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Design and Fabrication of Pneumatic Sheet Metal Cutting Machine

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Abstract: ***Normally the sheet metal cutting machine is manually hand operated for medium and small scale industries. This paper gives an insight about the automatic sheet metal cutting machine. Any automatic machine aimed for economical use of man. In this paper, pneumatic cylinder is used for cutting in easy way which can be use in small scale industries at lower cost. The sheet metal cutting machine works with the help of pneumatic double acting cylinder. The piston is connected to the moving cutting tool which his used to cut the sheet metal. The cutting process is operated by a direction control valve by using compressor. In manual method sheet metals goes to the scrap sometime because of wrong dimensions, improper cutting etc. Hydraulic machines are also used for sheet metal cutting. But these machines are used for heavy metal cutting and its cost is very high. Hence, we are using a pneumatic system for sheet metal cutting in a easy manner. The main advantage of pneumatic sheet metal cutting machine is to improve product quality, repetition of work and increasing production rate.***
Keywords: Pneumatic Cylinder, Control Valve, Compressor, Sheet Metal.

I. INTRODUCTION

The sheet cutting machine is the heart of sheet metal industries. In some industries, hand sheet cutter is used which is operated manually. In these machine, we are using 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 . The main objective of our project is to perform job holding operation effectively with less human efforts by using a machine with the pneumatic power. This will also reduce the time required for metal cutting. By using these machine we can increase the production rate and automatically the industry will be in profit. Automation plays an important role in mass production. Automation can be achieved through pneumatic form. The main advantage of pneumatic system is economically cheap and easy to handle. The manufacturing operation is being atomies for the following reasons.

A. To reduce human efforts
B. To increase production rate
C. To increase efficiency of industry
D. To reduce the work load
E. To reduce production time

II. CONSTRUCTION

A. Raw Material Used-
1) Cast iron bar for base frame
2) High speed steel for shearing blade
3) Cylinder fitting like fork end, base plate, support link
4) Angle section for blade fitting,
5) Connecting link
6) Blade link

B. Ready items used-
1) Pneumatic double acting cylinder
2) Direction and flow control valve
3) Pneumatic pipe and pipe fitting
4) Bold and nuts

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5) Paint
6) Machine and tool used

C. *Machine and tools used-*
1) cutting machine
2) welding machine
3) hacksaw cutting machine
4) Radial Drilling Machine
5) Grinder
6) Hand Grinder
7) Screen Holder
8) Hammer

D. *Specification*
1) Pneumatic Cylinder-
Quantity: 1
Total Length :510mm
Bore Diameter : 80mm
Piston Road Diameter : 20mm
Maximum Working Pressure : 10bar
Weight : 3kg
2) Pneumatic Pipe-
Quantity : 1500mm
Diameter : 10mm
Thickness : 2mm
3) Direction Control Valve-
Quantity : 1
Operation : Manual
Type : hand lever
Number Ports : 5
Number of Position : 3
Construction : Sliding Spool Type
4) Fork End Nut-
Quantity :2
Length : 16mm
Size : M16
5) Cylinder Base Plate Bold-
Quantity : 4
Length : 64mm
Size : M6
6) Blade Fixing Bold-
Quantity :3
Length : 125mm
Size : M12

III. MATHEMATICAL CALCULATION

Table I

Sheet metal material	MILD STEEL
Thickness	2 mm
Length of cut	30 mm

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Max. shear strength of mild steel	$60\ \frac{N}{mm^2}$

Cutting Force = $l \times t \times \tau_{max}$
= 2×30×60
= 3600 N

This the force required to cut the sheet metal, however the initial force required to cut sheet more and it is 140-150 % than we calculated ,

Therefore max force required to cut sheet =5040-5400 N

Now we have chosen 10 bar pressure cylinder

Design of a cylinder

Since the max force required to cut sheet =5400 N and pressure applied by 10 bar pressure.

