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Fabrication of Industrial Automated Pneumatic Sheet Metal Cutter Using Pneumatic Cylinder

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ABSTRACT: The shearing machine and bending machines are most important in sheet metal industry. This machine should be used for straight cutting machine with wide applications. But in some industry, hand sheet cutter and hand benders are used. To operate such machines the human effort is required. Automation in the process is incorporated by using microcontroller, inductive proximity sensor, electrically controlled solenoid valve and DC motor controlled roller feed system. The automation provides provision to enter the number of sheets to be cut and required length of the sheet. The system works by pneumatic means which consists of air compressor, pipe lines, control valves and pneumatic cylinder. The design is particularly suited for the applications where working space is constrained. Introducing a pneumatic sheet metal cutting by the use of pneumatic shearing technique, It can reduce human effort in cutting sheet metal and it is a time saving process. Pneumatic shearing machines are useful when materials need to be cut in hazardous areas such as oil & gas refineries, chemical factories or oil rigs as well as dusty and wet environments where electric tools are not effective. This paper involves the design of an efficient system which reduces the human effort and help to increase production output. It also includes pneumatic system, pneumatic component and shearing die and bending die.

KEYWORDS: Straight cutting machine, Pneumatic shearing machine, Plastic deformation.

I. INTRODUCTION

Sheet metal is a metal formed into thin and flat pieces. It is one of the fundamental forms used in metal working and can be cut and bent into variety of different shapes [1]. Sheet metals are available in flat pieces or as a coiled strip. The thickness of the sheet metal is measured in gauge. Commonly used steel sheet metal ranges from 30 gauge to 8 gauge [2]. The larger the gauge number, the thinner the metal. Sheet metals has wide range of applications in car bodies, airplane wings, medical tables, roofs of buildings and many other things. Sheet metal of iron and other materials with high magnetic permeability are known as laminated steel cores [4]. The shearing machine is most important in sheet metal industry. In most of the small scale industries, hand sheet cutters are used, which requires human effort to cut down the sheets. It can be replaced by a pneumatic cutting machine which can cut the sheet metal at a faster rate and in a convenient way. In shearing operation, the pressure exerted by the punch, causes the plastic deformation of the sheet metal. Since the clearance between the die and punch is very small, the plastic deformation takes place in the metal adjacent to the cutting edges. This causes the fracture to start on both sides of the sheet and the sheet is sheared. A lot of researchers have worked on pneumatic systems as well as on sheet metal experiments. The work done by various authors are explained below.

II. RELATED WORK

Aniruddha Kulkarni et.al.[1] deals with manufacturing of bending of sheet metal by using power operated sheet bending machine. Especially discussion made the productivity analysis of manually or power operated sheet bending machine. Considering manual operation is replaced by power operated devices. It also gives information about limitation of manually operated sheet bending machine and power operated sheet bending machine. Ajit Kumar Singh et.al.[5] deals with pneumatically operated cutting machine. The manually operated machine was converted into pneumatically operated machine by applying proper design Procedure. The design was drawing back using CREO software. The end of task, the conclusion is made and several recommendations are Suggests to make

an improvement about produce good quality products at large scale and cheaper cost. **Varpe Akshay** et.al.[6] investigated pneumatic auto sheetmetal cutting machine which is use to cut sheet metal without any human efforts. The working medium of used in this project is compressed air. The compressed air from compressor is used to movement of piston of double acting cylinder in forward and backward positions. **Neeraj Pandita** et.al.[7] reviewed of the previous work done on the sheet metal where the cutting and bending of the sheets has been studied under various conditions. The pneumatic sheet Cutting machines are one of the modern techniques which are used efficiently to make the Sheet cutting and bending an efficient process. Performance and the possibilities of simplifying the design of the pneumatic sheet cutting machines. The energy efficiency of pneumatic and compressed air Systems is an important element in the overall development of sustainable production.

III.MATERIALS

1. Double Acting PneumaticCylinder



Fig: 1 Pneumatic cylinder

A double acting pneumatic cylinder is one where the thrust, or output force, is developed in both extending and retracting directions. Double acting cylinders have a port at each end and move the piston forward and back by alternating the port that receives the high-pressure air, necessary when load must be moved in both directions such as opening and closing a gate.

2. Solenoid



Fig: 2 Solenoid

A solenoid valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid: in the case of a two-port valve the flow is switched on or off; in the case of a three-port valve, the outflow is switched between the two outlet ports. Multiple solenoid valves can be placed together on a manifold.



