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DESIGN & DEVELOPMENT OF PNEUMATIC SHEARING MACHINE

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ABSTRACT

Today in the rapid competition of the industries to get the best quality of the product in the minimum required time is the main aim of industries. To get the best quality and maximum production most advanced machines are used. But there is no facts that use nly the advanced machines, to maintain their performance is real requirement of the industries, also to give proper facilities to the workers with good environmental condition and to reduce their efforts is one of the objects to achieve the best quality and high production.

Keywords: Automation, Pneumatic System, Shearing Machine, Metal Sheet Cutter

I INTRODUCTION

It is always focused towards challenges of bringing ideas and concepts to life. Therefore, sophisticated machines and modern techniques have to be constantly developed and implemented for economical manufacturing of products. At the same time, we should take care that there has been no compromise made with quality and accuracy.

In the age of automation machine become an integral part of human being. By the use of automation machine prove itself that it gives high production rate than manual production rate. In competition market everyone wants to increase their production & make their machine multipurpose. The engineer is constantly conformed to the challenges of bringing ideas and design into reality. New machines and techniques are being developed continuously to manufacture various products at cheaper rates and high quality.

So we are going to make a machine for sheet metal industryand make it multipurpose & should be used as circle cutting cum straight cutting machine. The machine is simple to maintain easy to operate. Hence we tried our hands on “pneumatic shearing machine.”

Shearing machineis one of the principal machines in sheet metal industry. It is mainly used as the name indicates to cut metal strips & Blades.

1.1 Project Statement

The statement of project is “Design & Development Pneumatic shearing machine”for the cutting of metal strips & HSS Blades of different sizes as per requirements for die making industry.

1.2 Objective

IJARSE
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1) To reduce the power consumption during machining.

2) To maintain the accuracy & reduced the scrap of HSS blades.

3) To develop automation unit for the Shearing, so that m/c can easily be adopted in today's automated plants.

4) This type of m/c provides work practically at low cost, low maintenance, low capital investment in less space.

5) To perform the most rigid operation with high speed.

II PNEUMATIC SYSTEM

Pneumatic systems form the most primitive and distinct class of mechanical control engineering. They are classified under the term 'Fluid Power Control', which describes any process or device that converts, transmits, distributes or controls power through the use of pressurized gas or liquid. In a pneumatic system, the working fluid is a gas (mostly air) which is compressed above atmospheric pressure to impart pressure energy to the molecules. This stored pressure potential is converted to a suitable mechanical work in an appropriate controlled sequence using control valves and actuators. Pneumatic systems are well suited for the automation of a simple repetitive task. The working fluid is abundant in nature and hence the running and maintenance cost of these systems are exceptionally low. All fluids have the ability to translate and transfigure and hence pneumatic systems permit variety of power conversion with minimal mechanical hardware.

Conversion of various combinations of motions like rotary-rotary, linear-rotary and linear-linear is possible. The simplicity in design, durability and compact size of pneumatic systems make them well suited for mobile applications. These features make them versatile and find universal applications including robotics, aerospace technology, production and assembly of automotive components (power steering, chassis and engine assembly), CNC machines, food products and packaging industry, bomb deployment units and fabrication process of plastic products.

2.1 Properties of Air

Air is a mixture of 78% nitrogen, 21% oxygen and 1% other inert gases with moisture by volume. Air exerts pressure at sea level of about 1.013 bar (14.7 psi) called atmospheric pressure. It is equivalent to 760 mm of Hg or 10.3 m of water pressure as measured by U-tube manometer.

2.2 Other physical properties of air are

1. Molecular mass, M = 28.96 kg/kg mol.
2. Boiling point at 1 bar = -191º C to -194º C.
3. Freezing point at 1 bar = -212º C to -216 ºC.
4. Characteristic gas constant, R = 287 Nm/kg K.

2.3 Advantages of Compressed Air Pneumatic Systems

1. Freely available from the atmosphere.
2. Explosive proof. No protection against explosion required.
3. Easily transportable in the vessels and pipes.

IJARSE
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4. No return lines are required.

