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Design and Development of Pneumatic Shearing Machine

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ABSTRACT

In today's era of automation, machines have become essential components of human life. Through automation, machines demonstrate that they can achieve higher production rates compared to manual methods. In a competitive marketplace, there is a strong desire to boost production and develop multifunctional machines. Engineers are continually faced with the challenge of transforming concepts and designs into tangible products. New machines and techniques are being persistently developed to produce a variety of items at lower costs while maintaining high quality. Therefore, we aim to create a machine for the sheet metal industry that is multifunctional and can be utilized for cutting metal strips and blades. The machine is designed to be easy to maintain and operate. As a result, we focused our efforts on the "Pneumatic Shearing Machine."

KEYWORDS: *Sheet metal, industrial, automation, cutting.*

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INTRODUCTION

The most common cutting methods involve applying a shearing force, so they are often called shearing processes. These methods separate sheet metal by applying enough force to make the material break. When enough shearing force is applied, the shear stress in the material becomes greater than its ultimate shear strength, leading to failure and separation at the cut. This force is applied using two tools, one above and one below the sheet. Whether these tools are a punch and die or upper and lower blades, the upper tool delivers a fast downward strike to the sheet metal, which is positioned over the lower tool. A small gap exists between the edges of the upper and lower tools, which helps the material to break. As the cut progresses, the effects of shearing on the material become visible along the edge. When the punch or blade hits the sheet, the gap allows the sheet to bend and roll over the edge. As the tool continues to cut through, the shearing creates a vertical burnished area of material. Eventually, the shear stress becomes too high, causing the material to fracture at an angle with a small burr formed at the edge. The height of these areas of the cut depends on several factors, including the sharpness of the tools and the gap between them. Cutting methods involve separating sheet metal by applying enough force to make the material fail. The most common methods are shearing processes, which use a shearing force. When sufficient shearing force is applied, the shear stress in the material overcomes its ultimate shear strength, causing it to break at the cut location. This force is applied by two tools, one above and one below the sheet. Whether these tools are a punch and die or upper and lower blades, the upper tool delivers a quick downward strike to the sheet metal, which is placed over the lower tool. A small gap exists between the edges of the upper and lower tools, which helps the material to fracture. The size of this gap is typically 2-10% of the material's thickness and depends on factors such as the specific shearing process, material type, and sheet thickness. As the cut progresses, the effects of shearing on the material become visible along the edge. When the punch or blade impacts the sheet, the gap allows the sheet to deform plastically and roll over the edge. Finally, the shear stress becomes too great, causing the material to fracture at an angle with a small burr formed at the edge .The dimensions of these areas depend on factors like the sharpness of the tools and the gap between them. Pneumatic systems are widely used in many industries and are typically powered by

compressed gases or air. These systems are usually driven by an electrically powered, centralized compressor that powers air motors, cylinders, and other pneumatic devices. A pneumatic system can be controlled either manually or automatically using solenoid valves, which are chosen for their low cost, flexibility, and safety compared to electric motors and actuators. Pneumatic systems find use in various fields such as mining, dentistry, construction, and more. These tools can include upper and lower blades or a punch and die. The upper tool delivers a quick downward blow with a certain amount of force to the sheet metal, which is positioned over the lower tool. A very small gap exists between the blades, i.e., the edges of the upper and lower tools, which helps to break the sheet metal. An effort has been made to review the literature on pneumatic systems in sheet cutting based on various criteria .Pneumatic systems are a branch of engineering that utilize pressurized air or gas. These systems are used widely in industries and are typically powered by compressed gases or compressed air .They are powered by an electrically powered, centralized compressor that drives air motors, cylinders, and other pneumatic equipment .A pneumatic system can be controlled either manually or automatically through solenoid valves, which are preferred for their low cost, flexibility, and safety over electric motors and actuators .These systems have applications in various areas such as mining, dentistry, construction, and others.

CONSTRUCTION

It consists of mainly;

A. Frame:

The frame is made of M.S. material. Lower part of frame is basically used to support the pneumatic components support mounted on it. That is Piston cylinder, Direction control valve are mounted on lower frame. On the upper frame vertical cylinder is mounted.

B. Pneumatic cylinder:

Our project is on Pneumatic control system. The Pneumatic piston-cylinder is an actuator which converts pressure of compressed air to displacement. When the pressure on one side of the piston is higher than campair to other side, it results in a linear displacement. The speed of traversal is proportional to the pressure difference. A double acting cylinder has two ports through which the supply of air is reversed to cause displacement in either direction. We used double acting cylinder to hold the wok piece that is to be weld**.**



Fig.2. Pneumatic cylinder

C. 5/2 Valve DCV:

In our machine, we used two 5/2 valve to direct the flow of compressed air on the either side of piston for the reciprocating motion of same**.** The directional control valve must direct the flow from the compressor either to port A or port B. The fluid exhausted by the cylinder must be directed from the other port to back to tank. The valve shown has 5 ports and 2 positions so called as 5/2 valve. Valves are necessary to control the pressure, flow rate and direction of the fluid. Pneumatic systems are low pressure systems. Pneumatic valves are made from cheaper materials (e.g. aluminum and polymer) and are cheaper to manufacture. The directional control valve must direct the flow from the compressor either to port A or port B. The fluid being exhausted by the cylinder must be directed from the other port back to tank. The number of ports (External connections) and the number of positions describe such valves. The valve we used and shown above has 5 ports and 2 positions so it is designated as a 5/2 directional Control Valve. It is noted that the third position in a 5/2 valve is a center position. The air control mechanism inside 5/2 valve (usually a spool of some sort) is shifted into the center position inside the valve by one of two internal spring valve actuators. There is a spring located inside the valve at each end of the internal spool.



