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Design and fabrication of automatic and multifunctional pneumatic machine

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ABSTRACT

A pneumatic machine is for sheet metal industry and can be made into multiple machines and should be used as "U" shaped clamp and also circle cutting cum straight cutting machine. This machine is simple to maintain easy to operate. Hence we tried out hands-on Pneumatic Shearing Machine In shearing operation as the punch descends upon the metal, the pressure exerted by the punch first cause the plastic deformation of the metal. Since the clearance between the punch and the die is very small, the plastic deformation takes place in a localized area and the metal adjacent to the cutting edges of the punch and die edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses. And the working of the pneumatic system depends upon air compressor, which converts mechanical energy into, pressure energy of compressed air. The compressed air should be proposed to move the piston of the pneumatic cylinder. The linear movement of the piston and piston rod can be used to get various mechanical operations like bending, cutting, punching, and hammering etc.

Keywords— *Design and modeling of components, Designing components of the pneumatic system, Fabrication of pneumatic sheet metal clamp making the machine*

1. INTRODUCTION

Pneumatics, from the Greek (pneumatikos, coming from the wind) is the use of pressurized gases to do work in science and technology. Pneumatics was first documented by Hero of Alexandria in 60 A.D., but the concept had existed before then. Pneumatic products represent a multi-billion dollar industry today. Pneumatic devices are used in many industrial applications. Generally appropriate for applications involving less force than hydraulic applications, and typically less expensive than electric applications, most pneumatic devices are designed to use clean dry air as an energy source. The actuator then converts that compressed air into mechanical motion. The type of motion produced depends on the design of the actuator. Pneumatics is employed in a variety of settings. In dentistry applications, pneumatic drills are lighter, faster and simpler than an electric drill of the same power rating (because the prime mover, the compressor, is separate from the drill and pumped air is capable of rotating the drill bit at extremely high rpm). Pneumatic transfer systems are employed in many industries to move powders and pellets. Pneumatic tubes can carry objects over distances. Pneumatic devices are also used where electric motors cannot be used for safety reasons, such as mining applications where rock drills are powered by air motors to preclude the need for electric motors deep in the mine where explosive gases may be present. Pneumatic cylinders are generally less expensive than hydraulic or electric cylinders of similar size and capacity.

2. DESIGNING AND MODELING OF COMPONENTS

2.1 Design parameters

Statement for design

The multifunctional Pneumatic machine is to be designed to operate at the maximum pressure of 10 bar and the lever operating force required is 150N, with the operating temperature of 2000 C. Cylinder Sizing Calculator

The air cylinder sizing calculator below performs the following steps:

Step 1: Calculate the area of the cylinder piston

$$\text{Area } = A = \pi r^2$$

Step 2: Multiply the piston area by the air pressure to be used

$$\textit{Force Output} = \textit{Area} \times \textit{Pressure}$$

Note: The force output on the rod end of a cylinder will be slightly less due to the displacement of the rod. The real force output of a cylinder will be less than the theoretical output because of internal friction and external side loading. It is best to use a cylinder that will generate from 25.

Material: Al. fs= 210kg/cm2
Bolt material: M.S. ft = 280 kg/cm2
Design a cylinder of internal diameter for Di=7.2 cm, Internal air pressure
P= 25 kg/cm Max. ft=210kg/cm and max. ftb= 280 kg/cm.

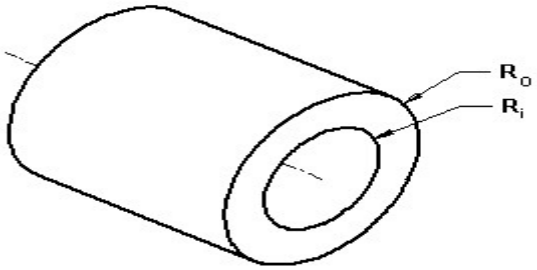

Fig. 1: Design parameter of a cylinder

For safety purpose, we will design the cylinder using a factor of safety as 4.

