



Review of Pneumatic Sheet Metal Cutting Machine

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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: Sheet Metal, Pneumatic Cylinder, Control Valve, Compressor.

1. Introduction

In some industries, hand sheet cutter is used which is operated manually. In these machine, we are using a pneumatic cylinder for sheet metal cutting. These 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 fracture to start on both side of the sheet as the deformation progresses and sheet is shear.

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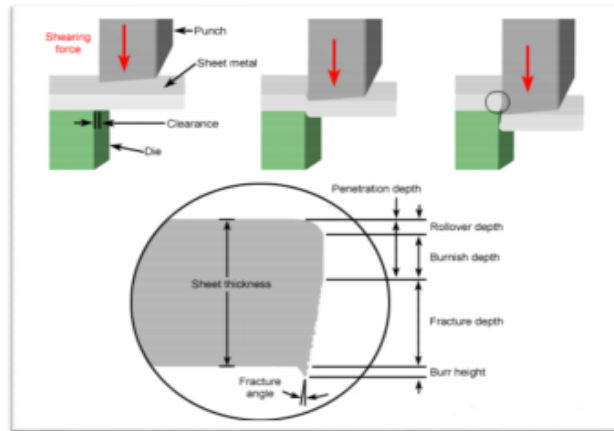


Fig 1 Schematic Diagram

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.

1.1 Component Used

- Pneumatic Cylinder
- Direction Control Valve
- Pneumatic Compressor
- Polyurethane Tube
- Cutting Blade

● Pneumatic Cylinder

Pneumatic cylinder are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a disc or cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage.

● Direction Control Valve

Directional control valves (DCVs) are one of the most fundamental parts of hydraulic and pneumatic systems. DCVs allow fluid flow (hydraulic oil, water or air) into different paths from one or more sources. DCVs will usually consist of a spool inside a cylinder which is mechanically or electrically actuated. The position of the spool restricts or permits flow, thus it controls the fluid flow. there are five operating method in direction control valve- Manual, spring, electrical, pneumatic, and hydraulic. Solenoid valve are widely used in the hydraulics industry. These valves make use of electromechanical solenoids for sliding of the spool. Because simple application of electrical power provides control, these valves are used extensively.

● Pneumatic Compressor

An air compressor is a pneumatic 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 the tank's pressure reaches its engineered upper limit, the air compressor shuts off. The compressed air, then, is held in the tank until called into use.[1] 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. An air Compressor must be differentiated from a pump because it works for any gas/air, while pumps work on a liquid

● Polyurethane Tube

It is used to pass substances which can flow through it. It can be used for various applications. The hollow pipes are generally stiffer than solid pipes. [4] It generally consists of a nominal diameter and schedule that defines the thickness.

- Cutting Blade

It is one of the main components which cut the metallic sheets. Generally it is made of high carbon steel because there is huge resistance in the metallic sheets which are to be sheared. It is used to cut the sheets of metal of varying sizes; generally thickness may vary from 1 mm to 5mm. A compressor of size nearly 8-14 Kg/cm² is enough to cut down the sheet having thickness up to 5 mm.[1]

Table 1 ^[2] Material Used for different components

SR.NO.	COMPONENT NAMES	MATERIAL
i	Frame	Mild steel
ii	Cylinder	Alloy steel
iii	Piston rod	
iv	Cutting blade	Alloy steel
v	Fixing blade	Alloy steel
vi	Both side control valve	Steel

2. 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 localized area and the metal adjacent to the cutting edges of the blade edges become highly stress, with courses the fracture 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 a 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.

3. Literature Review

The sheet cutting machine is the heart of sheet metal industries. In some industries, hand sheet cutter is used which is operated manually and less accurate. Hence, we are introducing a pneumatic sheet metal cutting machine, these machine should be easy to operate and maintain also, which will reduce manufacturing cost and minimize industrial labour problems. If we use the machine the work will be completed in time as compared to the previous situation.

4. Methodology

4.1 Merits & Demerits [5]

Merits

1. Hydraulics present certain advantages over pneumatics, but in a given application, pneumatic powered equipment is more suitable, particularly in industries where the factory units are plumbed for compressed air.
2. Moreover, to avoid corrosive actions, oil or lubricants are added so that friction effects can be reduced.
3. Compressed air is used in most of the machines and in some cases compressed carbon dioxide, whereas cutting process is become easy.
4. Fast cutting action is carried out.
5. Cutting without bending is achieved.

