Bottle Indexing and Filling Mechanism

Kusekar Sambhaji K.
Assistant Professor, Mechanical Engineering Department
Solapur University, Solapur India

Ravikumar Babar, Mohseen Wadwan, Amol Pawar,Samadhan Vaidya, Mayur Algude
Students, Mechanical Engineering Department Solapur University,
Solapur India

Abstract - Bottle Indexing & filling machines are widely used in the domestic purpose. The Bottle Indexing & Filling machines play very important role in the Medical, Bislery, and Wine industry. In industry there is always used a Bottle Indexing & filling machine to fill the bottle in desired quantity.

For this purpose Bottle Indexing & filling machines are widely used. These machines are used for special purpose machine, out of that there is normally a traditional filling machine is used in the industry. A traditional process contains filling the bottle by hand that will take more time. & also lot of wastage of water. Generally traditional process takes lot of process means first of clean the bottle, then whether the bottle is crack or not. But there is problem arises with this type process. The work setting time is more as compared with the filling time of the bottle. So due to this problem the idle time of the process is more as compared to the working time of the machine this will results in the low productivity of the machine & also it requires many worker for this process. This will effect on the efficiency of the machine it my reduced to 55% just due to the more idling time.

By providing a Geneva mechanism & one limit switch time of the machine is minimized by providing this attachment the efficiency of the machine is improved up to 94% & also average skilled operator may be required for operate the machine due to this provision this machine is used for mass production also & it give facility to operate this machine easily.

So the main goal of the project is to minimize the cycle time of the machine & achieve the high production rate on traditional machine. This goal of the project is nearly achieved by completion of the project. For achieving this goal we used different types of the flow process & engineering knowledge.

These processes consist of:

1) Collection of data of machine.
2) Understanding the main problem.
3) Creating solution for problem.
4) Design of system (Mechanical design & system design).
5) Preparation production drawing.
6) Manufacturing of component by different machining process.
7) Assembly of the component.
8) Testing of machine.
9) Analysis of the test data.
10) Preparation of the report.

Keywords: Filling time, Cycle time, Automation, Productivity, and Efficiency.

.

1. INTRODUCTION:

There is huge demand of commodities in market properly placed and sealed commodities have many advantages over loose one .They have protected from dirt, dust, germs and micro bacterial attacks due to packing .Also before packing they are checked for volume or weight. The weight & selling units are written on packing along with date of packing and validity for use. Packing& filling many times done manually.

Mass amount of filling packing work is done by with automation. Most of the containers are polyethylene bags or thin walled metallic cans etc. mass production & commodity items save cost of product. While filling liquid or semi liquid materials care is taken to avoid leakage some chemical liquids are poisonous and hence manual handling is difficult. In this project work we have selected task of automatically filling a bottle. This is demonstration model which has been developed considering the actual work in automation.

2. OBJECTIVE:

The Bottle Indexing & Filling machine can be used to fill the bottle in sequence. It is the ideal filling machine for manufacturing and processing. It is used for medical, water distillery plant, etc.

In this machine, where Geneva wheel start rotating, in that Geneva wheel 6 stations. In this machine bottle will be automatically filled and then indexing.

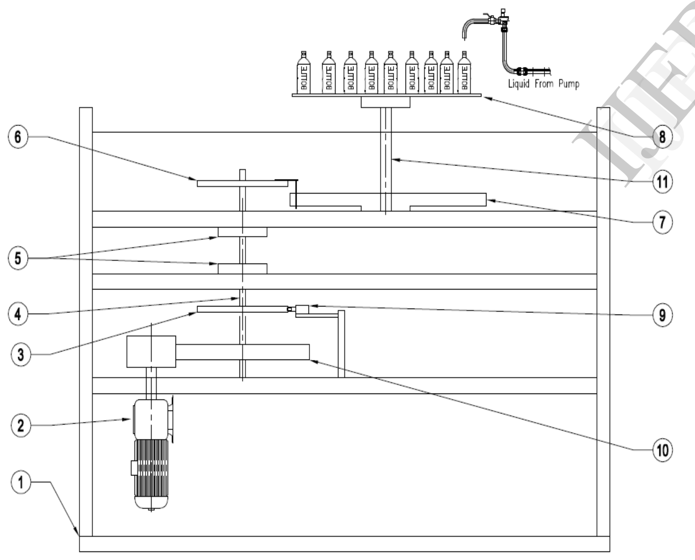
This machine is equipped with international standard motor with big power, and the base of machine is extra-heavy, very difficult to move during filling process. The whole project is based on Sturdy base frame are made of high-quality cast iron, with long lifetime. In traditional bottle filling process there is many problems arise with traditional process. This problems are generally are as follows.