Therefore, t = 9 mm
To find the outer diameter of the cylinder,

Outer diameter Do = Di + 2 (t)
= 72 + (2 X 9)
=90 mm

Force trying to separate the flanges,

$F = \pi d^2$ x P/4
= (3.14/4) (9) (9) × 25
= 1590.4 kg

Therefore the minimum Length of diagonal of square,

L =127.2 mm

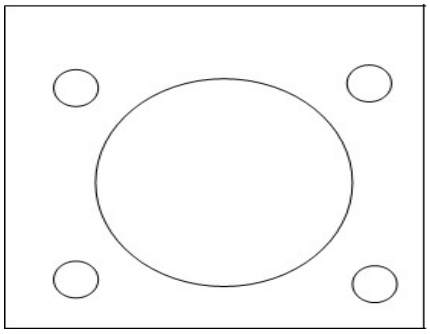

Fig. 2: Diagonal of square

3. DESIGNED COMPONENTS

3.1 Automatic pneumatic cylinder

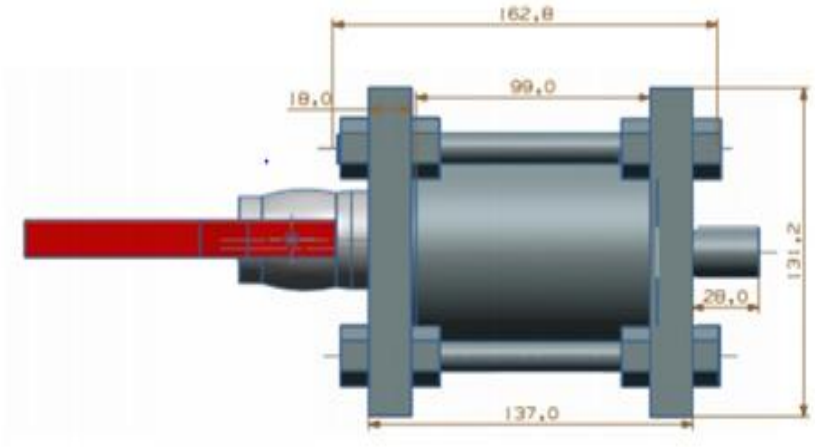

Fig. 3: Pneumatic cylinder

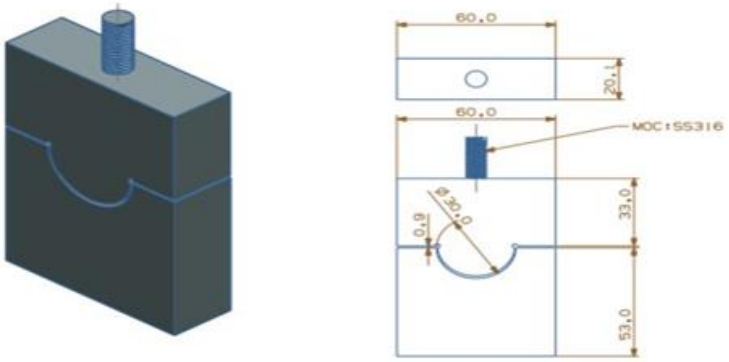

Fig. 4: Dies and frame

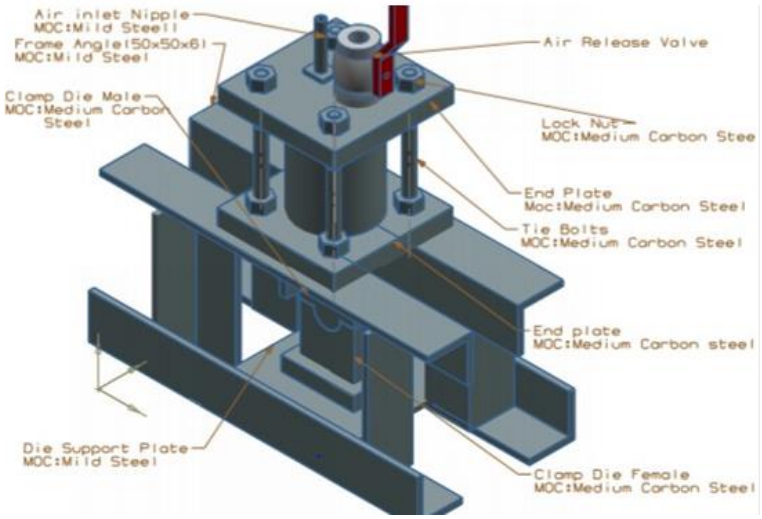

Fig. 5: Designed total assembly of the project

4. FABRICATION OF PNEUMATIC SHEET METAL CLAMP MAKING MACHINE

In this project, we are using a pneumatic cylinder or actuator. The pneumatic cylinder or actuator causes a liner movement of the piston by using the force exerted by air which is compressed by a compressor. The compressor driven by an electric motor which runs with the help of electricity is compressed the air drawn from the atmosphere up to certain pressure depending upon the compressor capacity. Then the compressed air is allowed into the pneumatic cylinder through the hand-operated valve. The compressed air which enters into the pneumatic cylinder causes or exerts some pressure, when there is no way to escape from the cylinder (because the valve is closed) on the piston inside the cylinder, this causes the piston to move linearly up to some distance. We are using this linear movement of the piston to do our work. The arrangement contains (the dies used to bend, punches used to punch holes & cutter used to cut) for making the required clamp is attached to the piston of the pneumatic cylinder. By using the movement of the piston, both bending and cutting will happen and a clamp will be obtained. Once the clamp is obtained the air will be released into the atmosphere by using a hand operated valve. Then the process will be repeated to obtain a number of clamps.

