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Pneumatic Shearing and Bending Machine

[1]Vishal Tambat, [2]Nilkanth Rane, [3]Omkar Savant, [4]Pankaj Yadav

[1,2,3,4] B.E. Mechanical, Theem College of engineering, Chilhar road, boisar (East), dist. Palghar, India

Abstract: **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.**

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.

In bending operation the bend has been made with the help of punch which exerts large force on the work clamped on the die. The bending machine is designed in such a way that, it works automatically. The machine is designed by observing the factors to improve the efficiency and to reduce the cycle time by producing quality output. Automation of machine is achieved with the help of pneumatic system.

This paper involves the design of an efficient system which reduces the human effort and help to increase production output. It also includes pneumatic system, pneumatic component and shearing die and bending die.

Keywords: **bending operation, pneumatic component, pneumatic system, shearing operation.**

1. INTRODUCTION

In industries the automatic sheet bending and sheet shearing are widely used. Earlier the process was carried out manually. The manual process was time consuming as well as the output of machine was very less. The main aim of the project is to improve the efficiency of the required output and to increase the production with quality output.

In this project we used pneumatic system, ‘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 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. Pneumatic cylinders are generally less expensive than hydraulic or electric cylinders of similar size and capacity.

We have developed the system in which shearing and bending operation are carried out in one machine by changing the machine die according to the given application. In this operation the pneumatic system is installed on the C-frame body with required attachment. And pneumatic cylinder is placed on C-frame body vertically with front flange mounting. The model which have prepared to working in 100 psi air pressure, which cuts various sheet metal between 20 to 24 gauge. And for bending we used ‘v ‘bending die.

1.1. ABOUT PNEUMATIC SYSTEM:

A pneumatic system is a system that uses compressed air to transmit and control energy. Pneumatic systems are used in controlling train doors, automatic production lines, and mechanical clamps.

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The advantages of pneumatic systems:

Pneumatic control systems are widely used in our society, especially in the industrial sectors

For the driving of automatic machines. Pneumatic systems have a lot of advantages.

- **High effectiveness:**

Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes. After use, compressed air can be released directly into the atmosphere without the need of processing.

- **High durability and reliability:**

Pneumatic components are extremely durable and cannot be damaged easily. Compared to

Electromotive components, pneumatic components are more durable and reliable.

- **Simple design:**

The designs of pneumatic components are relatively simple. They are thus more suitable for

Use in simple automatic control systems.

- **High adaptability to harsh environment:**

Compared to the elements of other systems, compressed air is less affected by high Temperature, dust, corrosion, etc.

- **Safety:**

Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded.

- **Easy selection of speed and pressure:**

The speeds of rectilinear and oscillating movement of pneumatic systems are easy to adjust

And subject to few limitations. The pressure and the volume of air can easily be adjusted by a Pressure regulator.

- **Environmental friendly:**

The operations of pneumatic systems do not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

- **Economical:**

As pneumatic components are not expensive, the costs of pneumatic systems are quite low Moreover, as pneumatic systems are very durable, and the cost of repair is significantly lower than that of other systems.

1.2. ABOUT PRINCIPLES OF PNEUMATIC CONTROL:

- **Pneumatic circuit:**

Pneumatic control systems can be designed in the form of pneumatic circuits. A pneumatic circuit is formed by various pneumatic components, such as cylinders, directional control valves, flow control valves, etc. Pneumatic circuits have the following functions:

1. To control the injection and release of compressed air in the cylinders.

2. To use one valve to control another valve.

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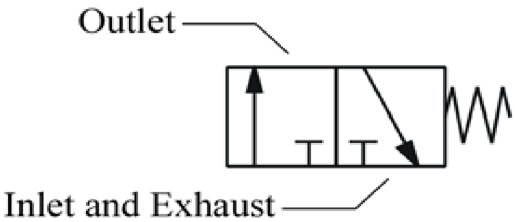
- **Pneumatic circuit diagram:**

A pneumatic circuit diagram uses pneumatic symbols to describe its design. Some basic rules must be followed when drawing pneumatic diagrams.

