*International Journal on Emerging Technologies* (Special Issue on ICRIET-2016) **7**(2): 360-365(2016)

**ISSN No. (Print) : 0975-8364**
**ISSN No. (Online) : 2249-3255**

# Fabrication of Pneumatic Sheet Metal Cutter

***Raj Reddy***
*Asst. Prof. Department of Mechanical Engineering,*
*BKIT Bhalki: 585328. Karnataka, India*

*(Corresponding author: Raj Reddy)*
*(Received 28 September, 2016 Accepted 29 October, 2016)*
*(Published by Research Trend, Website: www.researchtrend.net)*

**ABSTRACT: We are using scissors for simple sheet metal cutting. It is a manual method so that sheet metals are to be wasted sometime because of mistakes happened such as wrong dimensions etc., and also even a simple cutting may take long time. 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 a easy way. It is operated by a pneumatic hand lever of two way control valve. Control valve is operated by a compressor.**

**Keywords:** Hydraulic, Pneumatic, FRL unit, double acting cylinder. DCV, Pressure relief valve etc.

## I. INTRODUCTION

The formation of any business begins with someone producing the initial idea for the project. The continued success of an established business depends upon the number and quality of the ideas fed into it. Without a continual flow of new ideas, a business cannot function profitably or expand successfully and must, therefore eventually fade into total obscurity. Ideas for a new business project, a new product, a means of reducing manufacturing costs or for solving industrial labor problems, begin in the human mind. Most people conceive their ideas unconsciously, and because they are unaware of the mental mechanics that caused the 'idea' to be produced, they cannot repeat the ideation process to produce further profitable ideas at will. Fortunately, there are available established creative techniques which, when used correctly, do enable a person to produce a large number of first-class ideas at will. One such creative technique, and probably the most widely used in American industry, is 'brainstorming'.

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.

### *A. Sheet Metal*

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 is available in flat pieces or as a coiled strip. The coils are formed by running a continuous sheet of metal through a roll slitter. The thickness of the sheet metal is called its gauge. Commonly used steel sheet metal ranges from 30 gauge to about 8 gauge. The larger the gauge number, the thinner the metal. Gauge is measured in ferrous (iron based) metals while nonferrous metals such as aluminum or copper are designated differently; i.e., Copper is measured in thickness by Ounce. There are many different metals that can be made into sheet metal, such as aluminum, brass, copper, steel, tin, nickel and titanium. For decorative uses, important sheet metals include silver, gold and platinum (platinum sheet metal is also utilized as a catalyst.)

Sheet metal also has applications in car bodies, airplane wings, medical tables, roofs for buildings (Architectural) and many other things. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines. Historically, an important use of sheet metal was in plate armor worn by cavalry, and sheet metal continues to have many decorative uses, including in horse tack. Sheet metal workers are also known as "Tin Bashers",("Tin Knockers") which is derived from the hammering of panel seams when installing tin roofs.

## II. LITERATURE SURVEY

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.

Types of shearing machine

**1) Pneumatically operated:** Here the advancement of the header is carried out in the upward and the downward direction using the pneumatic double acting piston and cylinder unit arrangement along with the foot operated direction control valve. In this type of machine high pressure air is used as the working fluid for the transfer of power and the motion.

**2) Hydraulically operated:** Here the lowering and raising of the header is carried over using the hydraulic piston and cylinder arrangement. To actuate the piston and cylinder, the oil is allowed to enter the cylinder from front or the back side of the piston. But the oil is comparatively costlier and its leakage may cause so many problems.

**3) Rack and pinion operated:** Here the lowering and the raising of the header are carried out manually using the rack and pinion arrangement. In this case the required pressure is applied manually using direct hand pressure on the rack using pinion and lever arrangement. Since the machine is robust and requires large pressure, hence it is not suitable.

**4) Spring operated:** The working of spring operated machine is similar to the rack and pinion operated machine but differs from it in construction. Here the lowering and the raising of the heating handle are carried out manually and it requires too much pressure for its operation and also there is possibility of having damage to the work piece if not handled carefully.

