period to time is not ergonomic to human body. It will give back problem in due of time. Moreover, the sa1'ety lectures are also not enough for operator to operate the present jack. Present car jack does not have a lock or extra beam to withstand the massive load of the car. This is for the safety precaution in case if the screw break.
- Furthermore, available jacks are typically large, heavy and also difficult to store, transport, carry or move into the proper position under an automobile. Suppose car jacks must be easy to use or pregnant women or whoever had problem with the tire in the middle.
- The purpose to this project is to encounter these problems. An electric pneumatic car jack system Which would comprise of 4 electro jacks attached with the chassis at the four corners each operating individually would be developed. Operator only needs to press the button from the controller without working in a bent or squatting position.

OBJECTIVE

In order to fulfilled the needs of present car jack, some improvement must be made base on the problems statement:

1. The aim of the project is to design a simple scissor jacket that is stable even on uneven surfaces with a structural improvement.
2. To make it convenient economically.
3. To design and implement a car jack system that is safe, reliable and able to raise and lower the height level when framed with the chassis of a car individually at each corners
4. To develop a car jack system that is powered by internal car power and fully automated working individually with a button system.

FLOW CHART OF DESIGN & OPTIMIZATION PROCESS

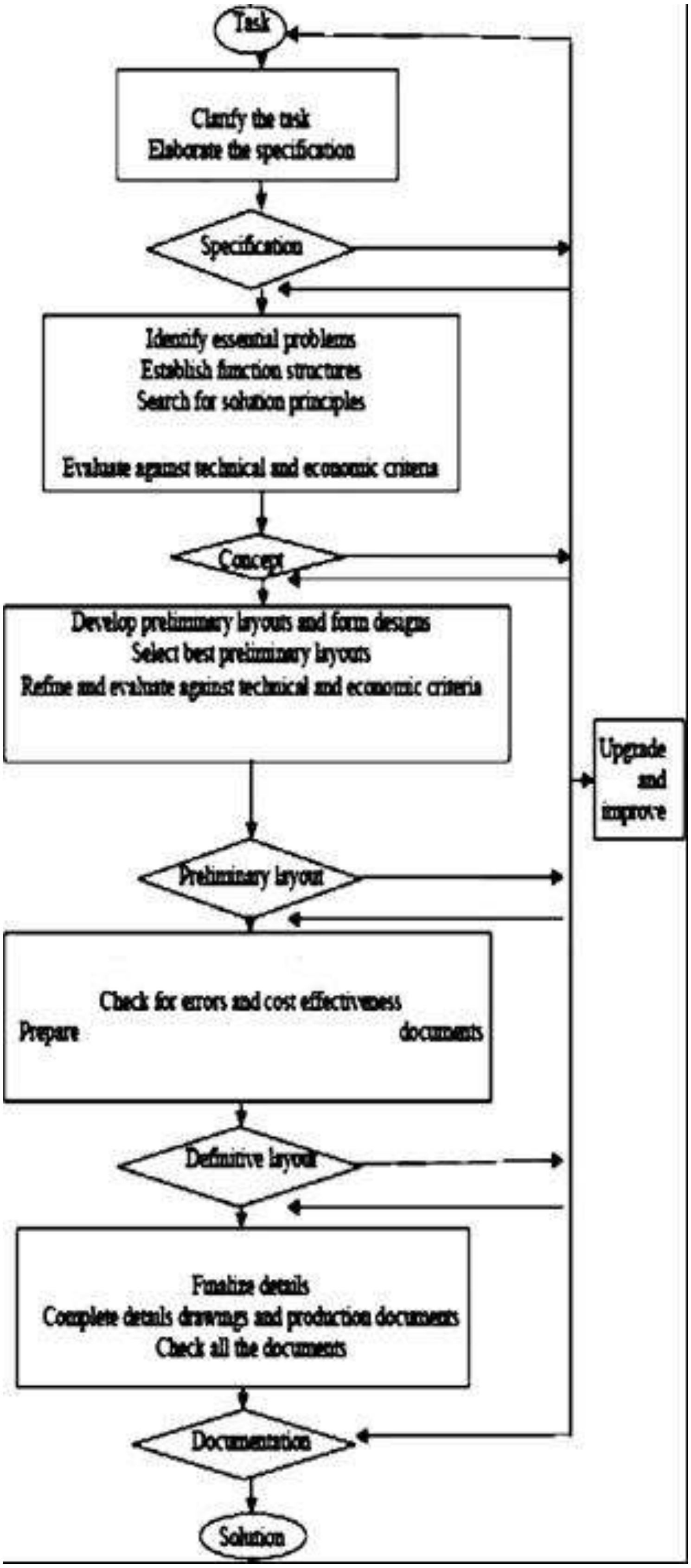

Fig. 4 Model of design Process

TERMINOLOGY OF POWER SCREW

