Bottle Filling and Capping Using Geneva Mechanism

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Abstract- In our project we are going to focus on bottle filling and packing process, which must complete in only 2 steps. In present application machine there are three steps for completion of bottle packing process. So less time is required as compared to present application machine. In our project pneumatic solenoid valve is going to use for bottle filling and cap is fitted by using pneumatic cylinder which is fitted at next station. So we reduce the maintenance of the machine and increase the efficiency of the machine, and also increase the production rate.

It based on only mechanical properties. Such mechanism is designed for especially to increase the efficiency of the machine and reduce the maintenance. In present application machine there are used sensors to detect the bottle and pass information to next step for complete the process. But in new design machine sensor are not used there are to arrange the time setting mechanism to inform the next step for complete the process.

I. INTRODUCTION

There are many devices available for producing intermitted motion but out of These entire devices “Geneva wheel” for intermitted motion is preferred because of the following reasons:-

1. It has simplicity in design and construction.
2. It is economical in cost.
3. It can be operated manually or mechanically.
4. It is widely used in industries.
5. It requires less maintenance and inspection.
6. It has wider application in practice.

There are 3 device in general for producing intermittent motion, they are:-

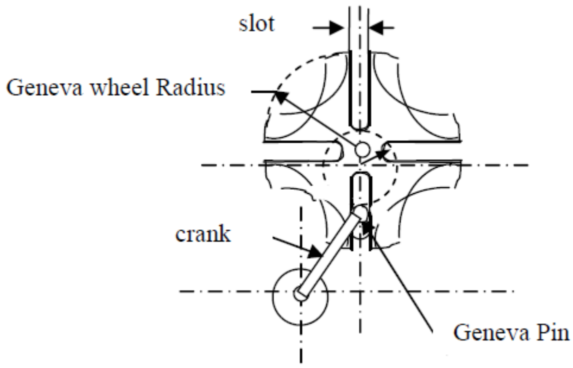
1. Geneva mechanism
2. Ratchet gear mechanism
3. Cam mechanism

Out of these above three we have opted Geneva mechanism for intermittent motion.

Geneva Mechanism:

The Geneva mechanism consists of a driving disc which related continuously and a wheel with 4 radial slots. The axis on the driving disc and wheel provide a locking effect against rotation of the slotted wheel e.g. in the position the wheel cannot rotate. As the, disc continuous to rotate point A of the disc comes out of contact with the arc and immediately thereafter pin P mounted at the end of the driving arm enters the radial slots. The wheel now begins to rotate when it has turned through an angle 90 degree the pin comes out of radials slot and immediately these after point B comes in contact with the next arc of wheel preventing its further rotation. Thus the wheel makes 1/k revolutions, where K is no. of radial slots.

Therefore this mechanism is used in limits and angle simple automatic machine for indexing cutting tools & in multiple spindle automatic machines for indexing spindle through a constant Angle.



II. LITRETURE REVIEW

We referred many research papers during our project work but the papers we found relevant are as follows:

Prof. D.U. Patil, Thakare Tushar, Kudale Nikhil and Pangare Ankur describe in his research paper about Bottle Filling Machine Based on Geneva Mechanism in details. They says that one of the important of automation is in the soft drink and other beverage industries, where a particular liquid has to be filled continuously for this kind of applications. The trend is moving away from the individual device or machine towards continuous solutions. Totally integrated automation puts this continuity into consistent practice. Totally integrated automation covers the complete production line from receipt of goods, the production process, filling and packaging, shipment of goods. Our project is also an application of automation wherein we have developed a liquid filling to bottle. The various processes are controlled using a Geneva mechanism. The main objective of the project is to design and develop a automatic liquid filling in bottle by using Geneva mechanism. To develop a filling machine which can fill different sizes of containers on the bases of height same principle can be used in different industries like medicine, oil, chemical industries for filling liquid to different sized component by a one machine.

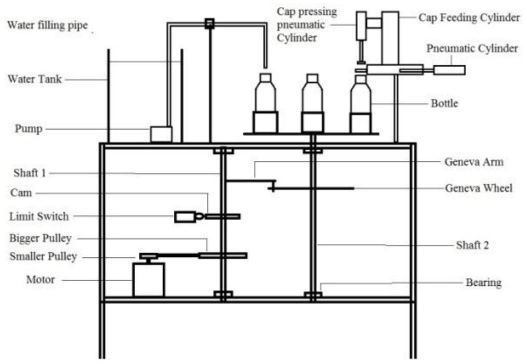
Ujam A. J., Ejeogo G., and Onyeneho K. C. describe in his research paper about Development and Application of Geneva Mechanism for Bottle Washing in details. They says that Geneva mechanism is a simple and widely used timing mechanism that provides intermittent motion from a continuously rotating input. It consists of a rotating drive wheel (Driver) with a pin that reaches into a slot of the driven wheel (Geneva wheel) advancing it by one step. They are cheaper than cams, have good motion curve characteristics compared to ratchets and maintain good control of its load at all times. In addition, if properly sized to the load, the mechanism generally exhibits very long life. It is used in machine tools to index spindle carriers weighing several tones, in transfer machines for indexing work piece from one work station to another, as a turret indexing mechanism in automatic lathe, in counting instruments, peristaltic pump drives in integrated circuit manufacturing, intermittent advance of films in motion-picture projectors and discrete motion drives with high load capacity in robotic manipulators. One of the most important processes in beverage production is bottle washing. The high quality of the product depends largely on how thoroughly the bottles are cleaned immediately before filling. Manual washing of bottles does not give the desired productivity requirement of industrial setting. On this note, a mechanized system of washing and detoxification is very imperative in order to achieve the desired productivity for industries. The need to address this problem has led to the design of a mechanized bottle washing and detoxification system using a rotary table propelled by a Geneva mechanism.

