IJSRD - International Journal for Scientific Research & Development| Vol. 6, Issue 03, 2018 | ISSN (online): 2321-0613

Design & Fabrication of Electromagnetic Multipurpose Sheet Working Machine

Dhaval Patel[1] Harshil Patel[2] Nilesh Patel[3] Poojan Kaswekar[4] Jigar Pathak[5]
[1,2,3,4]UG Student [5]Assistant Professor
[1,2,3,4,5]Department of Mechanical Engineering
[1,2,3,4,5]Indus Institute of Technology and Engineering, Indus University, Ahmedabad, Gujarat, India

Abstract— Everyone who works in industrial sector knows the importance of sheet metals, almost all major and minor industries use sheet metals in one form or another, it could be an integral part of their product or it could be part of the machines that they are using to manufacture products. There are lots of reasons why sheet metals are popular; they are easy to handle, light weight, less expensive, easy to work with, etc. After analysing that sheet working operations are popular, one must wonder what are the machines that are required to work with sheet metals, the answer in most cases is age old conventional means such as hydraulics and pneumatics, but these machines have inherit drawbacks. To address this problem, we thought of using a new principle and that principle is electromagnetism. Basically we used electromagnetic force by storing it in the form of potential energy in a spring and then using it in the form of kinetic energy to do the desired work. Numerous operations such as coining, blanking, perforating, notching, etc. can be performed. With this concept we want to reduce the cost for performing various forming operations on sheet material by using a new principle and application method.

Key words: Electromagnet, Electromagnetism

I. Introduction

An Electromagnet is a type of magnet in which the magnetic field is produced by an electric current. The magnetic field disappears when the current is turned off. A spring is an elastic object that stores mechanical energy. These two components provide the basis of our product, manipulating the medium of energy can help us achieve the necessary requirement of any operation.

A. Advantages

- Simpler mechanism compared to hydraulic or pneumatic system.
- More economical than the other two systems.
- Requires less maintenance.
- Portable and requires less space.
- Gives better edge quality.
- More customizable for flexible working.
- Less power requirement than the other two systems.
- Parts are simple and easy to replace
- Easy to understand and comprehend
- Has superior tool life

II. Design

The design of the prototype that we made is simple to understand and uses commonly available materials for further simplicity. The frame is made up of two sheets and a column, the structural integrity is checked by our analysis on the frame, all the parts are joined together by fillet welds using arc welding and consumable flux coated electrode (E6013). The electromagnet is mounted on the top plate. Plunger, spring and chuck are suspended in one line from the electromagnet. Punch tool is mounted on the chuck which is in line with die; the die is mounted on a stand which is variable in height.

Fig. 1: Designed Model of Electromagnetic Machine

A. Working & Construction

The Electromagnet works on DC power, when the switch is turned ON the electromagnet attracts the plunger inside it, this results in the spring being compressed. This compressed spring holds the power and stays compressed till the switch is ON, once the switch is turned OFF the plunger retracts back to its original position and the spring retracts back to its original length too and releases all the stored energy, this energy is utilized to do all our operations on sheet material.

Fig. 2: Fabricated Model of Electrimagnetic Machine

B. Calculations

Calculating force on ferromagnetic materials is quite difficult because of fringing effect and complex shape. Although, we can calculate it by finite element analysis. It is possible to calculate under certain circumstances. If high permeable material, such as steel alloys, is placed inside space, Maximum force is given by following equation.

$$F = \frac{B^2 A}{2\mu_0}$$

Where, F = Force on plunger, N
B = magnetic field, T (web/m^2)
A = Cross section area of Electromagnet, m^2
= $\pi(D^2 - d^2)$
Where, D = outer diameter of Electromagnet
d = inner diameter of Electromagnet
μ_o= permeability of free space, N/A^2
In a closed magnetic circuit:

$$B = \frac{\mu NI}{L}$$

Where, μ = permeability of material of plunger
N = number of turns of coil
I = current, A
L = length of electromagnet, m
Based on the above formulas we designed electromagnet for our prototype model considering:
Number of turns of electromagnet = 1000
Supplied current = 4 A
Voltage = 24 VDC
Length of electromagnet = 80 mm
By using this magnetic field equation,

$$B = \frac{\mu NI}{L}$$

B = 0.504 web/m^2
Force on plunger is obtained by,

$$F = \frac{B^2 A}{2\mu_0}$$

Where, A = Cross section area of Electromagnet, m^2
= $\pi(D^2 - d^2)$
Where, D = outer diameter of Electromagnet
= 0.070 m
d = inner diameter of Electromagnet
= 0.035 m
by calculating force by putting above values in equation,
F= 292 N

