

## **Pneumatic Sheet Cutting Machine**

Kamble swapnil sudhakar<sup>1</sup>, bhingole Pritam gangadhar<sup>2</sup>, Prashant chame vijaykumar<sup>3</sup>, musande raman daulat<sup>4</sup>, Prof. Nizammehdi abdul mannan<sup>5</sup>

1,2,3,4 Student of Diploma in Mechanical Engineering Department Vishweshwarayya Abhiyantriki Padvika Mahavidhyalay, Almala, Maharashtra, India

5 Guide Lecturer in Mechanical Engineering Department, Vishweshwarayya Abhiyantriki Padvika Mahavidhyalay, Almala, Maharashtra, India.

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### **Abstract :**

*This is a review of the previous work done on the sheet metal where the cutting and bending of the sheets has been studied under various conditions. In the industries, a lot of work is done on sheet metal. To ensure the adequate demand, sheet metal is cut and bent into variety of shapes. The pneumatic sheet cutting machines are one of the modern techniques which are used efficiently to make the sheet cutting and bending an efficient process. This work reviews the reliability, performance and the possibilities of simplifying the design of the pneumatic sheet cutting machines.*

**Keywords:** Control valve ,pneumatic cylinder ,pipes, cutting plate ,nuts.

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### **I. INTRODUCTION**

In some industries, hand sheet cutter is used which is operated manually. In this machine, we are using a pneumatic cylinder for sheet metal cutting. This machine should be easy to operate and maintain also. Hence, we are introducing a pneumatic sheet metal cutting machine which will reduce manufacturing cost and minimize industrial labor problems which is the biggest headache for human.

Sheet metal is simply a metal formed into thin and flat pieces. It is one of the fundamental forms used in metalworking and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material. Normally the sheet metal cutting machine is manually hand operated for medium and small-scale industries. Any automatic machine aimed for economical use of man. In this project, pneumatic cylinder is used for cutting in easy way which can be used in small scale industries at lower cost. The sheet metal cutting machine works with the help of pneumatic double acting cylinder. The main advantage of pneumatic sheet metal cutting machine is to improve product quality, repetition of work and increasing production rate. In cutting operation as or blade descends upon the metal, the pressure exerted by the blade first caused the plastic deformation of the metal, since the clearance between to blade is very small. The plastic deformation takes place in localize area and the metal adjacent to the cutting edges of the blade edges become highly stress, with courses the facture to start on both side of the sheet as the deformation progresses and sheet is shear.

### **II. LITERATURE REVIEW**

Normally the sheet metal cutting machine is manually hand operated for medium and small-scale industries. Any automatic machine aimed for economical use of man. In this project, pneumatic cylinder is used for cutting in easy way which can be used in small scale industries at lower cost. The sheet metal cutting machine works with the help of pneumatic double acting cylinder. The main advantage of pneumatic sheet metal cutting machine is to improve product quality, repetition of work and increasing production rate. In cutting operation as or blade descends upon the metal, the pressure exerted by the blade first caused the plastic deformation of the metal, since the clearance between to blade is very small. The plastic deformation takes place in localize area and the metal adjacent to the cutting edges of the blade edges become highly stress, with courses the facture to start on both side of the sheet as the deformation progresses and sheet is shear. Sheet metal is simply a metal formed into thin and flat pieces. It is one of the fundamental forms used in metal working and can be cut and bent into a variety of different shapes. Countless everyday objects are constructed of the material. Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate. Sheet metal also has applications in car bodies, airplane wings, medical tables, roofs for buildings (Architectural) and many other things. The most common cutting processes

