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"AUTOMATIC INDEXING FIXTURE SYSTEM"

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Abstract - *Many industries nowadays are using automation for their production process. Automation has great advantages over manual labor but setting up an automated machine like VMC, automatic turning center, CNC lathe is very costly. A conventional machine can be made to work as a CNC machine by changing guideway or fixture.*

Jobs of conventional upright drilling machine require positioning of drill over all holes location which can be done more easily by adjusting the guideway or fixture. The spindle is fixed so only option is to move the work piece with help of fixture. It is also required to do marking on the work piece which may raise problem due to error in marking by the operator. It will require more time and reduce production rate. Also the drill is required to be set at center of the hole.

Our aim is to make an arrangement which will reduce the time consumed in marking the center of the hole on work piece and to prevent the requirement to make jigs. Instead of making the whole guideway automated we will develop a fixture which will automatically adjust the center of the hole of work piece. By using this method the production rate will be increased with minimum efforts of human.

Key Words: **FIXTURES, AUTOMATIC, INDEXING, LOW COST, PITCH CIRCLE DIAMETER, MICROCONTROLLER.**

1. INTRODUCTION

In India, one can come across factories with outdated and inefficient technology and also factories with modern and highly sophisticated technology. The main reason for the latter is the fact that the latest technological developments from the already developed countries have been transplanted is worthwhile to remember that the technological advancement that has taken place in the developed countries has been, achieved in stages, depending upon the changed conditions and requirements. For example many of the developments in industrially more advanced countries require minimum labor force because of the fact that increasing wages, shortage of skilled labor, and lower Productivity have made the older technologies inadequate to meet the demands, inefficient, and like ours where there is abundance of labor and also whose social and economic conditions uneconomical. It is not necessary to stress here as to what would be the result of such overnight transplantation of latest technologies from industrially advanced countries to a developing country are different from those of many of the developed countries.

1.1 Problems

In conventional drilling there is inaccuracy in the job due to following:

- Positioning of drill every time.
- Moving work piece.
- Not precise marking by operator.
- Setting drill at center point frequently.
- Time consuming.

1.2 Solution

VMC, automatic turning center, CNC lathe is very costly solution for medium scale industries. So an automatic indexing fixture with a provision to move the plate in linear motion on guideways and providing pitch circle diameter(pcd) to drill holes at precise and desired distance eliminating chance of minute error even without need of markings and jig placement can be a decent solution to the above mentioned problems. Hence instead of making the whole machine automatic we developed such a Mechanism which will adjust the center of the hole of work piece just by linear motion of plate without moving the workpiece with the help of stepper motor and microcontroller. Thereby using this method the production rate will be increased with minimum human efforts and at low cost.

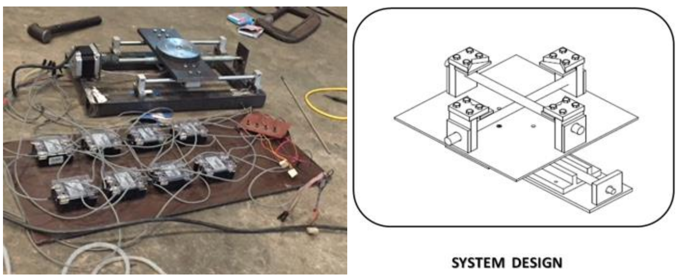
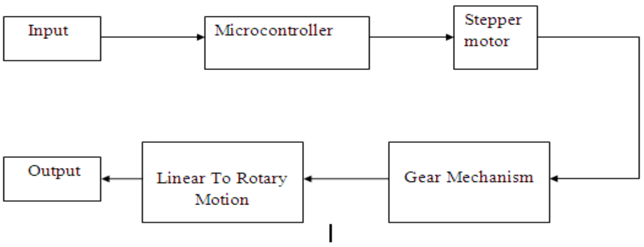


Fig 1. Complete system

Automation is useful for the following factors:

- To increase labor productivity.
- To reduced labor cost.
- To mitigate the effect of labor shortages.
- To reduced or eliminate routine manual and clerical tasks.
- To improve worker safety.
- To reduced manufacturing lead time.
- To improve product quality.
- To accomplices process that cannot be done manually.
- To avoid the high cost of not Automating.

