Design of Bottle Filling Indexing Table with Proximity Sensor

Waykole N.G[1], Panchal S. V[2], Rajput P. D[3]

[1,2,3] Student at Smt. S. S. Patil Institute of Technology (Polytechnic)

Abstract: **In this paper design for bottle filling technique has been presented. In this fast developing era there is huge demand for bottled things. So there is need to develop techniques which can be used for increasing the rate of bottle filling. There are many other methods used for filling of bottles but inline bottle filling machines are widely used. These inline filling machines can be used only where abundant linear space is available. Contradictory to this if rotating machines are used there will be reduction in the space required for bottle filling.**

Keywords: **Bottle Filling Technique, Conventional Manufacturing Methods.**

1. INTRODUCTION

In this mass production epoch we often need to revise our conventional manufacturing methods. Bottle Filling Indexed Table is an advancement in the packaging world. In this method number of indexing is equal to number of bottles that can be filled in one cycle of the table. Number of indexing can be varied by varying the number of the actuators. The system is driven by a Single phase AC motor whose power consumption is 100 watts and speed is continuously variable from 0 to 6000 rpm. The speed of motor is variated by means of an electronic speed Controller. Motor is a commutator motor i.e., the current to motor is supplied to motor by means of carbon brushes. The power input to motor is varied by changing the current supply to these brushes by the electronic speed controller; thereby the speed also changes. Using increased or decreased the quantity of the substance to filled in bottle can be controlled.