III. CONCLUSIONS

The current yearly production of just iron ore throughout the world is 4000 million metric tons, out of which a significant proportion is used to make sheet metal, and this is just iron. The overall combined use of sheet metal using different materials would be estimated in hundreds of millions of metric tons. Thus it is clear that there is enormous scope for utilization of sheet working machines. Energy and money are a finite source and civilization needs to protect these resources and use them is most effective manner, this is the main goal of the project and the results obtained are satisfactory. The most satisfactory observation in the project was its flexibility, that too in many ways such as accommodation of different materials, portability of the machine, power adaptability and adjustment according to the budget. The force obtained is sufficient to operate on sheet metals up to 0.5 mm, which can be increased if wanted by increasing the size of magnet. The future for sheet working is bright and it gives immense pride to provide dome contribution to the growth.

A. Future Scope

The utilization of the electromagnetic punching machine can be done in various areas of fabrication, this is one of the major strengths of the project. The prototype that is presented validates the proper function of the principle as shown in the theory and design. The potential use case can vary according to different situations of application, for example if more thick materials are to be operated on then power can be increased by using a stronger magnet. As stated before, use cases may vary but here we have designed a potential modification that can accommodate lots of applications. In this design the punch and die sets can be moved more freely because there position is not fixed but rather they can move in both X and Y directions. This is possible due to use of C channels and rollers. The die plate and punch plate have cylindrical rods comings out from the bottom due to which they sit on their respective X and Y direction channels. The channels are connected to the frame with the help of rollers, these rollers can be operated manually or can be controlled by using motors or other actuators. The sheet clamping mechanism can also be variable so different thickness materials can be accommodated, the sheet can also be automated along with operation of the magnet itself and thus the whole process can be automated according to application.

A specific example can be the front cover plates of electronic devices in labs. They are custom made by industries and have lots of operations to be performed on them such as holes for lights, switches, meters, etc, and also embossing of names and symbols, etc, the electromagnetic machine can do all such operations by using punch and die according to the design needed. One such example is shown here.

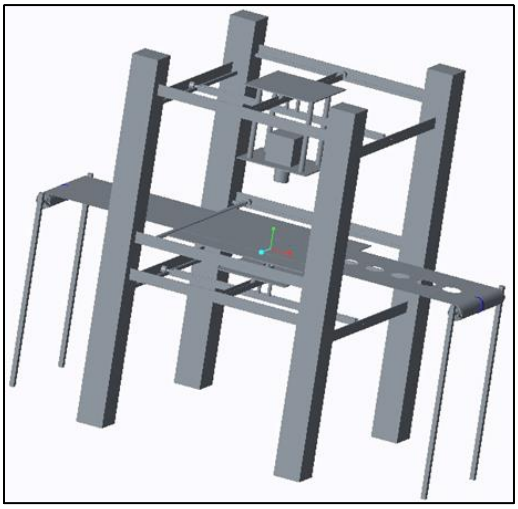

Fig. 3: Design of Future Scope

ACKNOWLEDGEMENT

We would like to thank all the people who have helped us reach till this movement, not just particularly for the project purposes but for all the help that precedes it. We want to thank all the faculty members as well as internal review panel that helped us in understanding the fundamental principles of engineering throughout our years in the University. We also want to thank our internal guide, Head of department, external reviewer's and other fellow students who helped us when we got stuck in some way or another.

REFERENCES

[1] Nave, Carl R. (2012). "Electromagnet". Hyperphysics. Dept. of Physics and Astronomy, Georgia State Univ. Archived from the original on September 22, 2014. Retrieved September 17, 2014.
[2] Khurmi and Gupta "Machine Design" Edition 2005.
[3] Khurmi and Gupta "Theory of Machine" Edition Reprint 2007.
[4] Design of machine Elements: - Prof. V. B. Bhandari, Tata Mc .Grew Hill Publishing Co. New Delhi.
[5] PSG Design Data Book, PSG College of Technology Coimbatore 641004.
[6] "Design & Fabrication of Electromagnetic Punching Machine for Industrial Application" International Journal of Emerging Technology and Advanced Engineering, Volume 5, Issue 4, April 2015
[7] Workshop Technology, Hajara Chaudhari.
[8] M. Mahajan, "Manufacturing Engineering-II", Punch Tools and Die block Design Page No. 73, 83, 91, 92.
[9] "Electromagnetic Punching Machine", International Journal of Modern Trends in Engineering and Research, e-ISSN No.:2349-9745, Date: 2-4 July, 2015