Worm Gear Jack for Scissor Lift

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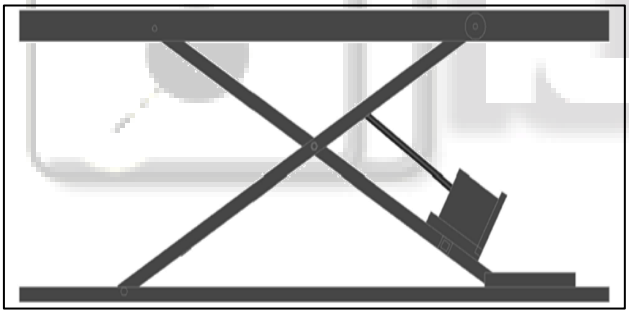
Abstract— Power screws are used to convert rotary motion into translatory motion. A screw jack is an example of a power screw in which a small force applied in a horizontal plane is used to raise or lower a large load. The principle on which it works is similar to that of an inclined plane. The mechanical advantage of a screw jack is the ratio of the load applied to the effort applied. The screw jack is operated by turning a lead screw. The height of the jack is adjusted by turning a lead screw and this adjustment can be done either manually or by integrating an electric motor. In this project, an electric motor will be integrated with the worm gear jack and the electricity needed for the operation will be taken from the battery of the vehicle or already charged battery and thereby the mechanical advantage will be increased, also Remote control device can also be used to upgrade the model. The worm gear screw jack has ability to be used individually or linked mechanically and driven by electric motors or even manually. It has the lifting capacity of few kilos to the tones of weights with the raising capacity about 3 feet.

Key words: Worm Gear Jack, Hinge & Rolling Arrangement

I. INTRODUCTION



Replacing the tyre with conventional screw jack is painful and tedious job even for most advantages and commonly used jack such as the screw jack, pneumatic jack and hydraulic jack as it involves manual effort; the time has come to be innovative and more creative. To overcome problem idea of worm and worm wheel jack has come forward and attempt is made to fabricate worm and worm jack for lifting the vehicle for the purpose of maintenance and changing the tyre or to repair the punctured tyre tube of a four wheeler, it can also be used in scissor operated platform using worm gear screw jack instead of hydraulic jack. It works on the simple basic principle of the speed reduction using worm and worm wheel jack. The rotary motion of the motor is given to the worm which transmits it to the gear. A square threaded nut is fixed to the gear at centre which rotates as gear rotates. The screw at centre raised upwards as its rotation is avoided by means of key.

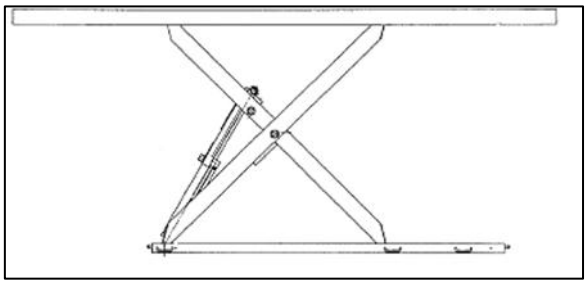
A. Problem Statement:

In Screw, Hydraulic and Pneumatic Jack –

- Involves manual effort
- It allows wear and tear
- It is not very stable
- Mostly used for low loads
- Expensive
- Filter oils on a regular basis
- Leakages
- Aeration

According to the problem statement defined above, we selected worm gear jack for scissor lift for two wheeler used in workshops and industrial purposes.

B. Construction Details:



Scissor platform consist of the following components

1) Upper & Lower Bed
2) Scissor link (X type arrangement)
3) Hing & Rolling/sliding arrangement
4) chucker plate
5) Worm gear Jack with .Motor (1 HP, 1440 RPM)

C. Upper Bed & Lower Bed:

- Material used :- MS (Mild Steel)
- Square Bar (Pipe) = 38 X 38 X 2.5 mm

Dimension:-

- Upper bed- 1890 mm * 610 mm
- Lower bed -1890 mm * 610 mm

D. Hinge & Rolling Arrangement:

1) C-Channel (For Sliding):

- Material- MS
- Dimension- 38mm*38mm*2.5thk
- Sliding length- 441 mm

2) Roller:

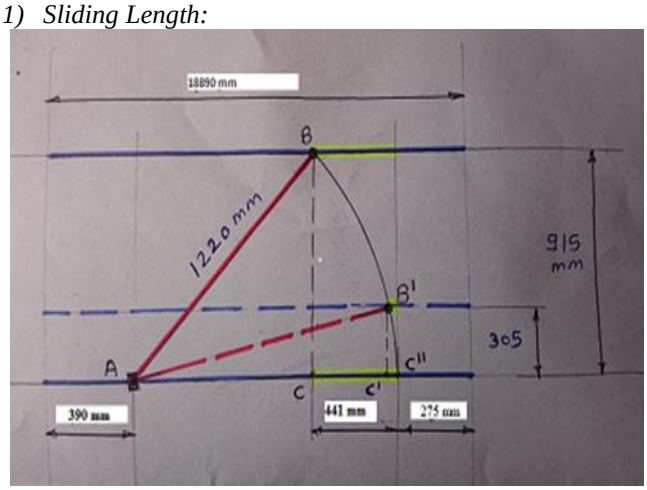
Bearing used which is travel in c-channel 6202z = ball bearing has 35 mm outer dia

