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AUTOMATIC BOTTLE CAP STAMPING MACHINE FOR SMALL SCALE BOTTLE INDUSTRIES

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ABSTRACT
Our objective is to make machinery for stamping details on water bottle cap. As company is small scale company it requires a machine with low cost, high accuracy, less floor area and less interaction of human being. We made a machine with same requirement using Geneva mechanism for indexing purpose which reduces human interaction. For stamping we use electromagnetic actuator which is actuated using ultrasonic sensors to read the location of cap under the plunger. Geneva table reduces the floor area and also makes the loading, unloading and indexing simple in one mechanism. Using sensors stamping becomes automatic and overall cost becomes very low as compared to the machineries used in industries like laser printing and all.

KEYWORDS: Geneva mechanism, electromagnetic plunger, actuator, ultrasonic sensors.

INTRODUCTION
Automation is the must required for any developing and developed industry. Many companies are now becoming very adaptive to the automation as it gives large production rates, accuracy and less requirements of workers. And there by decreasing the money required and increasing the overall profit.

Most of the times large industries uses robots and robotic arms for automation. They also uses laser machineries, sensors and other electronic components for automation. But small scale industries cannot afford this much of machineries and therefore they required machines with low cost and more effectiveness.

The company we are working with is Baily water bottle company in Kudal MIDC. They are facing the problem with stamping of details on the 5 & 20 lit. of water bottle caps like MFG Date, Batch No., Price etc. They are presently using manual stamping for this operation. In large scale industries for printing such details laser ink jet machine is used which is very costly.

We try to solve this problem. First we go through the present technology available for same operations. Then we make primary rough design and go through various mechanism for loading , indexing, stamping and unloading. By considering all the pros and cons we finalize on Geneva mechanism as it is suitable for loading, indexing and unloading at a time and very beneficial for the mass production. We use electromagnetic stamp as it lower on power consumption accurate and actuate it by using sensors and electronic components like aurdino, relays etc.

The machine cost reduces up to 1/10 th of the ink jet machine and accuracy very good as comparative to the manual stamping which is very uneven.

MATERIALS AND METHODS
Rough designing
By considering all the requirements of industries we started rough designing the machine. First we consider 4 main systems

Loading – water bottle caps on the machine for stamping
Indexing – water bottle cap perfectly under the stamping mechanism
Stamping – imparting details on water bottle caps
Unloading – unloading the printed bottle cap from machine

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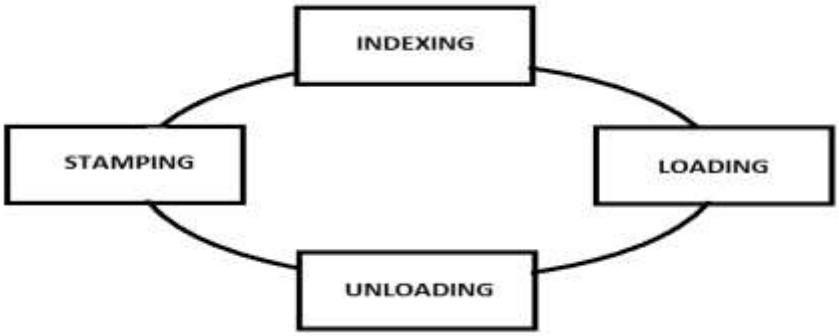
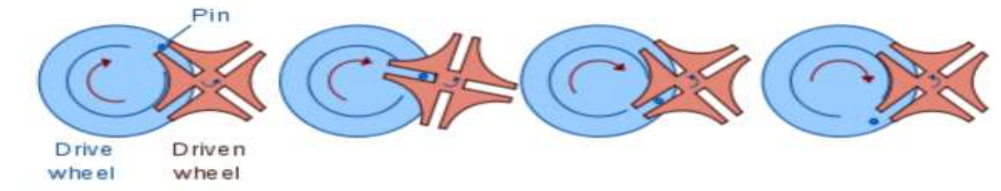


For each of this system we consider some of the mechanism that are mostly used in the industries and then select suitable mechanisms for our application. From lots of mechanism like scotch yoke, conveyor belt, cam and follower, four bar linkages and sensors like IR sensors, proximity sensors we select Geneva mechanism and ultrasonic sensor along with electromagnetic plunger for stamping.

Geneva mechanism

The most common type of indexing mechanism is a Geneva mechanism .Geneva mechanism come in many varieties, both planar and spherical. The Geneva drive or Maltese cross is a gear mechanism that translates a continuous rotation into an intermittent rotary motion. The rotating drive wheel has a pin that reaches into a slot of the driven wheel advancing it by one step. The drive wheel also has a raised circular blocking disc that locks the driven wheel in position between steps.



Geneva mechanism provides loading, indexing and unloading system in a single mechanism at a time. Intermittent motion mechanism provides enough time intervals between two stamps. Hence it is very useful in our application.

