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DESIGN AND FABRICATION OF ADJUSTABLE TORQUE SPRING BALL CLUTCH SETUP

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Abstract

In today's life science and technology are increasing at rapid rate. Due to rapid industrialization growth, quality and quantities production requirement the automation of machine are increasing day by day. For this machine has to operate continuously a safety of machine plays an important role in today's industrial environment.

Design and fabrication of test-rig and Testing of drive to derive performance characteristics for Torque Vs Speed and the process consist the following experiments and checks the validity of experimental results with theoretical results and carry out comparative study of experimental. An attempt is made in this project the electrical motor from overloading by installing a "Spring Ball Clutch". Many clutches required manual operations for engaging and disengaging the input and output shaft. The Spring Ball Clutch done this automatically.

Overload Safety Devices with spring ball clutch which provide reliable overload protection. When a jam-up or excessive loading occurs the spring ball clutch will reliably and quickly release to prevent system damage.

Keywords: Over load protection, torque limiting device, fabrication spring ball clutchetc.

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1. INTRODUCTION

Positive clutches are used to transmit power between two coincident shafts. The positive engagement between the clutch elements ensures 100% torque transmission on but occasionally the output shaft may the subjected to a suddenly overload which may make the driving motor or engine to stall; which will lead to burnout of the electric motor.

In order to avoid overloading some preventive measures are incorporated between driving and driven mechanism, by using spring ball clutch damages can be avoided.

Spring ball clutch is of a Flying ball type which transmits torque from input to output using balls held by a spring in assembly when overload occurs the balls will come out of assembly and thus disconnecting input and output thereby saving part failures. Hence in this paper the spring ball clutch is so designed that the balls will not come out of assembly when there is overload. There will only be slipping of the balls, this comes as an advantage as the clutch can be preset without removing it from assembly and this will save considerable amount of downtime of process as compared to the conventional clutch.

1.1 OBJECTIVE

1. Making machines safer & more reliable
2. Repairs and down times are minimized
3. Disengages immediately in case of an over load and disconnects input and output shaft with accuracy
4. To increase the productivity

Fig. –Spring ball clutch

2. METHODOLOGY

Design calculation

In this section there is design of the system which is Shown in the figure. It contains the motor of 373 watt, 230 Volt (50 Hz), 0.5 amp and speed range 1500 rpm.
Here we are designing the spring ball clutch to limit the Value of torque to 1.25 Nm i.e., by considering 25% of Overload.

Refer: - DESIGN DATA HAND BOOK

a) Ball Clutch Nomenclature
b) d = Diameter of ball , mm
c) D = Pitch circle diameter of groove, mm
d) F = Total tangential force on balls, N
e) Fs = Total spring force, N
f) F = spring force on each ball, N
g) α= Angle of inclination of groove
h) Ks = Spring stiffness, N/mm
i) Lf = Free length of spring, mm
j) Td= Torque transmitted, N mm
k) N = Number of turns in the spring
l) P = Pitch of spring coil, mm
m) Zb = Number of balls in the clutch
n) μ = Coefficient of friction
o) K1 = Stiffness per turn N /mm
p) δ2 =Movement of ball while Clutch is slipping, mm
q) δ1 = Compression of spring to exert force F, mm

2.1. Torque Calculation

$$T = \frac{P \times 60}{2\pi N}$$

$$T = \frac{373 \times 60}{2\pi \times 1500}$$

$T = 2.37 \times 10^3$ N-mm

Considering 25% overload

$T_d = 1.25 \times 2.37 \times 10^3$ N-mm

$T_d = 2.96 \times 10^3$ N-mm

2.2. Calculation of Tangential force on balls (F_t)

Assume pitch circle of groove diameter =90 mm

$$F_t = \frac{2 \times Td}{D}$$

$$F_t = \frac{2 \times 2.96 \times 1000}{90}$$

$F_t = 65.77$ N

2.3. Calculation of total spring force on balls (F_s)

$$F_s = Ft\left[\frac{\cos\alpha - \mu \sin\alpha}{\sin\alpha + \mu\cos\alpha} - \mu\right]$$

$$F_s = 65.77\left[\frac{\cos 45 - 0.08 \sin 45}{\sin 45 + 0.08\cos 45} - 0.08\right]$$