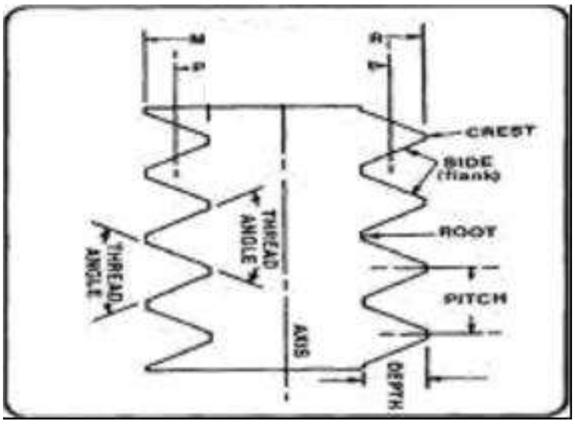

Fig. 5 Terminology of Power Screw

1. Pitch: The pitch is defined as the distance, measured parallel to the axis of the screw, from a point on one thread to the corresponding point on the adjacent thread. lt is denoted by the letter ‘p’.
2. Lead: The lead is defined as the distance, measured parallel to the axis of the screw that the nut will advance in one revolution of the screw. lt is denoted by the letter ‘L’. F-or a single-threaded screw, the lead is same as the pitch, for a double-threaded screw, the lead is twice that of the pitch, and so on.
3. Nominal diameter: lt is the largest diameter of the screw. lt is also called major diameter. lt is denoted b y the letter d„’.
4. Core diameter: lt is the smallest diameter of the screw thread. lt is also called minor diameter. lt is denoted by the letters ‘dr’.
5. Helix angle: lt is defined as the angle made by the helix of the thread with a plane perpendicular to the axis of the screw. Helix angle is related to the lead and the mean diameter of the screw. lt is also called lead angle. lt is denoted b y n.

DESIGN CALULATION

Geometric Layout of the Jack

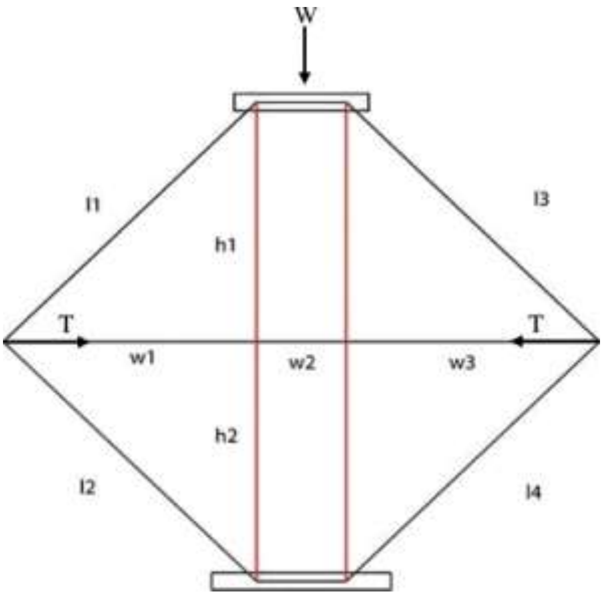

Fig. 6 Layout of Scissor Jack

Power Screw

The weight of the car is considered as 1.5 ton. The weight acting on front and rear axle is 60a and 40% of total weight respectively, hence the weight acting on front axle i.e.; 900 kg is considered for designing the jack. A weight of 450 kg acts on each wheel. And the maximum load on screw act when jack is at its lowest position. We assumed the thread on screw be a Double Start Square thread and coefficient of friction between threads is 0.20.

