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Experimental Investigation of Motorized Screw Jack

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***Abstract*— Over the recent decades maintenance in automobile engineering become a challenging task among the engineers. Saving economy has become the task of highest priority in our generation. Design modification of existing product allows the work as much as easier than the previous model. In this work, design and fabrication of motorized screw jack is fabricated to reduce the power consumptions and to decrease the human effort. Here the existing screw jack is modified as motorized screw jack to increase the human comfort. The motorized power jack can be widely used in low cost automation in manufacturing industries. The weight lifting is quick and effortless, which reduces the physical fatigue (tiredness) felt by the worker.**

***Index Terms*—Clamp, Jack, Lead Screw.**

I. INTRODUCTION

This paper deals with the design and fabrication of motorized screw jack which is used for lifting heavy automobiles, using the power from a dc motor. The project helps in reducing the effort as well as time taken to lift the load in comparison to the ordinary screw jack. It consists of a **D.C motor, battery, worm gear** arrangement and a screw jack arrangement. A screw jack's compressive force is obtained through the tension force applied by its lead screw. A square thread is most often used, as this thread is very strong and can resist the large loads imposed. These types are self-locking, which makes them more intrinsically safe than other jack technologies. This type of screw jack will be helpful for *women and adolescents* during the puncture to lift the vehicle when they have no means to serve.

Electrical actuation is chosen here because the power obtained through this is comparatively high. The direction of the rotation of the motor is obtained by the pulse modulation from the control relay. Thus it is considered to be the most efficient and easy method to actuate. A scissor lift (jack) or mechanism is a device used to extend or position a plate formed by mechanical means. The term "*scissor*" is used since the folding supports are in *criss cross "X"* pattern. The extension or displacement motion is achieved by applying force to one of the supports and thus the elongation of the crossed pattern occurs. The force applied to extend the scissor mechanism may be hydraulic, pneumatic or mechanical means. Our objective is to actuate through electric mean.

II. MOTORIZED SCREW JACK

A. Scissor Jack

The scissor jack is used to lift the vehicle where the action is carried it out by *mechanical, hydraulic or pneumatic* means. Such a jack is a standard accessory with many cars. It consists of a *diamond shaped frame* having a nut on one side and a sleeve on the other. A screw is supported in the nut and the sleeve. Rotating the screw the nut moves towards or away from the sleeve depending upon the direction of the rotation, so that the vehicle supported on the jack is lifted or moved down. The jack is so designed that there is always sufficient friction in the screw to hold the jack from moving down under load. But we are using the motor to rotate the screw for lifting the vehicle.

B. Screw Jack Mechanism

We have used ON/OFF switch in this project; the ON/OFF switch keys are interface with control circuit with battery. And we are connecting the DC motor with the mechanical model for the up and down movement. When we switch ON, it will send a high pulse to control circuit then the control circuit activates the corresponding relay to rotate the DC motor in forward direction, so that the jack will move up. When we switch OFF, it will also send a low pulse to the control circuits its activating relay to rotate the DC motor in reverse direction so the jack will move down. Using this we can lift the load using power jack without human effort.

III. EXISTING PROBLEMS IN JACK

A. General Problems

i. Requires manual work.
ii. Leakage in hydraulic system.
iii. Delay in time.
iv. No self-locking.

B. Conclusion from Existing Problems

To increase the human comfort and to decrease the power consumption, we need to modify the existing design. Thus, we brought out an idea that the screw jack is actuated

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electrically to reduce human effort. This idea is more favorable than any other means of actuation.

In comparison with hydraulic and pneumatic actuation, electrical actuation stands tall. Pneumatic actuation is equal to *10 man power* while hydraulic equals *100 man power*. But electrical actuation gives *500 man powers*. This symbolizes the need for electrical actuation.