i) A pneumatic circuit diagram represents the circuit in static form and assumes there is no supply of pressure. The placement of the pneumatic components on the circuit also follows this assumption.

ii) The pneumatic symbol of a directional control valve is formed by one or more squares. The inlet and exhaust are drawn underneath the square, while the outlet is drawn on the top. Each function of the valve (the position of the valve) shall be represented by a square. If there are two or more functions, the squares should be arranged horizontally Fig: 1



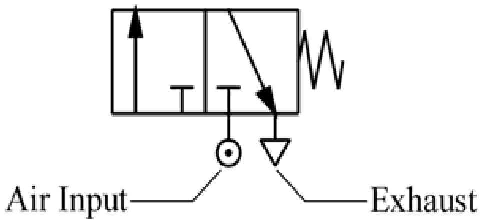


Fig: 1 3/2 directional control valve

(Normally closed type)

Fig: 2 3/2 directional control valve

(Normally closed type)

iii) Arrows "↓↖" are used to indicate the flow direction of air current. If the external port is not connected to the internal parts, the symbol "┬" is used. The symbol "⊙" underneath the square represents the air input, while the symbol "▽" represents the exhaust. Fig 2 shows an example of a typical pneumatic valve.

iv) The pneumatic symbols of operational components should be drawn on the outside of the squares. They can be divided into two classes: mechanical and manual (fig 3 and 4)

(a) Pulley lever **(b) Unilateral pulley lever**

Fig: 3 mechanically operated pneumatic components

(a) Standard **(b) Lever** **(c) Button** **(d) Pull & push**

Fig: 4 manually operated pneumatic components

v) Pneumatic operation signal pressure lines should be drawn on one side of the squares, while triangles are used to represent the direction of air flow.

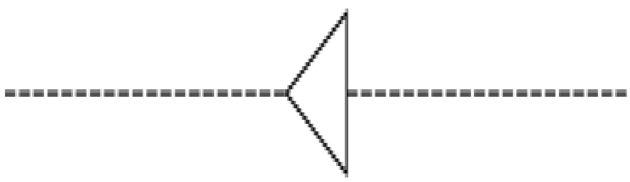


Fig: 5 Pneumatic operation signal pressure line

- **Basic principles:**

fig: 6 shows some of the basic principles of drawing pneumatic circuit diagrams, the numbers in the diagram correspond to the following points:

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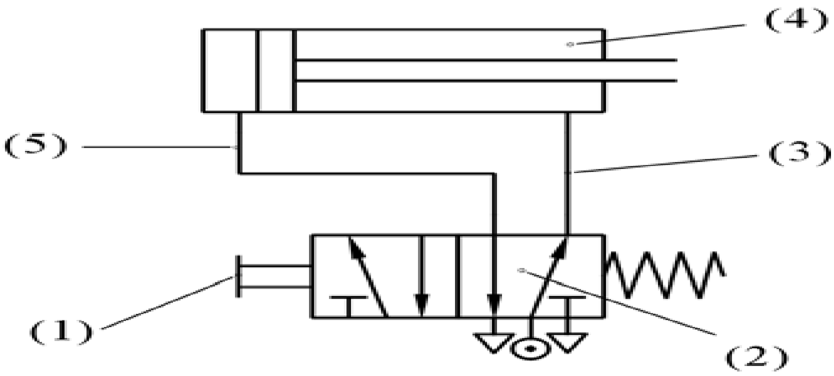

Fig: 6 Basic principles of drawing pneumatic circuit diagrams

i) When the manual switch is not operated, the spring will restore the valve to its original position.

ii) From the position of the spring, one can deduce that the block is operating. The other block will not operate until the switch is pushed.

iii) Air pressure exists along this line because it is connected to the source of compressed air.

iv) As this cylinder cavity and piston rod are under the influence of pressure, the piston rod is in its restored position.

v) The rear cylinder cavity and this line are connected to the exhaust, where air is released.