1. Overflow of water.
2. Improper water filling.
3. More time required for filling water.
4. Extra human efforts required.
5. Wastage of water.
6. Chances of bottle damage.
7. Chances of contamination of water due to human contact.

To overcome this problems this project work has been done. By using this machine all this problems are overcome & the efficiency of human being will be improved. The automatic bottle filling machine will filled the water with metered quantity set by pump so there is no wastage of water & accuracy of filling water quantity is high.

3. SCOPE OF STUDY:

This project is prototype model all the parts are mounted on sturdy base frame. Main frame is made from square tube.



Constructional Detail Fig.1.

1. Main Frame
2. Electric Motor
3. Timing Cam
4. Shaft
5. Bearing
6. Indexing (Locking) Disc
7. Geneva wheel
8. Round Table
9. Limit Switch
10. Gear Train
11. Geneva Shaft

Main frame has square bas of size 300 mm x 300 mm. both shaft are mounted vertically as shown in figure. A Servomotor is mounted on horizontal plate & bolted to the plate. A pinion is mounted on motor shaft. A gear which is meshing with pinion is mounted on locking disc shaft. Above the gear a timing cam is fitted on locking disc shaft. This shaft is supported on bearing fitted in cylindrical seats. A care is taken to prevent axial movement of shaft. Locking disc is mounted at the upper end of shaft. It has roller at the end of strip which engage in a slot of Geneva mechanism. Geneva wheel has a six station arrangement.

Geneva has six slot separated by equal angle i.e. $60^{0,}$ It has also six curves mating with locking disc periphery, The arrangement is made to adjust vertical distance of Geneva wheel shaft table is felted. Table has 300 mm diameter. Above the table a circular plastic sheet is mounted such that it will be concentric to a table.
This circular plastic sheet has six circular holes cut by 60^0 the bottles which are to be filled & kept in these holes.

A limit switch is flitted on a bracket as shown in fig. I. limit which is roller and lever type. Roller of limit switch is in contact with timing cam. A liquid pump is situated in a separate storage reservoir. Delivery pipe is brought to the filling point. This pipe is made of plastic and has spherical joints and has more flexibility to position. Electrical motor and pump run on a.c.230 v, single phase supply which is easily available.

Before starting the filling procedure pump is run dry or no supply us given to pump, delivery end of pipe is adjusted such that there is no wastage of liquid and preset quantity will be filled in a bottle. After starting the electrical motor & pump locking disc will rotate, during indexing period roller enters the Geneva wheel slot and table will be indexed by 60^0 next bottle will come under filling pipe. After leaving the slot a timing cam adjusted such that lever of limit switch will be pressed to make a contact between electrical terminals. Due to this electrical supply will be given to pump and it starts to deliver liquid. After some degree of rotation of bottle on disc and electrical supply to pump is cut due to release force on roller. Similarly next bottle will be indexed and filled.

4. PROJECT ACTION PLAN

Phase 1: Data Collection

Data collection phase involves the collection of reference material for project concept; the idea is taken from book Mechanisms and mechanical linkages by I A Chronis.

Phase 2: System Design

The system design comprises of development of the mechanism so that the given concept can perform the desired operation. The mechanism is basically an inversion of four bar kinematic linkage, hence the mechanism is suitably designed using Grashoff's law and the final outcome is shown in the figure shown before.

Phase 3: Mechanical Design

The parts mentioned above in the part list will be designed for stress and strain under the given system of forces, and appropriate dimensions will be derived. The standard parts will be selected from the PSG design data handbook.

Phase 4: Production Drawing Preparation

Production drawings of the parts are prepared using Auto Cad, with appropriate dimensional and geometric tolerances. Raw material sizes for parts are also determined.

Phase 5: Material Procurement & Process Planning

Material is procured as per raw material specification and part quantity. Part process planning is done to decide the process of manufacture and appropriate machine for the same.

Phase 6: Manufacturing

Parts are produced as per the part drawings.

Phase 7: Assembly –Test & Trial

Assembly of device is done as per assembly drawing and test and trial is conducted on device for evaluating performance.

