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# Pneumatic Toggle Press

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**Abstract** — *The pneumatic system has gained a large amount of importance in last few decades. Pneumatic is vastly used in transmission of energy. It is basically a science of compressed air. However, till now it has developed its scope in a wider area & succeeded over conventional power transmission method. This importance is due to its accuracy and cost. This convenience in operating the pneumatic system has made us to design and fabricate this unit as our project. This project will focus on build of low force punching tool with using a pneumatic System. It is because, in the real industry, most company needs to buy a hydraulic machine whether they only need a small force to punch. Whether hydraulic machine can used for low or high force, high cost of machine and maintenance are needed. Therefore, this pneumatic punch also can help small company to use semi auto puncher than using manual puncher. The paper implies principle of converting pendulum movement of toggle by applying air pressure into linear motion of ram with suitable linkage for the operation. It works on the principle of compressed air. The compressed air with a pressure of 4-6 bar passing through the punching machine and the punch will be done. The material is sheared to the required profile of the punch and blank is moved downwards through the die clearance. For alternate operation of air in the ports we are using the 5/3 direction control valve. Pneumatic toggle press is mainly use for operations on sheet metal such as piercing, riveting, stamping, clinching, etc. This machine is used in mass production and more efficient way to form metal into finish product.*

***Keywords***- *Pneumatic system, compressor, Pneumatic Toggle Press, pneumatic punching tool*

## I. INTRODUCTION

Manufacturing companies face a daunting engineering issue that accompanies the decision to erect a machine for their plant. Most people are unaware of the methods and machinery that are responsible for creating a large variety of consumer goods for purchase. The integration of machinery to mold and construct products that are highly detailed has been apparent over the last 25 years. Molding machinery comes in many different styles depending upon the process and the applications that are required. Some of the types of press machines are a forging press, rolling press, screw press, stamping press, and a molding press. These machines are capable of apply pressure to materials which allows the material to undergo a significant change as it proceeds through a process to facilitate a desired end product. In most of the operations of press machinery a large amount of force and torque are created. This energy can be generated by steam, electricity, and hydraulics or pneumatic. It is possible to press-mold work pieces into a plurality of shapes with a single mold assembly, thereby reducing the cost for manufacturing the mold assembly, omitting an operation of exchanging the mold assembly, and reducing the manufacturing cost.

In this machine use toggle mechanism, combination of solid, usually metallic links, connected by pin joints that are so arranged that a small force applied at one point can create much larger force at another point. The press is the punching and bending machine tool designed to punch metal plate by applying mechanical force or pressure. The metal is punched or bends to the desired requirement. The presses are exclusively intended for mass production and they represent the fastest and more efficient way to form a metal into a finished punched or bend product. Press tools are used to punch and bend thin metals. Press tools operation can be simplified to a few simple operations involving a punch and die. There are Nemours types of presses in Engineering field, which are used to full fill the requirements. We are interested to introduce pneumatic system in presses. The main function of pneumatic press is to punch or bend thin sheet metals or non-metals using pneumatic power. In this project we have used to punching process and bending process for simple application and we are using foot operated valve instead of hand operated lever so single man can performed the operation of machine like punching and bending easily. The compressor forms the main part of the pneumatic system by producing the compressed air. Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air intake conduction, namely at atmospheric pressure and normal ambient temperature. The clear conduction of the suction air one of the factors which decide the life of a compressor. For a pneumatic system, we need the pressurized air which is free from dust, moisture and smoke. To remove these pollutants, air is filtered. During the filtration, the dust, moisture and smoke are eliminated about 90%. Then the pressurized air passes through the air dryer to remove the moisture and make the air dry. Then it passes through another filter, where a complete free air is available for the system.

All the above reasons show that the press machine issue is to the core of many industries. So by studying concept “Pneumatic Toggle Press” as our final year project & we are trying to co-relate with core of industries.

 

## II. LITERATURE SURVEY

Documentation of process influencing parameters of blanking/piercing process covers thorough literature review of the factors have been elaborated by various authors. Comprehensive literature review is conducted by collecting various research papers from various journals, and various popular research related sites viz. Science Direct, Springer Link and various standard Hand Books.