IV. Technical Details

A. DC Motor Specifications

Voltage = "12 V" (DC)
Speed = "30 rpm"
Power = "18 W"
Length of the motor = "170 mm"
Outer diameter of motor = "60 mm"

B. Jack Specifications

Height of Jack base = "218 mm"
Length of Jack base = "340 mm"

V. Design and Fabrication

A. Clamper

A clamp is a fastening device to hold or secure objects tightly together to prevent movement or separation through the application of inward pressure. Clamper views are shown in the Fig. 1.

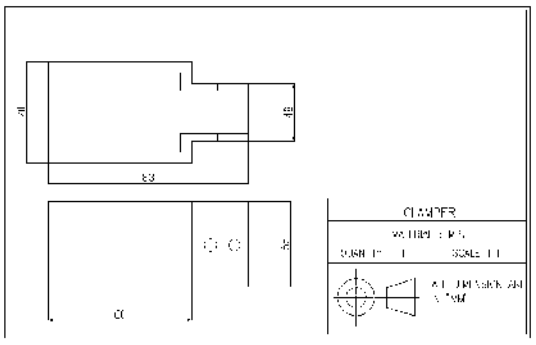

Fig. 1. Clamper

The clamper here is used to hold the motor with the jack. It is the most important component of the motorized screw jack. In this project the clamper is being welded to the screw jack, it prevents the jack from vibrations produced from the motor.

B. Worm and Worm Gear Arrangement

Worm and worm gear arrangement is being employed in this innovative project. Worm is connected to the motor shaft while the worm gear is connected to the lead screw. Rotation of the lead screw is done by the worm gear. The worm gear arrangement is shown in the Fig. 2 and Fig. 3.

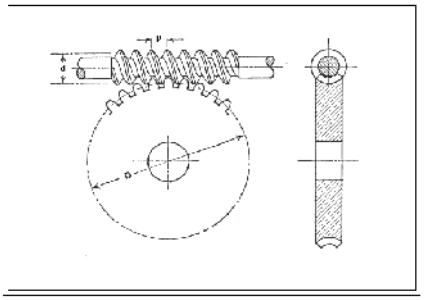

Fig. 2. Worm and Worm Gear Arrangement

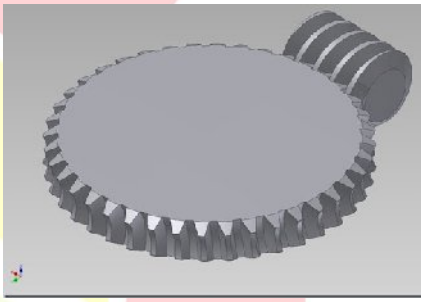

Fig. 3. Worm and Worm Gear Arrangement (solid works)

C. Screw Jack

A Screw jack is a type of jack that is operated by turning a lead screw. In the form of a screw jack it is commonly used to lift moderately heavy weights such as vehicles as shown in Fig. 4 and Fig. 5.

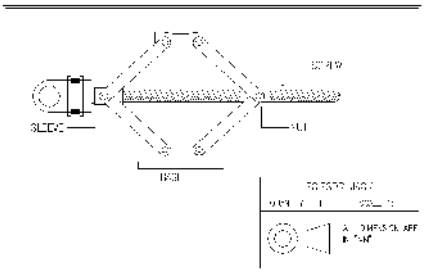

Fig. 4. Scissor Pattern

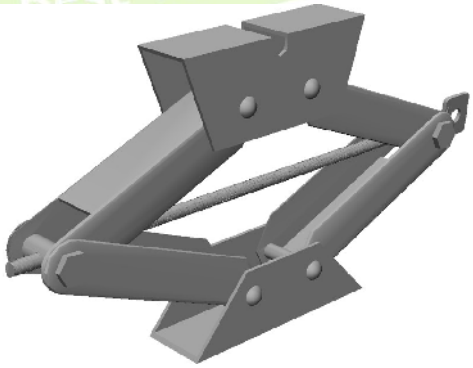

Fig. 5. Scissor Pattern (solid works)

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D. Fabrication Methods

- Drilling has been done on the base in order to fasten the bolts.
- Welding, the clamp has been welded to the jack in order to support the motor.
- Grinding, In order to obtain a good surface finish on the base and the clamp grinding has been carried out.