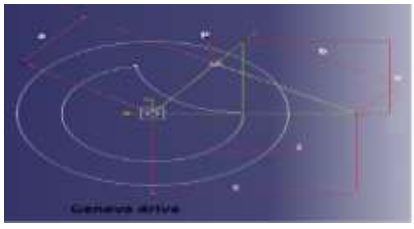
We design geneva mechanism which as follows

In our project we are using four slotted Geneva mechanism.

n = number of slot = 4
Centre distance=200mm

If the driven wheel has n slots, it advances by 360°/n per full rotation of the drive wheel .The driven wheel has four slots and thus advances by one step of 90 degrees for each rotation of the drive wheel.

Geneva drive design:



a =drive crank radius p=drive pin diameter

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b =Geneva wheel radius

t=allowed clearance

c =centre distance

y=stop arc radius

s =slot centre length

z=stop disc radius

v =clearance arc

Drive pin diameter=10mm

Allowed clearance=5mm

b = c* cos(180/n)
= 200cos(180/4)
=141.421mm

a = $(c^2-b^2)^{1/2}$
= $(200^2-141.421^2)^{1\backslash 2}$
= 141.421mm

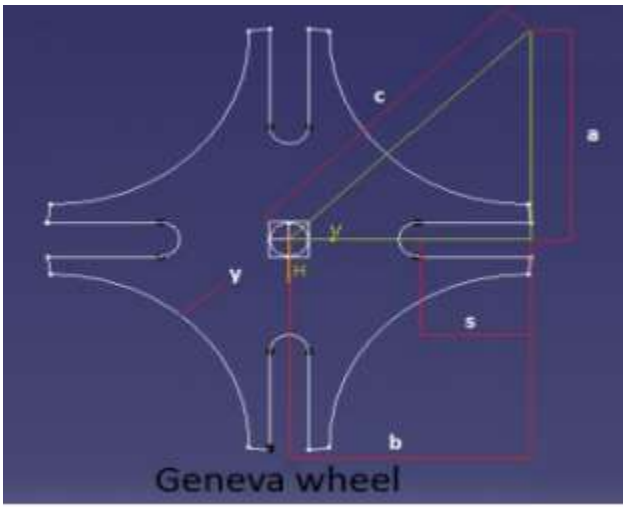
p = 10mm

y = a-(1.5p) = 141.421-(1.5*10) = 126.421mm

z = y-t = 126.421-5
= 121.421mm

v = b*z/a = 141.421*121.421/141.421
= 121.421mm

Geneva wheel design:



a = drive crank radius

p = drive pin diameter

b = Geneva wheel radius

w = slot width

c = centre distance

t = allowed clearance

s = slot centre length

Drive pin diameter = 10mm

Allowed clearance =5mm

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a = c*cos(180/n) =200cos(180/4)
=141.421mm

b =$(c^2-b^2)^{1/2}$ =$(200^2-141.421^2)^{1\backslash 2}$
= 141.421mm

s = (a+b)-c = (141.421+141.421)-200
= 82.842mm

w = p+t = 10+5 = 15mm

Electromagnetic plunger

Electromagnetic plunger is simply working on AC supply. It consist of winding around the bobbin and plunger inside the bobbin which will be actuated when electric supply is passed through the copper coils. We put spring inside the bobbin which helps the plunger to returns to its original position.

Electromagnetic plunger specifications-

- Bobbin dimensions

18mm breadth, 29 mm length and 44mm hight

- Winding specification

No. Of turns- 1950

No. Of layers - 15

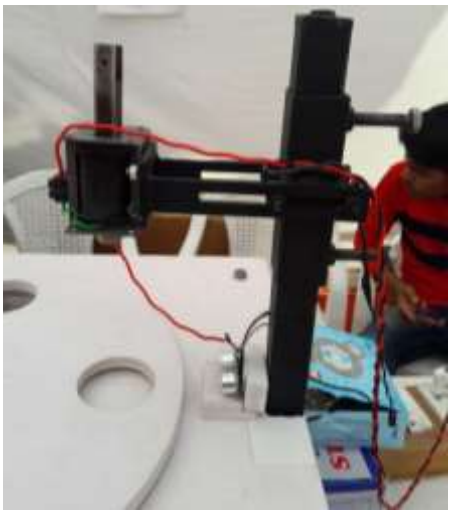
- Wire specification

Material- copperm

Gauge- 30

- Power supply required

230 v 5 amp



Ultrasonic sensors and components

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Ultrasonic transducers convert AC into ultrasound, as well as the reverse. Ultrasonics, typically refers to piezoelectric transducers or capacitive transducers. Piezoelectric crystals change size and shape when a voltage is applied; AC voltage makes them oscillate at the same frequency and produce ultrasonic sound. Capacitive transducers use electrostatic fields between a conductive diaphragm and a backing plate.