## III. DESIGN AND CONSTRUCTION

**Raw Material Used-**

1. Mild Steel bars for base frame.
2. 35C8 material for shearing blades.
3. Cylinder fittings like fork end, base plates, support links.
4. Angle section for blade fitting.
5. Connecting link.

**Ready Items Used-**

1. Pneumatic double acting cylinder.
2. Direction & flow control valves.
3. Pneumatic pipe & pipe fittings.
4. Bolts & nuts.
5. Antirust coat & paint.

**Machines & Tools Used-**

1. Cutting Machine.
2. Hacksaw Cutting Machine.
3. Sensitive Drilling Machine.
4. Horizontal Milling Machine.
5. Electric Arc Welding Machine.
6. Table Grinder.
7. Hand Grinder.
8. Surface Grinding Machine.
9. Tap & Tap Holder.

**DESINE**

**1. Base Frame-**
Quantity: 1
Height: 300mm
Length: 900mm
Width: 300mm
Weight: 5kg

**2. Shearing Blade-**
Quantity: 2
Length: 300mm
Height: 60mm
Thickness: 15mm
Blade Angle: 15o
Weight: 3.5kg

**3. Base Plate-**
Quantity: 1
Height: 65mm
Width: 65mm
Thickness: 6mm

**4. Fork End-**
Quantity: 1
Length: 75mm
Width: 20mm
Thickness: 5mm

**5. Angle Section-**
Quantity: 1
Height: 45mm

Length: 300mm
Width: 45mm
Thickness: 7mm
Weight: 0.5kg

**6. Connecting Link-**
Quantity: 1
Length: 360mm
Thickness: 5mm
Height: 25mm
Weight: 0.3kg

**7. Support Links-**
Quantity: 2
Height: 90mm
Width: 25
Thickness: 5

**8. Blade Link-**
Quantity: 1
Height: 90mm
Width: 20mm
Thickness: 5mm
Welded Length: 30mm

**SPECIFICATION**

**1. Pneumatic Cylinder-**
Quantity: 1
Total Length: 375mm
Bore: 40mm
Stroke: 200mm
Piston Rod Diameter: 20mm
Max Working Pressure: 8 bar
Weight: 3kg

**2. DC Valve-**
Quantity: 1
Operation: Manual
Type: Hand Lever, Detent Type
Number of Ports: 5
Number of Positions: 3
Construction: Sliding spool type

**3. Pneumatic Pipe-**
Quantity: 3000mm
Diameter: 8mm
Thickness: 1mm

**4. Fork End Nut-**
Quantity: 2
Length: 16mm , Size: M16

**Double Acting Cylinders.** Double-acting cylinder (DAC) uses the force of air to move in both extraction and retraction strokes. They have two ports to allow air in, one for outstroke and one for in stroke. Stroke length for this design is not limited; however, the piston rod is more vulnerable to buckling and bending. Additional calculations should be performed as well.

Pneumatic cylinder consist piston, piston rod and a body or tube. Compressed air enters at one end of the tube imparting Force on the piston which is then displaced in order to balance the force exerted on the piston .cylinders are available in a variety of sizes and shapes and has varying stroke. A typical cylinder sizes range from a small 2.5 mm air cylinder which might be used for picking up a small transistor or other component.

**Fig. 1.** FRL Unit.

Air leaving a compressor is hot, dirty, and wet—which can damage and shorten the life of downstream equipment, such as valves and cylinders. Before air can be used it needs to be filtered, regulated and lubricated.

An air line filter cleans compressed air. It strains the air and traps solid particles (dust, dirt, rust) and separates liquids (water, oil) entrained in the compressed air. Filters are installed in the air line upstream of regulators, lubricators, directional control valves, and air driven devices such as cylinders and air motors.