Therefore ,

Force applied by cylinder , F=$\frac{\pi}{4} \times d^2 \times p$

5400 = $\frac{\pi}{4} \times d^2 \times \frac{10}{10}$ ∴ d = 82 mm

IV. COMPONENTS

A. Pneumatic Cylinder

Double acting cylinder are equipped with to working ports- on the piston size add the other on the road side, to achieve forward motion of the cylinder, compress air is admitted on the piston side and road side is connected to exhaust, during return motion supply air admitted at the road side while the piston side volume is connected to the exhaust, force is exhausted by the piston both during forward and return motion of cylinder.

Fig 1:Pneumatic Cylinder

B. Direction control valve

A Control Valves are used to reduce the rate of flow in a section of a pneumatic circuit, resulting in a slower actuator speed. Unlike a Needle Valve, a Flow Control Valve regulates air flow in only one direction, allowing free flow in the opposite direction. A control valve is a valve used to control fluid flow by varying the size of the flow passage as directed by a signal from a controller this enables the direct control of flow rate and the consequential control of process quantities such as pressure, temperature, and liquid level. Air control valves are fundamental components of any pneumatic system. Selecting the right air control valves to regulate system pressure, direction of flow, and rate of flow is crucial when designing fluid power circuitry. If the pneumatic valve is too big for your application, you will be wasting air and money.

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Fig 2: Direction Control Valve

C. High speed cutting blade

Sheet metal is a metal form by an industrial process into think, flat pieces it is one of the fundamental forms used in metal working and it can be cut and bend every day object are fabricated form sheet metal.

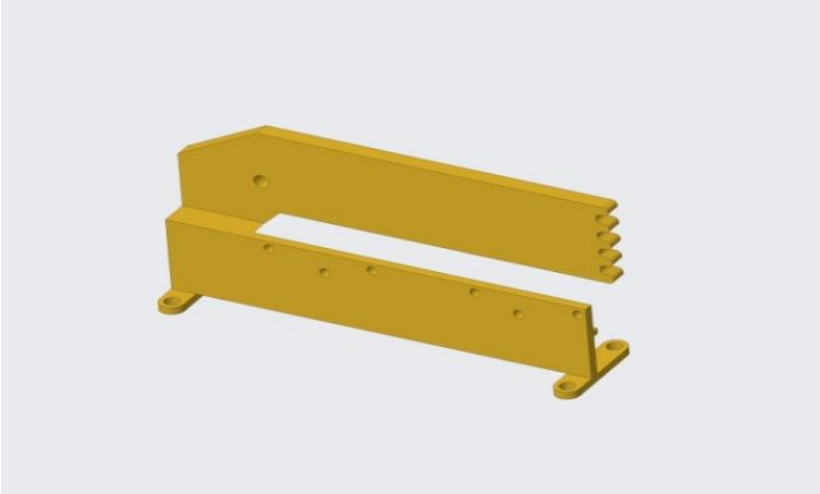
Fig 3: High Speed Cutting Blade

D. Air Compressor

Air compressor is a device that convert power (using and electric motor, diesel or gasoline engine etc) into potential energy stored pressurize air (that is, compress air), by one of several method and air compressor force more and more air into storage tank, increasing the pressure, when tank pressure reaches is upper limit the air compressor shuts of the compress air, then, held in the tank until called into used.

Fig 4: Air Compressor.

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V. WORKING OF SHEET METAL CUTTING MACHINE

The sheet metal cutting machine work with the help of pneumatic double acting cylinder. The piston is connected to moving cutting tool which is used to cut small size of the sheet metal. The machine is portable so it is easy to transportable, the compress air form the compressor is used to force medium for this operation. There is pneumatic double acting cylinder control valve flow air. With the help of direction control valve to perform cutting operation. The controlled air from the flow control valve enter in cylinder and piston rod moves forward and force exert on cutting tool and cutting stroke are obtained. Then at next position, air enter other side and piston rod moves backward so that the releasing stroke is obtain the speed of cutting and releasing stroke is varied back by the time control unit circuit.

Fig 5: Pneumatic Sheet Meal Cutting Machine

VI. CONCLUSION

The design and fabrication of pneumatic sheet metal cutting machine is totally economical in human effort and useful in improvement of cost factory, show and work place layout and design of plant and equipment. We know that pneumatic sheet metal cutting machines are very chip as compare to hydraulic sheet metal cutting machine. The range of cutting thickness can be increases by installing high pressure cylinder and more harder blade. The small sheet metal cutting industry cannot afford the expensive hydraulic cutting machine so that we use pneumatic sheet metal cutting machine.