5. Clean system. It has self-cleaning properties.

6. Simple construction and ease of handling.

7. Unduplicated exhaust clear air which escapes through leaking pipe or componentsdon‟ t cause contamination.

8. The pressure, speed and forces required can be controlled easily..

9. Overload safety- Pneumatic tools and operating components can be loaded to the point of stopping and are therefore overload safe

10. Air enables high working speed to be obtained

11. Low cost of maintenance.

2.4 Disadvantages of Compressed Air System

1. It is inaccurate in operation.

2. High forces cannot be transmitted.

3. It provides non-uniform speeds.

4. Creates noise pollution.

5. Expensive.

6. Conditioning of air is needed.

2.5 Types of shearing machine

Shearing machines are classified according to the following:-

1) Pneumatically operated

2) Hydraulically operated

3) Rack and pinion operated

4) Spring operated

Brief descriptions of all the types are as follows:

1) Pneumatically operated

Here the advancement of the header is carried out in the upward and the downward direction using the pneumatic double acting piston and cylinder unit arrangement along with the direction control valve. In this type of machine high pressure air is used as the working fluid for the transfer of power and the motion.

2) Hydraulically operated

Here the lowering and raising of the header is carried over using the hydraulic piston and cylinder arrangement. To actuate the piston and cylinder, the oil is allowed to enter the cylinder from front or the back side of the piston. But the oil is comparatively costlier and its leakage may cause so many problems.

3) Rack and pinion operated

Here the lowering and the raising of the header are carried out manually using the rack and pinion arrangement. In this case the required pressure is applied manually using direct hand pressure on the rack using pinion and lever arrangement. Since the machine is robust and requires large pressure, hence it is not suitable.

4) **Spring operated**

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The working of spring operated machine is similar to the rack and pinion operated machine but differs from it in construction. Here the lowering and the raising of the heating handle is carried out manually and it requires too much pressure for its operation and also there is possibility of having damage to the work piece if not handled carefully.

III CONCEPT OF PNEUMATIC SHEARING MACHINE

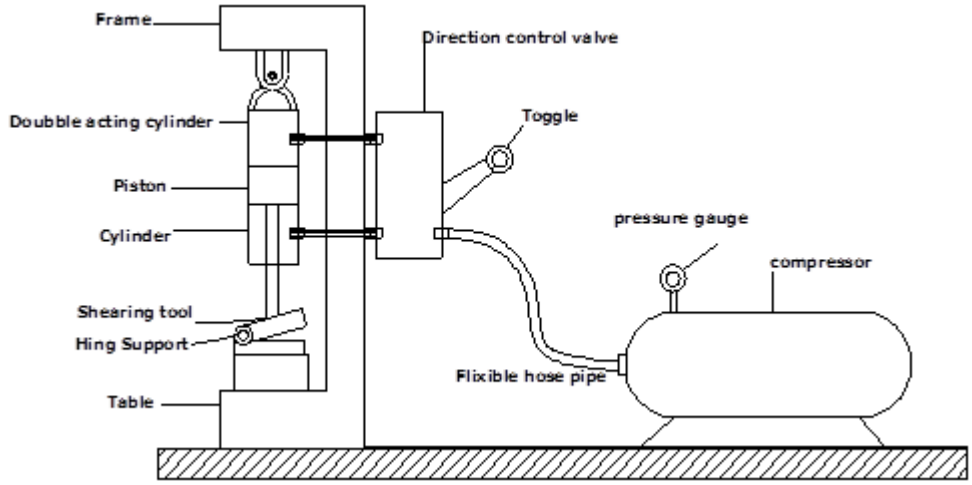

Fig.3.1 Concept of Pneumatic Shearing machine

As shown in above figure a frame is support to all pneumatics & shearing tool of a machine. Here we used a compressor for a generation of compressed air. A compressed air is supply to the double acting cylinder by means of hose pipe& 5/3 Direction control valve.

The shearing tool is provided at end of the pneumatic cylinder rod. When compressed air is supply by the DCV to double acting cylinder due to pressure & force created by compressed air causes Shearing action of the sheet metals strips & HSS cutting blades. Here the advancement of the header is carried out in the upward and the downward direction using the pneumatic double acting piston and cylinder unit arrangement along with the hand lever operated direction control valve. In this type of machine high pressure air is used as the working fluid for the transfer of power, force and the motion to the system.