2. Block Diagram

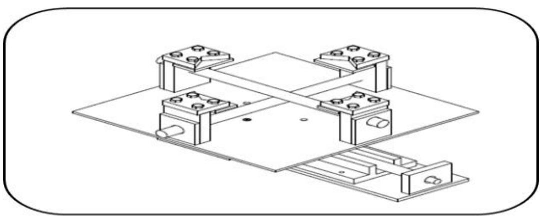


Block Diagram of project

2.2 Working Principle

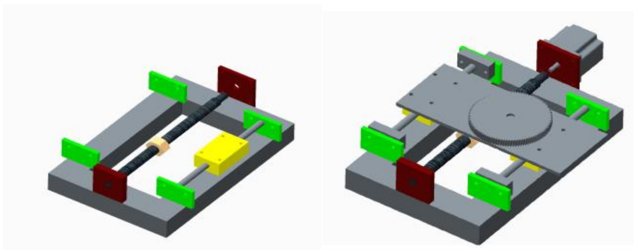
Here the manual input will pass to the microcontroller and microcontroller will calculate according to the program which will be taken from manual input. According to program stepper motor will run. Stepper motor will give rotary motion to the gear mechanism and this Rotary motion will convert into linear motion of the jaws. In this manner automatic indexing will be done with more accuracy and less errors.

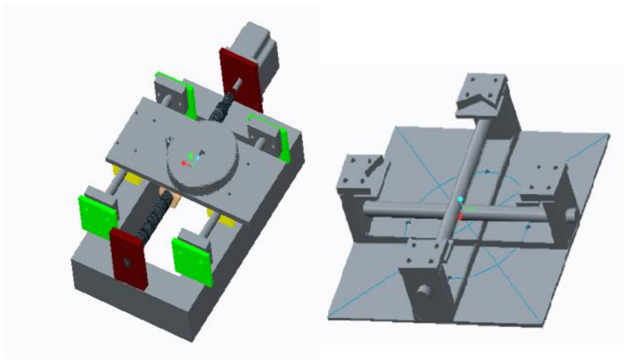
2.3 System Design



SYSTEM DESIGN

Fig 2. System Design





BASE DESIGN TOP DESIGN

Fig 3. Designing of the system

3 System Components

Mechanical components

- Base Plate
- Lead screw
- Couplings
- Bracket
- Sliding plate
- Gear.
- Circle plat
- Jaws.
- Clamp Lead screws.
- Thrust bearing.

Electrical components

- Stepper motor
- 12V DC power supply.
- Stepper motor driver circuit

Electronic components

- AT MEGA16 Microcontroller
- LCD

Softwares used

- Win AVR programmers NOTEPAD.
- Robo-kits AVR USB programmer.
- PRO-E

4 Design Calculations of Mechanical Components:

- **First calculating how much load exerting on the lead screw.**

1. Weight of Upper plate , Weight of Thrust bearing & Rotary axis (Total weight on Lead screw)
2. =$\{4x[(15x70x50)+(10x45x50)+(55x30x5)]\}+(285x285x4)+(10x60x110)+\{(100x88x30)-(45x18x100)\}+\{2x(\pi/4x(300)^2 x 4)\} + \{(\pi/4x(16)^2x310)x2\}$

=2.59+2.53+1.2+ (2.05-0.6) + 2.02+0.96= 10.75 kg

=10.75x9.81=**105 N**

Here, Assuming the Motor Weight is 10 N

- **Second thing is material of Lead Screw and its strength.**
  The material of lead screw is Mild Steel and yield strength of mild steel is 280Mpa.
  Considering Factor of Safety = 2.5
  σt = σy/f.o.s = 112 Mpa
  σc = 1.5 × σt = 168 Mpa
  τ = 0.5 × σt = 56 Mpa

In our case, a lead screw having single start 'V' Thread of 16(Dc) mm Core diameter, 2(p) mm pitch and exerting load is 105(W) N. For that we have to check that it's safe or not.