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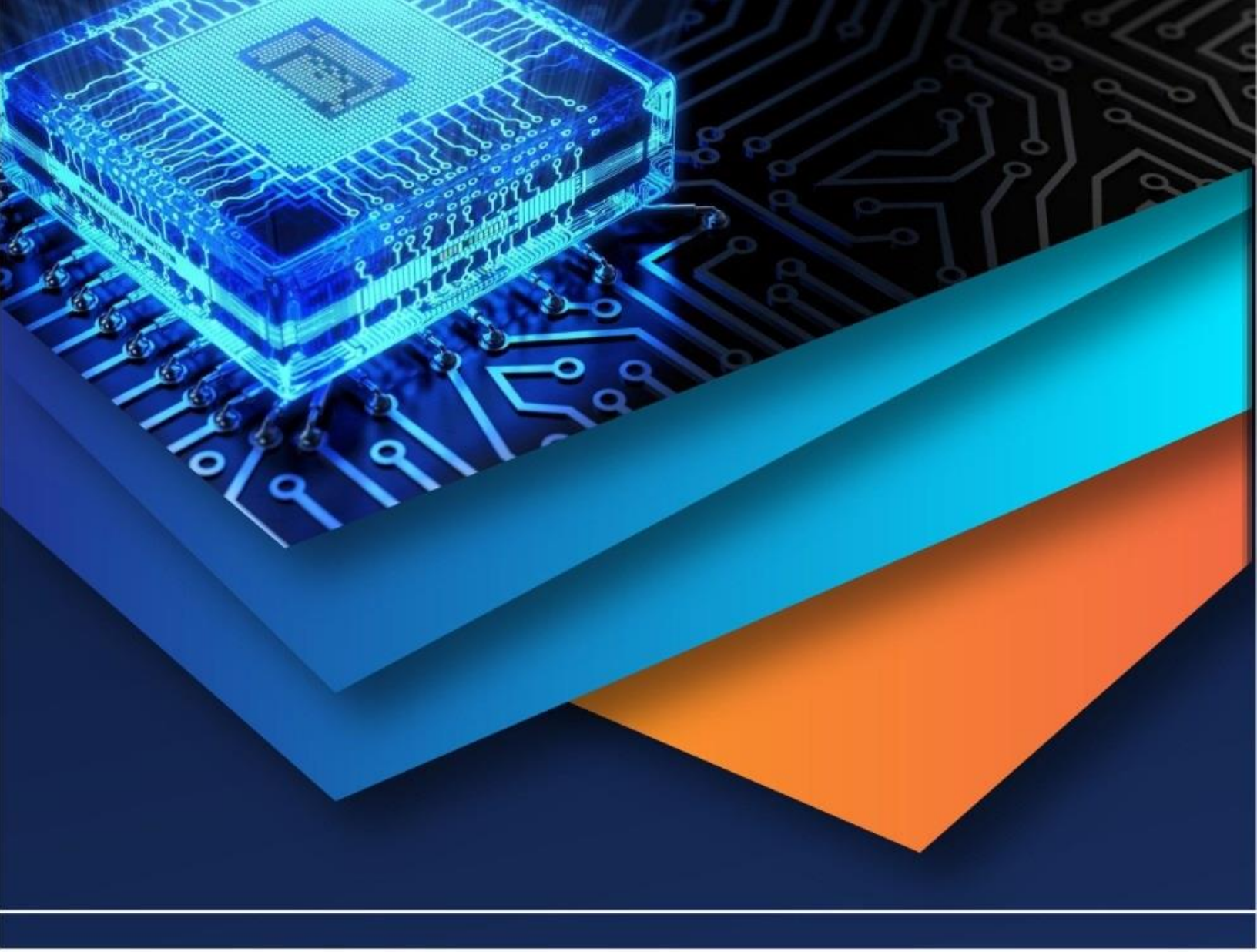

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