Design and Fabrication of Labour Intensive Soap Punching Unit

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Abstract – As today is the age of Industrialization and Automation, and today's need is to incubate the growing industries by providing them with sustainable environment to retain their existence in the global scenario. In MSME (Micro Small Medium Enterprise) every industry starting from Micro to Medium Scale is trying to do the optimum production by implementing newer technology with less human inputs and fighting to get stable in the market. The objective of this work is to help small soap manufacturing units by providing state of art manual and compact special purpose soap printing instrument. A Geneva Mechanism is used to satisfy the aim. The Geneva mechanism converts the rotary motion into intermittent rotary motion. In this working model, our goal is to achieve loading, punching/stamping, unloading, oiling and cleaning of soap cake. In this actual working model; associate only have to place all the components at its proper position and rest of the work will be carried out by the equipment itself.

Index Terms – Soap, Punching, Unit, Machine.

INTRODUCTION

Every manufacturing organization mainly focuses on quality with higher productivity and less human interface. As there is lot of competition in the global market and also consumers are very passionate about best product and its salient features. So there is need of developing an alternative method or process for effective manufacturing. The same process or method which will fulfill the requirements about precision and accuracy etc. It is necessary to reduce the manufacturing lead time. There are various ways by which the manufacturing lead time can be effectively calculated and minimized. There are various time consuming steps or sub process, which can be minimizing by various methods. In mass production the "takt time" criteria is very much important. The main constraint was within small time span, a single unit job has to be completed. For minimizing the production time for job, the handling time job should be minimum. For minimizing the handling time; we introduce the attachment for loading and stamping/punching as well as unloading machine for the operation. Suppose for one job "A", there are number of sequential operation such as loading, stamping, unloading, oiling and cleaning that can be effectively perform by one after another with greater accuracy & at faster rate. For completing this, all set of operations needs to be performed on table, earlier the associate is using manual process, but with this attachment, there is only one operation of loading and unloading the job is required. Then automatically rest of the operations like stamping/punching, oiling, cleaning the die will be carried out by equipment itself. This attachment is very useful for small-scale industry as well as for small workshops.

LITERATURE REVIEW

The various components of mechanically operated automation system [1] studied in detail such as Main base/table height, Geneva wheel diameter, Geneva shaft diameter, length of Crank shaft, crank, size of Bevel gears, Bearings etc. And also have studied the actual implementation of these components. While designing the model it is noted that across various difficulties such as Geneva mechanism fitting. Initially collected all the components required for mounting of system. All the components are arranged in a mechanically operated automation system according to their specific function. There is a need of developing a new method or process for effective manufacturing.

Simply Automats can be defined as a device which can develop an effective manufacturing process. The model is basically small version of punching/stamping machine; the operation of stamping which is carried out manually in most of the non automated soap manufacturing industries. Various Processes are performed on this machine. The soap stamping machine comprises of various mechanism, gear pairs, various transmission system and the various chain and sprockets transmission system.

RECOGNITION OF NEED

After having a market survey and lots of search for the problems which is faced by the micro and small soap manufacturing industries, here enlisted some of the requirements by the industries,

1. To reduce the time required to perform various operations like are stamping, loading, unloading, oiling and cleaning.
2. To reduce human efforts.
3. To manufacture a job with high accuracy and precision.

It is noted that; the moisture content in the soap was very high, cutting of soap was not proper and stamping/punching logo on the soap was even at a small extent.

By doing Pareto Analysis out of above three problems, it is worked on the problem of stamping of logo on the soap. In earlier stamping machine there was a problem that worker were doing all four operation with some specific time interval and because of that the more time was required for the operation. Another problem identified that earlier this machine was manually hand lever operated and the worker handle all machine parts starting with loading to the unloading the job with manually and due to that worker is not happy to do this repetitive fatigue job all the time[2]. Hence the production rate of the conventional soap stamping machine was very low and it required more man power for the stamping of soap.

Due to this production rate was low, the current setup is not even convenient from the management point of view as there is wastage of man power for loading, unloading of soap and oiling & cleaning of die cavity.

ROOT CAUSE OF PROBLEM:

For carrying out these all set of simultaneous four operations (loading, stamping/punching, unloading, oiling & cleaning) , it is concluded that it is required to design such a mechanism which will satisfy management and associates requirement which will work with less effort and operator must feel relaxed during working. For this purpose a mechanism with raw structure designed and developed which carries all the four set of operations simultaneously with less man power and mechanical energy and increased production rate.

