International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

Testing of Compact Self-Locking Lifting Device by Application of Twin Worm Arrangement

Mr. Vikrant D. Sathe[1], Prof. Abhay M.Kalje [2]

[1]M.E. Mech-Design, Department of Mechanical Engineering, N.B.Navale Sinhagad College of Engineering, Kegaon, Solapur, Maharashtra.
[2]Associate Professor, Departement of Mechanical Engineering, N.B.Navale Sinhagad College of Engineering, Kegaon, Solapur, Maharashtra.

Abstract - *M/s Paramount Industries 36/5 MIDC ROAD, Morwadi, Pimpri, Pune -18 produces special purpose machinery, Jigs Fixtures etc for small scale Industry. A certain Vertical Turret lathe requires a compact lifting device with lifting capacity of 125 kg maximum, presently the loading of work-pieces is done using a Chain Winch, which requires two or more labor to handle the system. Problem in hand is to develop a compact lifting device. This paper describes experimental testing of a prototype which is a zero slip lifting device to be operated using 12 Volt DC power. The proposed model is to be developed to demonstrate the load lifting system, and self locking ability.*

Key Words: **Lifting device, Self Locking, Worm, Torque, efficiency.**

1. INTRODUCTION

The term self locking as applied to gear systems denotes a drive which gives the input gear the freedom to rotate the output gear in either directions but the output gear locks with input when an outside torque attempts to rotate the output in either direction. This characteristic is often sought after by designers who want to be sure that the loads on the output side of the system cannot affect the position of the gears. Worm gears are one of the few gear systems that can be made self locking, but at the expense of efficiency, they seldom exceed 45% efficiency, when made self locking.**[2]**

1.1 Problem Statement at Company End.

M/s Paramount Industries 36/5 MIDC ROAD, Morwadi, Pimpri, Pune -18

Company produces special purpose machinery, Jigs Fixtures etc for small scale Industry. A certain Vertical Turret lathe requires a compact lifting device with lifting capacity of 125 kg maximum, presently the loading of work-pieces is done using a Chain Winch, which requires two or more labor to handle the system. Problem in hand is to develop a compact lifting device to be operated using 12 Volt DC power, system to be button operated with easy loading and unloading facility so that operator can single handed load or unload the work-piece onto machine. The proposed model is to be developed to demonstrate the load lifting system, and self locking ability. The PMDC motor is to be used to demonstrate the load raising and lowering ability of the device by reversing the polarity of the motor by use of 2-pole 2-way motor. Point to point position control of device to be done using a NO-NC push button.

1.2 Objective

The objectives of dissertation is as follows,

a. Design of mathematical model of dual worm system with internal threaded ring system for optimal load lifting capacity, optimal factor of safety & optimal efficiency for reduced power consumption.
b. Derivation of optimal power for individual motor, selection of BLDC motor for application so as to make device compact.
c. Development of mathematical model of system of forces, derivation and resolution of system forces by drawing free body diagram of linkage, determination of forces and utilizing system of forces to determine the linkage dimensions of following parts:

2. WORKING OF COMPACT SELF LOCKING LIFTER

The power supply to the motor is 12 V Dc which is routed to the poles either to rotate motor clockwise to raise the load or counter clockwise to lower the load. The 2-pole 2-way switch controls the direction where as the push button controls the position. The input from the motor is given to the input right hand threaded shaft via spur gear pair. The pinion of 1.5module 18 teeth mounted on the motor shaft where as the gear with 50 teeth 1.5-module mounted on the right hand worm shaft. The Right Handed worm shaft is held in ball bearings. Te motion of the Right Hand worm shaft is imparted to the threaded internal ring which there by rotates the load drum via the ring gear cage.

The load drum thus will either raise or lower the load depending upon its direction of rotation.

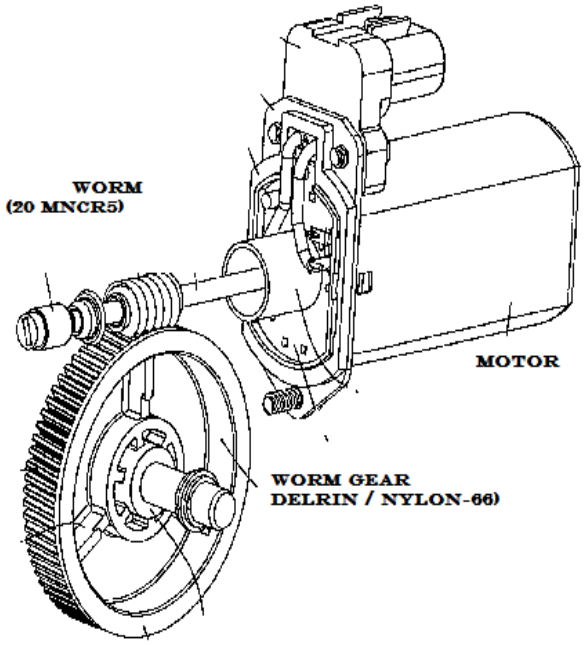

Fig.1 Schematic of the Gear Box Layout.

