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Electromagnetic Punching Machine

Deshmukh S. R.[1], Gharate H. B.[2], Rane A. S.[3], Yeshi A. W.[4] Prof. Sonar R. M.[5]

[1]*Department of Mechanical Engineering, S.N.J.B's KBJ COE, Chandwad, deshmukhsonu5@gmail.com*
[2]*Department of Mechanical Engineering, S.N.J.B's KBJ COE, Chandwad, harshalgharate90@gmail.com*
[3]*Department of Mechanical Engineering, S.N.J.B's KBJ COE, Chandwad, adirane412@gmail.com*
[4]*Department of Mechanical Engineering, S.N.J.B's KBJ COE, Chandwad, amolyeshi@gmail.com*
[5]*Department of Mechanical Engineering, S.N.J.B's KBJ COE, Chandwad, rahulkumarsonar@rediffmail.com*

Abstract- Punching Machine is one of the principal machines in paper cutting industry & sheet metal industry. It is mainly used as the name indicates to cut strips.
So we are going to make a machine for '' PUNCHING INDUSTRIES " and make it multipurpose & should be used to cut the card board , asbestos sheets, papers, foam, thin plastic sheets. The machine is simple to maintain, easy to operate. Hence we tried our hands on "automatic punching machine."
Automatic punching machine is working on the principle of electromagnetic. This type of punching machine is used to punch basically card board, asbestos, sheets, papers, foam, and thin plastic sheets. Punching is depend on feed rate which done manually.
The Greatest challenge faced by an engineer is to overcome the energy wasted due to friction in any mechanical process. In a conventional punching process, mechanical or hydraulic force is used to operate the punch which involves large amount of metal to metal contact in the drive system components, as well as inaccuracy in the control of the punching forces at the micro level. This paper introduces the basic construction of an electromagnetic assisted punching machine to carry out the punching operation. After successful fabrication, the set up was tested and the punching force produced was validated.
Keywords- Electromagnet, Friction, Punching, Automation

I. INTRODUCTION

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 recycle and reused or discarded. Punching is the cheapest method for creating holes in a sheet metal for medium to high production rates.

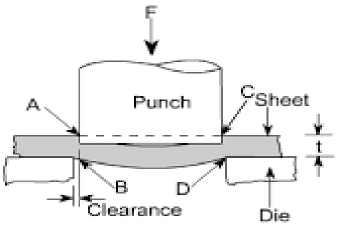

Fig. 1 Punching Process

In forging applications the work is often punched while hot, and this is called hot punching. A punch is often made of hardened steel or carbides. A die is located on opposite side of the work piece and helps to localize the shearing force for a cleaner edge. There is a small amount of clearance between the punch and the die to prevent the punch from sticking on to the die.

II. DESIGN METHODOLOGY

The Electromagnetic punching machine consists of a punching tool, die, push rods, transverse beam, return springs and an external support structure. A switch is connected between AC power supply and the windings of an electromagnet. When the set up is connected to a 12 volts, 7Amps AC supply. The coils are supplied with electricity and the magnetic field is developed around the coil. The electromagnetic core which is within the magnetic field gets magnetized and in turn it exerts a force proportional to the electricity and attracts the transverse beam. The mild steel plate is connected to the ends of a punching tool through two push rods. Thus when the plate move towards the core, the push rods transmits the motion on to the punching tool with the same force developed by the electromagnet. The punching tool moves towards the die block and punches the surface of the work piece. The tool and work piece then separated by means of two returns springs. The springs are initially compressed during the forward stroke. When the electric supply is cut off, the magnetic field ceases to exist and after the electromagnet loses its magnetization, the spring retracts, moving the punching tool away from the work piece and the cycle is completed.