**U.P.Singh**: This paper deals with the design analysis of various type of punches with special attention to their cutting profiles, using the finite element technique. Results obtained by the finite element analysis of the punches enable the drawing of specific conclusions with regard to the selection of punches in practice for minimum distortion of the punch and reduced stresses on the punch. The present study on punch design has resulted in the development of 3-D finite element models of various types of punches and demonstrates the usefulness of these models in solving practical problems involving range of design parameters .That the radial deformation of punches with balanced convex and concave shear have a minimum value within the shear angle range of 17-22 degree. Suggest that a shear angle of 20 degree can be proposed safely for practical purposes [1]. **Siti Noor AzrinBintiSukiran**: This project is study about the design and fabricates of pneumatic punching tool which shows capability to design more than one concept and fabricate the machine using a variety of machine. Other than that, it is important to studies on pneumatic and die for punching tool which are the main topic for this project. So, at the end of this project, student will practicing on how to build and steps to follow to complete the requirement for this project. Compared to hydraulic system, pneumatic system has better operational advantages but it cannot replace hydraulic system so far as power requirement and accuracy of operations are concerned. In areas of hazards, probably air will be a better medium of power than electrical system, hydraulic system and steam power system [2].

**A. K. Gupta, P. Bharadwaj, S. Sahgal, P. M. Pradhan**: This paper presents the investigation, design and fabrication of blanking of thin sheet (0.1-2 mm) of different sheet material. The blank diameter is considered as 10 mm. The study helped to evaluate the influence of tool clearance, burr formation, sheet thickness, punch/die size and blanking layout on the sheet deformation. The punch load variation with tool travel and stress distribution in the sheet has been obtained. The results indicate that a reduction in the tool clearance increases the blanking load and formation of burr increasing or decreasing at different pressure. The objective of this paper is to study the behavior of punch and formation of burr [5].

**Arun ,sreeRajendra , VijayavithalBongale**: The proposed work describes the design and fabrication of prototype of automatic punching machine controlled by PLC and shedding light on the working principle and the hardware structure on the system. Punching or pressing process is one of the most important and necessary processing step in sheet metal industry. By automatic this process one can have better control over the process. Programmable logic controllers are used for the control of the system. This system can replace existing manual field and operated punching and pressing machines. By interfacing the PLC controls with the conventional machines, it is possible to achieve good results in the form of reduced manufacturing lead time. Reduced cost and increased safety of the worker.

**Vivek Sharma, Suman Rani and Parvesh**: In an attempt to improve the accuracy and efficiency according to the requirement. No work is done in proper designing of special manual machine press machine. These days rather rule of thumb prevails. To keep pace with company demands improvement in the design of the manual press is needed. So I worked to improve the designing of the machine for getting the best results by designing the balls of cast iron that provides appropriate pressure to stop fluctuation in size of components. The specific dimensions of the press machine is as Improvement in design of the manual small press machine for sheet metal job under 900rnrn2 area X 1mm thickness in stainless steel grade 304. Though in extreme case it can work even on 2.0 mm thick stainless steel of specified area without any problem.

**Gaurav pradipSonawane, Gaurav Udgirkar**: A Hydro-pneumatic press is a press machine utilizing both air and oil in its operation and gives higher outlet hydraulic pressure with lower inlet pneumatic pressure. In this project the press is design and manufacture for pressing sleeve bearing into the circular casting part. Casting part is thick cylinder and sleeve bearing is kind of cylindrical bearing. Two actuators are used in the press one is for vertical pressing and other is for horizontal pressing. This paper includes the concept development, design, analysis and manufacturing of press machine. Various parts of the press are modeled by using Pro-E modeling software. Structural analysis has been applied on the parts of press machine by using analyzing software ANSYS. The design had main focus on reducing operator fatigue and increase safety, improving the flexibility and makes operation more convenient, and to achieve dimensional and positional accuracy. Components of press are designed to avoid bending failure due to applied load. Mild steel is selected as material based on its properties such as high bending & tensile strength, it compatibility with operation like machining, welding, finishing, cutting etc. and cost as economic factor [9].