Motor is 12 V Dc motor gear box ratio to be 1:55 reduction output of the gear box will be a direct shaft with dynamometer pulley arrangement to carry out the testing of the gear box under various load conditions.

3.TEST & TRIAL

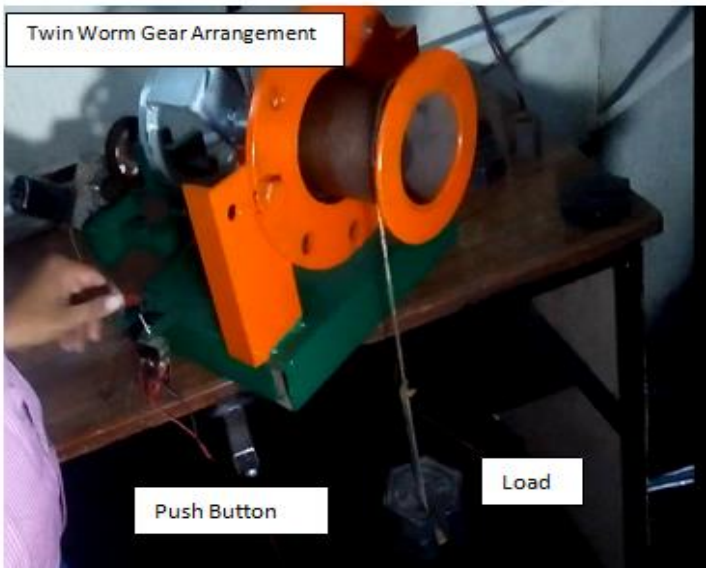

Fig.2 Image of Experimental Set Up.

The trial is conducted in order to test the following characteristic of the lifting device which are as follows,

A. Torque Vs. Speed
B. Output Power Vs. Speed
C. Efficiency Vs. Speed.

INPUT DATA:-

a) Drive Motor 12 V dc 92 rpm OUTPUT Power = 5 watt
b) Diameter (Effective) of brake drum = 100 mm

3.1 PROCEDURE

1. Start motor.
2. Let mechanism run & stabilize at certain speed (say 10 rpm)
3. Place the pulley cord on dynamo brake pulley and add 1 KG weight into , the pan , note down the output speed for this load by means of tachometer.
4. Add another 1 KG of weight & take reading .
5. Tabulate the readings in the observation table.
6. Plot the graphs of the above characteristics.

3.2 OBSERVATION TABLE

Table-1: Observation Table

Sr. No.	Loading		Torque (N-m)
	Weight (Kg)	Speed Rpm	
1	2	10	0.981
2	4	9.6	1.962
3	6	9.1	2.943
4	8	8.9	3.924
5	10	8.4	4.905

3.3 SAMPLE CALCULATIONS:- (AT10 kg Load)

1) Output speed = 8.4 rpm
2) Output Torque:-
   T = Weight in pan x Radius of Dyno brake Pulley = (10x 9.81) x 50
   =4905N.mm
   T=4.905 N.m
3) Input Power:- ($P_{i/p}$) = 5 WATT
4) Output Power:

$$P = \frac{2\pi NT}{60}$$

$$P = \frac{2 \times \pi \times 4.905 \times 8.4}{60}$$

P = 4.3124 watt

5) Efficiency:-

$$\eta = \frac{OutputPower}{InputPower}$$

$$= \frac{4.3124}{5} = 86.30$$

$$\eta = 86.30\ \%$$

Efficiency of transmission of gear drive at 10 kg load= 86.30 %

The similar calculations were done and it is tabulated as follows,

Table-2: Result Table

SR NO	Load (kg)	Speed	Torque	Power	Efficiency
1	2	10	0.981	1.0274	20.549
2	4	9.6	1.962	1.9727	39.453
3	6	9.1	2.943	2.8049	56.098
4	8	8.9	3.924	3.6577	73.153
5	10	8.4	4.905	4.3152	86.304

The graphs of various characteristics are plotted.