are performed by applying a shear force, and are therefore sometimes referred to as shearing processes. Cutting processes are those in which a piece of sheet metal is separated by applying a great enough force to cause the material to fail. When a great enough shearing force is applied, the shear stress in the material will exceed the ultimate shear strength and the material will fail and separate at the cut location. The reason for using pneumatics, or any other type of energy transmission on a machine, is to perform work. The accomplishment of work requires the application of kinetic energy to a resisting object resulting in the object moving through a distance. In a pneumatic system, energy is stored in a potential state under the form of compressed air. Working energy (kinetic energy and pressure) results in a pneumatic system when the compressed air is allowed to expand. Metal in the form of sheets is paramount in the manufacturing industry. Its applications are countless. But metal in the form of sheets cannot be directly used, operations like cutting, punching, blanking, bending, trimming, etc. are needed to be carried out on the metal sheets in order to fully utilize them. For these operations, most large-scale manufacturing industries use hydraulically operated machines. But since hydraulic machines are not cost-effective, most small and medium scale industries use hand-operated machines for carrying out sheet metal operation. The problem with hand-operated machines is that they are slow and cannot be automated. This is where the concept of pneumatics will prove itself advantageous. We are developing a pneumatically operated cutting machine which will use the help of compressed air to drive a shearing blade, to carry out the operations on a metallic sheet. Hydraulic machines are also available for sheet metal cutting. But this method is used for only heavy metal cutting and its cost is very high. We are using a pneumatic system for sheet metal cutting in an easy way. It is operated by a pneumatic hand lever of two ways control valve. Control valve is operated by a compressor. In shearing or cutting operation as or blade descends upon the metal, the pressure exerted by the blade first cause the plastic deformation of the metal. Since the clearance between the two blades is very small, the plastic deformation takes place in a localized area and the metal adjacent to the cutting edges of the blade edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses and the sheet is sheared.

## **1.PNEUMATIC SYSTEM**

The subject of pneumatics might probably be termed as compressible fluid mechanics. It deals with the use of pressurized gas as a source of power. The pressure energy of gas is directly converted into force to do the required work with high efficiencies of conversion.

The pneumatic cylinder utilizes a low-pressure fluid. It has the advantage that cylinder construction can be simplified reducing cost. It can be used for high-speed operations. Pneumatics is widely associated with low-cost automation. It generally offers the lowest initial and operating cost and simple, flexible control systems.

Though pneumatic system is the study properties of air other gases, we are concerned with the study of air.

### **1.1 CHARACTERISTICS OF COMPRESSED AIR:**

The greatest advantage of pneumatic system is the availability of working medium free of cost and it plentiful. Compressed air can also be transported easily and can be easily stored in a reservoir.

Another notable advantage is the insensitiveness of compressed air to temperature fluctuations. It ensures reliable operation even under extreme conditions of temperature. Compressed air offers no risk of explosion; hence no expensive protection cost is required. Compressed air is a very fast working medium where speed and force are infinitely variable.

### **1.2 CHARACTERISTICS OF PNEUMATICS:**

#### **1.2.1 Compressibility**

A pneumatic fluid is compressible. Compressibility plays a major role in the actuation of piston, i.e., opening a valve does not move the piston immediately, rather sufficient fluid must flow into the volume to increase the pressure until the force overcomes that on the other side.

Compressibility is the energy storage of a fluid. As it is possible to store compressed fluids and transport them, pneumatics has the advantage of transportability. Another advantage of the energy storage capacity is the small compressor charging a tank can supply a system having high peak loads but small average loads.

#### **2. Leakage Sealing Problems**

Several methods are used to minimize leakage. One is to use a low operating pressure. Another method to prevent leakage is sealing. Good sliding and rotating sealing are to obtain in pneumatics is because of low viscosity of the fluids Diaphragms and bellows are used to avoid sliding seats.

#### **3. Low Viscosity:**

A highly encounter problem due to low viscosity is that of sealing. They provide less viscous damping due to low viscosity hence sliding parts wear considerably. This adds the necessity for external sources of lubrication. Another problem is that the pneumatic cylinder should be thinner enough to maintain a laminar flow inside.