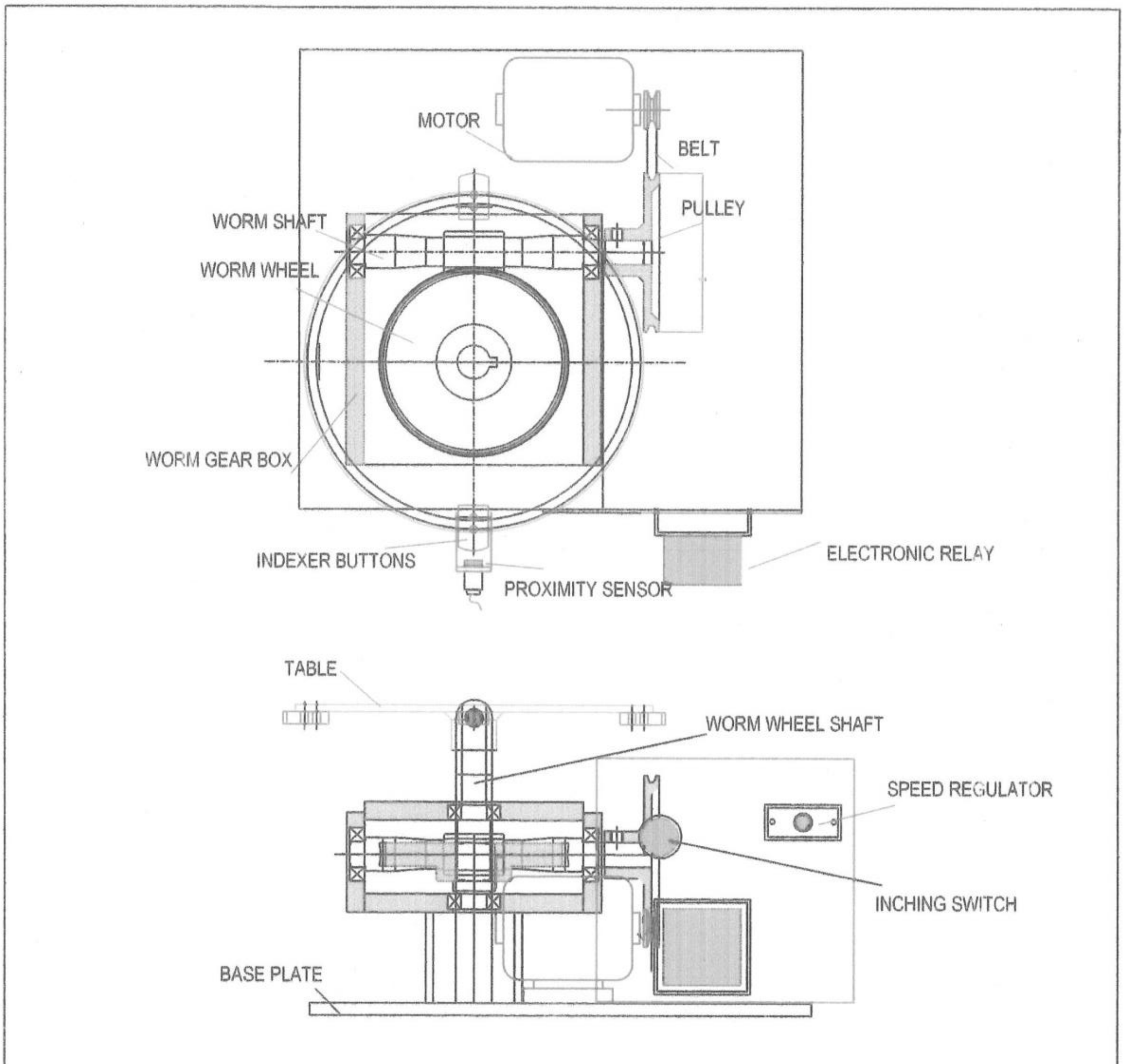
2. CONCEPT

If required the Bottle Filling Indexed Table can be given angular tilt from 0 to 45 ˚. On a flat plate two vertical pillar are provided. These pillars support a horizontal member which has a bearing in it. On the bottom side of the horizontal plate there is a worm wheel whereas on the upper side there is indexed table. The power from motor is transmitted to the worm through a reduction pulley. Worm rotates the worm wheel which in turn rotates the table. The speed of thee table can be varied by varying the speed of motor.

3. ELECTRONIC PROXIMITY SENSOR

The Electronic proximity sensor is mounted on the sheet metal panel on the base frame by means of an Z shaped clamp. The proximity sensor as the name suggest senses the proximity if the indexer buttons which acts as stops such that operated to step the table motion the proximity sensor is connected to the electronic relay and the power source.

Fig .1 Proximity Sensor



AUTO INDEXER TABLE WITH PROXMITY SENSOR

4. SPECIFICATION OF INDEXING TABLE UNIT

Table – 1

Maximum capacity table in the flat position	60 Kg.
Power consumption	120 watts
Table tilt degrees	0-45 ˚
Rotation speed	0-75 rpm
Table diameter	210 mm
Table height in the flat position	200 mm
Weight approximate	18 kg
No. of auto stop position (actuated positions)	4
Min. degree of indexing	90˚

NOTE: Minimum degree of rotation can be varied by varying the number of indexing buttons (actuators)

5. MOTOR SELECTION

Single phase AC motor

Commutator motor TEFC construction Power = 100 watt

Pdesign = 100 * 1.2 (service factor) = 120 watts

Speed= 0-6000 rpm (variable)

Motor is a Single phase AC motor, Power 120 watt;

Speed 0 to 6000 rpm.

Speed of motor is varied by electronic controller

Motor Torque:

We have

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

$$T = \frac{60*120}{2\pi*6000}$$

T= 0.191 N-m.

Power is transmitted from the motor shaft to the input shaft of drive by means of an open belt drive, Motor pulley diameter = 15 mm

I/P shaft pulley diameter = 75 mm

Reduction ratio = 5

I/P shaft speed = 6000/5 = 1200 rpm

Torque at I/P shaft = 5 x 0.191 = 0.955 N-m

6. DESIGN OF OPEN BELT DRIVE

Motor pulley diameter = 15 mm

IP _ shaft pulley diameter = 75 mm

Reduction ratio = 5

Coefficient of friction = 0.2

Maximum allowable tension in belt = 200 N

Center distance = 100

$$\theta = 180 - 2\sin^{-1}(\frac{D-d}{2C})$$

$$\theta = 180 - 2\sin^{-1}(\frac{75-15}{2*100})$$

$$\theta = 153.99° \approx 154$$

$$\theta = \left(\frac{154*\pi}{180}\right) = 2.53\ rad$$

Considering Flat Belt Drive

Material of belt rubber canvas for industrial use

Assume $\mu = 0.2$

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

$$\frac{T_1}{T_2} = e^{(0.2*2.53)}$$

$$T_1 = 1.66T_2$$

$$(T_1 - T_2)v = P$$

$$(1.66T_2 - T_2) * \left(\frac{\pi * 75 * 1200}{60000}\right) = 120$$

$$T_2 = 38.58\ N \approx 39\ N$$

$$T_1 = 1.66 * 39$$

$$T_1 = 64.74\ N \approx 65\ N$$

Tension in Tight side is $T_1 = 65N$

Tension in Slack side is $T_2 = 39N$

= 1.98 x10^6 N-mm

The lower value of torque is on the wheel = 1.98 x10^6 N-mm

KW = 2Π n2 Mt/60 x 10^6 (Power transmitting capacity) KW = 7.46 KW

As the drive is capable of transmitting 7.46 KW and we intend to transmit 0.12 KW the drive is safe.