IV CIRCUIT DIAGRAM

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IJARSE
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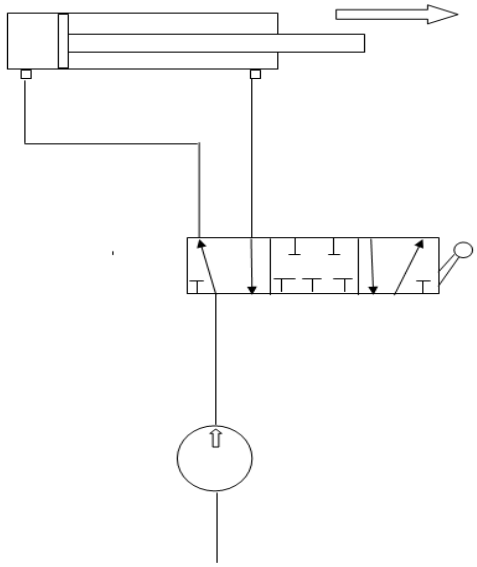

Fig. 4.1 Cutting Stroke

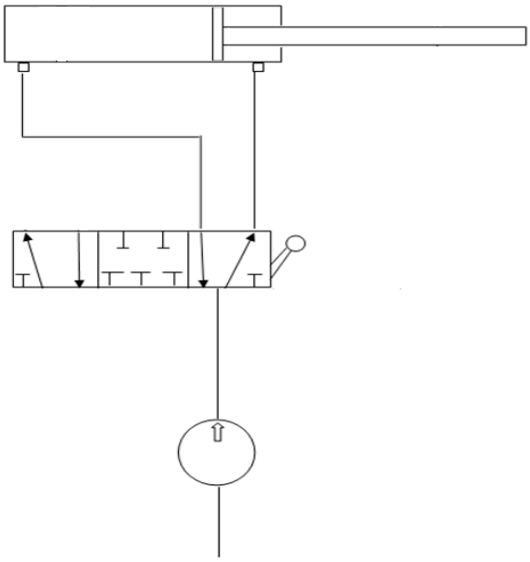

Fig. 4.2 Return Stroke

V WORKING

A frame is support to all pneumatics & shearing tool of a machine as shown in fig. Here, we used a compressor for a generation of compressed air. Compressed air is supplies to the double acting cylinder by means of pneumatic hose pipe & 5/3 Direction control valve. The shearing tool is provided at end of the pneumatic cylinder rod. When compressed air is supply by the DCV to double acting cylinder due to pressure & force created by compressed air causes Shearing action of the sheet metals strips & HSS cutting blades. Here the advancement of the shearing tool is carried out in the upward and the downward direction using the pneumatic double acting piston and cylinder unit arrangement along with the hand lever operated direction control valve. In this type of machine high pressure air is used as the working fluid for the transfer of power, force and the motion to the system.

We developed a model of the pneumatic shearing machine. In this we have used piston-cylinders with small stroke. But if we want to develop a pneumatic shearing machine that is to be used in the factory floor, we can use the piston-cylinders with higher stroke & Bore diameter to get the large movement & force of the shearing tool. Also for high shearing capacity to cut the heavy material blades.

VI MATERIAL USED

The material used in this project are detailed as follows:

Mild steel

The machine is basically made up of mild steel.

Reasons

1. Mild steel is readily available in market
2. It is economical to use
3. It is available in standard sizes

IJARSE
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4. It has good mechanical properties i.e. it is easily machinable.

5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure

6. It has high tensile strength

7. Low co-efficient of thermal expansion

Properties of Mild Steel

M.S. has carbon content from 0.15% to 0.30%. They are easily wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases. Mild steel serve the purpose and was hence was selected because of the above purpose.

VII DESIGN

1) Calculation of cutting force on blade.

Let,

A = Area of cross-section of blade which is to be cut by shearing machine

A = (width x thickness)

A = (30 x 0.71) mm2

Let, we have

Pressure P =

By assuming pressure in working cylinder is,

Working Pressure P = 3 bar = 0.3 N/mm2

[F = 6.39 N] = Working or cutting force.

2) Design of Pneumatic Components:

Clavarino'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 Gray Cast iron.