Lead screw in Direct Compressive stress

$$\sigma t = \frac{W}{\left(\frac{\Pi}{4}\right) \times (Dc)^{\wedge}2} = 0.522 \text{ Mpa}$$

Science these stresses within permissible limit, therefore **design for lead screw is safe.**

Lead screw in Torsional Shear stress

$$\tau = \frac{16 \times T}{\Pi \times (Dc)^{\wedge}3} = \frac{16 \times W \times Dc}{\Pi \times (Dc)^{\wedge}3} = 2.08 \text{ Mpa}$$

Science these stresses within permissible limit, therefore design for lead screw is safe.

So, from these calculations the lead screw with 2 mm pitch, single start, 12 mm **nominal diameter is safe.**

4.1 Coupling

In our case coupling is used to eliminate motor shaft damage when at loading condition and easy to connect or disconnect.

Specification of coupling:

Material mild steel, τ = 56 Mpa

Internal diameter, D_i = 9 mm

Outer diameter, D_o = 18 mm,

Maximum Torque = 140 kg-mm

Here, we **have to check coupling in Torsional shear stress**.

$$\tau = \frac{16 \times T \times D_o}{\pi \times [(D_o{}^{\wedge}4) - (D_i{}^{\wedge}4)]} = 0.130 \text{ Mpa}$$

Since, the induced shear stress is less than permissible value of 56 Mpa, therefore the **design of coupling is safe**.

4.2 Bracket

In our case, the function of the bracket is like as a bearing.

Design calculation for gear-pinion mechanism.

Z_p = Number of teeth on pinion = 10

Z_g = Number of teeth on gear = 100

m = Module = 1.5

p_c = Circular Pitch = Π × m = 4.7 mm

ϕ = Pressure Angle in degrees = 20°

b = Face width = 20 mm

y = Lewis from factor

K_v = Velocity factor

D_p = Pitch circle Diameter of Pinion = 18 mm

D_g = Pitch circle Diameter of gear = 164 mm

$$Q = \text{Ratio Factor} = \frac{2Z_g}{Z_p + Z_g} \text{ for external gearing} = 1.81$$

V_m = Pitch line Velocity in m/s

F_s = Static Tooth load in N

F_t = Tangential Load in N

F_w = Wear Load in N

F_d = Dynamic Tooth load in N

f_b = Design bendig stress in Mpa

f_{es} = Surface endurance stress or contact stress in Mpa

E_p = module of elasticity of pinion material in Mpa

E_g = module of elasticity of gear material in Mpa

Lewis Equation:

F_t = Tangential Load in N

$$F_t = f_b \times b \times \pi m \times Y \times \frac{K_v}{K_s} \quad (\text{Ass. } f_b = 195 \text{ Mpa})$$

Lewis tooth factor based on p_c

$$Y = 0.154 - \frac{0.912}{Z_p} = 0.0628 \quad (\text{For } 20^\circ \text{ In volute full depth})$$

$$V_m = \frac{\pi \times D_p \times N_p}{60} = 11.30 \text{ m/s}$$

$$K_v = \left(\frac{6}{6 + V_m}\right) = 0.35$$

(V_m = 5 to $\frac{20m}{s}$ for commercially cut gear)

K_s = Services Factor = 1 (For Steady Load)

Now, $F_t = 195 \times 20 \times \pi \times 1.5 \times 0.0628 \times 0.35$

$= \mathbf{403.995\ N}$

Buckingham's Dynamic tooth load:

F_d = Dynamic Tooth load in N

$$\mathbf{F_d} = F_t + \left[\frac{21V_m \times (cb + F_t)}{21V_m + \sqrt{(cb + F_t)}}\right] = 702.51\ N$$

edeformation factor(Depend on material of pinion & gear)

For, 20° Full depth involute tooth, steel material of pinion & cast iron material of gear c is 7990e. Where e is Expected errors 0.05 (for up to 4 m).

