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Fabrication With Design of Electromagnetic Punching Machine

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ABSTRACT

Conventionally in various manufacturing industries punching operation is carried out manually or by means of a machine. These machines are mechanical, pneumatic or hydraulic. These machines are costlier for manufacturing, installation and for maintenance also. Along with the running cost of these types of machines is also high. An electromagnetic punching machine proves itself better against these machines in respect with above said points. this research is about building a working prototype of above electromagnetic punching machine. In this machine punching operation is carried out on very thin Aluminum sheet or other soft material sheets.

Keywords: Dies, Punching, Al plate, Electromagnet

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I. INTRODUCTION

The Electromagnetic system has gained a large amount of importance in last few decades. This importance is due to its accuracy and cost. this convince in operating the electromagnetic system has made us to design and fabricate this unit as our work. This unit can be operated easily with semi skilled operator. Electromagnetic punching mechanism provides us opportunity of large scale production in very less time and at very low cost. The other methods of punching mechanism are very laborious but in electromagnetic punching machine we get the required output at very lowest manpower.

II. PROBLEM DEFINITION

Punching is a metal forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. The punch often passes through the work into a die. A scrap slug from the hole is deposited into the die in the process. Depending on the material being punched this slug may be recycled and reused or discarded.

Electromagnetic Punching is aprocess of using electromagnetic forces to form metal, without a tool or punch coming into contact with the part. It is also an ideal process for mechanically joining or assembling dissimilar metal components. An appropriate electromagnetic coil driven by an electric current in the form of a sharp pulse generates the required force for metal forming. A product formed by this process is free from toll marks and heat effects as there is neither tool coming in contact with the job nor any abnormal heat being produced during the process.

III.LITERATURE REVIEW

Joseph Henry explain that he wrapped two wires around opposite sides of an iron ring or "torus" (an arrangement similar to a modern toroidal transformer). Based on his assessment of recently discovered properties of electromagnets, he expected that when current started to flow in one wire, a sort of wave would travel through the ring and cause some electrical effect on the opposite.
R.SrinivasaSugash plugged one wire into a galvanometer, and watched it as he connected the other wire to a battery. Indeed, he saw a transient current (which he called a "wave of electricity") when he connected the wire to the battery, and another when he disconnected it.
Henry Lenz gives the direction of the induced EMF and current resultingfromelectromagnetic induction. Following the understanding brought by these laws, many kinds of device employing magnetic induction have been invented, the liquid battery provides a current which flows through the

small coil, creating a magnetic field. When the coils are stationary, no current is induced. But when the small coil is moved in or out of the large coil, the magnetic flux through the large coil changes, inducing a current which is detected by the galvanometer.

IV. DESIGN METHODOLOGY

1. Die: Die is the lower part of the press tool. It is clamed on to the bolster plate of the press. It remains stationary during the operation. The die has a capacity suitable or respective profile to receive the punch. The cavity may or without a clearance. but based on the construction of die they are classified further as,

1. Simple die: Simple die can perform only one operation at each stroke of the ram. It consists of one punch and one die.
2. Compound die: A compound die can perform two or more operations in stroke of the press at a single station.

3. Combination die: These die can perform two dissimilar simulations operations at the same workstation.

4. Progressive die: Progressive dies can perform two or more press operations one after another every time the ram moves down.

2. Die Clearance- The operating of the die is slightly conical extending from the cutting edge. The metal is backed off all around the cutting edge to provide relief. The clearance is usually ¼ degree which may be more or less according to the type of material being punched. The die clearance is also serves to provide relief to punched metal to fall through without getting struck up in the die cavity. the die clearance is the space between the mating member of die set. For mild steel, a clearance of 10% is usually provided. Generally the die clearance varies from 5 to 10% of metal thickness.

3 Punching Tool:

Punch is the upper part of the press tool. It is attached to the lower end of the ram of the press. It slides with the press ram during the operation and is forced in the die cavity.