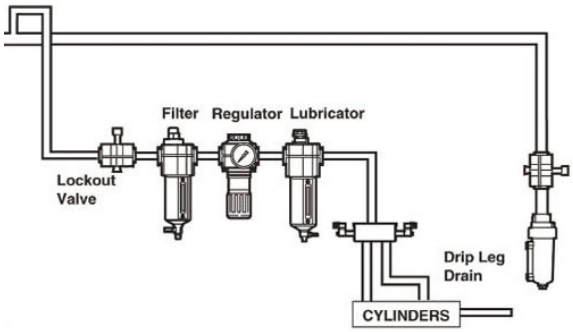



**Fig. 2.** General layouts.

Air line filters remove contaminants from pneumatic systems, preventing damage to equipment and reducing production losses due to contaminant related downtime. Downtime in an industrial plant is expensive; often it is the result of a contaminated and poorly maintained compressed air system.

**Fig. 3.** Directional Control Valves.

Selecting the proper size of filter for any application should be done by determining the maximum allowable pressure drop, which can be caused by the filter. The pressure drop can be determined by referring to flow curves provided by the manufacturer.

Directional control valves are one of the most fundamental parts in hydraulic machinery as well as pneumatic machinery. They allow fluid flow into different paths from one or more sources. They usually consist of a spool inside a cylinder which is mechanically or electrically controlled. The movement of the spool restricts or permits the flow, thus it controls the fluid flow. A 5/2 directional control valve would have five ports and two spool positions.

**Fig. 5.** Direction Control Valve.

**Sheet Cutter.** Sheet cutter are hand-operated shearing tools. They consist of a pair of metal blades pivoted so that the sharpened edges slide against each other when the handles (bows) opposite to the pivot are closed.High-carbon, high chromium steel is used in production of sheet cutter

**Fig. 6** Frame Base.

It forms the robust supports to stand the machine vertically. It holds the weight of the vertical post and supports the direction control valve. It is made of mild steel. It is made of rectangular base with the vertical post and the horizontal channel.

**Fig. 7.** Base Frame.

**Air Compressor.** An air compressor is a device that converts power (using an electric motor, diesel or gasoline engine, etc.) into potential energy stored in pressurized air (i.e., compressed air). By one of several methods, an air compressor forces more and more air into a storage tank, increasing the pressure. When tank pressure reaches its upper limit the air compressor shuts off. The compressed air, then, is held in the tank until called into use. The energy contained in the compressed air can be used for a variety of applications, utilizing the kinetic energy of the air as it is released and the tank depressurizes. When tank pressure reaches its lower limit, the air compressor turns on again and re-pressurizes the tank

**Force Calculation**

Force required to cut the Sheet = L*t*Tmax

For sheet of 0.5 mm thickness, force required = 25*0.5*30= 375 N

This is the force required to cut the sheet metal, however the initial force required to cut the sheet is more and it is 140-150% than we calculated. Therefore, max force required to cut the sheet = 525 to 562.5 N.

Now we have chosen 12 volt DC Air Compressor that develops a pressure of 10.34 bar (150psi).

Design of Cylinder

Since the max force required to cut the sheet = 562.5 N

And pressure applied by 12 volt compressor =10.34 bar

Therefore, Force applied by the cylinder,

F = (Pi/4)*d2*P

562.5=(Pi/4)*d2*(10.34/10)

d=26.3 mm

For safety , we have taken the cylinder of diameter 30 mm.

**Materials:**

**Stainless Steel:**

The three most common stainless steel grades available in sheet metal are 304, 316, and 410.

- Grade 304 is the most common of the three grades. It offers good corrosion resistance while maintaining formability and weld ability. Available finishes are #2B, #3, and #4. Note that grade 303 is not available in sheet form.
- Grade 316 offers more corrosion resistance and strength at elevated temperatures than 304. It is commonly used for pumps, valves, chemical S equipment, and marine applications. Available finishes are #2B, #3, and #4.
- Grade 410 is a heat treatable stainless steel, but does not offer as good corrosion resistance. It is commonly used in cutlery. The only available finish is dull.