- **The setting of circuit diagrams:**

When drawing a complete circuit diagram, one should place the pneumatic components on different levels and positions, so the relations between the components can be expressed clearly. This is called the setting of circuit diagrams. A circuit diagram is usually divided into three levels:

Power level, logic level and signal input level.

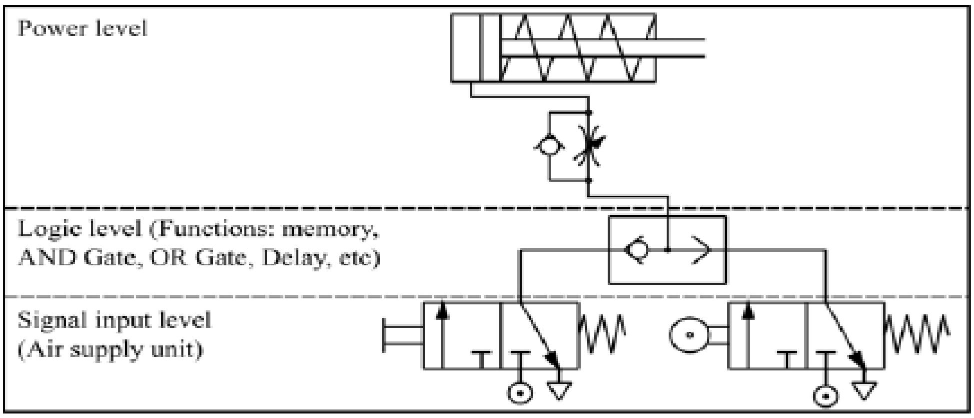

Fig.7 Power level, logic level and signal input level

2. LITERATURE REVIEW

Most of the earlier pneumatic control systems were used in the process control industries, where the low pressure air of the order 7-bar was easily obtainable and give sufficiently fast response. Pneumatic systems are extensively used in the automation of production machinery and in the field of automatic controllers. For instance, pneumatic circuits that convert the energy of compressed air into mechanical energy enjoy wide usage, and various types of pneumatic controllers are found in industry. Certain performance characteristics such as fuel consumption, dynamic response and output stiffness can be compared for general types of pneumatic actuators, such as piston-cylinder and rotary types. Figure (8a) and (8b) show the two types of pneumatic actuators (Sorli et al., 1999). The final decision on the best type and design

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configuration for pneumatic actuator can be made only in relation to the requirements of a particular application. The pneumatic actuator has most often been of the piston cylinder type because of its low cost and simplicity (Tablin et al., 1963)