4.1 Construction

The pneumatic cylinder selection was based on the force requirements for bending and cutting. The cylinder has a piston, tie bolts, air release 3 phase valve. The material of construction is Medium carbon steel. The pneumatic cylinder ID or bore is 72mm and the piston tightly fits into it with a nylon piston ring. Tie bolts are mainly for safety and reinforcement to the cylinder end plates. This pneumatic cylinder is mounted on a frame made from mild steel angles. This frame supports the clamp die and also holds the pneumatic cylinder intact during its operation. The die is made up of medium carbon steel and is much harder than aluminium. The die consists of two main parts namely male and female die. The male die part is having a cutter at its end and punches at the bottom and it is also attached to the piston rod by a threaded bolt. The female die part is secured to the bottom of the frame by welding.

4.2 Main components and their description

The major parts used in our project are

- Frame
- Pneumatic Cylinder
- Dies
- Cutter
- Control valve
- Base
- Stand

4.3 Dies

The dies are used to bend the sheet metal into a specific form (here we trying to make c shape clamp). The lower die is fixed and the upper die is attached to pneumatic cylinder, it will move along with piston. The sheet metal is placed in between these dies, due to the downward piston movement the upper die moves downward and the two dies will become together. Then the sheet metal placed in between these two dies will be formed into our required shape (c-shape). Then the upper die will be moving back after the clamp is made.

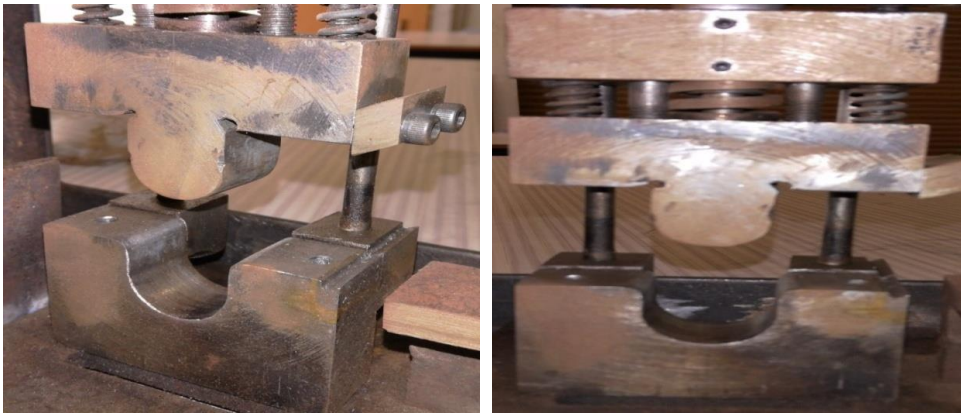

Fig. 6: Construction of dies

4.4 Cutter

The cutter is attached to the moving die connected to the piston. So that when piston moves downwards the cutter will also move downwards along with the upper die. After bending happens the cutting action will take place by the applied force (shearing). The cutting will happen only after the bending but not before the bending, to create the clamp correctly. This is achieved by adjusting the height of the cutter with the bending die.

Fig. 7: Fabricated cutter

4.5 Base

The base is a rigid part that is used to mount all the equipment or parts of a machine on it. It gives the rigid platform to mount the whole parts or total equipment. The base is made up of mild steel angled bars and rectangle rods welded in a particular manner or in a particular design. A plywood sheet is placed on top of the base.

Fig. 8: Base part of the multifunctional pneumatic system

4.6 Fabricated model of this project

Fig. 9: Multifunctional pneumatic machine U- Shaped clamps

5. CONCLUSIONS AND FUTURE WORK

5.1 Directions for future work

In this our project we can create the clamps of different thicknesses and with different materials such as Aluminum, Galvanized Iron Etc. In this machine, the feeding should be done manually. So we are planning for automatic feeding. And we are also planning for automatic removal of produced clamps. Actually, this machine can be used as a multipurpose machine by changing the dies of different shapes and by changing the frame we can use this machine as a pneumatic sheet metal cutting machine. We can use this machine as a pneumatic punching machine by changing the set up properly. We are planning for those applications in future.

5.2 Conclusion

Finally, we have designed and fabricated multi-functional pneumatic machine which performs various operations such as Bending, cutting, and punching. By these operations, we can produce the U- clamps with minimum effort and reduced cost.

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