Design Calculations

Length of each arm = Ll Length of the power screw = (w l +w2+w3) = 350mm wl = w3 = 150 mm
w2 = 50 mm
Maximum lift of the jack = (hl+h2) = 300 mm
If is the angle made by link with horizontal when jack is at its lowest position. cos (& = (175-25)/160 = 20.36’
W = (load * g) = (450*10) = 4500 N = 4.5 kN
The tension T acting on the power screw is shown in the. Tension, T = W/2*tan (&
Total tension = 2*T = W/tan (8)
For a power screw under tension we can take or = 124 N/mm' for mild steel Let d‹ be the core diameter of the screw. But load on the screw is
Load = (n/4)* d‹2 * ct So,
2*T = W/ian (It = (rr/4)* d,2 * ct
2*T = 4.5 kN/tan (20.36’) = 12123.44 N
A2 = (W/tan (&)*(4f (rr* ot))
Hence, U = 11 34 mm
Since the screw is subjected to torsional shear stress we adopt, d‹ = 14 mm Taking pitch, P = 2 mm
Outer diameter, th, = dr + P = (14+2) = 16 mm Mean diameter, d = d«- P/2 = 16-2/2 = 15 mm Check for self-locking
tan (It) = Lead/rr*d; If = helix angle
Lead L = 2*P; since the screw has a double start square thread. tan (ej = 2*p/n*d = 2*2/ z* 15 = 0.084
Helix angle; ‹f= 4 85’
Coefficient of friction; y = tan (§) = 0.20; friction angle; = l 1.3’) > If hence the screw is self-locking
Effort required to support the load = 2*T tan If)
= 12123.44 (tan (zf) + tan (J)/ (l- (tan (‹f) * tan (J))

= 3510.715 N

Torque required to rotate the screw = effort *d/2 = 3510.715 * 15/2 = 26330.36 N—mm Shear stress in the screw due to torque z= 16*T/ (rr* d ’) = l 6*26330.36/ (n*14')
= 48.87N/mm'
But tensile stress wi = 2*T/ (rr/4) * d‹2 = 12123.44/ (N4) * 14' = 78.755 N Max imum principal stress bit = at/2 + $(m2 + I)/2
= 102.13 N/mm’

= 62.76 N/mm'

Since the max imum stresses or and r within the safe limits, the design of double started square threaded screw is satisfactory.

Nut

Material Selected Bronze
Design Calculations
Let n be the number of threads in contact with the screw assumed that load is Uniformly Distributed over the cross section area of the nut. Allowable Bearing pressure between the threads (Pb) m

Material			
Screw	Nut	Safe Bearing pressure (N/mm)	Rubbing speed at thread pitch diameter
Steel	Bronze	12.6 - 17.5	Low speed < 2.4 m/min
Steel	C.l	l 1.2 - 17.5	Low speed < 3 m/min

Bearing pressure is assumed as 15 N/mm' Ps = (2*T)/((rr/4)*(do2-dc2)*n)
15 = (l 2123.44)/ ((N4)*(l 6'- l4')*n)
Number of threads, n = 10.6 11

ln order to have good stability let n= l l Thickness of Nut = n*p = l l*2=22 mm Width of Nut b =l.5*do =1.5* l6=24 mm
To control the movement of nuts beyond 300 mm the rings of 8 mm thickness are fitted on the screw with the help of set screw
The length of screw portion = 300 + (8*2) + 22
= 338 mm 350 rum
Total length of screw is 350 mm.

Pins in Nut
Material selected Mild Steel
Design calculations
Let di = diameter of pins in the nuts Since Pins are in double shear stress
Load on pins = W/2 = 2*(n/4)*di2*f= 12123.44/2 z= Shear stress = 50 MPa for steel
Hence di = 8.78 rum say 10 rum

Diameter of pins head is taken as l.5*di = 15 mm and thickness be 4 mm

Top Arm
Material selected Mild Steel
Design calculations
‹rp for mild steel = 248 N/mm'
Factor of safety IF.S) = 2.5
or -- ‹rpfF.S=248/2.5=99.2 N/mm’
‹r‹= 1.25*‹ri = 1.25*99.2 = 124 N/mm'

Cruss section area (A) = (4Oc3) + (24 e3) + (40*3) = 312mm^2 Moment of Inertia 1.. = 4737ti mm‘, l = 51ftt19.38
Radius of gyration R = 12 .323 mm, R,.= 12.78mm
Rankine's constant (a) =1/7500
Ends are hinged (Li = L)
P« in vertical plane
v‹= crippling stress = 330 N/nini'
P,, = (w‹*A)/(1+a*(L/ R,)2)= (330*312)/(1+(1/75ff1) (1 till/12 78ti)')
= 100854.2ti N
Pcr in horizontal plane
v —— crippling stress = 330 N/mm
P,, = (‹r‹*A)/(1+a*(L/2*R,)2)= (330 1 ISO 40)/(1+(1/75ffl)*(1tiO/2.12.323)')
= 21lD198.25h N