OBJECTIVES IDENTIFIED

a] GENERAL OBJECTIVE

- Design and Manufacture the Instrument/machine.

b] SPECIALIZED OBJECTIVE

- Manufacturing the components.
- Assembly of components.
- Use of Software for Design and Simulation as AutoCAD/CATIA.
- Identify the components.

CONSTRUCTION

THEORY

1. Now it is necessary to introduce the attachment for the stamping machine.
2. Rotary indexing plate for stamping machine to overcome said errors specified in conventional machines.
3. In this work it is tried to implement Geneva wheel mechanism which gives higher accuracy.
4. Using this instrument, it is possible to do stamping one by one simultaneously with certain required time delay, stamping, and unloading, oiling, and cleaning operation by indexing a machine fixture at an angle of 90^0.

DESIGN CONSIDERATIONS

The design and selection of component [3],[4] of engineering systems, the design, material selection and fabrication of the soap stamping machine was based on the following considerations:

1. The availability of materials locally to reduce cost of production and maintenance.

2. Force Calculation for the various components of this machine were based on the type of force that will be acting on various links, the work they are expected to perform and the environmental condition in which they will function.

- Design of Shaft:

As the shaft is subjected to combined [5] twisting and bending moment, hence the shaft must be design on the basis of the two moments simultaneously. Various theories have been suggested to account for the elastic failure of the materials when they are subjected to various types of combined stresses. Following theories are important from the subject point of view.

Maximum shear stress theory (For ductile material like M.S.) Maximum normal stress theory (Brittle Material) Let,

Stamping force or piston force = P = 70 N

Shear stress for mild steel = 40 N/mm^2

Direct bending stress for shaft = 70 N/mm^2

Length of the crank shaft = L = 950 mm

Twisting moment of shaft (T),

Taking the ratio of length of connecting rod to the radius of crank,

$$n = \frac{l}{r}$$

l = 4.2*10 (Assume radius of crank = 10 cm)

= 42 cm = 420 mm

Twisting moment is given by,

T = F*l = 70*420 = 24900 N-mm

For the calculation of Bending Moment

i.e Maximum bending moment;

Weight of sprocket = 10 N

Weight of chain = 5 N

Weight of Flywheel = 30 N

Total wt at A = 30 N

Total wt at D = wt of sprocket + wt of chain

= 10 + 5 = 15 N

Taking moment about A,

R_c*700 = 15*850+70*350-30*100

R_c= 13.92 N

R_B +R_c =30+15 =45 N

R_B =31.08 N

Bending moment at point A,

M_A = R_B*100 = 31.08*100 =3108 N-mm

Bending moment at point D,

M_D = R_C*150 = 13.92*150 =2088 N-mm

Maximum bending moment at point A,

M = M_A = 3108 N-mm

Equivalent twisting moment,

$T_e = \sqrt{M^2 + T^2}$ =$\sqrt{3108^2 + 29400^2}$ =29474.05 N-mm

Diameter of shaft in equivalent twisting moment,

$T_e = \frac{\pi}{16} * d^3 * \tau$

$d^3 = \frac{29474.05*16}{40*\pi}$

d = 15.53 mm

Equivalent bending moment,

$M_e = \frac{1}{2}$ (M+ $\sqrt{M^2 + T^2}$)

M_e = 15781.02 N-mm Diameter of in equivalent bending moment,

$M_e = \frac{\pi}{32} * \sigma * d^3$

$d^3 = \frac{15781.02*32}{\pi*70}$

d = 13.19 mm

Manufactured Component	Spare part
1) Table/ Base 2) Shafts 3) Press plate 4) Guide bars 5) Connecting Rod 6) Supporting square hollow bars 7) Top supporting holder angles 8) Flywheel with dead weight 9) Indexing Plate with cavity 10) Geneva plates (4 slot 1 Pin) 11) Small bush 12) Cam and Follower 13) Stamp and Stamp holder	1) Bevel Gears 2) Leg lever with pedal 3) Chains 4) Nuts and Bolts with Washers 5) Plywood 6) Sprockets 7) Bearing Housing and Small bearing with cover

The largest diameter is considered for the shaft

d = 15.53 mm

But the available standard size of the shaft is 20 mm So diameter ‘d’ ~20 mm is considered.