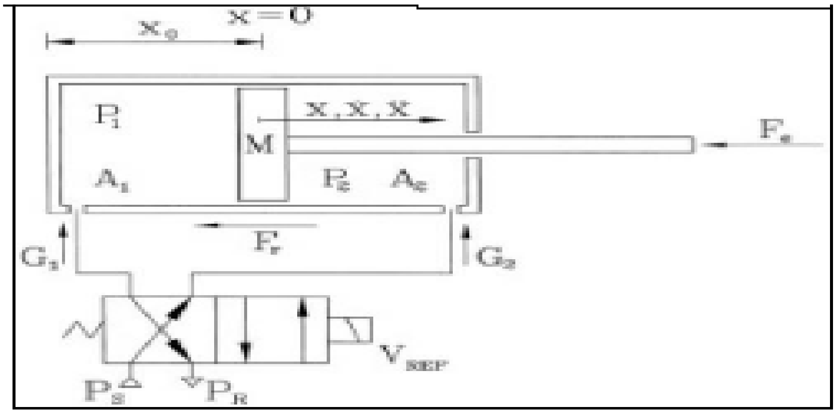

Fig: 8(a). Double Acting Linear Pneumatic actuator

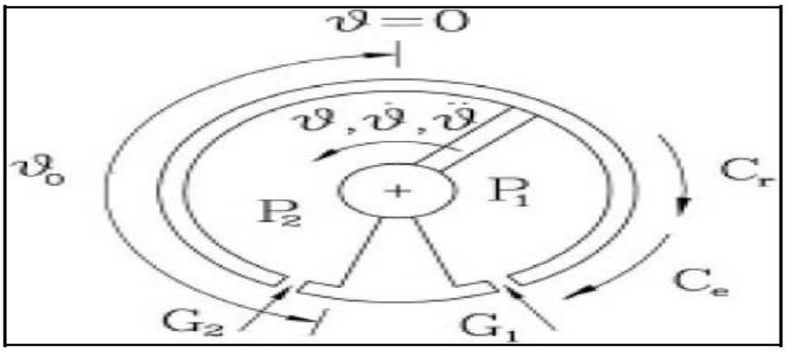

Fig: 8(b). Vane Rotary Pneumatic Actuator

The pneumatic power is converted to straight line reciprocating and rotary motions by pneumatic cylinders and pneumatic motors. The pneumatic position servo systems are used in numerous applications because of their ability to position loads with high dynamic response and to augment the force required moving the loads. Pneumatic systems are also very reliable (Clements and Len, 1985).The open literature surveyed showed a wide spectrum of new applications of pneumatic servos such as milling machines, robotics, and advanced train suspension. Therefore, the surveyed literature reported is subdivided into three main groups. The first group is concerned with various applications of pneumatic actuators. The second group includes the theoretical, experimental approaches for modeling the pneumatic actuator. The third group is related with the control strategies applied to pneumatic actuators.

Applications and Related Work: Pneumatic servos have advantages over hydraulics in high temperature and nuclear environments. The actuator, rather than the servo valve, generally limits system response and stiffness. Where simplicity and cost are paramount, the piston cylinder is probably the best choice. But if minimum fuel consumption is desired rotary type of motor is indicated. (Taplin et al., 1963) also have been shown the rotary servo has nearly twice the band pass of the piston cylinder servo. This result is typical for many applications. In short duration missile applications, the weight of a self-contained solid propellant pneumatic servo may be half that of an equivalent self-contained hydraulic system. Where a pneumatic system is to replace a heavier hydraulic system, maximum dynamic response and output stiffness are essential. The outstanding difference between pneumatic and hydraulic systems arises from the low bulk modulus of the pneumatic working medium. The bulk modulus of a gas is p, where hh is the ratio of specific heats for the gas and p is the instantaneous pressure. This is the major obstacle in achieving a high response pneumatic system. Several countries have been investigating and developing active suspension technologies in order to improve both vertical and lateral ride quality of fast train passenger cars. (Cho et al., (1985). investigated the use of actively controlled pneumatic actuators in parallel with conventional passive suspension to improve vehicle dynamics. The use of pneumatic actuators for vehicle active suspension reduced the rms car body lateral suspension stroke by 34 percent with a power requirement of 5.7 KW per car.

(Singh et al., 1985). Described the design process by which the air brake control valves of heavy and medium duty trucks were centralized modulus. Truck air brake control systems were reviewed and a floor mounted pneumatic application valve acting on a centrally advanced design was developed using dash mounted electrical controls and a floor mounted pneumatic application valve acting on a centrally located electro pneumatic controller. The system performance was demonstrated on an operational truck and tested to the applicable system requirements of federal brake regulations. Nearly all-modern process plants employ control valves, which use either pneumatic or electric actuators, the choice between the two being normally dictated by the size of the valve, the environment, media and availability of power source. (Clements *et al.,* 1985). Have developed dedicated electro pneumatic positioned for a class of process valves. The position uses solid-state electronics to combine the functions of both the electric to pneumatic converter and valve positioner. Such are the savings in size and weight that have been achieved by the use of electronics that the resulting unit is housed in an enclosure small enough to be mounted directly on the actuator, which it is to operate. (Virvalo *et al.*, 1988). Showed that electro pneumatic servo systems are viable alternatives to hydraulic systems for control of such machines as robots, but most of the research has been carried out on them using comparatively small cylinders. They have studied the problems involved in using heavier versions and have produced a satisfactory method of coping with the somewhat complex problems involved in designing such systems, since with a few simplifications a nonlinear model of a pneumatic servo system can be built and used to time the regulator. An interesting pneumatic servomechanism, which employs pulse width modulation driving technique, was reported by (Sano *et al.,* 1988). A new electro pneumatic on- off valve with a disk flapper driven by a pulse motor was developed. Experimental tests showed the positioning accuracy and the output power are tolerable but the speed of the response is comparatively less than those of other pneumatic servomechanisms.

