International Journal of Latest Engineering and Management Research (IJLEMR)
ISSN: 2455-4847
www.ijlemr.com || Volume 03 - Issue 04 || April 2018 || PP. 06-10

Design and Fabrication of Automatic CoilWinding Machine

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Abstract: Aim of this project is to design a mechanism and to wind the work piece over copper wire. Main objective of this winding machine is to wind the component of work piece with the evenly winding of copper wire around it, where the pulleys are fixed in the wooden piece, the circular ring which is used and meshed between the pulleys can rotate with the use of belt. The entire mechanism can rotate with use of fan motor, the belt is passed over the shaft can rotate in one direction. Due to rotation of shaft the pulley can rotate and finally it winds the work piece.

Keywords: Pulleys ,wooden piece, MS ring, bobbin, copper wire, flat belt, fan motor & regulator, base plate, work piece.

I. INTRODUCTION

The project automatic coil winding machine is used to wind the work piece. It has put end to endless frustration. This winding machine is simpler and easier to use. The efficiency will be high ,when compared to other electrical winding machine. This winding machine saves the time . before the start off winding machine process, this should be checked once.

This winding machine consists of major components such as pulleys ,wooden piece, MS ring, bobbin, copper wire, flat belt, fan motor & regulator, base plate, work piece .

At one end of the motor ,the shaft rotates when it's operated. Through the shaft, belt is passed over it. Pulleys are connected through the shaft with the flat belt. Over the pulley, ring gets meshed comfortably. Bobbin of copper wire is fitted on the ring. Above the ring ,at the end of wooden body it has split into two pieces and connect the spring with those pieces, and bind it with the metal plate at the top. Springs are used to reduce the vibration. To avoid the slippage of ring, three pulleys are fitted around the wooden piece

The work piece should be set inside perpendicular to the ring. It's shape be circular and inner diameter of circular work piece should be greater than the bobbin of copper wire fitted in the ring. so that it can freely rotated without the disturbance of work piece. The bobbin of copper wire from one end should get tied on the work piece, and it is winded on the work piece.

II. MATERIALS AND COMPONENTS

Pulleys:

The pulleys are generally use to lift the weight. In this mechanism where the pulleys are made of wooden and it rotates. Through the rotation further process are done. The diameters of pulley are around 5 mm and width is v-grooved 8.5 mm shown in figure 2.

Wooden Piece:

The entire wooden piece of dimension size 1 m x 1 m. It is the layout of project and withstands the weight of every components

Flat Belt:

The flat belt is made of nylon material. Pitch length of belt is around 420 mm. pulley and motor shaft are connected through the belt for rotation. The power transmitted through the belt around 186 watts

Motor:

The specification of motor can be shown as follows p= $\frac{1}{4}$ hp and the speed around 1500 rpm. From the motor shaft power get transmitted to the belt and further process are done automatically

Workpiece:

The shapes of work piece are circular in shape and the material used is wooden piece. It is interconnected and should perpendicular to the MS ring. Work piece are placed at top of the table.

Spring:

The spring which is used is helical. The number of turns is about 8.It is used to reduce the vibration. The diameter of spring is 10 mm and wire diameter is around 2 mm as shown in figure 2.

Base Table:

The entire setup has been supported under the base plate. The material used is teak wood. Thickness of the base plate is 30 mm and area is about 1 meter.

Bobbin of Copper Wire:

The length of bobbin is about 50 mm. the copper wire should wind on it. It is fitted at inner side of MS ring. The copper wire of one end should get tied on the work piece.

Ms Ring:

The material used is mild steel ring. The diameter of MS ring is about 120 mm shown in figure 2. It gets meshed with three pulleys. When the ring rotates, bobbin of copper wire present in MS ring will wind the work piece, through the rotation of clockwise direction.

III. EXPERIMENTAL WORKING

The experiment should be checked once and switch on the motor. Where the belt is passed over the motor shaft and pulleys will rotate. Due to the rotation of pulley ,mild steel ring meshed over the pulley also rotate .In between the two pulley ,belt is passed under the mild steel ring. when pulley rotate in clockwise direction. Simultaneously mild steel ring also in anticlockwise direction .So the bobbin of copper wire present mild steel ring, will wind the copper wire on the work piece. The work piece should be moved manually. So that the copper wire would not wind one over the other on work piece. The springs are used to reduce the vibration. To avoid the slippage Mild steel ring, the three pulleys present in the wooden piece. Construction shown in figure 1.