- Design of Sprocket chain:

The chain are mostly used positive power transmitting devices to transmit the motion and power from one shaft to another shaft when the center distance between their shaft is short.

To find chain length:

For a given pair of Sprocket at a fixed distance apart, the length of chain may be calculated in the same way as for an open belt. Since the pitch line of the sprocket is a polygon, Eq. listed below will give length slightly more thanthe actual length

Let,

R = Radius of pitch circle of big Sprocket = D/2 = 91 mm

r = Radius of pitch circle of small Sprocket = d/2 = 37 mm

T = No. of teeth on big sprocket = 44

t = No. of teeth on small sprocket = 18

P = Pitch of chain = 12.7 mm = 13 mm

Length of long chain:

C = Center distance between the sprockets = 1000 mm

L = π (R+r) + $(R - r)^2$ /C +2C

L= 2405 mm.

C = Center distance between the sprockets = 340 mm

$$L = \pi (R+r) + (R-r)^2 /C + 2C$$

L= 1090 mm.

Chain drive is used because of the following reasons [2]

(i) It can be operated under adverse temperature and Atmosphere conditions

(ii) It permits high speed ratio of 8 to 10 in one step

(iii) It gives high transmission efficiency (up to 98 %)

(iv) It may be used for both long as well as short Distance

(v) Since the chain are made up of metal, therefore they can occupy less space in width than a belt or Rope Drive

(vi) As no slip take place during chain drive, Hence Perfect velocity Ratio is obtained

FABRICATION

There are different parts used in system:-

- Manufactured Components

➢ BASE or TABLE:

In the production of this machine, several mechanical parts are used and which has too kept on the base. So base or chassis has to be design in such way that base will sustain all the load of mechanical parts. Hence it is necessary to design chassis.

First of all, to fabricate base plate of L-angle of length 500cm.which cuts into 4pieces, round pipe of length 350 cm cut in 4 pieces, T-angle of length 100 cm, Square bar of length 200 cm and cross-section 2×2 cm^2 cut into 4 pieces, Flat strip of a length 150 cm cut into 2 pieces of given sizes as per the design.

Later on with the help of welding that pieces with each other form a base and at the last to weld 4 legs two base at the center. As welding is used for fabrication some burr also formed on the base, that burr is cleaned by the grinding and then finished with the sand paper.

➢ SHAFTS

To fabricate the shaft; they are machined on lathe are of length 1000 mm. According to design first two shafts of two length 100 mm from that first shaft is transmission shaft is fabricated (Shafting) directly on the lathe Machine by reducing its diameter to the required dimension and the second shaft is a crank shaft is a first cut from the center and two cranks plates of size 8 cm are welded at the inner side and then that both crank welded together by another piece of rod. And third shaft one of them cut into two pieces to made one main shaft (driving) and another Geneva shaft. In such way that we fabricated four shafts as shown below.

a) TRANSMISSION SHAFT
b) CRANK SHAFT
c) GENEVA SHAFT
d) DRIVING SHAFT

➢ PRESS PLATE

To fabricate the cylinder first we have bought a hollow rectangular bar of length 45 cm. , two hollow pipe of length 24 cm and diameter 20 mm. , two hollow square bar of length 20 cm. ,solid rod of length 11.5 cm respectively. First of all we have to weld the hollow pipe on either side of the hollow rectangular bar. Then join two hollow square bar at middle of hollow rectangular bar. After that join the solid rod in between the two hollow square bar. Then, at last whatever burr is produced on the press plate at the place of welding is cleaned with the help of Grinding & sand paper.

➢ GUIDE BARS

To manufactured the Guide bar We have bought one solid rod of length 150 cm. and then cut into two pieces of length 70 cm. And reducing its diameter as per the required dimension with the help Lathe machine by turning (Shafting)

➢ CONNECTING ROD

For producing the connecting rod we have bought two bushes of length 6 cm. and OD and ID is 25 mm. and 20 mm. respectively. And take one hollow square bar of length 30 cm. To fabricate the connecting join two bush with the help of welding. Then, at last whatever burr is produced on both the ends is then cleaned with the help of Grinding & sand paper

➢ SUPPORTING SQUARE HOLLOW BARS

To fabricate Supporting Hollow Square Bar we have to bought one hollow square bar of a length 300 cm. and cut into four pieces of a length 70 cm.