Phase 8: Report Preparation

Report preparation of the activities carried out during the above phases is done.

DESIGN DETAILS:

1. GENEVA MECHANISM:

A Geneva Mechanism is a unique design that produces a repeated indexing motion. Because of this motion, the Geneva mechanism is commonly classified with cams, the Geneva wheel consist of disc with several radial slots and is fastened to the input shaft. The arm is usually attached to a locking disk that prevents the wheel from rotating when the driving roller is not engaged in a slot. The locking disk fits into a cut out on the wheel.

The motion of the Geneva Mechanism characterized by the roller entering a slot in the wheel, indexing the wheel loads into position until the rollers enters the next slot.

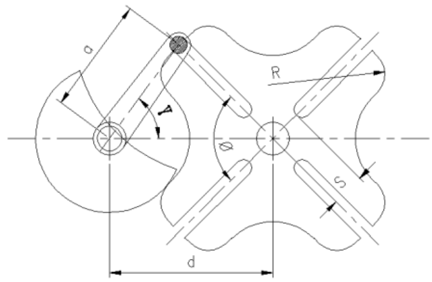


Figure -2.

IN fig. 2, the roller rotates clockwise and it just about to renter the Geneva Wheel.

Where, R = Radius of Geneva wheel

d = Center distance between Geneva Wheel & indexing disk

s = Distance between wheel center & slot

Φ = Angle between 2 successive slots

γ = Angle between center line

a = Center distance between driving roller & indexing disk

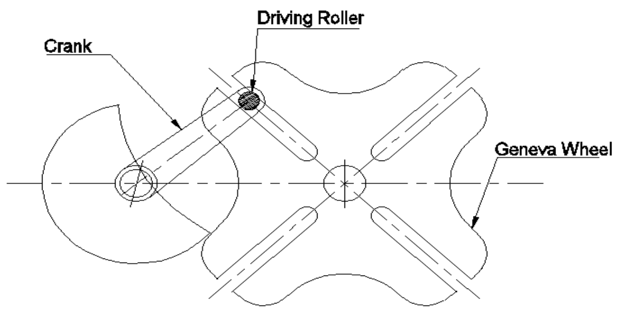


Figure -3.

In fig.3, the roller has entered the slot and has turned the wheel counterclockwise.

While designing the wheel, it is important that the roller enters the slot tangentially, otherwise impact loads are created and the mechanism will perform poorly at high speeds or loads.

2. GEOMETRICAL RELATINS:

Indexing angle $\emptyset = 360/n$

Where n= Number of station in Geneva wheel.

Angle

$R_0 = 90 - \emptyset/2$

$a = d \sin(\emptyset/2)$

$R = d \cos(\emptyset/2)$

$S < d - a$

In this model

Number of station of Geneva wheel=6

Angle of index $\emptyset = 360/n = 360/6 = 60^0$

Radius of Geneva wheel R=100 mm

$d = R/\cos(\emptyset/2) = 100/\cos 30 = 151.5$ mm

$a = d \sin(\emptyset/2) = 151.5 \sin 30$

a = 75 mm

3. ELECTRIC MOTOR:

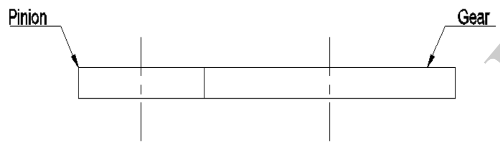
A servomotor is selected having following specifications.

Torque = 80N-cm

Speed = 60 rpm

Direction of rotation = reversible

Speed of disc shaft



Nq * Tq = Np*Tp

Where, Nq = Speed of Gear

Tq = Teeth of Gear

Np = Speed of Pinion

Tp = Teeth of Pinion

Nq = (Tp\ Tq) * Nq

Nq = (16/48)* 60

Nq =20 rpm

In this model

Number of station of wheel = 4

Angle of index $\emptyset = 360/n = 360/4 = 90^0$

Radius of Geneva Wheel R = 80 / cos (90/2) = 113 mm

$a = d \sin(\emptyset/2) = 113 \times \sin(90/2) = 80$ mm.