The die and punch must be in perfect alignment for proper operation. Materials used for punch and die,

1. High speed steel
2. Starlit or cemented carbide.

The punch geometry is shown in Fig. . In the present analysis the punchfillet provided adjacent to the intersection of diameters D and D2 is taken into account in order to represent the actual element geometry.The punching tool is made of High Carbon High Chromium Steel. It is used to punch the hole in the given work piece. When the work piece is kept in position, the punching toolstrikes the surface of the work piece and creates the requiredhole(Dimensions: Diameter = 10mm, Length = 61.34mm).

4 Punch Clearance-

For complete clearance of the metal is necessary that the punch should enter into the cavity of the die block. The space between each face of the die block and the corresponding face of the punch block and the corresponding face on the die is called punch clearance. The amount of clearance depends upon the type of the material and the thickness of the blank being should share. The usual value of the punch clearance is 5% to 8% of the plate thickness. If the punch clearance is less than the appropriate clearance, the fracture fails to meet at the center. If the punch clearance is too great, then the punch and die will operate like a drawing die.

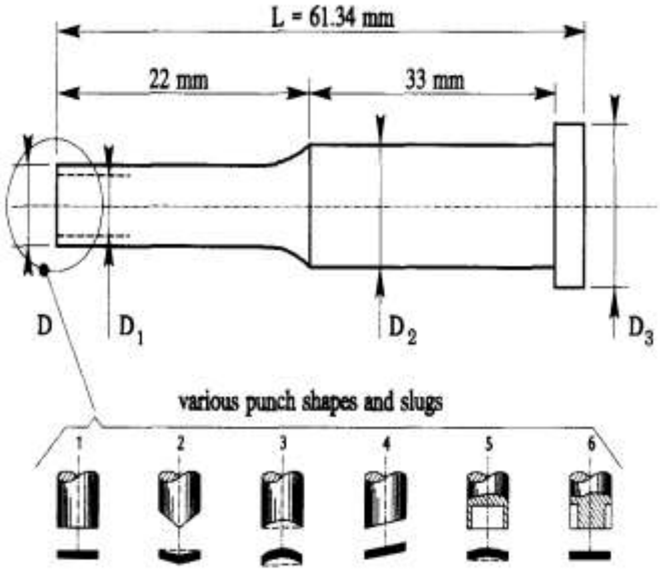

Fig 1. Punch configuration with various punch shapes and slugs.

5 Frame

The frame is either cast or fabricated. The shape of most frame used in presses resembles the letter “C”. It consist of a vertical frame, the top which overhanges towards the front. The overhanging portion works as housing for the crankshaft and ram.The cylindrical post called a horn is fitted in the front face of the frame. The top surface of the horn is made flat. The horn is use to support the die and is used for tubular work.

The solenoid frame serves several purposes. Since it is made of laminated sheets, it is magnetized when the current passes through the coil. The magnetized coil attracts the metal plunger to move. The frame has provisions for attaching the mounting. They are usually bolted or welded to the frame. The frame has provisions for receivers, the plunger. The wear strips are mounted to the solenoid frame, and are made of materials such as metal or impregnated less fiber cloth.

6 Solenoid Plunger

The Solenoid plunger is the mover mechanism of the solenoid. The plunger is made of steel laminations which are riveted together under high pressure, so that there will be no movement of the lamination with respect to one another. At the top of the plunger a pin hole is placed for making a connection to some device. The solenoid plunger is moved by a magnetic force in one direction and is usually returned by spring action.