➢ TOP SUPPORTING HOLDER ANGLES:

To fabricate the Top Supporting Holders Angles we have to buy the L- shape angle of length 220 cm. After that cut the angle into 2 pieces of length 31 cm. , 2 pieces of length 34 cm and 2 pieces of length 36 cm. respectively. Three pieces of angle weld together and made the top supporting holder angle. Then, at last whatever burr is produced on the Top Supporting Holder Angles is then cleaned with the help of Grinding & Sand paper

➢ FLYWHEEL WITH DEAD WEIGHT

To fabricate the Flywheel we have to bought the solid square rod of length 160 cm. , one solid rod of length 10 cm. and its diameter 10 mm. , and one dead weight of weight approximately 1 kg. First of all cut the solid square bar into 5 pieces of length. One bar of length 95 cm. and another four of

length 16 cm. After that bend the 95 cm. bar in circular section with the help of anvil and hammer. And join four pieces of rod with the help of small bush and welding. Dead weight attach at the end of the flywheel with the help of welding. Then, at last whatever burr is produced on the flywheel is then cleaned with the help of Grinding & Sand paper.

- INDEXING PLATE WITH CAVITY

To fabricate the Indexing Plate with cavity we have bought the flat strip of length 600 cm. First of all cut the strip of length 384 cm. and to bend with the help of hammering for producing circular shape. Then cut the strip of length 16 cm. into 16 pieces and to make the cavity of soap and also cut the strip as per required dimension. Finally join cavity to the circular plate with the help bush of length 15 cm by welding..

- GENEVA PLATES (4 SLOT 1 PIN)

To fabricate the Geneva wheel we have bought two circular plate of diameter 16 cm as per required diameter of 15 cm. on lathe machine and producing four slots on the wheel use CNC-VMC.

- SMALL BUSH

To fabricate the bush we have bought the solid rod of length 60 cm. length and cut into 5 pieces of several lengths of 6 cm. 8 cm. 10 cm. as per the requirement. After turning, facing & drilling on lathe machine the bush is produce. Figure 16: Small Bush

- CAM AND FOLLOWER

To fabricate the cam we have bought the strip of 5 cm. × 5 cm. and drill the eccentric hole 1 cm. apart. Then as per the requirement grinding the strip and to make a cam. To fabricate Follower we have bought hollow pipe, metal strip and small bush are welded in such way that bush and hollow pipe welded opposite to each other and non-collinear. Then, at last whatever burr is produced on the cam & Follower is then cleaned with the help of Grinding & Sand paper.

- STAMP AND STAMP HOLDER:

To fabricate the stamp we have bought the two strip of area 6 cm. × 6 cm. And two hollow pipe of length 6 cm. And after join the pipe to the strip with the help of welding

To fabricate the stamp holder we have bought the one strip of length 10 cm. And after that 1 cm. cut the strip in middle for adjusting the stamp. Small bush is weld to the strip. Then, at last whatever the burr is produced in the stamp and stamp holder then is cleaned by grinding and sand paper.

List of Spare Parts:

- BEVEL GEAR:

Bevel gears are gear where the axes of two shafts intersect and the tooth bearing faces of the gears themselves are conically shaped. Bevel gear is most often mounted on shafts that are 90 degree apart, but can be design to work at angles as well. Figure 19: Bevel Gear

- LEG LEVER WITH PEDAL:

The leg lever with pedal is the part of bicycle that the rider pushes with their foot to propel the machine. It acts as prime mover to the stamping machine. It provides the connection between operator and transmission shaft.

- CHAINS:

A bicycle chain is a roller chain that transfer power from pedal two the transmission shaft and crank shaft if the machine.

- NUTS AND BOLTS WITH WASHERS:

The Nut and Bolts with washer is used for fitting the sub part of machine.

- PLYWOOD:

To fabricate the plywood base plate we have bought plywood of size 90 cm. × 70 cm. And cut as per the required size with the help of portable cutter. Circular cavity base plate is also cut as per the dimension of the indexing plate in C-shape.

- SPROCKETS:

To fabricate big sprocket we have bought two front chain wheel of bicycle. And then lever of the pedal which we don't want is then cut with the help of gas welding and fixed on driving shaft. And another sprocket fixed on transmission shaft and crank shaft with the help of quarter pin and bolts as per the requirement.

- BEARING HOUSING AND SMALL BEARING WITH COVER:

The bearing is a mechanical device which is used to rotate the shaft smoothly. And bearing housing is used to support the bearing.