F_w = Wear Load in N

$F_w = D_p \times Q \times K \times b$

K= Material combination Factor

(for mild steel $E_p = 2.1 \times 10^5$ Mpa

Cast iron $E_g = 1.05 \times 10^5$ Mpa)

$f_{es} = (2.7459 \times BHN - 68.65)$ in Mpa for steel

$= (2.7459 \times 300 - 68.65) = 753.35$ Mpa

K= 1.98 ≅ 2

$F_w = 10 \times 1.81 \times 2 \times 20 =$ **724 N**

F_s = Static Tooth Load in N

$= f_b \times b \times Y \times \pi \times m =$ **1154.15 N**

For Satisfactory Design of gears & safety against tooth breakage following condition must be proving.

$F_s \geq 1.25\ F_d$ Steady and Midium shock condition

1154.58 N ≥ 878.13 N

$F_w \geq F_d$ for servere service

724 N ≥ 702.51 N

Hence, both **conditions are proved the design of pinion is safe.**

4.3 Motor Torque Require

The torque require to displace a load by means of V-Threaded screw may be determined by considering a screw jack. In our application, the lead screw has to displace the entire mechanical structure and the work piece which is machined with help of Dovetail guiding slide. And as per calculations carried out the dc stepper motor with motor torque 20 kg-cm for X- Axis to accomplish our required is much more.

5. INDEXING MECHANISMS

- Ratchet and pawl mechanism
- Rack and pinion mechanism
- Geneva mechanism
- Cams mechanism

6. ELECTRICAL COMPONENTS

Micro controller

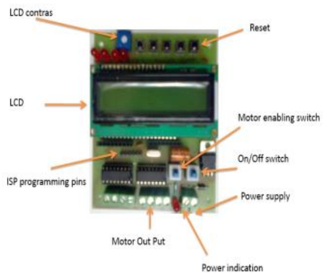


Fig 4. AT MEGA 16

Driver circuit

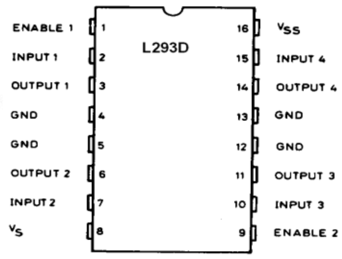


Fig 5.

- **Stepper Motor**

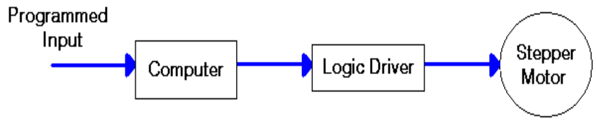


Fig 6.

H Bridge mechanism

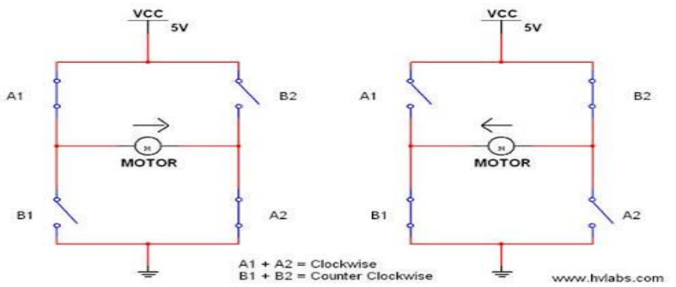
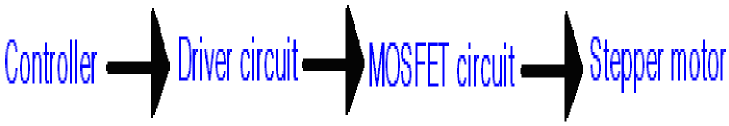


Fig 7.