4. DESIGN OF DISC SHAFT:

Torque on shaft = T_q / T_p X torque on pinion shaft

T = 3/1 X 8

T = 24 Kg-cm

Hence torque = $24 \times 9.81 \times 10^{-2}$ N-m

T = 2.3544 N-m

Speed of shaft = 2 rpm

Torsional shear stress developed

$\tau = 16/(\pi d^3) \times T$ (Min^{m}dia of shaft = 10.5 mm)

Shaft material C_{30} steel having yield strength according to design data book 500 N/mm^2

Taking factor of safety = 3

Allowable yield stress = 500/3 =166.66 N/mm^2

Allowable shear stress =166.66/2 = 83.33 N/mm^2

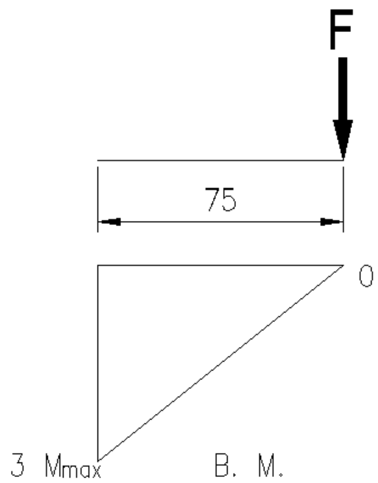
Torsional shear stress developed at shaft

$\tau = 16/(\pi d^3) \times T$

$\tau = 16/(\pi \times 10.5^3) \times 2354.4 = 10.36$ N/mm^2

Hence shear stress developed on a shaft is less than allowable strength of material, hence shaft is safe.

Checking crank for bending stress



Torque = 8 Kg-cm

T = 8 x 9.81 x 10

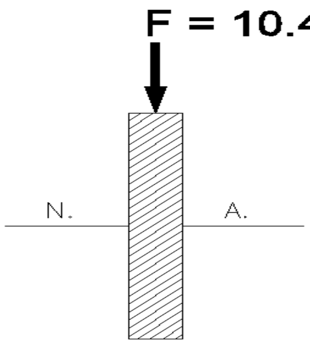
T = 784.8 N-mm

Force at 75 mm

F = T/R = 784.8/75 = 10.46 N

Max^{im} bending moment = 784.8 N-mm

Crank section



Moment of inertia of section about Neutral Axis (N.A.).

$I = bd^3/12$

Where, b = 3, d = 20.

$I = 3x\ 20^3/12 = 2000\ mm^4$

According to flexural bending moment

$\sigma / y = M/I$

Where, σ = stress developed

y = fiber distance from N.A.

M =bending moment

I = moment of inertia

$\sigma / y = M/I$

$\sigma = (784.8/2000) \times 10$

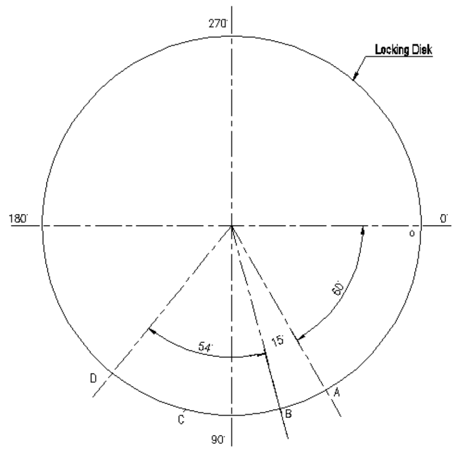
$\sigma = 3.924 N/mm^2$

Material used for crank is mild steel having lower yield strength according to design data Book = 600 N/mm^2. Considering factor of safety for this application = 3 Allowable stress in crank = yield strength / factor of safety

$\sigma_{Allowable} = 600/3 = 200\ N/mm^2$

Stress developed in crank material is less than allowable stress, hence design is safe.

5. INDEXING MECHANISM:



1. At 0 = Roller enters Geneva wheel slot.
2. At A after 60^0 =Roller exit from Geneva wheel slot.
3. At B (angle 15^0)= Idle
4. At B timing cam pusher the limit switch lever to make an electrical contact to make pump on.
5. During BCD (54^0) pump is on it delivers liquid to bottle
6. At D timing cam disconnects the contact of limit switch pump is off.
7. From D to 0 idle.

6. QUANTITY DELIVERED BY PUMP:

Pump used is a centrifugal pump with following specification.

Delivery head = 1.5 meter

Discharge = 400 LPH

Supply 230 volt, single phase speed of crank or disk = 20 rpm.

= 1/3 rev./sec

Pump discharge per second = 400/3600

= 0.111 lit /sec

Discharge per revolution of crank shaft

Q = 3 x 0.11 = 0.33 Liter.