The advantages and limitations of the conventional pneumatic cylinder were discussed by (Bird *et al.*, 1985). Recent developments in the design of pneumatic linear actuators have resulted in the production of more compact and better-guided actuators. The author worked on the development of special servo control system and its integration into complete control system. Typical applications of such systems are also given.

(Vincent et al., 1989) investigated an alternative approach to the design of controllers for positioning damping. To avoid conflicting requirements problem associated with traditional state variable feedback design, the design is based on energy methods and is not a full state variable feedback design. The method is illustrated using a low order spring mass example, and the results are compared with a linear quadratic design.

Electro hydraulic and electro pneumatic servo drives can provide precise position control for a multitude of industries from textile manufacture to machine tools. A significant application of the latter type was in a universal rotary machining center where the primary requirement was for an increase in both productivity and flexibility. With the advantages of exact positioning at high speed and the ease of machine programming brought about by microprocessor control, complicated three dimensional work pieces can be simultaneously cut, milled, drilled and taped, all in one operation.

Another interesting application to pneumatic actuators is that reported by (Ingold *et al.*, 1988). An electro pneumatic design was developed and tested to meet the engine characteristics such as start ability, load carrying ability, and engine dynamic performance. As an application of micro-mechanical actuators a new concept for a micro- pneumatically driven actuator has been developed and realized. This actuation principle has several advantages: high energy density, large achievable displacement, high generated forces, excellent dynamic behavior, usage of various fluids as driving medium, usage as final controlling element with continuous action and high design flexibility (Sebastian *et al.*, 2002)

On the other hand, in intelligent soft arm control (ISAC) robot system the pneumatic actuator was used for the position control of a joint. A physical actuator model was designed and used as the basis for a subsidiary torque control. Experiments showed that the static hysteresis nonlinearity of the actuator is less important than the dynamic one. The research focused on the modification of a physical static model and the extension with a dynamic part. The quality of the model was verified by implementing it as a torque controller and running experiments on a test bed (Joachim *et al.*, 2003).Also the pneumatic actuators are extensively used in conveying systems to transport granular materials. A methodology combining theoretical and experimental techniques for characterizing and predicting the friability of granules in a laboratory scale pneumatic conveying systems was developed by (Pavol *et al.*, 2008).

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3. CONSTRUCTION AND DESIGN

For this model we are used pneumatic cylinder which have 100mm internal diameter and 50 mm stroke. For body we used mild steel material.

Further information given as follow:

3.1. Dimension: of model:

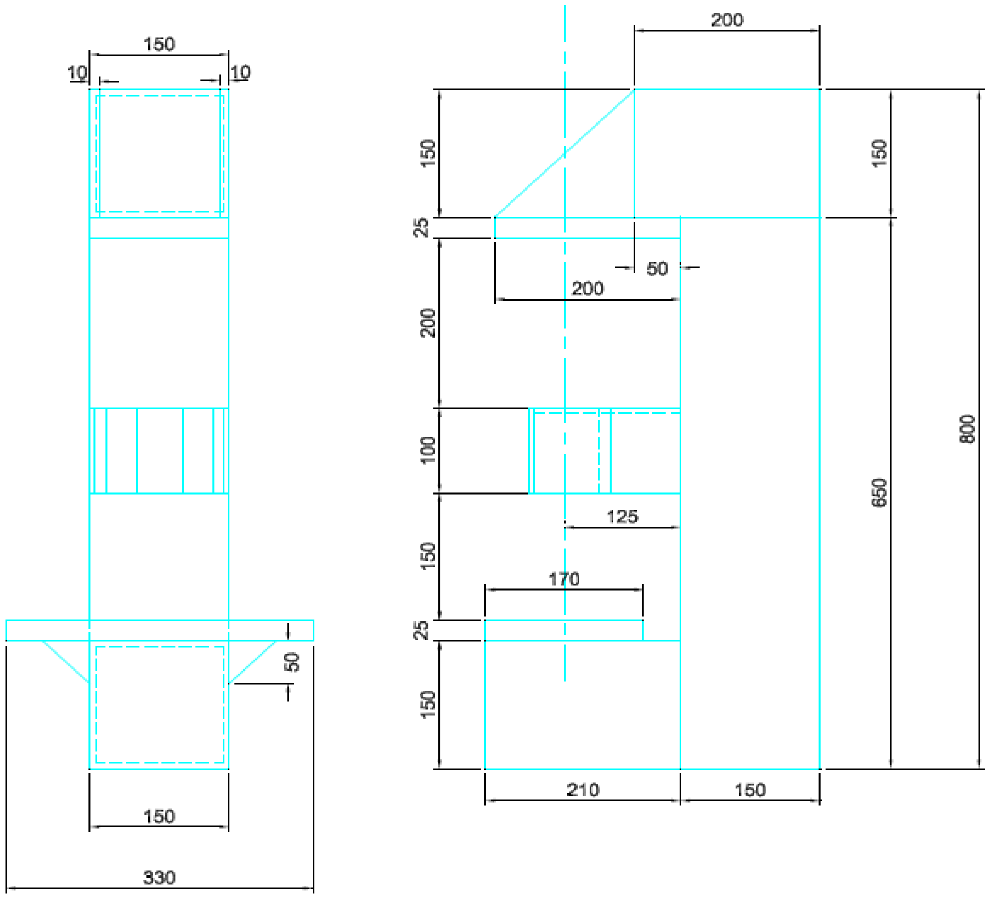

Fig: 9 Front view and side view of c frame body

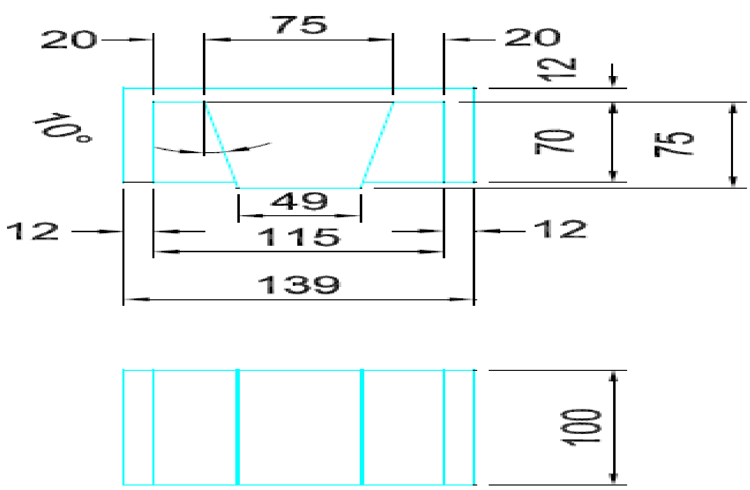

Fig: 10 Top view and front view of Ram

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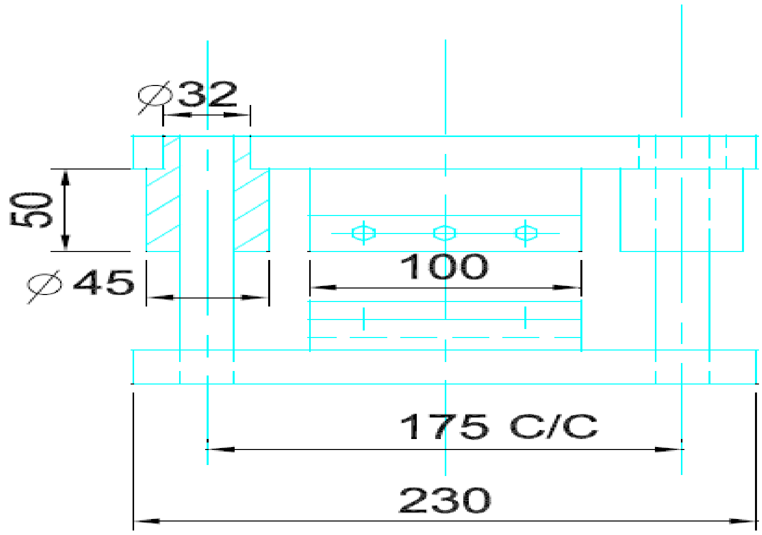