7. REDUCTION GEAR BOX

Reduction gear box is a warm and worm wheel gear box with ratio of 1:80 ratios. The gear box comprises of the following parts:

a) INPUT WORM SHAFT:

The input shaft is an high grade alloy steel (20MnCr5) part held in ball bearing at either end carries the reduction pulley at one end. Input worm shaft has the following specification:

GEAR DATA

Addendum diameter(Dal)=27mm

Deddendum diameter(Dfi)=20.4 mm

No. of operations= Right hand

Module=1.5 mm

b) Worm wheel:

The worm wheel is cast iron part keyed wheel shaft. Worm wheel has following specifications:

GEAR DATA

Addendum diameter(Da2)=123 mm

Dedendum diameter(Dfl)=11.6 mm

No. of teeth=80

Hand of operation= right hand

Module=1.5 mm

BORE DIAMETER=22 MM

KEYWAY=6*3*30

8. WORM SHAFT DESIGN MATERIAL SELECTION

ASME Code for Design of Shaft:

Since the loads on most shafts in connected machinery are not constant, it is necessary to make proper allowance for the harmful effects of load fluctuations. According to ASME code permissible values of shear stress may be calculated from various relations.

τ=0.18 x 800

τ =144 N/mm^2OR

τ_{max}= 0.3 fyt = 0.3 x 680 =204 N/mm^2

Considering minimum of the above values;

τ = 144 N/mm^2

Shaft is provided with key way; this will reduce its strength. Hence reducing above value of allowable stress by 25%

τ_{max} = 108 N/mm^2

This is the allowable value of shear stress that can be induced in the shaft material for safe operation.

Table - 2

Designation	Ultimate Tensile Strength (N/mm^2)	Yield Strength (N/mm^2)
EN 24	800	680

9. CALCULATION OF WORM SHAFT TORQUE

Motor is of 120 Watts,
Speed= 6000 rpm,
Connected to worm shaft by belt pulley arrangement with reduction ratio 1:5
Hence input to worm gear box = 1200 rpm
The worm gear box is the reduction gear box with 1:80 ratio
Hence input speed at the input shaft = 1200/80 =15 rpm

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

$$T_{worm} = \frac{60*120}{2\pi*1200}$$

T_{worm}= 0.95 N-m

$$T_{design} = 80 * 0.95$$

T_{design} = 76 N-m

10. CHECK FOR FAILURE OF SHAFT IN TORSION

Using trial and error method

Trial 1 .

Assume d= 15mm

$$T_{design} = \frac{\pi}{16} * ds^3 * \tau_{act}$$

$\tau_{act} = \frac{76*10^3*16}{\pi*15^3}$ =114.68 N/mm^2

As $\tau_{act} > \tau_{max}$ design fails

Trial 2.

Assume d =20 mm

$\tau_{act} = \frac{76*10^3*16}{\pi*20^3}$ =48.38 N/mm^2

As $\tau_{act} < \tau_{max}$ design is safe

I/P shaft is safe under torsional load.

11. SELECTION OF BEARING

Table - 3

ISI NO.	Bearing of basic Design (SKF)	d (mm)	D_1 (mm)	D (mm)	D_2 (mm)	B	Basic Capacity (kgf)		Max permissible speed (rpm)
							Static C_0	Dynamic C	
25BC02	6205	25	31	52	46	15	710	1100	13000

P = S.f. (X Fr + Yfa.)

Where;

P=Equivalent dynamic load, (N)

X=Radial load constant

Fr= Radial load (N)

Y = Axial load contact

Fa = Axial load (N)

In our case;

Radial load FR= BELT TENSION = 65 N+39 N =104 N

Considering steady load service factor S.F. =1.2

P = 104*1.2 = 124.8 N

Considering 8000 hrs for operation (N=1200 rpm)

L_mr=(L_hr * 60 *N (rpm))/〖10〗^6

L_mr=(8000 * 60 *1200)/〖10〗^6 = 576 mr.

C=L^(1/k)*F

C=〖576〗^(1/3)*124.8 = 1038.37 ≈ 1039 kgf

Therefore selecting bearing 6205 (Table 4)

12. CONCLUSION

This project emphasize on quality filling of the liquid/substances in the bottle. It contributes in reducing the fatigue of the perator.

This automation will considerably cut the filling time as a result high quality of filling will be obtained in less time. The oals of

Fabrication units are thus accomplished with minimum time investment.

REFERENCES

[1] Juvinall, R. C. 1967.Engineering Considerations of Stress, Strain, and Strength. New York, N.Y.: McGraw Hill.

[2] N. Bhargaya , D.C. Kulashtha ,S.C. GlIpta TTTI, "Basic Electronics & Linear Ckt" Tata McGraw Hill.

[3] B. V. Bhandari, "Design Of Machine Element", 2008.

[4] Design Data Book (PSG College).

[5] R, S. Khurmi, J.K. Gupta, "Design of Machine Element", S. Chand Publication 2007.