Q = 333 Milliliter

To get 50 ml quantity in bottle are have to calculate angle of rotation of crank or contact angle of cam with limit switch

For 360^0 = 333 ml (volume)

Let X^0 = 50 ml (volume)

Hence,

X = (360 x 50)/ 333

$X = 54.05^0$

PROCESS SHEET:

i. Main Frame:

PART,NAME:-Main-Frame

QTY.:-01

MATERIAL: - 1. M.S. square pipe 25 x 25 x 3 thk.

2. M.S. Flat 30 x 4 thk. 1 meter. Long.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Hacksaw Machine	Cutting required pieces from raw stock	40
2	Hand Grinder	Debarring	30
3	Manual	Notch making by hacksaw	30
4	Portable Drilling Machine	Drilling holes on flat	20
5	Arc Welding Transformer	Fabrication frame	40

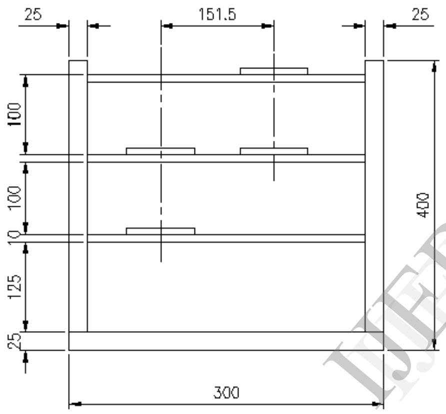
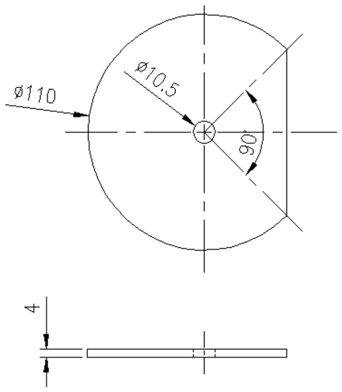


Fig: Main Frame

ii. Locking Disk

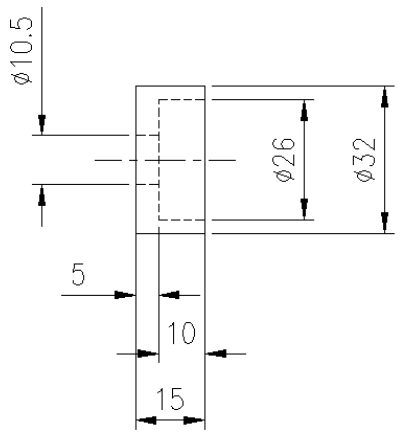


PART,NAME:-Locking-Disk
QTY.:-01

MATERIAL: - M.S. Plate 120 x 120 x 6 thk.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Oxyacetylene Gas Cutting Equipment Attached To Profile Cutter.	Cutting a blank of diameter (Ø110)	30
2	Lathe Machine	Facing	10
3	Lathe Machine	Drilling	10
4	Lathe Machine	Boring	25
5	Lathe Machine	Turning	25
6	Lathe Machine	Chamfering	05
7	Manual	Hacksaw cut	10
8	Manual	Filing	20

iii. Bearing Seat



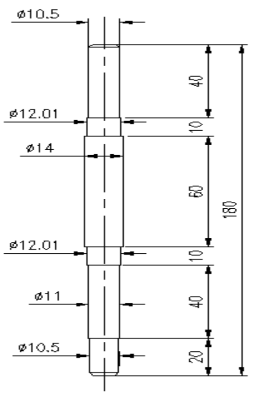
International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 6, June - 2014

PART NAME:- Bearing Seat QTY.:-02

MATERIAL: - M.S. Bar Ø 32 x 50 long.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Hacksaw Machine	Cutting required pieces from raw stock	10
2	Lathe Machine	Facing	05
3	Lathe Machine	Drilling	10
4	Lathe Machine	Boring	20
5	Lathe Machine	Chamfering	05