Fig: 11 Machine die

3.2. Calculation related to pneumatic cylinder:

- Dimension

i) Cylinder type – double acting

ii) Internal diameter; D – 100 mm

iii) Stroke – 50 mm

iv) Piston rod diameter; d – 20 mm

v) Maximum working pressure; P – 100 psi (≅ 7bar)

- Specification of pneumatic cylinder

i) Cylinder thrust in forward stroke

F = $\frac{\pi}{4} \times D^2 \times P$

F = $\frac{\pi}{4} \times 10^2 \times 7$

F = 549.77 ≈ 550 kg

ii) Cylinder thrust in return stroke

F = $\frac{\pi}{4} \times (D - d)^2 \times P$

F = $\frac{\pi}{4} \times (10 - 2)^2 \times 7$

F = 351.85 ≈ 352 kg

- Theoretical air consumption calculation

i) Free air consumption in liters for forward stroke; C-

C = $\frac{(\frac{\pi}{4} \times D^2 \times (P+1) \times L)}{1000}$

C = $\frac{(\frac{\pi}{4} \times 10^2 \times (7+1) \times 5)}{1000}$

C = 3.141 liters

ii) Free air consumption in liters for forward stroke; C-

$$C = \frac{(\frac{\pi}{4} \times (D-d)^2 \times (P+1) \times L)}{1000}$$

$$C = \frac{(\frac{\pi}{4} \times (10-2)^2 \times (7+1) \times 5)}{1000}$$

C = 2.0106 liters

Hence for one complete one cycle of operation for this cylinder, the free air consumption will be (3.141 + 2.106 = 5.1516 liters)

- Mounting types

i) Front plate mounting

ii) Rear plate mounting

iii) Double trunion mounting

iv) Centre trunion mounting

v) Neck mounting

vi) Leg mounting

vii) Hinge mounting

But we are select “Front type mounting” because it’s suitable for our project construction.

4. SAFETY MEASURES WHEN USING PNEUMATIC CONTROL SYSTEMS

i) Compressed air can cause serious damage to the human body if they enter the body through ducts like the oral cavity or ears.

ii) Never spray compressed air onto anyone.

iii) Under high temperature, compressed air can pass through human skin.

iv) Compressed air released from the exhaust contains particles and oil droplets, which can cause damage to eyes.

v) Even though the pressure of compressed air in pipes and reservoirs is relatively low, when the container loses its entirety, fierce explosions may still occur.

vi) Before switching on a compressed air supply unit, one should thoroughly inspect the whole circuit to see if there are any loose parts, abnormal pressure or damaged pipes.

vii) A loose pipe may shake violently due to the high pressure built up inside it. Therefore, each time before the system pressure is increased; thorough inspection of the entire circuit is required to prevent accidents.

viii) As the force produced by pneumatic cylinders is relatively large, and the action is usually very fast, you may suffer serious injuries if you get hit by a cylinder.

ix) Switches should be installed on the compressed air supply unit to allow easy and speedy control of air flow.

x) In case of a leakage, the compressed air supply unit should be turned off immediately.

xi) The compressed air supply unit must be turned off before changes can be made to the system.

xii) Stay clear of the moving parts of the system. Never try to move the driving parts in the mechanical operation valve with your hand.

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5. CONCLUSION

Now we know that Pneumatic Shearing machine is very cheap as compared to hydraulic shearing machine. The range of the cutting thickness can be increased by arranging a high pressure compressor and this machine is advantageous to small sheet metal cutting industries as they do not have rely on the expensive hydraulic shearing machine

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