Fig: 3 5/2 Solenoid valve symbol

3. Bearing



Fig: 4 Pillow block bearing

A pillow block bearing consists of a mounting bracket (pillow block) that houses a bearing and is used in low-torque, light load applications. With this configuration, the pillow block is bolted to a foundation, securing it, while the shaft and the inner ring of the bearing are free to rotate. Usually made of grey cast iron, pillow blocks come in two types, split or unsplit. With split pillow blocks the housing element or cap can be separated from the base. A unsplit pillow block is made from one solid piece.

4. Roller Bed Conveyor



Fig: 5 Roller bed conveyor

In this type of belt conveyor, the surface for the belt comprises of rollers. The rollers are selected based on the load of the items to be transported and the required speed of the belt. Usually there are two rollers in a short belt conveyor. However, the number of rollers may increase if the distance between the two ends of the belt conveyor is more. Typically, these belt conveyors are used when the items are loaded onto it with gravity rather than manually. Manual loading can cause mechanical shock to the rollers, resulting in damage.

5. Conveyor Roller



Fig: 6 Conveyor Roller

A line shaft roller conveyor or line-shaft conveyor is, as its name suggests, powered by a shaft beneath rollers.



These conveyors are suitable for light applications up to 50 kg such as cardboard boxes and tote boxes. A single shaft runs below the rollers running the length of the conveyor. On the shaft are a series of spools, one spool for each roller. An elastic polyurethane o-ring belt runs from a spool on the powered shaft to each roller. When the shaft is powered, the o-ring belt acts as a chain between the spool and the roller making the roller rotate. The rotation of the rollers pushes the product along the conveyor. The shaft is usually driven by an electrical motor that is generally controlled by an electronic PLC (programmable logic controller). The PLC electronically controls how specific sections of the conveyor system interact with the products being conveyed.

6. Johnson Motor



Fig: 7 Johnson motor

Table: 1 Material description of Johnson motor

Operating Voltage(VDC)	6 to 18	Load Current(A)	1.342
Nominal Voltage (V)	12	Input Power (W)	16.35
Rated Base Motor RPM	18000	Output Power(Watt)	8.292
Gear Ratio	30	Shaft Diameter (mm)	6
Gear Material	Metal	Shaft Length (mm)	30
Rated RPM	600	Gearbox Diameter (mm)	37
Rated Torque (N-cm)	15.1	Motor Diameter(mm)	27
Stall Torque (N-cm)	122	Motor Length(mm)	60
Rated Power (W)	10	Operating Temperature (°C)	-30 to 60
No-Load Current	345 Ma	Weight (gm)	154

7. Arduino UNO

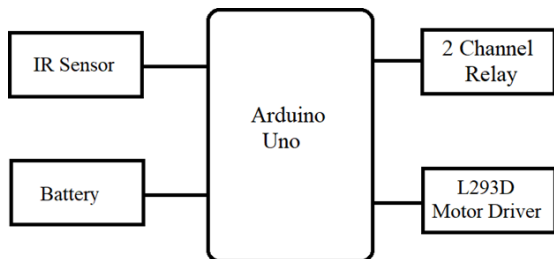


Fig: 8BlockDiagram



Fig: 9 ArduinoUNO

The Arduino UNO is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be

interfaced to various expansion boards(shields)andothercircuits.Theboardhas14Digitalpins,6Analogpins,and programmable with the Arduino_IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts.