II. WORKING PRINCIPLE

A scissor lift is a type of platform that can usually only move vertically. The mechanism to achieve this is the use of linked, folding supports in a criss-cross "X" pattern, known as a pantograph (or scissor mechanism). The upward motion is achieved by the application of pressure to the outside of the lowest set of supports, elongating the crossing pattern, and propelling the work platform vertically. The platform may also have an extending "bridge" to allow closer access to the work area, because of the inherent limits of vertical-only movement.

A. Design Calculation:

1) Sliding Length:



From ABC,

- AB^2 = BC^2 + AC^2
- 1205^2 = 915^2 + AC^2
- AC = 784mm

Therefore, Total sliding length CC''
= 1890-390-AC-CC''-275
=1830-390-784-CC'-275

- CC''=441mm

Travelling length of link when move from B' to B

- From AB'C',
- AB'^2= B'C'^2+AC'^2
- 1205^2=305^2+AC'^2
- AC'=1166mm
- Therefore, CC'= AC'-AC
- CC' = 1166-784
- CC' = 382mm

2) Motor Selection Calculation:

Total Screw moment = 450 mm

Mean dia. of screw, d_m = dia of screw - $\left(\frac{\text{pitch}}{2}\right)$

$= 22 - \left(\frac{5}{2}\right)$

$d_m = 19.5$ mm

$\tan \propto = \frac{p}{\pi d_m} = \frac{5}{\pi \times 19.5} = 0.0816$

Tangential force required of circumference of screw,

- $P = W \tan(\propto + \emptyset)$

$= W \left[\frac{\tan\propto + \tan\emptyset}{1 - \tan\propto + \tan\emptyset}\right]$

$(\tan\emptyset) = \mu =$ coefficient of friction between screw & nut

$(Assume\ \mu = \tan\emptyset = 0.15)$

- $P = 2 \times 10^3 \left[\frac{0.0816 + 0.15}{1 - 0.0816 \times 0.15}\right]$
- $P = 468.94\ N$

Torque required to operate screw,

- $T = P \times \left(\frac{d_m}{2}\right)$
- $T = 468.94 \times \left(\frac{19.5}{2}\right)$
- $T = 4572.16$ N. mm
- $T = 4.572$ N. m

Motor speed = 1440 rpm

- $P = \frac{2\pi NT}{60}$
- $P = \frac{2\pi \times 1440 \times 4.572}{60}$
- $P = 689.44\ w$
- $P = 0.689\ kw$

$(1\ H.P. = 0.75\ kw)$

- $P = \frac{0.689}{0.75}$
- $P = 1\ H.P.$

B. Benefits of Worm Gear Jack:

- High reduction ratio
- High torque
- Self-Locking Arrangement
- Continuous Loading for prolonged period
- Safety Latch to prevent back driving can be easily provided
- Lubrication Oil does not breakdown early
- Only oil level inspection is needed which an operator himself can do.
- Automation

III. Conclusion

After doing this project we got the knowledge of theory part of worm and worm wheel gear. We studied the various types of jacks.

We also studied the worm and worm gear and its applications. We noticed that it can be used in application of lifting as jack. We found that the existing Hydraulic jack is less costly but the operating and maintenance cost of this jack is higher than the worm and worm wheel jack which is little high in cost. Also it is self-locking and hence safer than hydraulic jack. So we suggested that the company can think on trying to implement some prototypes and approve after testing its feasibility and economy as well as the life of jack.

Thus the project helped us to improve the knowledge of various types of screw jack.

References

[1] Design of Machine Element by V.B.BHANDARI
[2] PSG Design Data Book of Engineers – may,2012
[3] Scissors Type Lifting Platform by Hubert Wanner - US6464205B2
[4] Highly Efficient Motorised Screw Jack by International Journal of Computational Engineering Research||Vol, 03||Issue, 5||
[5] Worm Gear Jack - Jhon.J.Dixon, Charlotte, N.C. , assignor to Duff Norton company - US3,220,27
[6] Worm Screw Jack Apparatus and Method of making same by Molyneaux, Martin Wlliam - EP0021623B1
[7] An Investigation on the Dynamic Stability of Scissor Lift by Ren G. Dong , Christopher S. Pan, James E. Harris
[8] Worm Screw Jack Apparatus and Method of making same by Molyneaux, Martin Wlliam - EP0021623B1