Dr. K. V. Mahendra Prashant, S. G. Chandrashekar describe in his research paper about Design and Implementation of automated tablet filler Prototype for Pharmaceutical Application Using PLC in details. They says that In this era of industrialization, the revolution in technology, more specifically, the automation has had a notable impact in a wide range of industries beyond manufacturing. When we look at the current industrial scenario, it is clearly notable that the birth of new products and private brands is sharply rising the competition among industries. In order to hold out the promise of timely delivery of product, high tech automated production is essential. Automation is the use of control system and information technologies to reduce the need of human work in the production of goods and services. The concept of Automation is so versatile that it can bring radical development in almost every field. In the scope of industrialization, automation is a step beyond mechanization. Mechanization provides human operators with machinery to assist them with the muscular requirements of work, whereas automation greatly reduces the need for human sensory and mental requirements as well. In small industries, the filling system usually operates in manual mode and even this is true for some other industries also. Literature suggests that microcontrollers are being used in these industries as it brings a cost effective solution for controlling the process. Although PLCs are costly, still those are also used in industries. The implementation of PLC for commercial tablet filling plants is not discussed widely in literature. Therefore in this work, an endeavor is made to bring out important facts about its commercial use.

BipinMashilkar, Pallavi Khaire, Girish Dalvidescribe in his research paper about Automated Bottle Filling System in details. They say that the current scenario in industries is to embrace new technologies to proceed towards automation. The same vision is exercised in bottle filling plants. To meet the customer demands and accelerate the filling of bottles, all operations are nearly automated. The automation of bottle filling involves use of PLC for control but it is costly. Despite of all such advance technologies small industries are still involved in manual filling of bottles. They might be discouraged to adapt to new technology due to high cost involved in automation. The study emphasize on reduction in cost using arduino microcontroller. The arduino microcontroller is relatively cheap and widely available. In small industries bottle filling operation is done manually. The manual filling process has many shortcomings like spilling of water while filling it in bottle, equal quantity of water may not be filled, delay due to natural activities of human etc. This work generally emphases on small industries. It aims to eliminate problem faced by small scale bottle filling system. With this system that operates automatically, every process can be smooth and the process of refilling can reduce the man power cost and operation time.

III. WORKING PRINCIPLE

The motor transmits power to smaller pulley. The smaller pulley is mounted on same shaft of motor. The power given by motor to the smaller pulley is transmitted to the bigger pulley for speed reduction. Due to this Geneva disc is rotated as the same speed of the bigger pulley. As the bottle base and the Geneva disc are mounted on the same shaft the base also rotate with the same speed. The base contains 5 slots for the placement of bottles. When the crank engages with Geneva disc, the bottle slot shifts from one position to another position. This time period is known as ‘Indexing time’. In this time period limit switch is in off position and it does not allow the flow of water. When the crank disengages from the Geneva disc and travels along its periphery, the bottle start filling. This time period is known as ‘Operation time’. In this time period limit switch is in ‘ON’ position and it does not allow the flow of water. Solenoid valve control the flow of water.



IV. DESIGN CALCULATION

1. Design of Motor:-

Power of motor = 40 N- m /s

Rpm of motor = 30 rpm

Calculation of Final Speed & Torque

Power of motor= P = 40 watt.

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

Where,

N→ Rpm of motor = 30 rpm

T →Torque transmitted

$$40 = \frac{2\pi \ \times 30 \ \times T}{60}$$

T_1 = 12.7324 N-m

T_1 = 12732.4 N-mm

Assume larger pulley diameter is 150 mm and small pulley diameter is 50 mm.

Then the ratio is 3.

$T_2 = T_1$ x 3

=12730 X 3

T_2 = 38190 N-mm

$N_1/N_2 = 3$

$N_2 = N_1/3$

N_2 = 30/3

N_2 = 10 rpm

2. Shaft design

Now, T_2 is the maximum torque among all shafts, so we will check shaft for failure here.

