

Development of Sheet Metal Cutter with Less Human Efforts

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Abstract - The sheet metal cutting machine is the soul of small-scale sheet industries. These industries primarily consist of simple hand cutters for cutting operations. Metal in the form of thin sheets is dealt with everyday applications in the manufacturing, production, etc. industries daily. They have a varied number of applications. Metal sheets are incapably taken into consideration for direct use for operations such as cutting, punching, blanking, bending, trimming, etc., and are supposed to be accomplished on the sheet itself for the extent of complete implementations. For these, mostly large-scale industries already have the use of hydraulically operated machinery. Due to hydraulic machines being of high capital, small-scale industries use simple hand-operated machines for achieving these operations on metal sheets. Problems upcoming with these hand machine is that they are slow, require human labor, and cannot be automated. This is the situation in which the framework of pneumatic is going to be evidence of the convenience, influence, and leverage that it brings to work. This machine shall be used for simple linear cutting operations. Pneumatic systems are of immense significance and provide great considerable advantages when sheet metals are needed to be operated in hazardous areas which are in constant contact with oil and gas refineries like one in chemical factories. Then, it was noticed that utilizing this system can be fruitful in terms of cutting preciseness, time productivity, and increased capacity for mass production as compared to traditional non-automated cutting machines. The machine can be easily shifted to any place simply and smoothly.

Index Terms- Sheet cutter, Pneumatic, Automation, Machine, Hydraulics.

I. INTRODUCTION

Sheet metals are the metal sheet pounded into slim, planar pieces. The basic fundamental form used within metalworking is sheet metals. Sheet metal is made to bent, cut about the various desirable range to diverse forms. Sheet metals come in the form of

coiled strips or flat pieces. Gauge is the unit in which the sheet's thickness is measured. With a gauge of more than 5 mm sheet metals are considered as plates. Unquestionably shearing machines are of utmost significance for sheet industries. Nearly every, small-scale industry, has been implemented of simple hand cutter, which demands labor work to shear sheets. A pneumatic cutting machine can replace a simple hand sheet cutter, because of which sheet can be cut in quicker scale and a much more handy system. The Shearing processes are the most crucial part of almost every industry. The pneumatic system comprises pipelines, control valves, air compressors, and pneumatic cylinders. The cost of a machine that operates hydraulically is high for small and medium scale industries. So we decided to have a paper that deals with a machine that can run based upon pneumatics principle motive for this project are the creation of a machine that can be operated by a minimum labor force using pneumatics as the working medium. The time constraints for shearing metals will also be reduced by the pneumatic power. With the help of these machines, one can complete the objectives for the work that requires a faster rate of production and processes that eventually brings profits for the industry. Automation plays the purpose in this. And for this accomplishment of automation pneumatics comes into the picture. The other plus point of this system is that they are relatively cheap and transportable.

II. LITERATURE SURVEY

Cutting operation takes place when the plastic deformation takes place on the material on the specific surface (face) and the metal adjoining to cutting faces; as they become highly stressed, the fractures tend to develop on both faces of sheets and due to this deformation process the sheet is shear out.

In manual methods, it makes use of a lever-operated blade to shear the sheets. As a result of this, the sheets can be thrown away in scrap if an error unwilling has been committed by the operator. It is also very tiresome and time-consuming. Over time researchers are finding out alternatives for these operations. There exist a plethora of options for a shearing mechanism that industry tends to implement for shearing operations that can bring economic benefits and also improve their efficiency.

Several other machines can be the alternative for the cutting operations namely:-

- Driven by pneumatics
- Driven by hydraulics
- Driven by racks and pinions
- Driven by springs
- Plasma Cutting
- Laser cutting
- EDM, Etc.

III. OBJECTIVE

- Designing and developing of Pneumatic sheet metal cutter to reduce manpower and cost is one of the major objectives of the project. The machine should be portable and should be able to transport anywhere easily to cut small size sheet metal.
- Developing a sheet metal cutting machine that operates on the pneumatic forces is the objective of the project.
- The manpower requirement for sheet metal cutting should reduce.
- The efficiency and accuracy of the cutting operation should increase.