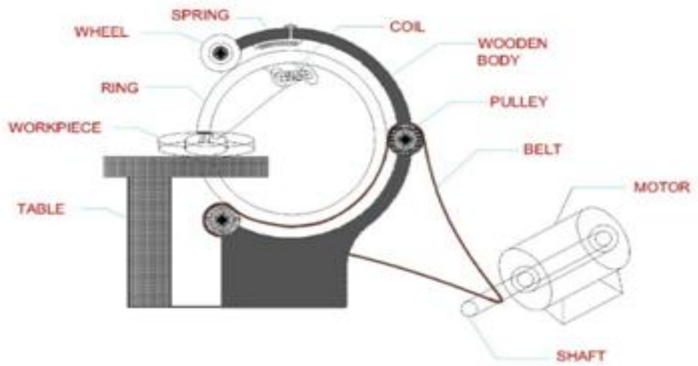
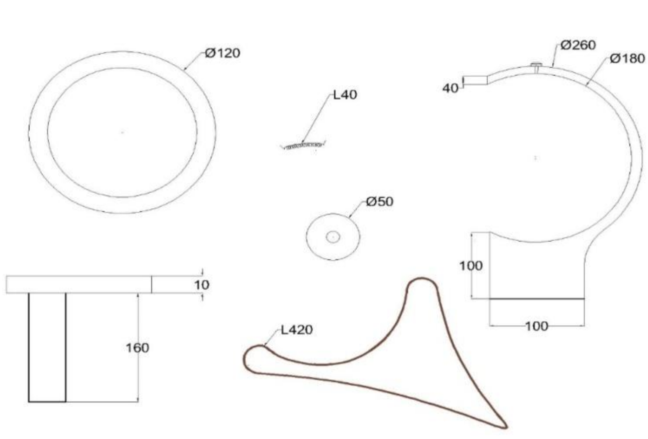


Figure 1. Construction

Part Drawing



All Dimension are in mm

Figure 2. Part Drawings

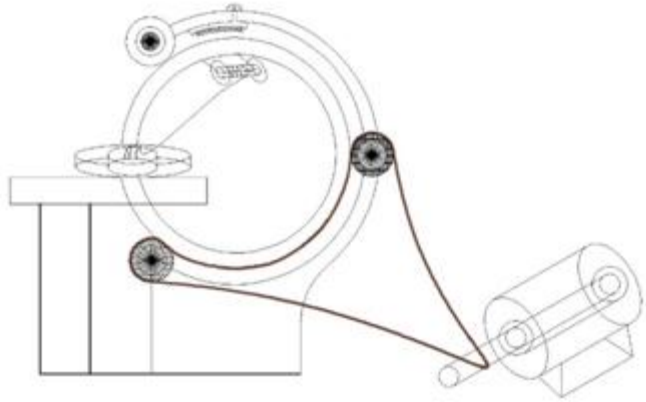


Figure 3. Assembled view

IV. DESIGN CALCULATION

MOTOR SPECIFICATION

$P = \frac{1}{4}$ hp =184.4watts [1hp =0.7457 watts]

N_1 = 1500 rpm (Driver speed, pulley)

N_2 = 625 rpm (Driven speed, ring)

DESIGN OF BELT & PULLEY DRIVE

- **Selection of cross section symbol of belt** **………[1]**

For power 184.4W, z section is selected

Table 13.12

- **Selection of various dimensions of flat pulley** **..……..[1]**

pitch width,	L_p= 8.5 mm
minimum distance down to pitch line	b = 2 mm
pulley pitch diameter	d_p= 50 mm
angle	2β = 34°
minimum depth below pitch line	h = 9 mm
Center to center distance of grooves	e = 12 mm
Edge of pulley to first groove center	F = 8 mm
Nominal width	w = 10 mm
Nominal height	t = 6 mm