Top Plate
(Loading Platform)
Material used Mild Steel
Deaign calculations

Moment, M = (p*l)/4 p = 5000 N
l = 50 mm
M = (5000*50)/4 = 250000/4 = 62500 N—mm
Z = (b*hÙ/6 = (36*4Œÿ6 = 9600 mm’ b = 36 mm, h = 40 mm
ce = M/Z = 62500/9600 = 6.51 N/mm2

Conclusion The permissible stress for mild steel is 124 N/nil and it is greater than m = 6.51 N/mm°
The top plate design is safe.

Fabrication and assembly motorized screw jack of is as follows:

Making of coupling

We have cut the blank of mild steel rod having diameter 60 mm and length 70mm by using power hacksaw machine from the given rod. Turning operation of MS rod has done on lathe machine which reduces the diameter up to 50 mm. Machining operation has done on CNC milling machine for making slot. Drilling operation has done on drilling machine for making hole of 10mm diameter for fixing bolt and nut. Surface finishing operation has done by grinding machine and filing.

Supporting component

Supporting component has used for fixing the D.C. motor. It has cut from the channel by using power hacksaw machine in required size. Drilling operation has done on drilling machine for fixing bolt. Finishing operation has done on bench vice using file.

Base plate

Base plate is made from mild steel plate. It has used for fixing all components of motorized lifting jack. Base plate ha scut from mild steel plate of bigger size in to required size of120mmx100mm. by using gas cutter machine. Surface finishing operation has done by using grinding machine. There are 4 holes made in the base plate by using drill bit of 10mm diameter on drilling machine.

D.C. Motor

A DC Motor of 12 Volt with a Current of 14 Amps is to produce the movement of the machine. The motor is internal geared one. So, it is strong enough to give the required torque. It can give two different speeds in one direction and two different speeds in the opposite direction.

Final finishing work

First power screw jack of 2-ton capacity has fixed on the base plate using bolt and nut. Power screw jack has connected to one end of first coupling by using nut bolt. First coupling has connected to one end of universal joint with the help of bolt and nut.

Testing

After assembly of all components on base plate, the Motorized Screw Jack was made and tested to lift the car. But the battery capacity is not enough to run the motor. So it has removed. Test was conducted by using main power supply instead of battery.

WORKING PRINCIPLE

The jack's screw rod is fixed to the motor shaft; the motor gets power from the power source. The on/off switch keys are interface with control circuit with power supply. And we are connecting the dc motor with the mechanical model fort he up and down movement when we press the ON & OFF switch. It will send power to motor to rotate in right direction& it will rotate in opposite direction respectively. Using this equipment, we can easily access the lifting of load in various purpose of our need. By alternating the motor with higher torque, the jack can lift heavy load easily.

CONCLUSIONS

The present invention is a vehicle screw jack jack positioned on each side between the front and rear wheels with an electric dc geared motor drive arrangement tor the operation of lilting and descending of the vehicle to its position for operation. The jack has gear configured for a low speed of operation. Switches and are used to control the direction of movement of the jack. Releasing the switches during operation stops the jack in the present position. This invention relates to a jacking arrangement for automobiles whereby a lilting jack is secured on the lower part of the chassis o1 a vehicle. The jack has a screw jack's configuration with a low speed geared motor motor. The extension of the jack is limited by a switch handle which is configured for cutting off the current flow as the switch is closed by the action of a power screw approximately reaching a maximum extension position. Simultaneously, a switch handle is depressed changing the polarity o1 the current now through the motor thereby positioning the motor for the retraction of the jack. At the instant prior to the jack reaching a maximum retracted position, polarity switch handle is depressed again reversing the polarity of the motor. In-place vehicle jack assemblies o1' the pivoted lever type configured for being permanently mounted at the front and rear of the vehicle frame structure are described. Each of the jack assemblies comprises a unitary device which is independently operable by an electrical motor, and independently selectively controlled at the jack or remotely from the control compartment of the vehicle.

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