IV. DESIGN

A. Material Selection

For the preparation of any machine part, considering design and safety, the selection of material is very crucial. Following factors are taken into consideration during the material selection for engineering applications:-

- Availability of required materials
- Material suitability for the components that are required
- Price of materials

Mild steel has been used to make the machine. Mild steel is readily available in the market and hence mild steel has been selected. Mild steel is available in all the standard sizes and is very economical to use. The machinability of mild steel is easy. As the factor of safety results in heavy selection and unnecessary wastage of materials, its factor of safety is moderate. The risk of failure increases due to the low factor of safety. The tensile strength of mild steel is high. The thermal expansion coefficient is low. Aluminum, mild steel, and plastic are generally the materials which are taken for cutting as various metals in the current situation are being replaced by them because of their prominent properties and features

Material of Sheet Metal	Aluminum	Mild Steel
Thickness	0.5mm	0.5mm
Cut Length	25mm	30mm
Shear Strength of Aluminum (max)	30 N/mm ²	60 N/mm ²

Table 1

B. Cutting Operation's Force Calculation

Force requirement for cutting of Mild Steel Sheet

$$F = (l) \times (t) \times (T_{\max})$$

For a sheet of thickness 0.5mm,
Required Force, $F = 20 \times 0.5 \times 60 = 900\text{N}$

The force required to cut the sheet metal is 900N.

C. Design of the cylinder for cutting operations

The maximum force that is required to cut the sheet is

$$F = 900\text{ N},$$

The pressure exerted by compressor $p = 9\text{bar}$,

Hence,

The force that is applied by the cylinder is

$$F = (\pi/4) \times d^2 \times p$$

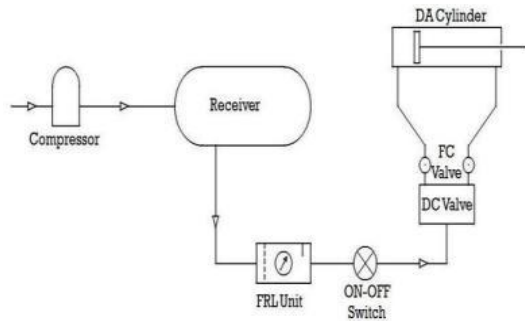
$$900 = (\pi/4) \times d^2 \times (9/10)$$

$$d = 35.68\text{mm}$$

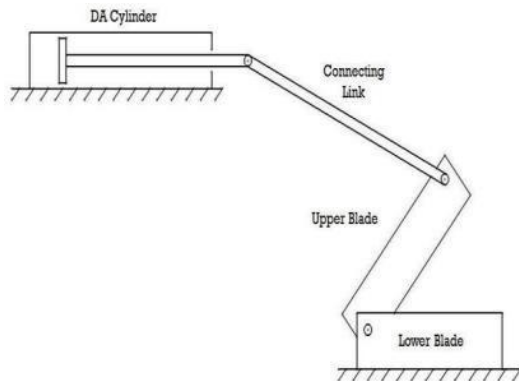
The diameter of the cylinder is taken as 35mm for safety reasons.

V. WORKING

The general layout of the machine is shown in the following figure.

Figure(1): General Layout

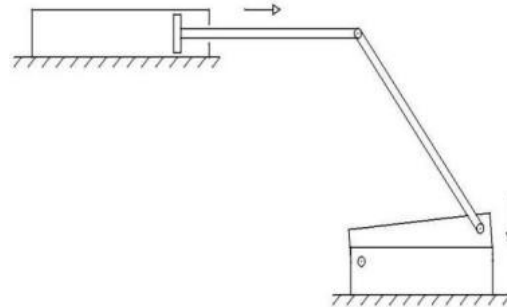
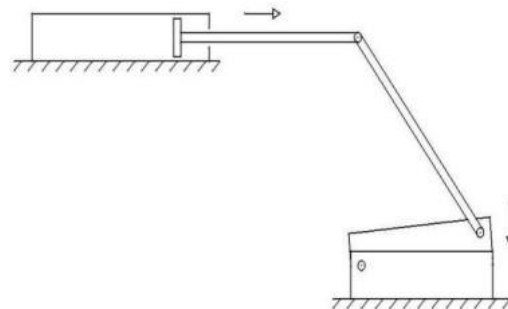
From the manifold, a separate supply is given to the machine. Initially, supply is provided to an air compressor and the receiver tank air pressure is allowed to reach 900kPa. The supplied air then passes through the ON-OFF switch of the manifold. Then the compressed air is carried first to the direction valve of the machine through the pipe. Position A shows the circuit diagram which is non-actuated. At this position, the piston is locked and steady. The status of all the ports is in a closed position.