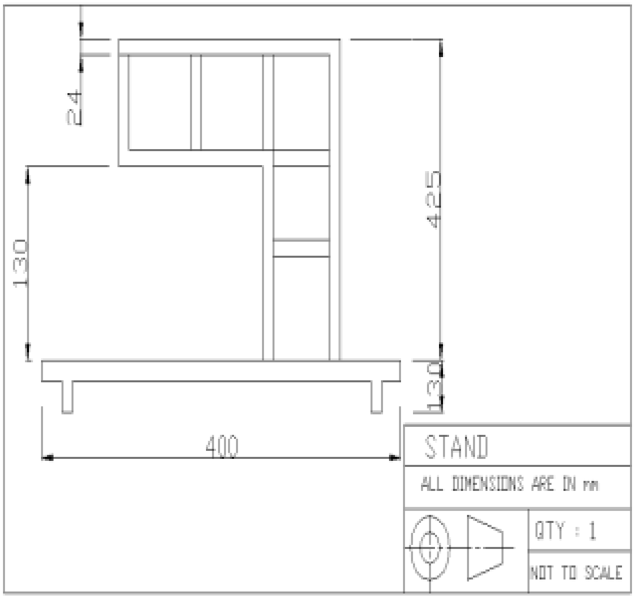

Fig 2. Base Frame

7 Electromagnet Core:

Fig 4. Electromagnetic Core

V. WORKING PRINCIPLE OF ELECTROMAGNETIC PUNCHING MACHINE

The rod is connected to the Solenoid valve with one input. The Solenoid Valve is actuated with Control Timing Unit. The Solenoid valve has one input. The power entering into the input goes out through the coil outputs when the timing control unit is actuated. Due to the high magnetism at the bottom of the piston. So these moves the piston rod upwards which move up the effort are, which is pivoted by control unit. This force acting is passed on to rivet which also moves downwards.

Every press has got certain basic units. They are bed frame, sliding ram, drive for the ram and power source. Base or bed is the lower part of the press frame. A thick plate called bolster plate is placed on the top of the bed. A die is fitted on the top of the bolster plate. The driving mechanism is mounted on the frame. The frame has got guide ways for the sliding movement of the ram. The driving mechanism is connected to the ram. The punch is fitted at the bottom of the ram. The die and punch are correctly aligned. The work piece is in the form of sheet metal. It is fed over the die. When the ram comes down, the punch presses the sheet metal. The required operation is carried out.As said earlier the force from the press is used to do a particular operation. This is done by two main parts die and punch.

VI. DESIGN

1. Design of spring

Spring is provided at the stopper end to stop the reciprocating plunger. The object of spring is to absorb the shock owing to the arrest of reciprocating plunger.

Specifications of spring
Wire Diameter(d) = 2mm
Mean coil diameter(D) = 18mm
No. of turns(n)= 10
C= D/d=18/2=9
Maximum deflection of spring:-
Deflection=δ=25mm
Where,
δ=25mm
Now,
$\delta=8WC^3n/Gd$

The weight of the empty plunger is approximately 3kg, hence the spring will easily deflect under the load weight of plunger plus weight of tool, hence the punching action is achieved.