## IV. WORKING PRINCIPLE

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.

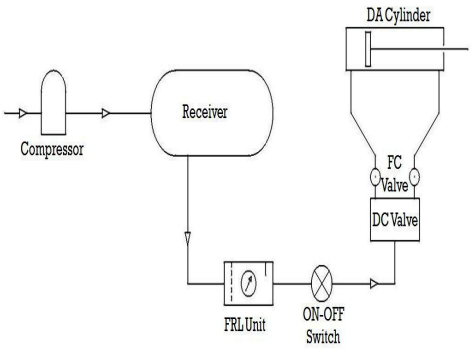



**Fig. 8.** General Layout.

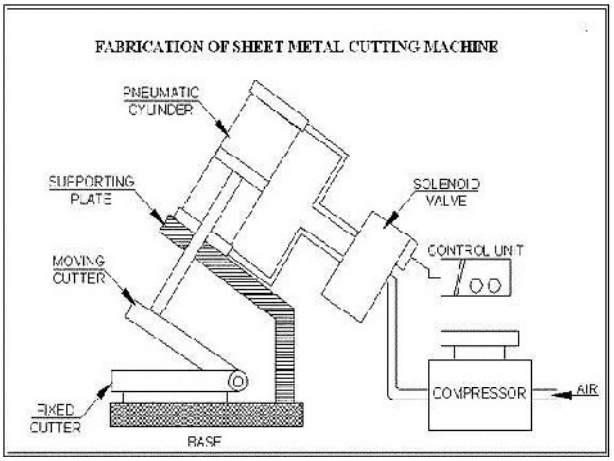
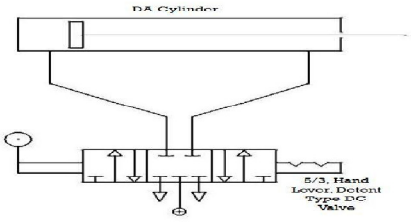
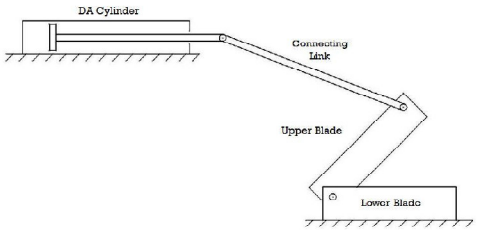



**Fig. 9.** General Layout Of Sheet Metal Cutting Machine.

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.




Position 'A'




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.

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 compressor.

## V. 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 installing more hardened blades. This machine is advantageous to small sheet metal cutting industries as they cannot afford the expensive hydraulic shearing machine.

## REFERANCE

[1]. Madhu Kumar V " Design and Fabrication of Pneumatic Sheet Metal Cutting and Bending Machine. *International Journal of Engineering Research And Advanced Technology (IJERAT).*

[2] Vishal Tambat, Nilkanth Rane, Omkar Savant, 4Pankaj Yadav. Pneumatic Shearing and Bending Machine, *IJRRCME*, Vol. **2**, Issue 1, pp: (9-18), Month: April 2015 – September 2015.

[3]. Aniruddha Kulkarni, Mangesh Pawar "Sheet Metal Bending Machine. *IJIERT,* I SSN: 2394-3696 VOLUME **2**, ISSUE 3, March.-2015

[4] Patil Rohit R, Jadhav Amol K . Hydraulic Rebar Cutter, *International Journal of Current Engineering and Technology*, E-ISSN 2277 –4106, P-ISSN 2347 –5161.

[5]. Aniruddha Kulkarni, Mangesh Pawar "Methodology Of Special Purpose Sheet Metal Cutting Machine. IJPRET, ISSN: 2319-507X, VOLUME **2**, ISSUE 9, 2014.

[6] Patil Rohit R, Jadhav Amol K . Analysis and Simulation of Sheet Metal Cutting By Using Radan Software, IJIR,, Vol-2, Issue-5, 2016 ISSN: 2454-1362.