$F_s = 50.75$

Where,

α =Angle of inclination of Groove=45˚

β = Coefficient of friction between the balls and body of the Clutch=0.08

2.4. Calculation offorce on each spring (F)

$$F = \frac{F}{Zb}$$

$$F = \frac{50.75}{3}$$

$$F = 16.91 \text{ N}$$

Where,Zb=3

Table 2.1: Stiffness and permissible static and dynamic load for helical compression spring

Rod Diameter of spring(mm)	Outer Diameter (mm)	Stiffness Of spring per turn K1 (N/mm)	Permissible load	
			Static Load (N)	Dynamic Load (N)
1.0	12.0	7.98	32.4	14.5

2.5. Stiffness of spring(Ks)

$Ks = \frac{F1}{n} = = \frac{7.981}{3} = 1.33$ N/mm

Where,

K1=Stiffness of spring per turn K1 (N/mm)

=7.98 (From Design Data Book)

n=Number of turns of spring=6

2.6. Compression of spring to exert a force (δ1)

$$\delta 1 = \frac{F}{Ks}$$

$$\delta 1 = \frac{16.91}{1.33}$$

δ1= 12.71 mm

2.7. Movement of ball while the clutch is sleeping (δ2)

$$\boldsymbol{\delta 2} = \frac{d(1-\cos\alpha)}{2}$$

$$\boldsymbol{\delta 2} = \frac{14(1-\cos 45)}{2}$$

$\boldsymbol{\delta 2} = 2.05$ mm

Where,

d = Diameter of a ball = 14 mm

2.8. Maximum Deflection of spring (δmax)

δmax = δ1+ δ2 = 12.71 + 2.05 = 14.76 mm

2.9. Free Length of a spring (Lf)

Lf= Solid length + Maximum deflection + Clearance between adjacent coils

L_f = n'd + δmax + (n' – 1)

Where,

n' = n + 2 = 6 + 2 = 8

Lf= 8×14 + 14.76 + (8-1) = 133.76 mm

Table 2.2: Parameters of Spring Ball Clutch

Sr.No.	Parameters	Notation	Value
1.	Diameter of ball	d	14 mm
2.	PCD of grooves	D	90 mm
3.	Angle of inclination of grooves	α	45 °
4.	Free length of spring	L_f	24mm
5.	Number of ball in clutch	Z_b	3
6	Outside diameter of spring	D'	12 mm
7	Rod diameter of spring	d'	1 mm

3. PICTURES

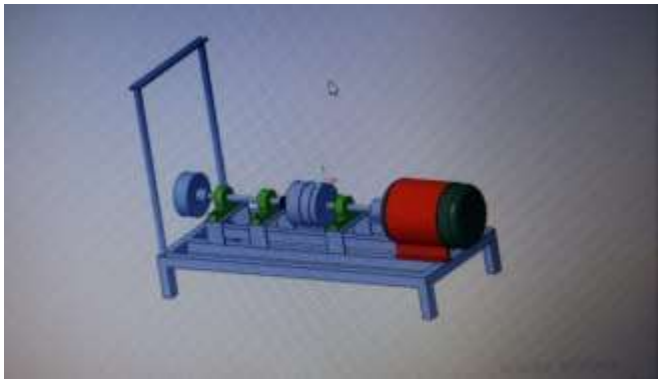

Fig 3.1- 3D Setup Model

Fig3.2-Actual Setup

4. CONCLUSION

By designing this type of spring ball clutch it is possible to disengage the motor from the transmission automatically.

These type of clutches can be used to protect motor from overload as well as we can disengage the motor from transmission without stopping motor.

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