iv.LOCKING DISK SHAFT

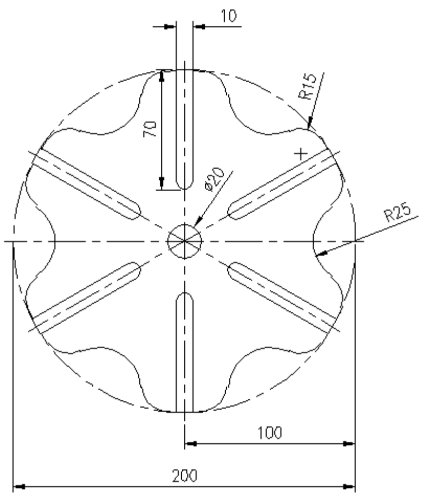


PART NAME:- Locking Disk Shaft
QTY.:-01

MATERIAL: - M.S. Bar Ø 32 x 50 long.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Hacksaw Machine	Cutting required pieces from raw stock	10
2	Lathe Machine	Facing	05
3	Lathe Machine	Turning	25
4	Lathe Machine	Chamfering	05

v. GENEVA WHEEL



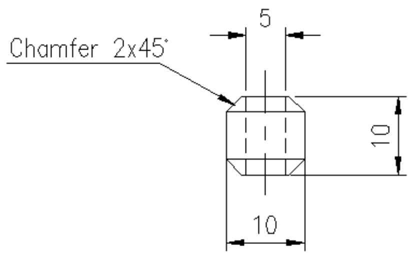
PART NAME:-Geneva wheel QTY.:-01

MATERIAL:-M.S. Sheet 250 x 250 x 2 thk.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Shearing Machine	Cutting a piece from raw stack	20
2	Shearing Machine	Cutting an air culler piece	20
3	Portable Drilling Machine	Drilling holes	20
4	Horizontal Milling Machine	Cutting slot as per drawing	30
5	Manual	Debarring	

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 3 Issue 6, June - 2014

vi. ROLLER

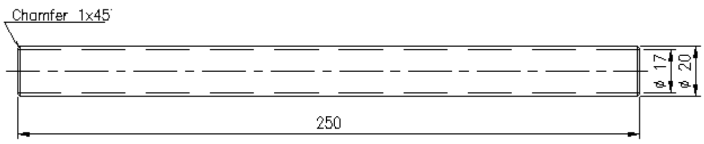


PART NAME:-Roller QTY.:-01

MATERIAL: - M.S. Bar Ø 12 x 15 long.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Hacksaw Machine	Cutting required pieces from raw stock	05
2	Lathe Machine	Facing	05
3	Lathe Machine	Drilling	10
4	Lathe Machine	Parting	10
5	Lathe Machine	Chamfering	05

vii. GENEVA SHAFT

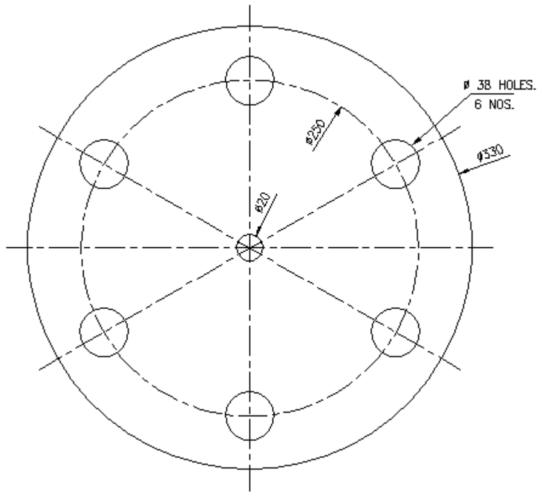


PART NAME:-Geneva Shaft QTY.:-01

MATERIAL: - M.S. Bar Ø 20 x 260 long.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Hacksaw Machine	Cutting required pieces from raw stock	05
2	Lathe Machine	Facing	05
3	Lathe Machine	Parting	05
4	Lathe Machine	Chamfering	05

viii. BOTTLE PLATE



PART NAME:-Bottle Plate QTY.:-01

MATERIAL: - Acrylic plate Ø 350 x 4 thk.