From design data book

Ultimate tensile strength = 400 N/mm^2

Yield strength = 260 N/mm^2

τ = 100 N/mm^2

Where,

d = diameter of shaft

T_1 = torque at shaft of motor

T_2 = torque at shaft

N_1 =speed of motor in rpm

N_2 =speed of shaft in rpm

P = power of motor

T=π/16 x τ x d^3

d^3=38190 x 16/ 3.142 x 100

d=12.48 mm ≈ 15mm

Fig. Pedestal Bearing

But we are using 20 mm shaft so design is safe.

For 20mm Shaft diameter we take standard breaking no. P204

P=Pedestal bearing

2=Spherical ball or deep groove ball bearing

=04=5 * 4 = 20mm

Bore diameter of bearing.

3. Geneva

Shaft Link:

On the same shaft link for rotating Geneva is mounted of length 140.

We know,

T_2 = F x R

38190 = F x 93

F = 410.64 N

F = 41 kg

This link may fail under bending

F = maximum force applied = 410.64 N

For cantilever, M = F x L

M = 410.64x93 = 38130 N-mm

And

Section modulas = Z = 1/6 bh^2

Z = 1/6 x 5x25^2

Z = 1/6 x 3125

$Z = 520.8\ mm^3$

Now using the relation,

$Fb = M / Z$

$Fb = 38130 / 520.8 = 73\ N/mm^2$

Induced stress is less then allowable 260 N/mm^2 so design is safe.

Now the torque on shaft on which Geneva disc is mounted

$T = F \times R$

$T = 410 \times 31$

$T = 12710$ N-mm

4. Geneva Wheel:-

Centre Distance = $\frac{b}{Cos(180/n)} = \frac{140}{Cos(180/5)} = 157$ mm

Crank Radius= $\sqrt{157^2 - 172^2}$=93 mm

Slot Cutter Distance= (a + b)-c

= (93+127)-157

= 63 mm

Thickness of Slot= 8+2 =10mm

Angle= (2*180/n)

= 75

Thickness of Wheel= 3mm

Height of Pin=6+2=8mm

We know Geneva shaft speed= 10rpm

Indexing Time/Process Time:

$= (180-72) = \frac{(180-72)}{360 \times N} = \frac{1.8\ sec}{360 \times 10}$

Dwell Time/Operation Time:

$= (180+72) = \frac{(180+72)}{360 \times N} = \frac{4.2\ sec}{360 \times 10}$

5. Frame design

Let the total weight (P) of our machine be 150 kg, now this 150 kg weight is kept on four angle,

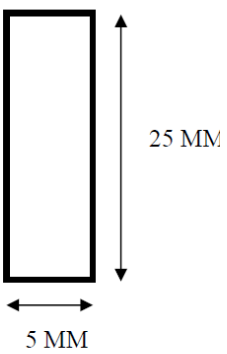
P = 50/4 = 12.5 kg.

P = 12.5 x 9.8 = 122.625 N.

L = 1000 mm.

$M = WL/4 = 122.625 \times 1000/4$

= 30656.25 N-mm



$A_1 = 120\ mm^2 \quad A_2 = 104\ mm^2$

$y_1 = 15$ mm $\quad y_2 = 2$ mm

$Y = \frac{120*15+10*2}{120+104}$

Y= 8.9642 mm

$I = \frac{Bd^3}{12} + A_1*(Y-y_1)^2 + \frac{Bd^3}{12} + A_2*(y_2-Y)^{2sss}$

$= \frac{4*30^3}{12} + 120*(15-8.96)^2 + \frac{26*4^3}{12} + 104*(8.96-2)^2$

= 13371.70 + 5182.67

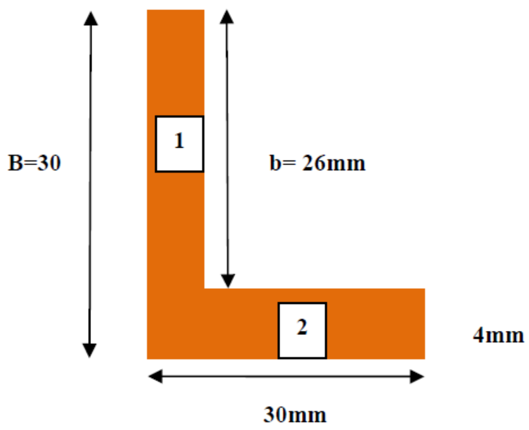
$= 18554.38\ mm^4$

$Z = \frac{I}{Y} = \frac{18554.38}{8.9642}$

Z= 2069.82 mm

$\sigma = M/Z = 30656.25/2069.82 = 14.81\ N/mm^2$

As induced bending stress is less then allowable bending stress i.e. 270 N/mm^2 design is safe.



V. CONCLUSION

The thesis presents an automated liquid filling to bottles of different height using Geneva mechanism. A total control is made in a filling is achieved. The present system will provides a great deal of applications in the field of automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there's need for increased production. The solenoid valve to this system developed is flexible, quickly and easily. This will increase the total production output; this increase in production can yield significant financial benefits and savings. This concept can be used in beverage and food industries, milk industries, medicine industries, mineral water, chemical product industries and manufacturing industries.

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