**P.Goyal, R.Singh**: This project work deals with design of pneumatically controlled small scale punching machine to carry out piercing on thin sheets 1-2 mm of different materials (aluminium and plastic) reduction in punching force requirement been the main name of this project work is obtained by modification in punch tool design that is by provision of shear on punch face. Model of the machine is developed on the basis of calculation with respect to punching force requirement. **Vishal Tambat, NilkanthRane etc**.: The shearing machine and bending machine is most important in sheet metal industry. This machine should be used for straight cutting machine with wide application. But in some industry hand sheet cutter and hand bender are used. For that machine to operate the human effort are required. The

 

machine should be simple to operate and easy to maintain, hence we tried out to develop the Pneumatic Shearing and Bending Machine.

## III. PROPOSED WORK

Pneumatic is vastly used in transmission of energy. It is basically a science of compressed air. However, till now it has developed its scope in a wider area & succeeded over conventional power transmission method. Our project implies principle of converting pendulum movement of toggle by applying air pressure into linear motion of ram with suitable linkage for the operation. It works on the principle of compressed air. The compressed air with a pressure of 4-6 bar passing through the punching machine and the punch will be done.
The material is sheared to the required profile of the punch and blank is moved downwards through the die clearance. For alternate operation of air in the ports we are using the 5/3 direction control valve. Pneumatic toggle press is mainly use for operations on sheet metal such as piercing, riveting, stamping, clinching, etc. This machine is used in mass production and more efficient way to form metal into finish product.

The main objectives of this project study are to design and fabricate a simple punching tool that used pneumatic system.
The outcomes of this project study will be:

i. To design a pneumatic system of a punching tool.
ii. To fabricate a pneumatic punching tool machine through several fabrication techniques.

### A. Components:

Pneumatic Toggle Press consists of following important components: -

1. Body
2. Toggle
3. Ram
4. Pin
5. Dowel pin
6. Side plate
7. Base plate
8. O-ring
9. Fastener
10. Press Male connector
11. 5/3 Directional Control Valve
12. Compressor
13. Hose pipe

### B. WORKING OF SYSTEM

The system is surrounding air as an input. This surrounding air is first filtered by air filter. Then this filtered air is compressed in a compressor. This compressed air is passing through port 1. Because of this pressure the toggle will move in clockwise direction .this toggle will drive the ram in downward direction figure 1. This will done the punching by the punching tool attached to the ram. Ultimately air will come out from the port 2 by using 5/3 direction control valve,

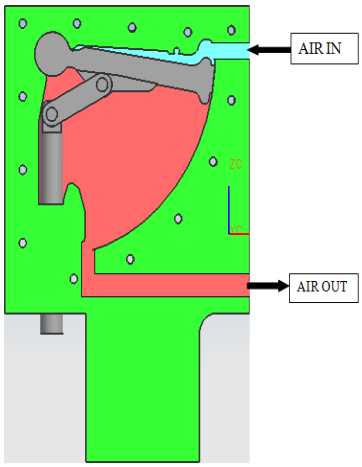


Figure 1

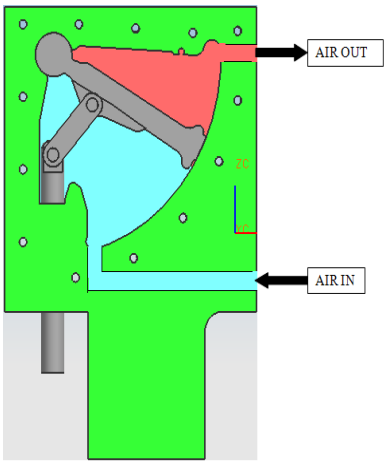


Figure.2

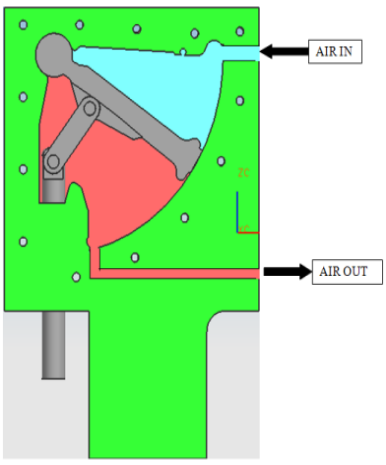


Figure 3

 

After this, compressed air is provided by port2.the toggle will move in anticlockwise direction. And this will drives the ram in upward direction by using DCV as shown in figure 2. Vise-versa the operation will takes place means air will provide from other port and will come out from the other port.