SR.NO.	MACHINE	OPERATION	TIME (min)
1	Jigsaw Machine	Cutting from raw sheet	30
2	Portable Drilling Machine	Drilling the holes as per Drg.	05

6. PART LIST:

Sr. No.	Specification of parts	Material	Quantity
1	Electrical motor 6 kg target	Standard	01
2	Water pump Head 1.5 M Discharge 400 LPH	Standard	01
3	Cooling Disc shaft	C30 steel	01
4	Locking disc	M.S.	01
5	Geneva Wheel	M.S.	01
6	Geneva Wheel Shaft	M.S.	01

7	Roller	M.S.	01
8	Bearing Seats for 6201 Bearing	M.S.	02
9	Baring 6201	Standard	02
10	Bush mgs	M.S.	02
11	Bottle plate 4 thick	Plastic	01
12	Bolts & Nuts 6mm x 30 mm	M.S.	06
13	Washers ϕ8 mm ID	M.S.	06
14	Screw M4	M.S.	06
15	Gears pinion 16 teeth	Teflon	01
16	Gear 48 Teeth	Teflon	01
17	Pipe 8 mm	PVC	1 Mtr.
18	Limit Switch	Standard	01

7. COST ANALYSIS

Cost incurred for the project model is calculated considering the expenditure on purchasing of raw material, transport charges, processing etc. Processing means to give a required shape to the raw material & manufacturing as per the design.

Expenses on processing are calculated considering rates of processing per unit time for example machining cost is calculated as :-

Machining Cost = Machine time in min. × Rate of machining in Rs./Min.

Total Manufacturing cost of item or Part is calculating as:-

Mfg. Cost = weight of material in Rs/Kg. × Rate of raw material in Rs./Kg. + Cost of processing in Rs.

Details of cost is given below

Sr. No.	Particulars	Cost In Rs.
1	Manufacturing Cost	7000
2	Cost of bought out parts	6000
3	Transport charges	1000
4	Miscellaneous charges	3000
Total		17000

8. ADVANTAGES & DISADVANTAGES:

ADVANTAGES:

1) This technique of indexing and filling a bottle is used in packaging industries for reducing production time thereby reducing cost of production.
2) Accuracy of filling a required quantity.
3) With this method there is very less or no wastage of liquid.
4) The process of filling a container can be remote operated so as to handle poisonous chemicals.
5) It is also suitable for handling medical liquid.
6) Unskilled person can handle this machine.

DISADVANTAGES:

1) The process is used for mass production work this requires an investment on machinery.
2) Filling containers should be identical in size & shape.
3) During running period there is always provide a filling container.
4) Care should be taken while mounting the container on indexing plate. (In case of packaged water bottle there is a chance of crushing of bottle due to high hand grip pressure.

8. FUTURE SCOPE

This project is a model, developed to demonstrate the working principle of indexing & filling mechanism. Speed of filling may be measured as bottles per hour. This speed is comparatively less in this model. In future this model may be developed to fill the bottles in arrays with high speed.By using this concept we can design it for large scale industry by providing conveyer line which can handle both empty container & filled container & also cap fitting arrangement can be provided at same time.

9. CONCLUSION

This project is a model for the actual task of bottle filling it is proved from the working and trial on this model that a bottle filling work can be done automatically with accuracy. In completing our project as per our time estimate gives us immense pleasure and a feeling of achievement. During the course of project we encountered numerous problems which we overcame with the able guidance of our project guide. Finally we conclude that by using this bottle filling machine we can save times which will ultimately increases the productivity.

ACKNOWLEDGEMENT:

Completing a task is not one man effort. It is often contribution of many people direct or indirect ways. The help of people, which has enabled his activity towards completion, is Unforgettable. We feel happiness in forwarding this project report as an image of our sincere efforts. The successful project report reflects our hard work, efforts and also positive involvement of our Guide in providing us good information. We would like to express our heartfelt gratitude to our guide Mr. Kusekar S. K. also we would like to express our heartfelt gratitude to our Head of Department for his constant interest and encouragement throughout the completing of our project report. We also express our deep gratitude to all staff member and all the people who lend us their valuable time support and co-operation to enable us to complete our project successfully. The most thanks we give to our parent who gives moral & positive support to us for complete this task of project.

REFERENCES:

1. United States Patent and Trademark Office Home Page. (2005 Novemember). Retrieved Novemember 6th 2005, from the World Wide Web: http://www.uspto.gov/.
2. R. S. Khurmi J. K. Gupta; “Theory of Machines”; S. Chand Publication, 4th edition.
3. R. S. Khurmi “Machine design”, S. Chand; 4th edition.
4. P. C. Sharma “Production Technology”;; Tata McGraw Hill; 2nd edition.
5. The Geneva Wheel (Tutorial), Cornell
6. “PSG Design Data Book”; Page No.1.10 & 1.12
7. “Mechanical Engineers Handbook”;Roger Timings; Newness; 3rd edition