Figure(2): Position A

As shown in the figure, at position B, the position of the DC valve is on the left hand. The exhaust port and end cap port are connected by the end part of the rod and the pressure port gets connected. The compressed air enters through the cylinder's end cap and hence the piston gets pushed in an outward direction.

The force gets transmitted through connecting link when the piston moves outwards and hence the upper blade moves in a downward direction. Before the DC valve is being actuated, the sheet is placed between the lower blade and the upper blade. Due to the downward motion of the upper blade, the metal sheet experiences shear stress. When the stress

generated in the metal sheet exceeds the ultimate shearing stress, the shearing of the sheet takes place. As shown in the figure, by operating the DC valve it is made to come at position C. Compressed air that enters the cylinder's rod end pushes the piston inwards. Air that was present in the cap end side of the cylinder gets pushed out. A similar process gets carried out for the cutting of sheet metal.

Figure(3): Position B**Figure(4): Position C**

VI. WORKING COMPONENTS

A. Sheet Metal

Sheet metal is the backbone of all engineering works and the metal industry today. We can see it everywhere right from cars and machinery to house facades and furniture; innumerable objects can be made out of sheet metals. The thickness starts from 0.5 mm and up to 6 mm. One with a thickness of more than 5 mm is considered a plate. In day-to-day activities in the industry, the thickness is denoted in terms of inches, millimeters, or microns rather than the gauge number. This also differs along with the sheets taken into consideration.

B. Air compressor

The process of increasing the pressure of a gas usually air, by reducing its volume is called compression. A compressor is a mechanical device

that is used to compress gases. A compressor delivers air at high pressure by compressing the low-pressure gas. A compressor used for compressing air is called an air compressor. Air from the atmosphere is sucked into the compressor. The compressor then compresses air to high pressure and delivers it to a storage tank or reservoir. From the reservoir, compressed air can be supplied to desired locations through pipelines.

Figure(5): Compressor



C. Pneumatic Cylinder

Pneumatic cylinder commonly known as air cylinders is the end equipment of our system. The equipment that converts compressed air into mechanical energy is known as air or pneumatic cylinders. This results in the linear motion of the cylinder. This can also be used at a system that requires rotary motion. Being relatively cheaper also provides an advantage for the industries that have financial concerns.

Figure(6): Pneumatic Cylinder



D. Solenoid Valve

In a system that requires control over the flow of fluid solenoid, value is taken into consideration. The main objective is that it performs the opening, shutting, releasing of the pathways for the flow of fluid.

Figure(7): Solenoid Valve



E. HSS Shearing Blade

High-speed steel saw blades or cold saw blades as they are commonly known, HSS blades are used primarily to cut hard metals such as stainless steel and mild steel and can also be used for cutting softer metals such as brass, copper, etc.

Figure(8): HSS Shearing Blade



F. Air Supply Tubes

Various components within a system that requires the air supply for their working are connected by the air supply tubes. These distribute the compressed air to a desirable component of the system that requires it. These are capable of transferring gases that are more than the atmospheric pressure.

Figure(9): Air Supply Tubes



VII. CONCLUSION

After comparing Pneumatic Sheet Metal Cutter machine to Hydraulic Sheet Metal Cutter Machine we concluded that for small-scale industries pneumatic sheet metal cutting machine is more efficient and economical. In a pneumatic sheet metal cutter, the range of cutting thickness can be increased by adding a compressor with higher pressure and by using more hardened blades.

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