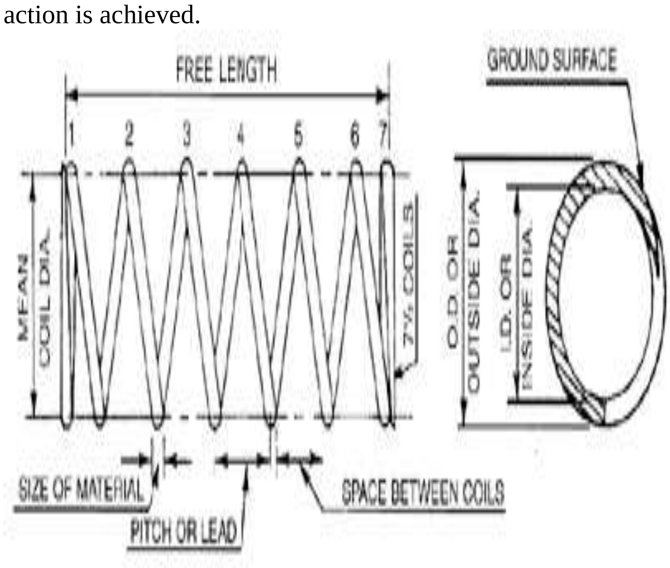

Fig 5. Helical Spring

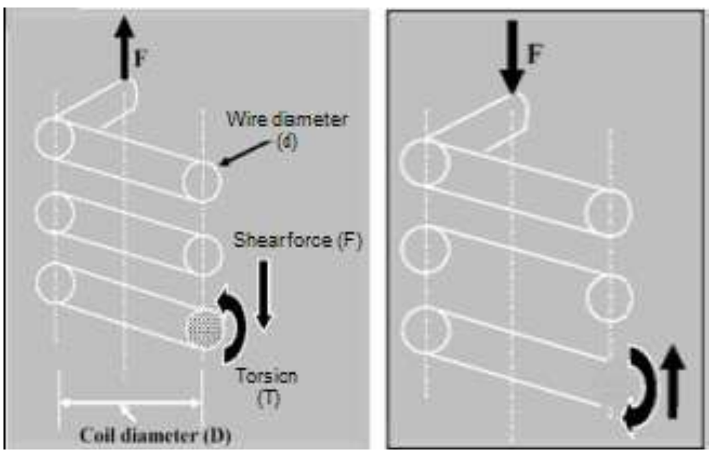

Fig 6. Axially loaded helical spring

2 Design of Electromagnetic Coil-

The key to understanding the role of magnet's punching lies in the general issue of biasing. Consider the simplest magnetic as shown in the figure, but omit the lower electromagnet. By omitting the finite permeability of the iron, the current in the coil controls the flux density.

B□(μ_0□N_1□ I_1) / 2□g_1

Where μ_0 is permeability of free space= (4 □ 3.144) □10^{-7}
N_1 is no. of turns
g_1 is air gap length (0.5mm).

The force, which was generated by this shifting the lever, is related to the square of the magnetic flux density in the gaps between the pole faces and the shaft

F = B^2 A g_1 / μ_0□N_1□ 2π□ 2□Ag_1^2

Where,

Ag_1,it is the area of each of the upper air gaps, assuming that they are equal. (Therefore, the total volume of each air gaps is g_1□ Ag_1)

The only parameter in this equation that can be controlled directly is the current It, which is squard. Consequently, it is only possible to pull the shaft toward the magnet; it is not possible to push the shaft. In some applications where there is a very large static force whose orientation is consistent and the dynamic loads are always less than the static level, it is sufficient to have a breaking which can only pull. However most applications require that the shifting the gear is able to exert a force in either direction. To accomplish this bi-directional capacity, another electromagnet is added to the bearing on the opposite side of the shaft. In this scheme, the net force generated by the two magnets is given by
F =μ_0□N_1□ 2 π□ 2 Ag_1/4□ g_1^2 - μ_0□ N_2^2□I_2^2□ Ag_2^2
Generally, the two magnets are designed to have the same pole faces area (Ag1 = Ag2 = Ag) and the same number of coil turns (N1 = N2 = N) the opposed geometry indicates that the gaps once related to a nominal gap and the shaft displacement, x, by g = g_0 – x and g^2 = g_0 + x. This reduces to,

F = μ_0 N_2 Ag / 4 { π / (g_0 – x) 2 – I2 2 / (g_0 + x) 2}

The two currents, I_1 and I_2 predominantly control the breaking force clearly, the problem of selecting these currents is under determined is that there once two variable to choose in generating a single result F. If the two currents are set equal to each other there, for the nominal centered case where x = 0, no free will be produced. The same condition holds if 1 1 = -1 2 because the two currents are squared by the force law.

Coil Resistance = Voltage * Current / 2
Wire diameter = Area of cross section * 1.273
Wire selection: 26 SWG diameter = 0.457mm
Resistance of the wire = Resistance per meter * total length of wire.

Resistance per meter at 20deg	0.1043
Required Turns per coil	3000
Mean turn length… m	2.5000
Total wire length… m	7500
Resistance of wire	781.88

3. Push rod design-

1) Material: Mild steel/Carbon steel
2) Properties: Young' s modulus E = 200 GPa Yield stress σ_y = 400 MPa
3) Safe Stress/Proportional Stress σ_{pl} = (0.5 ~ 1)□$_y$, □$_{pl}$= 200 MPa
4) Calculations: Direct Stress on column assuming a force of 400 N ,
σ=P/A

