FABRICATION OF A PNEUMATIC SHEET METAL CUTTING MACHINE

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Abstract

Sheet metal cutting is an important operation in manufacturing industries, where metal sheets are cut into the required size and shape for further processing. In many small-scale workshops and fabrication units, this operation is still performed using manually operated machines, which require considerable physical effort and reduce productivity. To overcome these limitations, this project focuses on the design and fabrication of a pneumatic sheet metal cutting machine.

The proposed machine uses compressed air as the source of power to operate a double-acting pneumatic cylinder. The movement of the cylinder is controlled by a solenoid-operated direction control valve, which drives the cutting blade to perform the shearing operation. The use of pneumatic power reduces manual effort, improves cutting speed, and provides consistent performance. The machine is constructed using a mild steel frame, a fixed cutting blade, a movable blade, and standard pneumatic components, making it simple, compact, and economical.

The fabricated model was tested under normal operating conditions and was able to cut thin sheet metal smoothly and efficiently. The machine demonstrated reliable operation with low maintenance requirements and improved operator safety. Its compact design makes it suitable for educational laboratories, fabrication workshops, and small-scale manufacturing industries. The project shows that pneumatic technology can provide a practical, cost-effective, and efficient solution for sheet metal cutting while reducing labour and increasing productivity.

I. Introduction

Sheet metal is one of the most commonly used materials in manufacturing industries because of its strength, durability, and ease of fabrication. It is used to produce a wide range of products, including automobile parts, electrical panels, household appliances, machine components, and construction materials. Cutting sheet metal into the required shape and size is one of the first and most important steps in the manufacturing process.

In many small- and medium-scale industries, sheet metal cutting is still performed using manually operated cutting machines. Although these machines are simple and inexpensive, they require considerable physical effort and are not suitable for continuous production. Manual cutting also consumes more time and may result in uneven cuts, reducing the overall quality of the finished product.

To improve productivity and reduce manual effort, industries are increasingly adopting pneumatic systems for different manufacturing operations. Pneumatic systems use compressed air to generate mechanical motion, making them clean, reliable, and economical. They are

widely used because of their simple construction, low maintenance requirements, and safe operation.

The Pneumatic Sheet Metal Cutting Machine developed in this project is designed to provide a simple and efficient cutting solution for small-scale manufacturing applications. The machine uses a double-acting pneumatic cylinder controlled by a solenoid valve to move the cutting blade. When compressed air is supplied, the piston moves forward to perform the cutting operation and returns to its original position after the cycle is completed. This arrangement ensures smooth operation with minimum operator effort.

The proposed machine is compact, portable, and easy to operate. It reduces human fatigue, improves cutting accuracy, and increases production efficiency compared to conventional manual cutting methods. Because of its low cost and simple design, it is suitable for workshops, educational laboratories, and small manufacturing industries where automation can improve productivity without requiring expensive equipment.

II. Literature Survey

The literature survey shows that sheet metal cutting is an essential manufacturing process used in industries such as automobile, electrical, fabrication, and construction. The quality of the cutting operation depends on factors such as blade alignment, cutting force, and machine design. Traditional manual cutting methods require more time, greater physical effort, and often produce inconsistent results, creating the need for more efficient cutting systems.

Various types of sheet metal cutting machines have been developed, including pneumatic, hydraulic, rack and pinion, and spring-operated machines. Among these, pneumatic machines are widely preferred for small- and medium-scale industries because they are simple, economical, clean, and easy to maintain. Hydraulic machines provide higher cutting force for heavy-duty applications but involve higher costs and maintenance. Rack and pinion and spring-operated machines are manually operated and are suitable only for light-duty work due to the greater manual effort required.

The survey also highlights the importance of pneumatic technology in industrial automation. Pneumatic systems use compressed air to produce mechanical motion and consist of components such as an air compressor, control valves, a pneumatic cylinder, and an FRL unit. These systems are widely used because they offer reliable performance, faster operation, low maintenance, and improved safety.