Demerits

1. Sheet more than 2 mm thickness cannot cut easily.
2. Compressed air is must.
3. Foundation is required also safety major must be taken

4.2 Applications [5]

Sheet metals are used 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.

4.3 Future Scope

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. [6] 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. [6] Software and advance controlling systems can improve the machine's performance. [6] 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. [7] 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. [7]

4.4 Advantages:[5]

- Low cost
- Less consumption of time
- Easy to handle
- Skilled labor is not required
- Less maintainance
- High accuracy
- Good surface finish
- Less floor space

5. 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.

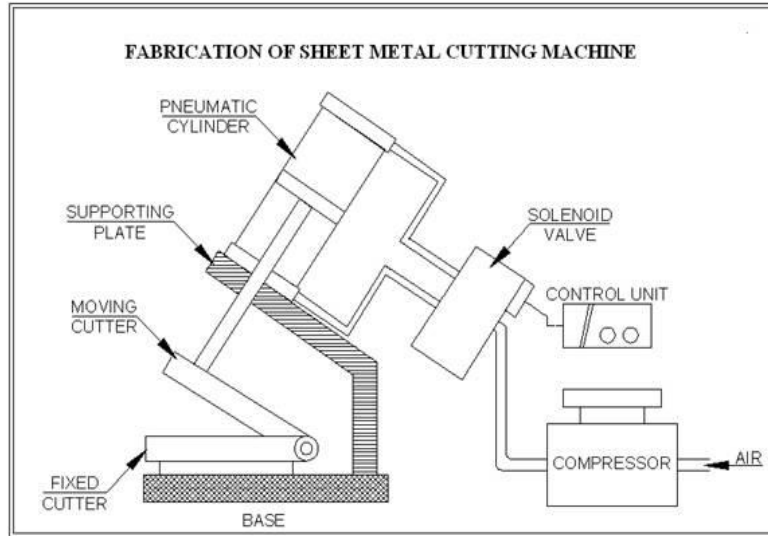


Fig 2 General Layout Of Sheet Metal Cutting Machine

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.

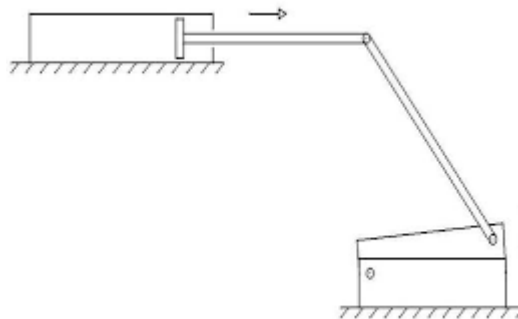


Fig 3 Mechanism

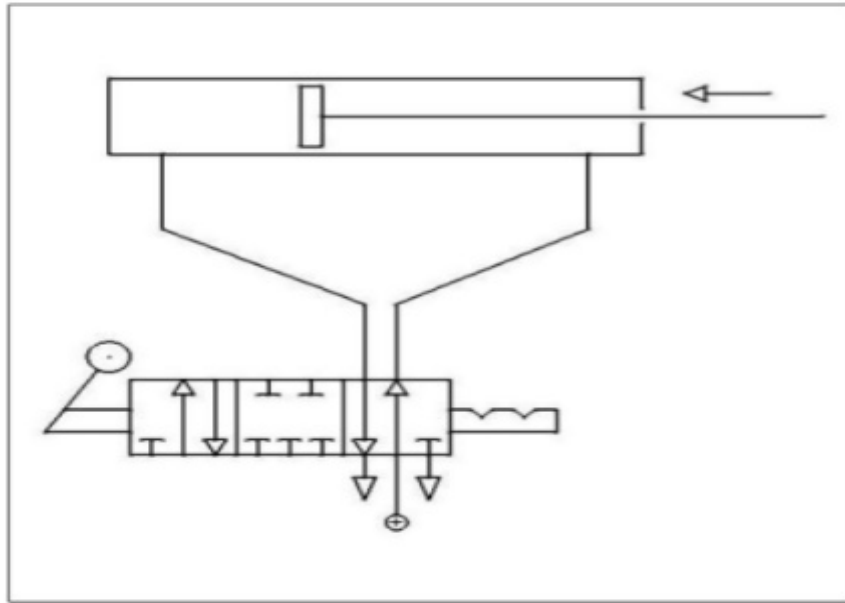


Fig 4

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.

6. Conclusion

After taking review, we can understand that there is a scope for work on sheet metal cutting operation using pneumatic system.

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