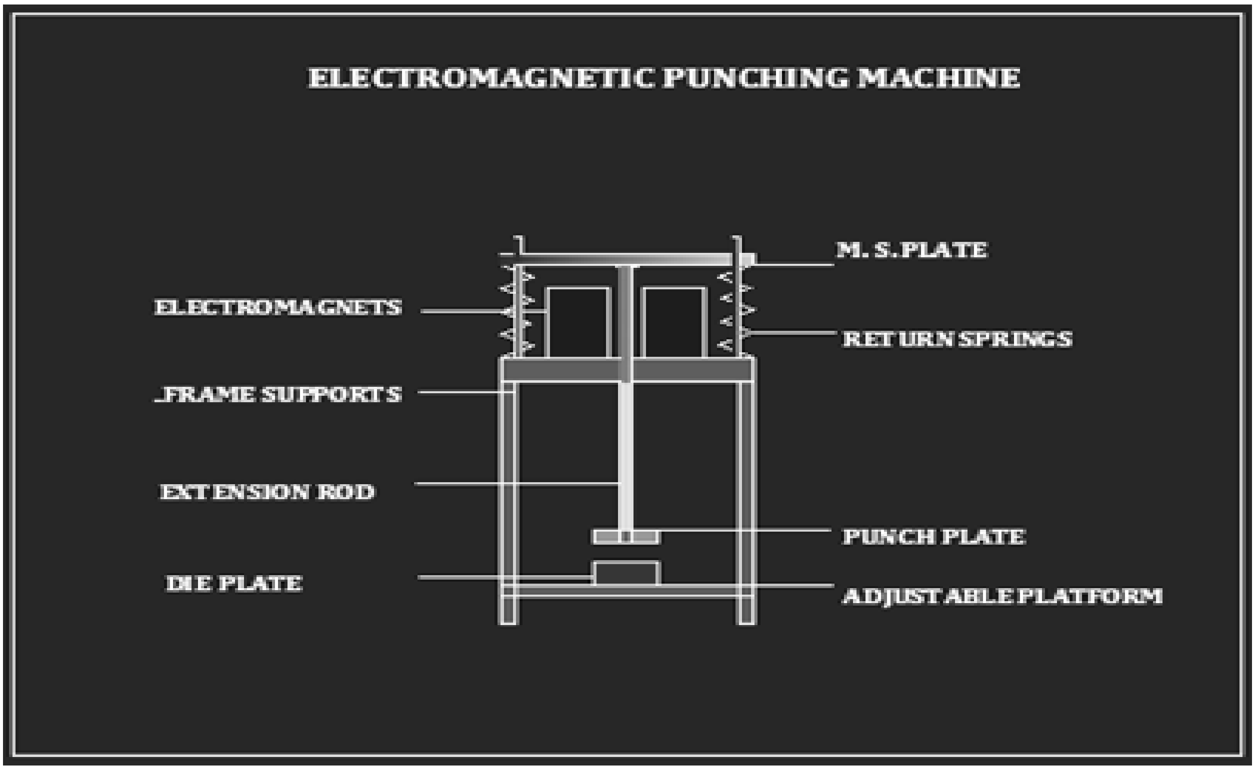

Fig. 2 Electromagnetic Punching Machine

III. DESIGN AND CALCULATION OF ELECTROMAGNET FORCE

Computing the force on ferromagnetic materials is, in general, quite complex. This is due to fringing field lines and complex geometries. It can be simulated using finite element analysis. However, it is possible to estimate the maximum force under specific conditions. If the magnetic field is confined within a high permeability material, such as certain steel alloys, the maximum force is given by:

$$F = \frac{B^2 A}{2\mu_o}$$

Where:

F is the force in Newton.
B is the magnetic field in teslas.
A is the area of the pole faces in square meters.
μ_o is the permeability of free space.

In the case of free space (air),

$$\mu_o = 4\pi \cdot 10^{-7}\,\mathrm{H \cdot m^{-1}},$$

In a closed magnetic circuit:

$$B = \frac{\mu N I}{L}$$

Where:

N is the number of turns of wire around the electromagnet.
*I*is the current in amperes.
L is the length of the magnetic circuit.
Based on the above formulas we design electromagnet for our prototype model considering:
No. of turns on electromagnet (N) =1000, (20 gauge wire)
Current supplied (I) = 20amp
Length of electromagnet (L) =70 mm.

So, using

$$B = \frac{\mu N I}{L}$$ (l is in meters)

B= 0.359wb/m^2

Also force on the piston is given by

$$F = \frac{B^2 A}{2\mu_o}$$

A is the area of electro magnet having diameters,
External diameter d_1=70 mm,
Internal diameter d_2=40 mm.

Hence area, A=3.14/4(d_1^2-d_2^2) 10^{-3}=2.591*10^{-3} m^2
Putting the values in above equation we get,
Force (F)=132.86Newton.(For each Electromagnet)
Total braking Force (F)=2 X 132.86
= 265.73 Newton.

Hence we test the performance_of_Punching _system for,

1)	No. Turns of coil of electromagnets (n)	
2)	Current variation.(I)	
3)	Magnetic flux density (B)	
4)	Speed variation (N)	
5)	Braking time (t)	
6)	Electromagnetic Force (F1)	265.73 N
7)	Spring Stiffness (K)	3.52 N/mm
8)	Mean Coil Diameter of Spring (D)	30 mm
9)	Diameter of Wire (d)	3 mm
10)	No. of Turns of coil (n)	8 Turns
11)	Free Length of Spring (Lf)	108 mm
12)	Solid Length of coil (Ls)	20 mm

IV. FABRICATION PROCESS

4.1. Raw Material Purchase

The first step involved in the fabrication process is the acquirement of all the required raw materials. Mild Steel is the material used for most of the components. High Carbon High Chromium Steel and EN 24 Steel are also obtained. After obtaining all the required raw materials, the various parts are machined.

4.2 Fabrication of Rectangular Components

The various rectangular components like transverse beam, top cover plate, bottom cover plate and side plates are machined to the required dimensions using a shaper. Then surface grinding is done to enhance the finishing of the components. Holes are drilled into the surface by the process of jig boring. Internal threads are cut onto the plates by tapping operation. Finally, blackening is done on the components. Blackening is a heat treatment process which improves the surface hardness of the components.

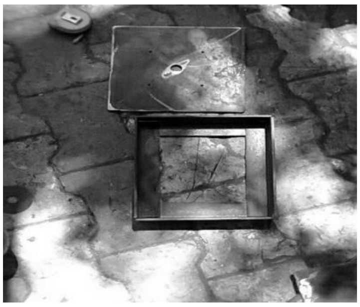

Fig. 3 Rectangular parts

4.3 Fabrication of Cylindrical Components

The various cylindrical components such as spring bush, push rods and core pins are machined to the required dimensions on a centre lathe using turning and facing operations. Drilling operation is done on the spring bushes. Cylindrical grinding is done on the components to improve surface finish. A heat treatment process called blackening is

Fig. 4 Cylindrical part

V. CONCLUSION

While concluding this report, we feel quite fulfill in having completed the project assignment well on time, we had enormous practical experience on fulfillment of the manufacturing schedules of the working project model. We are therefore, happy to state that the in calculation of mechanical aptitude proved to be a very useful purpose.

Although the design criterions imposed challenging problems which, however were overcome by us due to availability of good reference books. The selection of choice raw materials helped us in machining of the various components to very close tolerance and thereby minimizing the level of wear and tear. Needless to emphasis here that we had lift no stone unturned in our potential efforts during machining, fabrication and assembly work of the project model to our entire satisfaction.

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