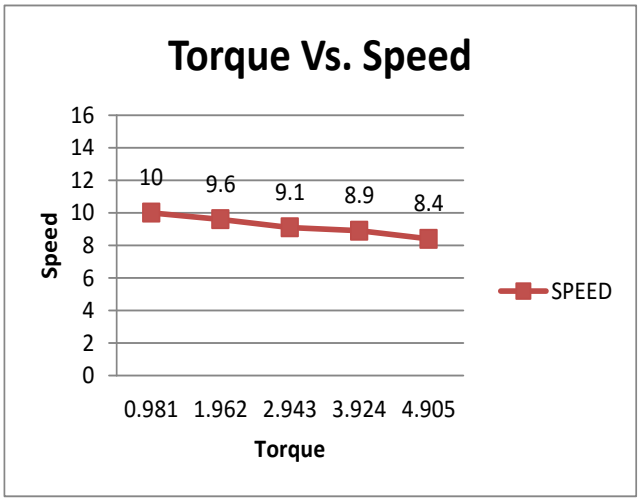

Fig.3 Graph of Torque Vs. Speed

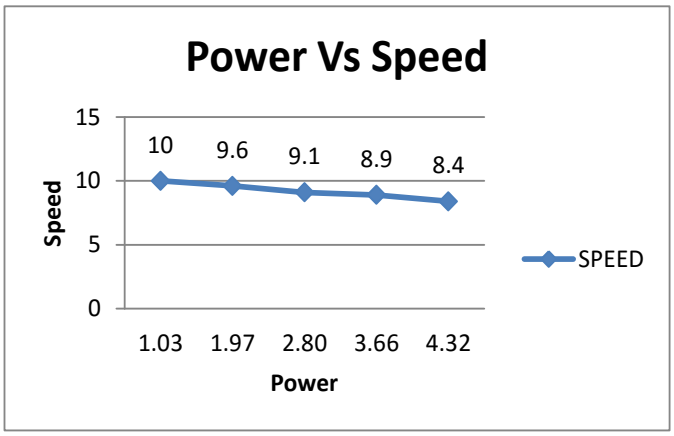

Fig.4 Graph of Power Vs. Speed .

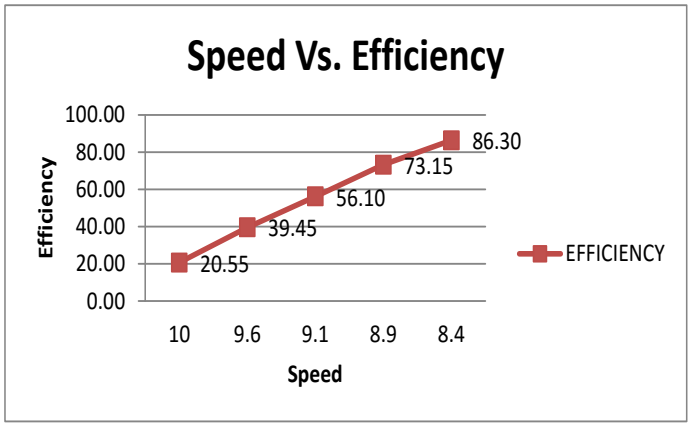

Fig.5 Graph of Speed Vs. Efficiency

4. CONCLUSION

From the above experimentation it is found that the use of twin worm system found to be useful in lifting of load with less effort. The conclusions are drawn which are as follows,

1. The torque required is more for increasing load and speed is also reduced.
2. The power required is maximum for increasing load.
3. The efficiency is maximum for increasing load.
   Hence the ultimate objective of self locking twin worm lifting device is found to be useful for the given conditions.

REFERENCES

1. Faydor L. Litvin, Alessandro Nava, Qi Fan, and Alfonso Fuentes University of Illinois at Chicago, Chicago, Illinois, "New Geometry of Worm Face Gear Drives With Conical and Cylindrical Worms: Generation, Simulation of Meshing, and Stress Analysis", NASA/CR—2002-211895,

National Aeronautics and Space Administration (2002),Page no. 1-3.

2. Prof. P.B. Kadam, Prof. M.R. Todkar "Improvement in the Design & Manufacturing of Twin Worm Self Locking Technique and applications", IOSR Journal of Engineering May. 2012, Vol. 2(5) Page no.1224-1233.

3. Padmanabhan. S., Chandrasekaran. M. and Srinivasa Raman. V. "Design Optimization of Worm Gear drive", International Journal of Mining, Metallurgy & Mechanical Engineering (IJMMME) Volume 1, Issue 1 (2013), Page no.61-57.

4. A.A.Pandharbale, Prof. A. J. Rajguru "Design and Analysis of Compact Self Locking Lifting Device by Application of Twin worm Arrangement" International Engineering Research Journal (IERJ) Special Issue 2 Page 4027-4033, 2015, ISSN 2395-1621

5. V.B.Bhandari, "Design Of machine elements", Tata McGraw Hill, 2005.