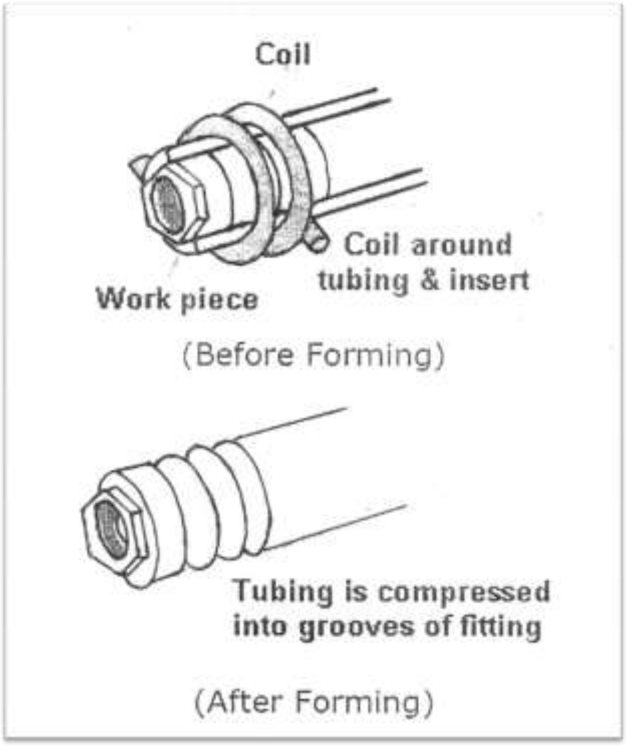

Fig 7. Electromagnetic coil

= 400/3.14 x0.0092
= 1572697.96 Pa
= 1.57 MPa
This is within the allowable stress of 200 MPa
Height of pushrod L= 100 mm
Radius of pushrod r= 10 mm
5) Critical slenderness ratio:
Slenderness Ratio = L/r = 100/10 = 10
SR_C = $[L_{eff}/r]_c$
= $\sqrt{E\pi^2/\sigma_{pl}}$

4. Design of Electromagnetic Core

Selection of core material:-

The cost of an electric machine depends upon its size and weight and primarily on the weight of magnetic and conducting materials as these being most costly ones. The weight of the magnetic materials is influenced by the size of the magnetic circuit of the machine. To a great extent, the size and the weighty of the machine depends upon the assigned values of specific magnetic loading, which is limited by the saturation and core losses of the magnetic materials used in the machine. However an increased value of specific magnetic loading could be assigned for designing an electrical machine, provided the magnetic materials has a comparatively higher saturation limit and lower core losses per kg of the material.

To indicate clearly the effects of magnetic material on the design of electrical machines, salient features of two similar transformers one designed with hot rolled steel and another with cold rolled grain oriented steel have been given. The hot rolled steel sheets 0.5 mm thick permit the flux density in the core varying from 1.4 to 1.45 tesla (wb/m²). These were used for a considerable undertaken. The windings are placed in each pole of the magnetic bearing. The numbers of turns in each pole are approximately 900 turns and the windings are provided for the same number for turns in all the four poles of the magnetic breaking. After the completing the winding works, insulation is provided over the wounded coils. Usually varnish was selected as an good insulating material for the coil insulation. Thus a radial type electromagnetic bearing was designed and fabricated.

5. Punch Design

The maximum allowable length of the punch, L, is given by

$$L=\frac{\pi d}{8}\left[\frac{E}{f}\,\square\,\frac{d}{t}\right]^{1/2}$$

where, d= diameter of the punched hole.
E= young's modulus of elasticity
f = unit compression stress on punch
t= thickness of sheet

6. Die Block Design

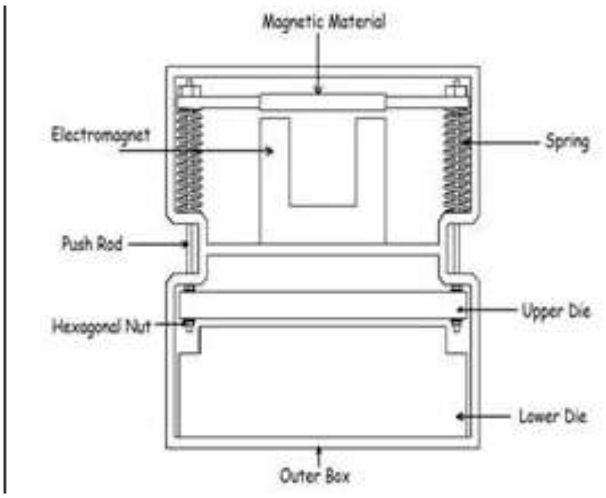

Fig 8. Dig block design

The die block constitute the female half of the two mated tools which carry the cutting edges. A vertical opening extending through the block determines the size and outline of the blank. The overall dimension of the die Block should be determined by having minimum wall thickness required for strength and by the space needed for mounting screw and dowels and for mounting the stripper plate.