Automation has become essential in modern manufacturing to increase productivity, reduce labour, improve product quality, and minimize production costs. Pneumatic automation is particularly suitable for small industries because it provides an affordable and effective alternative to manual operations.

The study further explains the working of a double-acting pneumatic cylinder, which converts compressed air into linear motion. In the proposed machine, the pneumatic cylinder drives the cutting blade through a solenoid valve, enabling smooth and accurate sheet metal cutting with reduced operator effort. Overall, the literature survey confirms that pneumatic technology is a practical and cost-effective solution for developing an efficient sheet metal cutting machine.

III. Implementation Methodology

The implementation of the pneumatic sheet metal cutting machine was carried out in a systematic manner to ensure proper fabrication, assembly, and smooth operation of the machine. The process began with the fabrication of a rigid mild steel frame, which serves as the base structure for supporting all the mechanical and pneumatic components. The frame was carefully welded and finished to provide adequate strength and stability during the cutting operation.

After completing the frame, the double-acting pneumatic cylinder was mounted vertically on the upper portion of the machine. The movable cutting blade was firmly connected to the piston rod of the cylinder, while the fixed cutting blade was installed on the lower section of the frame. The clearance between the two blades was adjusted properly to obtain clean and accurate cutting of the sheet metal.

The pneumatic system was then assembled by connecting the air compressor, Filter-Regulator-Lubricator (FRL) unit, solenoid-operated direction control valve, pneumatic cylinder, and air hoses. The FRL unit was installed to remove moisture and dust from the compressed air and to maintain the required operating pressure before supplying air to the cylinder.

PNEUMATIC CYLINDER

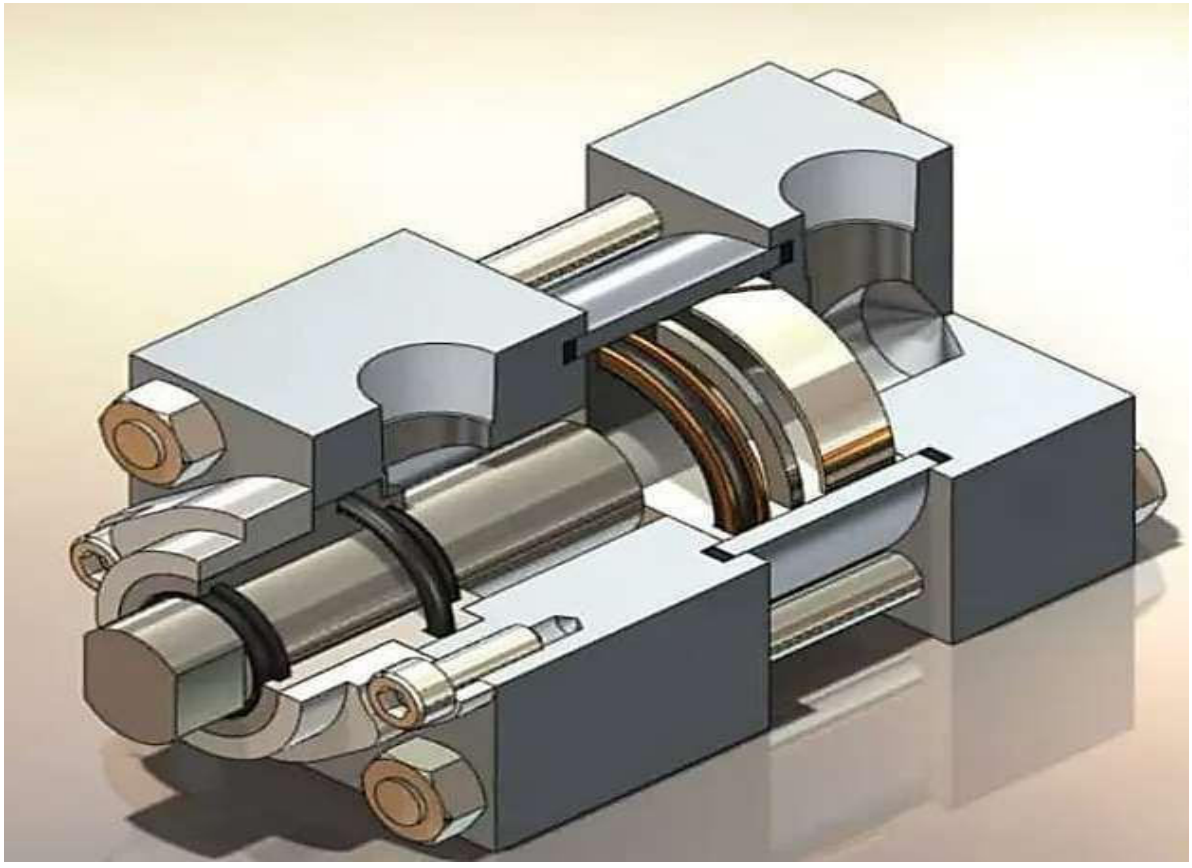
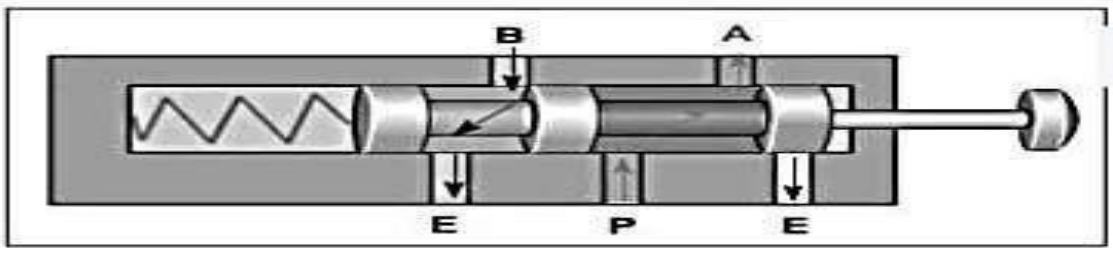