The beam pattern of a transducer can be determined by the active transducer area and shape, the ultrasound wavelength, and the sound velocity of the propagation medium. The diagrams show the sound fields of an unfocused and a focusing ultrasonic transducer in water, plainly at differing energy levels.

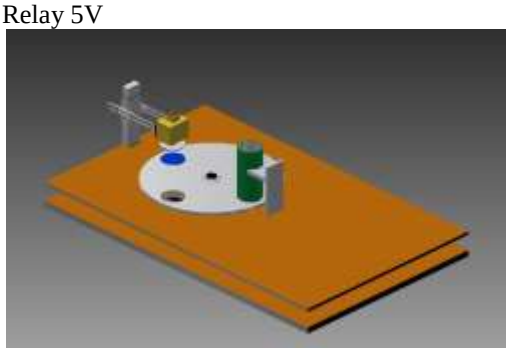
Since piezoelectric materials generate a voltage when force is applied to them, they can also work as ultrasonic detectors. Some systems use separate transmitters and receivers, while others combine both functions into a single piezoelectric transceiver.

Ultrasound transmitters can also use non-piezoelectric principles. such as magnetostriction. Materials with this property change size slightly when exposed to a magnetic field, and make practical transducers.

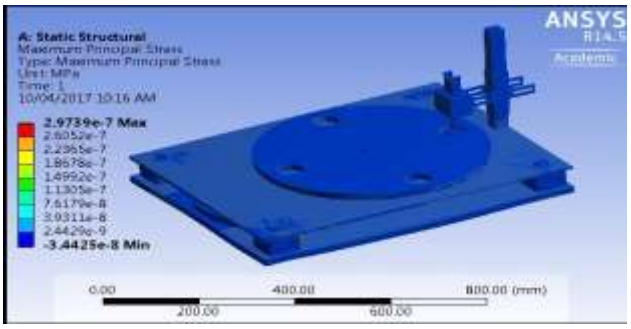
A capacitor ("condenser") microphone has a thin diaphragm that responds to ultrasound waves. Changes in the electric field between the diaphragm and a closely spaced backing plate convert sound signals to electric currents, which can be amplified.

The diaphragm (or membrane) principle is also used in the relatively new micro-machined ultrasonic transducers (MUTs). These devices are fabricated using silicon micro-machining technology (MEMS technology), which is particularly useful for the fabrication of transducer arrays. The vibration of the diaphragm may be measured or induced electronically using the capacitance between the diaphragm and a closely spaced backing plate (CMUT), or by adding a thin layer of piezo-electric material on diaphragm (PMUT). Alternatively, recent research showed that the vibration of the diaphragm may be measured by a tiny optical ring resonator integrated inside the diaphragm (OMUS).

Other electronic components
Aurdino UNO
Relay 5V



Cad model of the machine



Static analysis of the machine

Final design

Stamping mechanism

electronic circuits

In this design stamping mechanism is attached on a stand which can be movable according to the requirements of the industries. It can be moving in horizontal as well as vertical direction to move plunger. Stamping table can also be replaced according to the size of caps.

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Working

When we start the machine by starting motor under the geneva driver driver start rotating in clockwise direction and thus moving driven in anticlockwise direction with intermittent motion and 6 sec of delay. While table is moving it takes the cap one by one under the plunger for stamping. When bottle cap reaches under the plunger ultrasonic sensor senses the bottle cap and give command to the actuator through aurdino which is already programmed. Then plunger comes down to stamp and return within 0.5 sec and then never sense anything for further 4.5 seconds. For next strock of geneva bottle cap taken out of the table by throughout hole in the table to collect caps in the container. In this way bottle caps get stamped with required details on caps.

Future scope

In our machine most of the parts are detachable hence the replacement of the parts can be done easily. Also the uppermost table can be easily replaced with another different table for different application like bottle cap stamping for other caps with different sizes.

Also just by increasing one pin at proper position on geneva driving wheel we can increase the production rate by double.

Increasing no of slots on driven wheel we can increase the production proportionally.

By increasing the current or windings in electromagnetic actuator we can use the same machine for penetrating purpose.

Replacing the actuator with bottle filling mechanism we can use this machine for bottle filling or soda filling plant.

CONCLUSION

Our task is to make a machine which imparts detail on water bottle cap with efficient way and minimum funds. We try to fulfill the requirements of our company and make a machine in well budget. Our machine cost is very less than previously available machines like ink jet machine with cost of about 1.5 lakhs and pneumatic stamping machines available. It also increases production rate as it is fully automatic. Due the use of sensors it also becomes accurate to impart details. So by using simple mechanism we can produce machineries to help small scale industries to increase their profit by large margin.

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