PSG Data Book. Pg. No.5.36, table 13.23

- **Selection of pulley diameter (d & D)** **………..[1]**

smaller pulley diameter d=50mm

speed ratio $= \frac{D}{d} = \frac{N1}{N2}$

$\frac{D}{50} = \frac{1500}{625}$

D = 120 mm

PSG Data Book. Pg. No. 524, table 13.12

- **Selection of nominal pitch length** **..………[1]**

pitch length of belt (L_p) = 405 mm

PSG Data Book, Pg. no. 524, table13.14

- **Selection of center distance** **…………[2]**

C =A + (A² – B)½

where $A = \frac{L}{4} - 3.14\ (\frac{D+d}{8})$

$= \frac{405}{4} - 3.14(\frac{120+50}{8})$

A = 34.49 m

$B = (D\text{-}d) \times (\frac{D-d}{8})$

$= (120\text{-}50).(\frac{120-50}{8})$

B = 612.5 mm

C = 60 mm
PSG Data Book, Pg. No. 7.61

- **Selection of various modification factor**:

1. **length correction factor** **……….[1]**
$F_c = 0.86$
For z section , PSG Data Book, Pg. No. 534, table 13.21

2. **correction factor for arc of contact** **…………[1]**
arc of contact = $180 - (\frac{D-d}{C}) \times 60$
$= 180 - (\frac{120-50}{60}) \times 60$
$= 110$
$F_d = 0.78$
For 110 PSG Data Book Pg. No. 534, table 13.22

3. **service factor**
For light duty , for driving machining of type …..……..[1]
Service factor $F_a = 1$
PSG Data Book, Pg. No. 525, table 13.15

- **Calculation of maximum power capacity**

kw $= \frac{p \times Fa}{?b \times Fc \times Fd}$
$= \frac{0.184 \times 1}{1 \times 0.86 \times 0.78}$
= 0.274 kw > 0.184 kw

The design transmitted power < The maximum power capacity of belt
Hence the design is safe

- **Calculation of belt tension**

Power transmitted belt (P) = $(T_1 - T_2).V$
$V = 3.14 \times D \times \frac{N1}{60}$
$= 3.14 \times 50 \times \frac{1500}{60}$
= 3.92 m/s
$T_1 - T_2 = 47.46$ …………eq1

we know that the centrifugal tension ratio for flat belts
considering centrifugal tension:
$T_1 - mv^2 / T_2 - mv^2 = e\mu\alpha$. Cosec β
mass per meter length (m) = 0.596 kg/m …………[1]
angle (2β) = 34˚
Table 13.23
Already found that arc of contact for smaller pulley

$\alpha = 110 \times \frac{3.14}{180}$
= 1.919

$T_1 - 0.596.3.9^2 / T_2 - 0.596.3.96^2 = e^{0.3 \,.\, 1.919}.cosec17$
$T_1 - 9.15 / T_2 - 9.15 = 7.16$
$T_1 - 9.15 = 7.16\,T_2 - 65.60$
$T_1 - 7.16T_2 = -56.44$
$T_1 = 64.32$ N
$T_2 = 16.86$ N

- **Stress induced** = max . Tension/cross sectional area

$= \frac{64.32}{50}$
= 1.286 N/mm²
(for Z section cross section area =50mm²)

DESIGN OF SPRING (HELICAL)

- **Calculation of spring index:**

$C = \frac{D}{d}$ ………..[2]

D- spring diameter
d-wire diameter

$C= \frac{10}{2} = 5$

C = 5

- **Calculation of total shear stress:**

$\tau = 8DK_w/3.14xd^3$ …..…….[2]

$K_w = 4C-1/4C-4 +0.615/C$ ……..…..[2]

$= (4x5)-1/(4x5)-4 +0.615/5$

(wahl's factor) K_w =1.3015

$\tau = 8x10x1.3015/3.14x2^3$

$\tau = 4.144 N/mm^2$ (Both Ends of spring are cylindrical shaped)

- **Calculation of spring axial deflection:**

$\delta=8C^3n/G d(1+0.5/C^2)$ ……….[2]

n- no of active coils
G-modulus of rigidity

$= 8x5^3x25/(78x10^3x2)$

$\delta = 0.160$

- **Calculation of spring rate:**

$K= G d/8C^3n$ ………[2]

$= 78x10^3x2/8x5^3x25$

K = 6.24 N/mm

APPLICATION:

- It is used for winding coil in transformers.
- It is used for winding the armature.
- It is used for winding the amplifiers
- It is used for winding coil to the heaters.
- It is used for winding coil in induction systems.

V. CONCLUSION

Thus the project automatic coil winding machine finally saves the time and reduce the human effort. This mechanism is effectively used. So that the work piece component can be done by replacing number of times .compare to the other winding machine accuracy can be expected. The speed of the motor shaft equals to be windings made in the workpiece.

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