Figure: Pneumatic cylinder

DIRECTION CONTROL VALUE



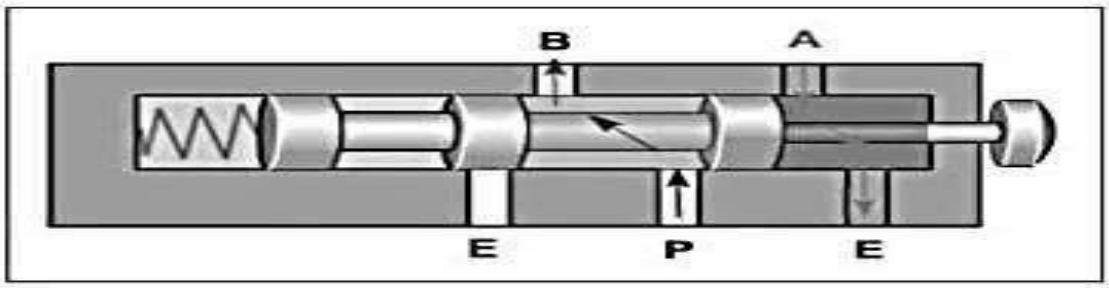


Figure : Direction control value

FLOW CONTROL VALUE

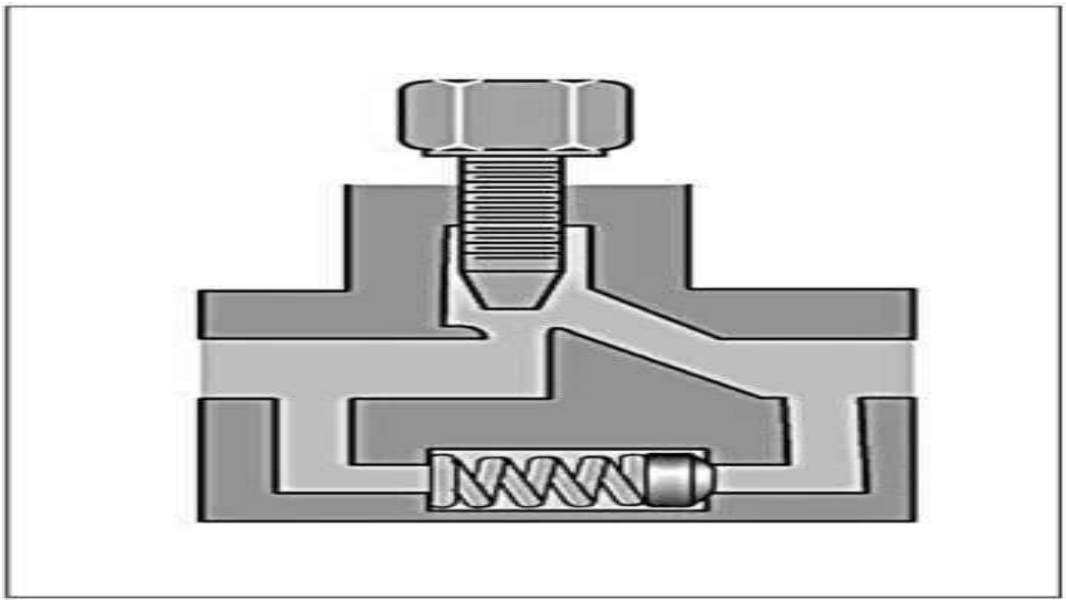


Figure : Flow control value

FRABRICATION OF SHEET METAL CUTTING MACHINE

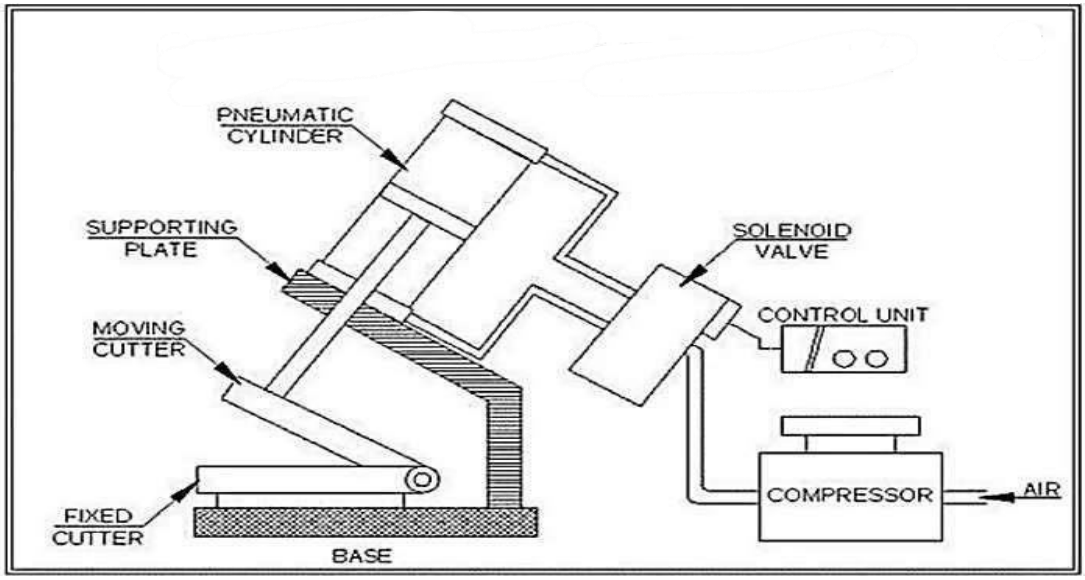


Figure: Concept Image for Project

The electrical circuit was connected to the solenoid valve through a control switch. When the switch is pressed, the solenoid valve directs compressed air into one side of the pneumatic cylinder. This causes the piston to move downward, carrying the movable blade towards the fixed blade and performing the cutting operation. After the sheet metal is cut, the valve changes its position and supplies compressed air to the opposite side of the cylinder. This returns the piston and cutting blade to their original position, completing one cutting cycle.