IV.DESIGN

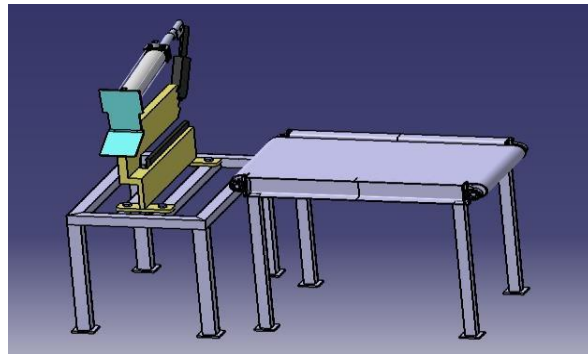


Fig: 10 Pneumatic Sheet Metal Cutter

Various Views of Pneumatic Sheet MetalCutter

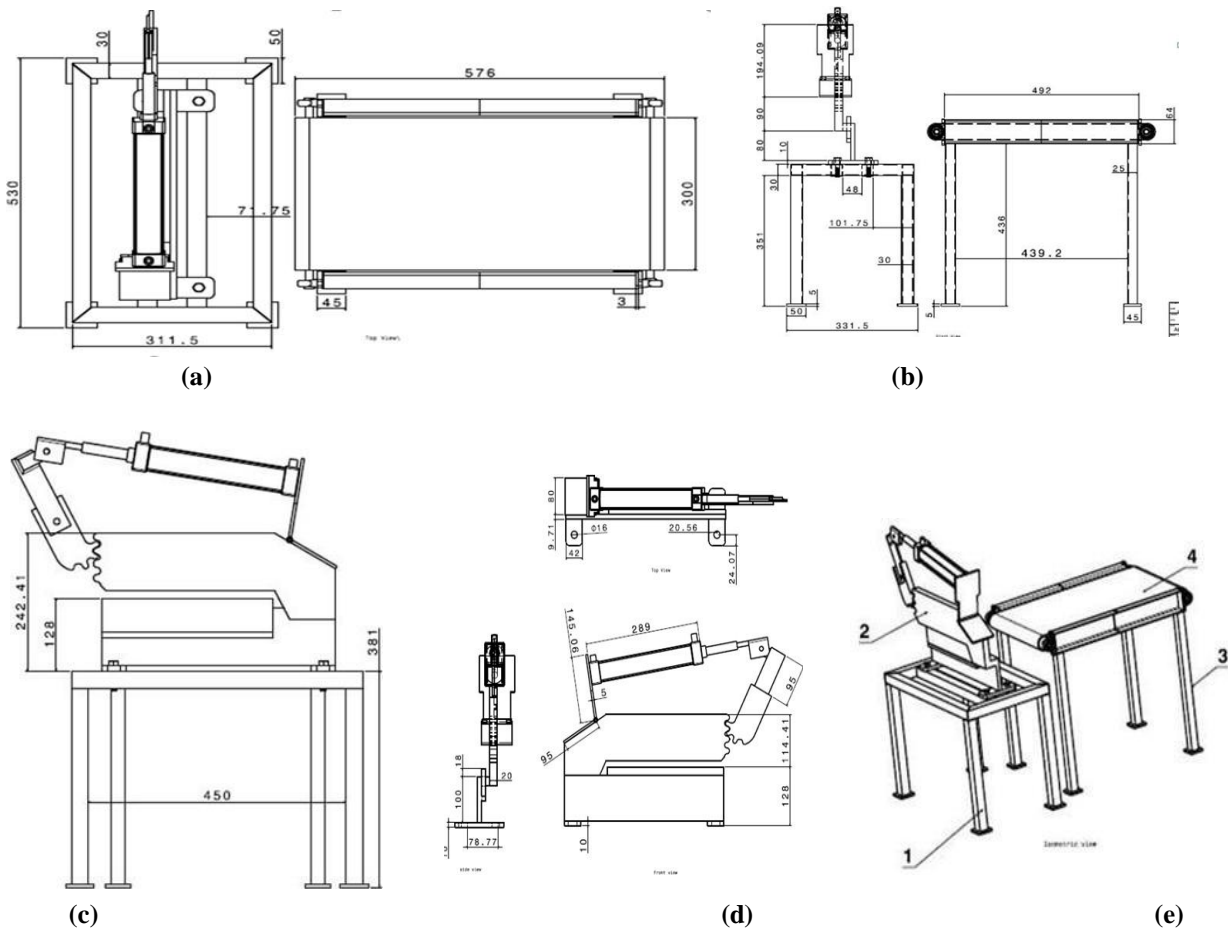


Fig: 9 (a) Top view, (b) Front view, (c) Left side view (d) Right side view (e) Isometricview

V. FABRICATION



VI. 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 & 5/2 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.

VII. RESULTS

The metal strips made of galvanized iron and aluminium with different thickness has been sheared by the pneumatic cutting machine at various pressures. Table 2 shows the force and pressure required to cut the different sheets of various thickness.



Table 2: Force reading for different sheets

Material used	Thickness (cm)	Applied pressure (bar)	Force (N)
Galvanized iron sheet metal	0.1	3.5	431.24
	0.15	5	615.07
Aluminium	0.1	1	123
	0.2	3	370
	0.3	5	616.07

With the use of scissor type blades, it acts as a lever system. less cylindrical force is used to generate the shearing force. Automation has reduced the time taken in measuring and cutting the sheet metal, with automation it takes 1-2 seconds persheet.

VII. 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. The pneumatic sheet metal cutting machines are very cheap as compare to hydraulic sheet metal cutting machine. The range of cutting thickness can be increases by installing high pressure cylinder and harder blade. The small sheet metal cutting industry cannot afford the expensive hydraulic cutting machine. Hence this Sheet metal cutting machine justify the search.

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