H bridge mechanism is used so that the current can flow through the motor in both the directions without changing the terminals. The direction may be clockwise or counter clockwise. For clockwise switches A1 and A2 are closed. While counter clockwise switches B1 and B2 are closed.

7. Interfacing

We have programmed a stepper motor to run at 50 RPM. Motor is having step angle 1.8 degree. Therefore 200 steps are necessary for one complete revolution. Motors used are unipolar motors. Motor is having four windings & 8 wires, of which four are for power supply & four are provided to drain. We designed four steps 8 bit pattern. Delay between every pulse is 6 mS. Bit pattern for clockwise rotation is given in the appendix C. Stepper motor is interfaced as shown below.



In our stepper motor we are winding structure like shown below:

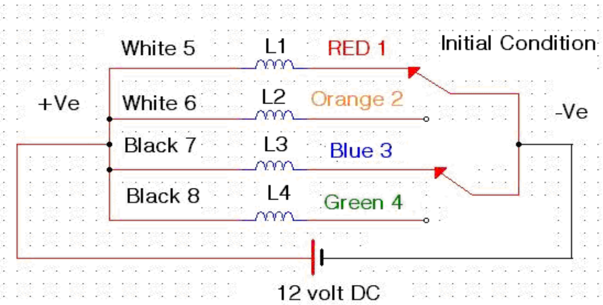
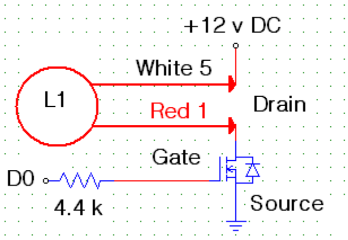


Figure: 8.1 Stepper motor winding arrangement

The connections of above wires to the MOSFET circuit are shown in figure 8.2, 8.3, 8.4 & 8.5 respectively.



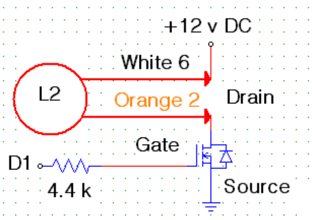
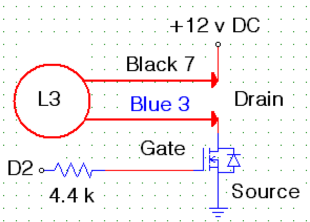


Figure: 8.2 (a) MOSFET ckt –I **Figure: 8.3 (b) MOSFET ckt - II**



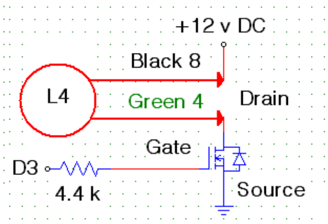


Figure: 8.4 (c) MOSFET ckt – III **Figure: 8.5 (d) MOSFET ckt – IV**

8. COMPLETE SYSTEM

Fig 9. Assembly

9. Conclusion

As explain earlier in our Abstract that our project more concern with small and medium scales Industry. So the more capital investment to build a system should not be more, however, it must improve production rate, Accuracy and reduced labor cost.

Hence the only solution is: - ***"LOW COST AUTOMATION"***

REFERENCES

[1] Rajput, R.K. (2010), "Strength of Materials" Revised Edition, S. Chand and Company Limited.

[2] Rajput, R.K, (2007), "A Textbook of Manufacturing Technology" Laxmi Publications, 1st Edition.

[3] Khurmi, R.S. and Gupta, J.K. (2005), "A Textbook of Machine Design", Eurasia Publishing House.

[4] International Conference on Emerging Trends in Technology, Science and Upcoming Research in Computer Science DAVIM, Faridabad, 25th April, 2015

[5] P H Joshi, "Jigs and fixtures" Tata McGraw-Hill Education, 2010 [2] Edward Hoffman