C. **ADVANTAGE**

Thin, compact, robust design reduced floor space area

- Easy & quick tool changing can possible
- Less maintenance & break down
- Due to Toggle mechanism the cylinder size is small and hence the consumption of compressed air is minimum.
- Accurate repetitive strokes and perfectly controlled force make it ideal for light assembly work.
- The optimum transmission ratios of the toggle press produce high forces at the end of the stroke, ensuring low air consumption.
- Movement of linkages in inner side of side plates increase safety of workers and also protect mechanism of machine
- Multiple forces are produced by adjust the air from compressor by air regulator.

**D. DISADVANTAGE**

- Need of external lubrication.
- Minute leakage reduced the working force
- Required external working medium ( compressed air)
- Absence of electricity, breakdown of compressor may stop the working of machine.
- Maximum force at the end of stroke

## IV. TESING & OBSERVATION

Force required piercing the hole on:

**Formula:**

F=π*d*t*Shear strength* Multiplication factor

Where,

d= Diameter of hole

t=Metal thickness

In following tables Force is calculate based on respective hole diameter& metal thickness

1] Brass [Shear strength= 248.21 N/mm$^2$, Multiplication factor= 0.72]

| Hole Diameter → / ↓ Metal Thickness | 3mm | 6mm | 9mm | 12mm | 15mm | 21mm | 25mm |
|---|---|---|---|---|---|---|---|
| 0.3mm | 506 | 1011 | 1513 | 2022 | 2525.76 | 3537.36 | 4211.28 |
| 0.5mm | 837 | 1685 | 2526 | 3369 | 4211.28 | 5896.08 | 7017.84 |
| 0.7mm | 1180 | 2359 | 3538 | 4717 | 5894.64 | 8254 | - |
| 1mm | 1685 | 3369 | 5053 | 6738 | 8422 | - | - |
| 1.2mm | 2022 | 4043 | 6064 | 8085 | - | - | - |
| 1.5mm | 2526 | 5053 | 7580 | - | - | - | - |
| 1.7mm | 2864 | 5727 | - | - | - | - | - |

**Table No: 1**

2] Aluminum [Shear strength= 48.26N/mm$^2$, Multiplication factor= 0.14]

| Hole → Diameter / ↓ Metal Thickness | 3mm | 6mm | 9mm | 12mm | 15mm | 21mm | 25mm |
|---|---|---|---|---|---|---|---|
| 0.3mm | 20 | 39 | 58 | 77 | 96 | 134 | 166 |
| 0.5mm | 32 | 64 | 96 | 128 | 160 | 223 | 266 |
| 0.7mm | 45 | 90 | 134 | 179 | 223 | 313 | 372 |
| 1mm | 64 | 128 | 192 | 255 | 319 | 446 | 531 |
| 1.2mm | 77 | 153 | 230 | 306 | 383 | 535 | 637 |
| 1.5mm | 96 | 192 | 287 | 383 | 434 | 669 | 796 |
| 1.7mm | 109 | 217 | 325 | 434 | 542 | 758 | 903 |

**Table No: 2**

 

## CONCLUSION AND FUTURE SCOPE

Now we know that pneumatic punching press is very cheap compared to hydraulic punching press machine. We can do simple operation like piercing, stamping, bending, riveting, blanking, etc. It compact size having less weight, required less working area, easy maintenance. It can be concluded that in case press machine design it is first important to know design requirement like material strength and availability, required pressure, space, dimension of machine. The further advantage of the system has safety to operator, made operation more convenient, improved dimensional and positional accuracy. Based on the shear provided on the punch face the punching force reduction of 25% to 60% thereby increasing tool life and reducing tool machining cost. Therefore with this force reduction we are able to easily punch sheets of thickness upto 2.25 mm for plastic sheet having tensile strength 90 N/mm2 and upto 1.5 mm of aluminium sheet having tensile strength 180 N/mm2.

The "PNEUMATIC TOGGLE PRESS" requires compressed air as a working medium to perform various operations.After the completion of the cycle the air moves out through the out port of Direction Control valve. This air is released to the atmosphere. In future the mechanism can be developed to use this air again for the working of cylinder.

It can be also operated manually or automatically as it reduces idle time of men & machineries. Hence it is used in mass production. By using PLC more control can be achieved on pneumatic toggle press. Even pneumatic toggle press consumes higher cost; it can play an important role in major industrial areas.

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