VI. Experimental Setup

A. Design and Construction

A scissor lift (jack) or mechanism is device used to extend or position a plate form by mechanical means. The term "*scissor*" comes as from the mechanical utilized which is configured with linked, folding supports in a *criss cross "x"* pattern. The extension or displacement motion is achieved applying of force to one of the support resulting and an elongation of the crossing pattern, the force applied to extend the scissor mechanism may be hydraulic, pneumatic or mechanical (via a lead screw or rack and pinion system).

B. Details of Mechanism

When high pulse is given to the motor, the motor rotates in clockwise direction and when low pulse is given it rotates in anticlockwise direction. Thus the worm gear rotates and enables the lead screw to rotate in both directions as shown in Fig.6.

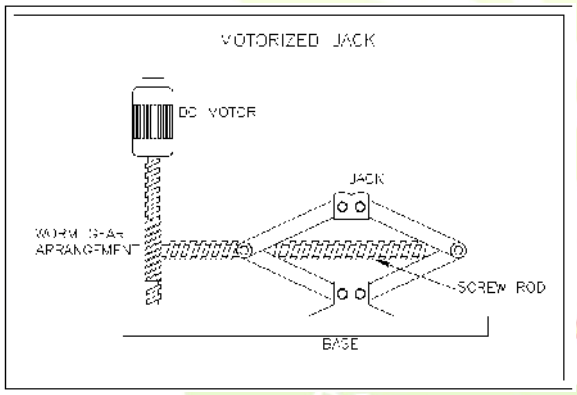

Fig. 6. Motorized Screw Jack

VII. Design Calculations

A. Design of screw jack

To find out the power of the motor that can lift load of 30 kg

We know that,

Major Screw diameter (d_o) =12 mm
Pitch of screw (p) = 3 mm
Mean diameter, $d = d_o - p/2$ (1)

$= 12-3/2$

d = 10.5 mm

$\tan\infty = p/\pi d$ (2)
$\tan\infty = 3/\pi \times 10.5$
$\tan\infty = 0.091$

Assuming co efficient of friction, $\tan\theta = 0.1$
Load to be raised = 30 kg
W = 300 N

P = Effort required to raise the load
$P = W \times \tan(\infty+\theta)$ (3)
$= W \times (\tan\infty + \tan\theta)/(1-\tan\infty \times \tan\theta)$ (4)
$= 300 \times (0.091+0.1)/(1-0.091 \times 0.1)$
$=300 \times (0.191/0.99)$

P = 57.82 N

B. Torque required operating the screw

$T=P \times d/2$ (5)
$T =57.82 \times 10.5/2$

$T = 303.58 \times 10^{-3}$ Nm

Since the screw moves in the nut at a speed of 65mm/min of speed of revolutions is minute is,

N = speed in mm/min/pitch in mm (6)
N = 65/3(pitch)

N =21.6 (22 rpm)

C. Power of the motors required

$p = T \times \omega$ (7)

Where ω is $= 2 \times \pi \times N/60$
$p = T \times \omega$
$p = 303.58 \times 10^{-3} \times 2 \times \pi \times 22/60$

p = 0.699 watts

VIII. Results and Discussions

As per the design calculations motorized screw jack is fabricated and as shown in Fig. 7 and Fig. 8.

Fig. 7. Side Elevation

Fig. 8. Top Elevation

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Compare with ordinary jack, it possess self-locking property, No radial thrust acts since square thread is used, higher range of speed control is obtained.

IX. CONCLUSION

The motorized power jack can be widely used in low cost automation in manufacturing industries. The weight lifting is quick and effortless, which reduces the physical fatigue (tiredness) felt by the worker. The project carried out by us made an impressing task in the field of automobile and automobile workshops. It is very useful in the service stations. And also reduced the cost involved in the concern.

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