Bottle Indexing and Filling Mechanism

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Abstract - Bottle Indexing & filling machines are widely used in the domestic purpose. The Bottle Indexing & Filling machines play very important role in the Medical, Bisleri, 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 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.

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](image)

   ![Figure 3](image)

   In fig. 2, the roller rotates clockwise and it just about to reenter 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

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2. GEOMETRICAL RELATINS:

Indexing angle θ = 360/n
Where n= Number of station in Geneva wheel.

Angle
R₀=90-θ/2
a=d sin (θ/2)
R= d cos (θ/2)
S < d – a

In this model
Number of station of Geneva wheel=6
Angle of index θ = 360/n = 360/6 = 60°
Radius of Geneva wheel R=100 mm
d = R/cos (θ/2) = 100/cos 30 = 151.5 mm
a = d sin (θ/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 θ =360/n = 360/4 = 90°
Radius of Geneva Wheel R = 80 / cos (90/2) = 113 mm
a = d sin (θ/2) =113 x sin (90/2) = 80 mm.

4. DESIGN OF DISC SHAFT:
Torque on shaft = T₀/ T₀X torque on pinion shaft
T = 3/1 X 8
T = 24 Kg-cm

Hence torque = 24 x 9.81 x 10⁻² N-m
T = 2.3544 N-m
Speed of shaft = 2 rpm
Torsional shear stress developed
τ = 16/(πd³) X T  (Min"dia of shaft = 10.5 mm)
Shaft material C₃₀ steel having yield strength according to design data book 500 N/mm²
Taking factor of safety = 3
Allowable yield stress = 500/3 =166.66 N/mm²

Allowable shear stress =166.66/2 = 83.33 N/mm²

Torsional shear stress developed at shaft
τ = 16/(πx 10.5²) X T
τ = 16/(πx 10.5²) X 2354.4 = 10.36 N/mm²
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
Max² bending moment = 784.8 N-mm
Crank section
Moment of inertia of section about Neutral Axis (N.A.).

\[ I = \frac{bd^3}{12} \]

Where, \( b = 3 \), \( d = 20 \).

\[ I = 3 \times 20 \times \frac{3^3}{12} = 2000 \text{ mm}^4 \]

According to flexural bending moment

\[ \sigma / y = M/I \]

Where, \( \sigma \) = 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 \]

\( \sigma = 3.924 \text{N/mm}^2 \)

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

\( \sigma_{\text{Allowable}} = \frac{600}{3} = 200 \text{ N/mm}^2 \)

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.

\[ = \frac{1}{3} \text{ rev./sec} \]

Pump discharge per second = 400/3600 = 0.111 lit/sec

Discharge per revolution of crank shaft

\( Q = 3 \times 0.11 = 0.33 \text{ liter} \)

\( Q = 333 \text{ Milliliter} \)

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 \( 360^0 = 333 \text{ ml (volume)} \)

Let \( X^0 = 50 \text{ ml (volume)} \)

Hence,

\[ X = \frac{(360 \times 50)}{333} \]

\[ X = 54.05^0 \]

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

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

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

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

ii. Locking Disk
PART NAME: Bearing Seat QTY.: -02

MATERIAL: - M.S. Bar Ø 32 x 50 long.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hacksaw Machine</td>
<td>Cutting required pieces from raw stock</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Lathe Machine</td>
<td>Facing</td>
<td>05</td>
</tr>
<tr>
<td>3</td>
<td>Lathe Machine</td>
<td>Drilling</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Lathe Machine</td>
<td>Boring</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>Lathe Machine</td>
<td>Chamfering</td>
<td>05</td>
</tr>
</tbody>
</table>

iv. LOCKING DISK SHAFT

PART NAME: Locking Disk Shaft QTY.: -01

MATERIAL: - M.S. Bar Ø 32 x 50 long.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hacksaw Machine</td>
<td>Cutting required pieces from raw stock</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>Lathe Machine</td>
<td>Facing</td>
<td>05</td>
</tr>
<tr>
<td>3</td>
<td>Lathe Machine</td>
<td>Turning</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>Lathe Machine</td>
<td>Chamfering</td>
<td>05</td>
</tr>
</tbody>
</table>

v. GENEVA WHEEL

PART NAME: Geneva wheel QTY.: -01

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

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shearing Machine</td>
<td>Cutting a piece from raw stack</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Shearing Machine</td>
<td>Cutting an air culler piece</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>Portable Drilling Machine</td>
<td>Drilling holes</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>Horizontal Milling Machine</td>
<td>Cutting slot as per drawing</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>Manual</td>
<td>Debarring</td>
<td></td>
</tr>
</tbody>
</table>
vi. ROLLER

PART NAME:- Roller  
QTY.:- 01

MATERIAL: - M.S. Bar Ø 12 x 15 long.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hacksaw Machine</td>
<td>Cutting required pieces from raw stock</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Lathe Machine</td>
<td>Facing</td>
<td>05</td>
</tr>
<tr>
<td>3</td>
<td>Lathe Machine</td>
<td>Drilling</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>Lathe Machine</td>
<td>Parting</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Lathe Machine</td>
<td>Chamfering</td>
<td>05</td>
</tr>
</tbody>
</table>

vii. GENEVA SHAFT

PART NAME:- Geneva Shaft  
QTY.:- 01

MATERIAL: - M.S. Bar Ø 20 x 260 long.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hacksaw Machine</td>
<td>Cutting required pieces from raw stock</td>
<td>05</td>
</tr>
<tr>
<td>2</td>
<td>Lathe Machine</td>
<td>Facing</td>
<td>05</td>
</tr>
<tr>
<td>3</td>
<td>Lathe Machine</td>
<td>Parting</td>
<td>05</td>
</tr>
<tr>
<td>4</td>
<td>Lathe Machine</td>
<td>Chamfering</td>
<td>05</td>
</tr>
</tbody>
</table>

viii. BOTTLE PLATE

PART NAME:- Bottle Plate  
QTY.:- 01

MATERIAL: - Acrylic plate Ø 350 x 4 thk.

<table>
<thead>
<tr>
<th>SR.NO.</th>
<th>MACHINE</th>
<th>OPERATION</th>
<th>TIME (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jigsaw Machine</td>
<td>Cutting from raw sheet</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>Portable Drilling Machine</td>
<td>Drilling the holes as per Drg.</td>
<td>05</td>
</tr>
</tbody>
</table>

6. PART LIST:

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

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Details of cost is given below

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Particulars</th>
<th>Cost In Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Manufacturing Cost</td>
<td>7000</td>
</tr>
<tr>
<td>2</td>
<td>Cost of bought out parts</td>
<td>6000</td>
</tr>
<tr>
<td>3</td>
<td>Transport charges</td>
<td>1000</td>
</tr>
<tr>
<td>4</td>
<td>Miscellaneous charges</td>
<td>3000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>17000</strong></td>
</tr>
</tbody>
</table>

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 conveyor 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 and 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 cooperation 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:
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