- WORKING PRINCIPLE

When the pedal operates it transmits power to the Transmission shaft. The transmission shaft transmits to three mechanisms.

1) The gear is mounted on same shaft. This gear is engaged with another gear having same number of teeth having same number teeth. As a result the Geneva wheel moves with the same speed of transmission shaft. As the Indexing mechanism and the Geneva wheel are mounted on the same shaft, the indexing mechanism also rotates with the same speed of Geneva shaft.

2) The rear wheel sprockets mounted on the same shaft which transmits power to the crank shaft of single slider crank chain

mechanism. The single slider crank chain mechanism converts rotary motion of crank shaft into reciprocating motion. The Press plate reciprocates along the guide bars. This is also called as stamp holder plate. The stamp is attaché at the bottom of the plate which is used for embossing the logo on upper side of the soap.

3) The cam is mounted on the transmission shaft. The follower reciprocates with the help of cam which is use for embossing the logo on lower side of the soap.

The indexing mechanism (plate) mounted on the guide bar which is rotate with the help of Geneva mechanism at an angle of every 90 degree.

Each 90 degree rotation performs one operation. So there are four operation carried out in complete one rotation of indexing plate. These four operations are loading, stamping, unloading, oiling and cleaning.

- ADVANTAGES AND APPLICATION

Advantages

- This machine should be able to stamp a logo on both side of soap.
- It can give the proper shape
- Reduce lead time and Increase production rate
- Quality soap is manufactured
- Less effort required during its operation
- Unskilled worker can operate
- Working of this machine is very simple anyone can operate easily

Applications

- This machine can manufactured soap in various shapes such as square, rectangular and elliptical
- It is used in Small scale industries
- It is used in where there is no electricity
- It is used to stamp the variety of soap such as Bath soap, Detergent soap etc.

RESULTS AND DISCUSSION

As per the previously mentioned objectives of the new machine which is fulfilled after completing the project. The objectives Identified for the Production rate of the new machine is also increased as compared to previous machine and is given as below,

- Required Production Rate = 10,000 soaps/shift.
- Considering all fatigue and allowances, Production Rate of New Design of M/C = 15,000 soap / shift

CONCLUSION

Considering the problems of soap manufacturers Micro and Small scale soap manufacturers, we have tried to provide solution in the form of stamping machine. The machine for stamping of soap is successfully designed and fabricated. The model fabricated has solved several issues within industry and also fulfills the requirement of industry. The growing needs of people called for mechanization and automation, hence to fulfill those needs industries are aiming to have higher production rates. The attempts are also made to reduce the man power, machine hours, energy consumption as well as the cost associated with overall process.

The machine is able to solve the several issues discussed above are as follows

1. The machine is manually operated
2. The machine has higher efficiency than conventional machine
3. Little or no special skill required in operating machine.
4. The cavity plates (i.e. Die) of machine are interchangeable to allow various sizes of soap to be stamp.
5. The machine gives uniform and smooth surface of soap.

REFERENCES

[1] Mr. ShindeTushar B. Mr.Bhalrao Ganesh N., Ms.Anita V. Hase, “Mechanically Operated Automation System” International Journal of Science, Engineering and Technology Research (IJSETR), Volume 4, Issue 5, May 2015
[2] Engr, Issa A. K, M. H Idris, and U. J Ibrahim “Design and Construction of Manually Operated Soap Cutting and Scraping Machine for Small Scale Industries” International Journal of Engineering Research & Technology (IJERT)ISSN: 2278-0181 Vol. 4 Issue 06, June-2015
[3] Developing Cost Effective Automation In Soap Manufacturing Rajesh B. Salwe et al Int. Journal of Engineering Research and Applications www.ijera.com ISSN : 2248-9622, Vol. 4, Issue 1(Version 3), January 2014
[4] B.N. Nwankwojike “DESIGN AND DEVELOPMENT OF A SOAP STAMPING AND TABLETING MACHINE FOR SMALL SCALE SOAP MANUFACTURING” Nigerian Journal of Technology (NIJOTECH) Vol. 31, No. 2, pp. 199{205. Copyright c 2012 Faculty of Engineering, University of Nigeria. ISSN 1115-8443, July, 2012
[5] R.S Khurmi and J. K. Gupta (2005).Machine Design.3rd Edition, S. CHAND & COMPANY LTD, New Delhi