Fig.5.2. 5/2 Toggle DCV Valve

D. Pneumatic hoses and fittings:

This can be used for connection of pneumatic system with total drill assemble.



Fig.3. Pneumatic hoses and fittings.

E. Nut and Bolt:

As nuts and bolts are not perfectly rigid, but stretch slightly under load, the distribution of stress on the threads is not uniform. In fact, on a theoretically infinitely long bolt, the first thread takes a third of the load, the first three threads take three-quarters of the load, and the first six threads take essentially the whole load. Beyond the first six threads, the remaining threads are under essentially no load at all. Therefore, a bolt with six threads acts on an infinitely long nut or bolt.

F. Compressor:

A compressor is a mechanical device that raises the pressure of a gas by decreasing its volume. An air compressor is a particular kind of gas compressor. Compressors are similar to pumps in that both increase the pressure of a fluid and both can move the fluid through a pipe. Since gases can be compressed, the compressor also lowers the volume of a gas. Liquids are generally not easily compressed; although some can be compressed slightly, the primary function of a pump is to increase the pressure and move liquids.

Plagiarism removed 100%.

Double acting cylinder Design:

Assume the force required to shear the sheet is W = 150 N.

By assuming pressure in working cylinder is, P = 3 bar =0.3 N/mm2

We know that,

Pressure =Force /Cross Section Area

0.3=150/ area

D = 25.23 mm.

This is required cylinder diameter for sharing operation Ø32 X 80mm (Diameter X Stroke)

Clarion's equation for closed end cylinder at both ends. For ductile material use to determine the thickness of cylinder.

Let,

Material of the cylinder is aluminum

$$t = ri\left[\sqrt{\frac{\sigma t + (1 - 2\mu)P}{\sigma t - (1 + \mu)P}} - 1\right]$$

Considering, double acting cylinder ⌀32x80 (Diameter X stroke)

By assuming pressure in working cylinder is, P = 3 bar =0.3N/mm^2 .

So according to Clavarino's equation, For closed end cylinder at both ends to determine the thickness of cylinder

Assume,

P=3bar=0.3N/mm^2, μ = 0.29, ri= 20 mm.

t =16 x {√200.784/199.808- 1}

t = 0.39 mm.

Available thickness, t = 1mm

Piston dia-=32 mm, Stroke dia-= 80 mm Piston rod dia- = 12 mm.

Machine working let,

A=Force area of cross section piston.

A= π/4(D$^{2)}$ mm^2

A= π/4(32$^{2)}$ mm^2

A= 804. 247mm^2

Apr=Force area of cross section piston on rod side.

Apr = π /4 ((D2 – d2) mm^2

Apr = π/4 (32^2 – 12^2) mm^2

A_{PR}= 691. 15 mm^2

P = 3bar =0.3 N/mm^2

Piston force acting during forward stroke.

Fa= P x π/4(D$^{2)}$

= 0.3 x 804.247

F_a = 241.27 N.

Piston force acting during return stroke.

$F_R = P \times \pi/4(D^2-d^2)$

$F_R = 0.3 \times 691.15$

$F_R = 207.34$ N.

Time required to complete stroke is 2 second.

Linear velocity of piston, **V**= L/t

V=80/2

V = 40 mm/sec.

CONCLUSION

By utilizing a high pressure pneumatics system, we can enhance the performance of a pneumatic shearing machine that is specifically designed for cutting materials such as cutting dies blades, cork, leather, plastic, and PVC. This machine is most popular and compact, requiring minimal space. It also has a short setup time and can produce a sufficient amount of output per hour. With the proper balancing of the pneumatic system and its components, this machine is suitable for high-speed and high-production-rate applications. Using suitable pneumatic balancing parts, it can effectively cut hard materials and handle thicker sheets or blades. Performance is further improved by incorporating imported guide rails and an advanced control system. This multi-functional pneumatic shearing machine is suitable for future full-automatic cutting processes .By increasing the pressure of the working air, different thicknesses of blades can be cut with varying forces. We have developed a single model of the pneumatic shearing machine, in which small stroke cylinders have been used. However, if we aim to develop a pneumatic shearing machine for use on a factory floor, larger stroke and bore diameter cylinders can be employed to achieve greater movement and force from the shearing tool. Additionally, for higher shearing capacity, especially for cutting heavy material blades, this can be achieved.

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