For accurate and permanent positioning two and only two dowels should be provided on to each block. They should be located as far a part as possible for maximum locating effects, usually near diagonally opposite corner.

No. of screw used will depend upon the size of the Die block. The minimum distance of screw should be about 1.5 times their diameter from the outer or inner edges. Die block thickness is also governed by strength requirement of the material is to be worked.

For a die block made of tool steel the thickness should be 20mm minimum for a blanking perimeter are 75mm or less. For a blanking perimeter of between 75 to 250mm, 25mm and for large perimeter 30mm thickness should be used.

There should be minimum a 32mm margin around the opening in the die block.

In order to secure die block to the die holder or shoe use the following rule.

1. On die block up to 150mm square use two 10mm allen screws and two 10mm dowel pins.
2. On section up to 250mm square use thee allen screws and two dowel pins.
3. For heavier stock and steels bigger blocks, use screws and pins of 12mm diameter. Counter bore the die block to accommodate allen heads at least 3mm dipper than length of heads to compensate for a die sharpening.

The die opening should be straight for a maximum of 12.5 and then it should angle out at 0.25^0 to 1.5^0.

Die blocks for small work pieces are usually constructed from a solid block of tool steel. Die blocks made in two or more section, known as sectional die block are used in the construction of large dies or when the complexity of the die counter is such that it is easier to make it in sections. The sectional components may be screwed and doweled to a die holder or a die shoe with the sections butting against each other.

VII. APPLICATIONS

1. It is used in sheet metal operations.
2. It is used for creating small holes in heavy work.
3. It is used in printing press.
4. It is used for spiral binding.
5. It is used in industrial laboratory.
6. It is used in stamping.
7. It is used for punching aluminum and iron sheets.
8. It is used in robotics.
9. It is used in automation industry.
10. It is used for punching a plastic sheets.
11. It is used in electrical field for various purposes.

VIII. ADVANTAGES

1. Friction loss is very minimal due to very little metal-metal contact in the drive system.
2. The force created per punch can be controlled precisely as it is an electrical process.

3. It is a compact device.
4. It is portable.
5. Variety of operations can be performed by just using different dies i.e. it is a flexible setup.
6. It can punched the sheets of more thickness than the others machines.
7. It reduce frictional losses.
8. Maintenance cost is low.
9. Time saving machine.
10. It is not labourous.
11. It does not produce the noise, vibrations etc.
12. Simple in operation.
13. The outstanding advantage of electromagnetic system is the control unit which consistently applies a specified load with minimum effort.
14. It can be modified to any extend to bring out the required effort.
15. Its outcome can be utilized properly in the extensive mechanical field.
16. Multiple coil systems can be put into action according to the need of pressing effort.
17. In modern payer plants this electromagnetic system can be used for loading press roll

Disadvantages

1. Hard and thick materials can not be riveted.
2. Even a bit of leakage may result in power loss.
3. Due to the linkages there will be frictional losses.
4. Maintenance will be more due to the number of moving parts.
5. Stroke length is fixed.
6. Hole should be done in job before riveting

IX. CONCLUSION

The electromagnet-assisted punching setup is a device which uses the principles of electromagnetic attractions combined with a mechanical, few mechanical elements to punch a hole on the surface of a given sheet of material form or shape a given material to desired shape. It is a very flexible process with the frictional effects reduced to the maximum possible extent. This is a significant improvement from the
currently existing mechanism for punching. As well as being a portable and a compact device, the power consumption of the setup is also controlled accurately as electrical energy is used. This enables the punching machine to develop the required force to punch a hole of the surface of the work piece.

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