Sut = Ultimate tensile strength = 200 N/mm2

¥ì = Poisson.s Ratio for the cylinder material = 0.29 (std.)

di = Inner diameter of cylinder = 50mm

Consider,

Double acting cylinder 50 X 50 (Diameter X Stroke)

[ri =25 mm]

By assuming pressure in working cylinder is, P = 6 bar =0.6 N/mm2

So according to Clavarino's equation,

For closed end cylinder at both ends to determine the thickness of cylinder.

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Material of the cylinder is Gray Cast iron.

Let,

Nf = factor of safety = 1.5

[¥òt = 133.34 N/mm2]

VIII COMPARISON BETWEEN ALL SYSTEMS

Sr. No.	Point of comparison	Hydraulic	Pneumatic	Mechanical
1	Capital investment	Very high	Moderate	Low
2	Capacity	Very high	Moderate	Moderate / high
3	Running cost	Moderate	Moderate	High
4	Maintenance	Very high	Low	Moderate
5	Space requirement	High	Low	High
6	Speed of cutting	Low	High	Moderate
7	Requirement of skilled driver	Yes	Yes	No
8.	Requirement of foundation	Yes	Yes	Yes
9.	Rate of cutting	Low	High	Low
10.	Complexity	High	Low	High
11.	Power requirement	Moderate	Moderate	High

Fig. 8.1 Comparison between Existing System

IX ADVANTAGES, DISADVANTAGES & FUTURE SCOPE

9.1 Advantages

1) Machine work on the low power consumption as compare to the old Shearing machine.

2) It provides multiple cutting sizes of the metallic blades &alluminium sheets.

3) The operation of the new Shearing machine is well controlled.

4) Complex shapes can be Shearing as per requirement easily.

5) Very thin sections up to 0.5mm to 1mm can cut easily.

6) Well balanced system.

7) It approximately matches the efficiency of old Shearing machine in low cost

8) Only simple support structures are required Design & fabrication is easy.

19) It is a faster process of Shearing.

10) Wide variety of cork, aluminum sheet & plastic sheets can be cut.

11) Highly accurate profiles and good cutting finishing can be easily obtained.

12) Metal removal cost & Initial investment is low.

13) Operation is noiseless.

14) More accurate and economical in mass production.

15) A finished work pieces are made at each stroke of the operation.

16) It reduced undesirable deflection in punching force/pressure.

17) It minimizes misalignment & less floor space is required.

9.2 Disadvantages

1) Dimensional accuracy of cutting Blades & sheets is depends on the performance of the operator.

IJARSE
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2) Production rate for Shearing is depending on feed rate of the operator.

3) Constant monitoring is required to avoid the material scrap.

4) Balancing problem of cutting die may affect the cutting speed & feed of machine.

5) Depth of cut depends on blade height approximately 1mm maximum.

6) Additional operation of scrap removal is needed.

9.3 Future Scope

1) If we adjust the arrangement of piston at center of frame & by adding a punching dies to piston end & adding additional a base table we can use this machine as "Pneumatic Punching machine" also for punching work.

2) By using automation & electronics system we can improve the performance of Pneumatic shearing machine particularly designed for Cutting Dies blades, cork, leather, plastic and PVC materials etc. Most Handsome and compact patronized Model requires Minimum Space. Minimum "Make-Ready" Time and provides sufficient hourly production.

3) By using proper balancing of pneumatic systems & reciprocating parts we can use this Pneumatic shearing machine for high speed & high production rate applications.

4) By using proper pneumatic balancing weight of parts we can use this pneumatic shearing machine for cut the hard material & for more thick sheets or blades.

5) Improve performance by adopting imported guide rails stopper, advanced controlling system and our special designed software.

6) Automatic tracing system, by using counter will be use for counting the cutting strokes.

7) Match up our multi-function Pneumatic shearing machine, can realize the full automatic processing of cutting/ punching.

8) If we increase pressure of working air then we cut different thickness of blades by different forces.

X CONCLUSION

We developed a branch and bound approach which is coupled with quick, effective bounds to optimize the "Pneumatic shearing machine "which serves the cutting of die blades for punching die within a manufacturing cell.

The design of control architecture was an important aspect of study because a strong interaction between the many different parts was needed. We know that the "Pneumatic shearing machine" developed by us cannot be directly used on the factory floor because of some limitations. But we will correct the drawbacks in this system & it will be used in industries. So we are satisfied with our project.

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