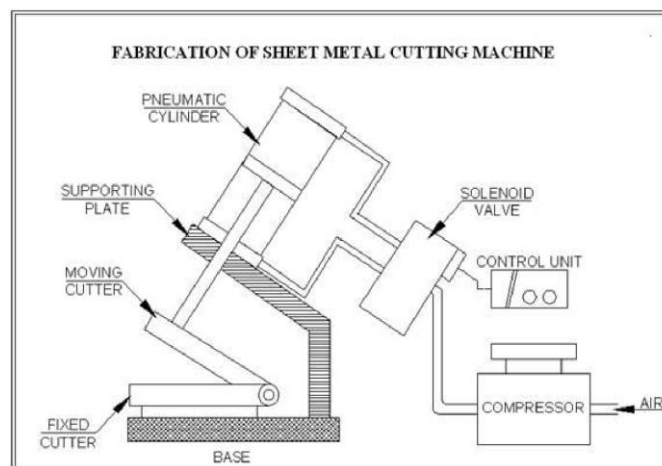
## **2. ADVANTAGES OF PNEUMATIC SYSTEM OVER OTHER SYSTEM:**

1. Output power of the pneumatic system can be easily controlled
2. Pneumatic system is not affected by over loading

3. The pneumatic system can be used at various working temperatures
4. Air can be easily distributed through pipelines over very long distances
5. Pneumatics enables high working speeds
6. It is a maintenance-free system
7. Pneumatics enables the application of force very gently which is not only beneficial to pneumatic components but also the equipment which they are installed.
8. The working fluid which is stored in the storage tank can be taken through number of lines which eliminates the use of individual power sources such as electric motor and many other machine parts.

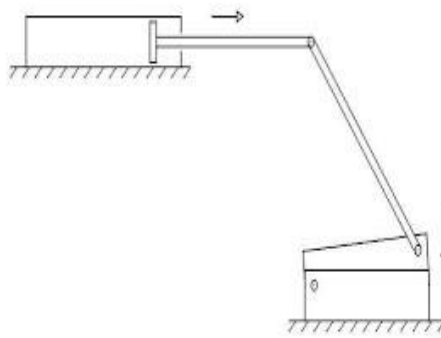
### 3. WORKING PRINCIPAL

The pneumatic machine includes a table with support arms to hold the sheet, stops or guides to secure the sheet, upper and lower straight-edge blades, a gauging device to precisely position the sheet. The table also includes the two-way directional valve. The two-way directional valve is connected to the compressor. The compressor has a piston for a movable member. The piston is connected to a crankshaft, which is in turn connected to a prime mover (electric motor, internal combustion engine). At inlet and outlet ports, valves allow air to enter and exit the chamber. When the compressor is switched ON, the compressed air is flow to inlet of the pneumatic cylinder. The sheet is placed between the upper and the lower blade. The lower blade remains stationary while the upper blade is forced downward. The upper blade is slightly offset from the lower blade, approximately 5–10% of the sheet thickness. Also, the upper blade is usually angled so that the cut progresses from one end to the other, thus reducing the required force. After the material is cut, adjust the pneumatic hand lever to the mid position (i.e., normal position) and then the compressor is switched OFF. The following figure shows general layout for the machine.

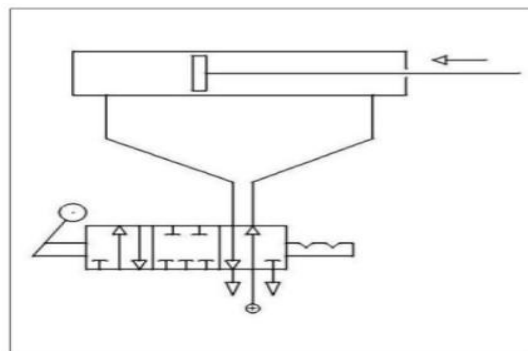


**Fig 3 General Layout of Sheet Metal Cutting Machine**

Through FRL unit air can be controlled. From the manifold a separate supply for the machine is taken out and given to initially the air-compressor is started and allowed the receiver tank air pressure to reach up to 8 bars. The supply air is then passed to the manifold ON/OFF switch; so as to operate the machine at will without interrupting the running of compressor. Then the pipe carries compressed air first to machine's Direction Control Valve. At position „A“ shows the non-actuated circuit diagrams. At this position the piston is steady and locked. All ports are in closed condition at position „B“, the DC valve is at left hand position as shown in figure. The cap end port & pressure port get connected to each other and the rod end port gets connected to the exhaust port. The compressed air comes in the cap end of the cylinder and pushes the pistons outwards.