After the complete assembly of the machine, trial runs were conducted to verify the alignment of the blades, movement of the cylinder, air pressure, and overall machine performance. Necessary adjustments were made to ensure smooth operation and accurate cutting. The machine was then tested with thin sheet metal specimens under normal operating conditions. The cutting operation was completed successfully with minimum manual effort, demonstrating the effectiveness of the pneumatic system.

The implementation process confirmed that the fabricated machine operates reliably, requires simple maintenance, and provides an economical solution for sheet metal cutting in small-scale manufacturing and fabrication industries.

IV. SPECIFICATIONS OF PNEUMATIC ELEMENTS

The various pneumatic elements are specified according to different standards. The standard varies depending upon the manufacturers.

1. Double acting Cylinder

Stroke length	=	50 mm
Piston Diameter	=	40 mm
Maximum Operating Pressure	=	12 bar

Temperature range	=	120C to +80C
Material	=	Aluminium alloy
Seals	=	Polyurethane
O' ring	=	Nitrile

2. Solenoid Directional Control valve:

We have used 5/2 solenoid valve as the directional control valve.

Voltage 230 volts	=	230 volts
Frequency 50 Hz	=	50 Hz
Maximum Operation Pressure	=	10 bar
Port size	=	7 mm

3.Flow control Valve:

Technical Data

Parameter	**Specification**
Port Size	0.635×10^{-2} m (6.35 mm)
Operating Pressure	$0 – 8 \times 10^{5}$ N/m² (0–8 bar)
Working Medium	Compressed Air
Pressure	0 to 10kg / cm2
Quantity	1

V RESULTS AND DISCUSSION

The pneumatic sheet metal cutting machine was successfully designed, fabricated, and tested under normal working conditions. The machine performed the cutting operation smoothly using compressed air, requiring very little manual effort from the operator. The double-acting pneumatic cylinder and solenoid valve worked effectively, ensuring smooth movement of the cutting blade and automatic return after each cutting cycle.

The fabricated machine was found to be compact, stable, and easy to operate. Proper alignment of the cutting blades resulted in clean and accurate cuts, while the pneumatic system maintained the required air pressure without noticeable leakage. The machine also operated with low noise and required very little maintenance.

The experimental results showed that the proposed machine provides better performance than conventional manually operated cutting machines. It reduces operator fatigue, improves cutting

speed, and offers consistent cutting quality. The use of standard pneumatic components makes the machine economical, reliable, and suitable for small-scale industries and educational laboratories.

Although the machine is designed mainly for cutting thin sheet metal, its cutting capacity can be increased by using a larger pneumatic cylinder and higher operating pressure. Overall, the project achieved its objective of developing a simple, low-cost, and efficient pneumatic sheet metal cutting machine that improves productivity, reduces manual labour, and provides safe and reliable operation.

VI CONCLUSION

The pneumatic sheet metal cutting machine was successfully designed, fabricated, and tested. The machine effectively used compressed air to cut thin sheet metal with less manual effort and reliable performance. The double-acting pneumatic cylinder and solenoid valve ensured smooth operation, accurate cutting, and automatic blade movement.

The developed machine is compact, economical, and easy to operate, making it suitable for small workshops, fabrication units, and educational laboratories. Compared with manual cutting methods, it improves productivity, reduces operator fatigue, and requires minimal maintenance.

Although the machine is intended for thin sheet metal, its performance can be enhanced by using a larger pneumatic cylinder or incorporating advanced automation in future. Overall, the project demonstrates that pneumatic technology provides a simple, cost-effective, and practical solution for sheet metal cutting in small- and medium-scale industries.

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