**Fig 3.1 Mechanism**



**Fig.3.2 working diagram**

The air already present in the rod end side is pushed out of the cylinder. When the piston moves outwards, the force is transmitted through the connecting link and the upper blade moves downwards. Before the actuating DC valve, the sheet is inserted in between the upper & lower blades. As upper blade moves downwards, the stress is generated in the sheet metal and goes beyond ultimate shear stress of sheet metal. And thus, the shearing action takes place. Now the DC valve is operated to come at position „C“, as shown in figure. The rod end port & pressure port get connected to each other and the cap end port gets connected to the exhaust port. The compressed air comes in the rod end of the cylinder and pushes the pistons inwards. The air already present in the cap end side is pushed out of the cylinder. sheet metal is either again inserted for further cutting in case of large pieces; the small cut pieces are removed and the next sheet is inserted to cut.

**Shearing.** As mentioned above, several cutting processes exist that utilize shearing force to cut sheet metal. However, the term “shearing” by itself refers to a specific cutting process that produces straight line cuts to separate a piece of sheet metal. Most commonly, shearing is used to cut a sheet parallel to an existing edge which is held square, but angled cuts can be made as well. For this reason, shearing is primarily used to cut sheet stock into smaller sizes in preparation for other processes. Shearing has the following capabilities. Sheet thickness: 0.005 – 0.25 inches Tolerance: 0.1 inches the shearing is performed on a shear machine, often called a squaring shear or power shear, that can be operated manually or by hydraulic, pneumatic, or electric power. A typical shear machine includes a table with support arms to hold the sheet, stops or guides to secure the sheet, upper and lower straight - edge blades, a gauging device to precisely position the sheet. The sheet is placed between the upper and the lower blade, which are then forced together against the sheet, cutting the material. In most devices, the lower blades remain stationary while the upper blade is forced downward. The upper blade is slightly offset from the lower blade, approximately 5 – 10% of the sheet thickness. Also, the upper blade is usually angled so that the cut progresses from one end to the other, thus reducing the required force. The knife edge and are available in different materials, such as low alloy steel and high carbon steel.

**Pneumatic Transmission of Energy:** The reason for using pneumatics, or any other type of energy transmission on a machine, is to perform work. The accomplishment of work requires the application of kinetic energy to a resisting object resulting in the object moving through a distance. In a pneumatic system, energy is stored in a potential state under the form of compressed air. Working energy (kinetic energy and pressure) results in a pneumatic system when the compressed air is allowed to expand. For example, a tank is charged to 100 PSIA with compressed air. When the valve at the tank outlets opened, the air inside the tank expands until the pressure inside the tank equals to atmospheric pressure. Air expansion takes the form of airflow. To perform

any applicable amount of work then, a device is needed which can supply an air tank with a sufficient amount of air at a desired pressure. This device is positive displacement compress

Pneumatic sheet cutting machine is a very versatile machine and has a lot of applications because of its flexibility and ease of doing operations. This machine can be converted into a punching machine by removing the blade and adding punching die to the end of the piston.] By increasing the pressure, we can cut more sheets collectively. Because of its enormous use in industries higher production rate can be achieved by balancing the forces and making the design more compact. Software and advance controlling systems can improve the machines performance. By replacing the pneumatic circuit with rack and pinion arrangement, it can be converted into rack and pinion operated machine. The electric motor air compressor can also be replaced by an IC engine installed compressor where we are deprived of electric energy. In this machine, the ideal stroke wastes the air which moves out through the out port of control unit. In future, mechanism can be developed to use the air again for the working of cylinder.

### **III. CONCLUSION**

It is similar to that of an internal combustion (IC) engine consisting of cast-iron or aluminum body with an oil tank, the base piston with piston rings, valves, connecting rods, cranks, crank shaft and bearing etc. If the piston is moving down air is sucked in through the suction valve and a filter and is compressed in return stroke Oil level gauges, oil filling screw and oil outlet screw etc. are also important parts of an air compressor.

The pressure switch is connected to the driving motor and is set such that it automatically trips off, disconnecting the electrical connection to the motor as soon as the receiver achieves the desired set pressure.

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