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Fabrication of Pneumatic Sheet Cutting and Drilling Machine

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ABSTRACT We are using scissors for simple sheet metal cutting. It is a manual method so that sheet metals are to be wasted sometime because of mistakes happened such as wrong dimensions etc., and also even a simple cutting may take long time. Hydraulic machines are also available for sheet metal cutting. But this method is used for only heavy metal cutting and its cost is very high. We are using a pneumatic system for sheet metal cutting in an easy way. It is operated by a pneumatic hand lever of two, way control valve. Control valve is operated by a compressor.

KEYWORDS :

1. INTRODUCTION:

Pneumatic devices are used in many industrial applications. Generally appropriate for applications involving less force than hydraulic applications, and typically less expensive than electric applications, most pneumatic devices are designed to use clean dry air as an energy source. The actuator then converts that compressed air into mechanical motion. The type of motion produced depends on the design of the actuator. Pneumatics is employed in a variety of settings.

In dentistry applications, pneumatic drills are lighter, faster and simpler than an electric drill of the same power rating, because the prime mover, the compressor is separate from the drill and pumped air is capable of rotating the drill bit at extremely high rpm. Pneumatic transfer systems are employed in many industries to move powders and pellets. A device which gets heated by the sun's energy is called solar heating device. All the solar heating devices are designed in such a way that they help in collecting as much sunlight as possible. It is a device which converts solar energy directly into electricity. Since solar energy is a light energy so we can say, "Solar cell is a device which converts light energy into electrical energy.

2. SHEET METAL:

Sheet metal is simply 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 a variety of different shapes. Countless everyday objects are constructed of the material. Thicknesses can vary significantly, although extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate. Sheet metal is available in flat pieces or as a coiled strip. The coils are formed by running a continuous sheet of metal through a roll slitter. The thickness of the sheet metal is called its gauge. Commonly used steel sheet metal ranges from 30 gauges to about 8 gauges. The larger the gauge number, the thinner the metal. Gauge is measured in ferrous (iron based) metals while nonferrous metals such as aluminum or copper are designated differently; i.e., Copper is measured in thickness by Ounce.

3. LITERATURE SURVEY:

In shearing or cutting operation as or blade descends upon the metal, the pressure exerted by the blades first cause the plastic deformation of the metal. Since the clearance between the two blades is very small, the plastic deformation takes place in a localized area and the metal adjacent to the cutting edges of the blade edges becomes highly stressed, which causes the fracture to start on both sides of the sheet as the deformation progresses and the sheet is sheared.

Types of shearing machine

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 foot operated 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:** 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 are 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.

4. MAIN COMPONENTS OF THE MACHINE:

There are five main components:

1. Compressor
2. Pneumatic Cylinder
3. Solenoid Valve
4. Solar System
5. Battery

COMPRESSOR:

The air under high pressure is given by a compressor. It is driven by an electric motor. The compressor delivers air to inlet of the cylinder. An air compressor as the same indicates is a machine to compress the air and to raise its pressure. The air compressor sucks air from the atmosphere, compresses it and then delivers the same under a high pressure to a storage vessel from the storage vessel it may be conveyed by a pipeline to a place where the supply of compressed air is required. Since the compression of air requires some work to be done on it, therefore compressor must be driven by some prime mover.

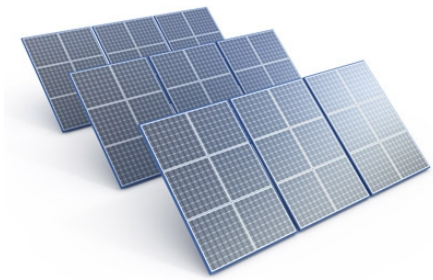
PNEUMATIC CYLINDER:

Pneumatic cylinders (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Pneumatic cylinders are designed for a variety of services. Pneumatic cylinders transform the flow of pressured fluid into a push or pull of the piston rod since out system uses double acting cylinders.

SOLENOID VALVE:

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.

SOLAR CELL SYSTEM:



Solar panel refers to a panel designed to absorb the sun's rays as a source of energy for generating electricity or heating.

A photovoltaic (PV) module is a packaged, connect assembly of typically 6×10 photovoltaic solar cells. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. Each module is rated by its DC output power under standard test conditions (STC), and typically ranges from 100 to 365 watts. The efficiency of a module determines the area of a module given the same rated output – an 8% efficient230-watt module will have twice the area of a 16% efficient 230-watt module. There are a few commercially available solar modules that exceed 22% efficiency and reportedly also exceeding 24%. A single solar module can produce only a limited amount of power; most installations contain multiple modules. A photovoltaic system typically includes an array of photovoltaic modules, an inverter, a battery pack for storage, interconnection wiring, and optionally a solar tracking mechanism.

BATTERY:

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. When a battery is connected to an external circuit, electrolytes are able to move as ions within, allowing thechemical reactions to be completed at the separate terminals and so deliver energy to the external circuit. It is the movement of those ions within the battery which allows current to flow out of the battery to perform work. Historically the term "battery" specifically referred to a device composed of multiple cells, however the usage has evolved to additionally include devices composed of a single cell.

In this project battery is basically used to store the energy from solar panel and an electrical circuit are also used to convert the solar energy into electrical energy.

5.SPECIFICATIONS OF PNEUMATIC SYSTEM:

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

1. Double Acting Cylinder:
Material-Aluminum Alloy
- Polyurethane
- Nitrile

Stroke Length-120mm
Piston Diameter-20mm
Maximum Operating Pressure-12bar

2. Solenoid Directional Control Valve:
We are using 5/2 Solenoid Valve as the directional control Valve.
Voltage-12V
Frequency-50Hz
Max. Operating Pressure-10bar
Port Size-6-8mm
Fluid Media-Air
3. Compressor:
Voltage-DC 12V

Amperage-14A
Duration-12-15Min
Max. Pressure-7Kg/Cm2 (150PSI)
Displacement-35L/Min

6.PART MODEL AND ASSEMBLY PROCESS:

Pneumatic Cylinder-Frame**:** Assembled by Drilling.
Upper Blade and Lower Blade:Bolt and nut tightening at the hinge point so that Upper blade can rotate smoothly.
Connecting Link-Upper Blade:They were joined by bolt nut tightening and grinding on it to work smoothly.
Connecting Link-Cylinder:There was a threading at the end ofConnecting Rod of Cylinder. So, the connecting Link was tightened with nuts and bolts to the Connecting Rod of upper blade.

7. MATERIAL SELECTION:

Base frame: To choose the material for the 'Base frame' would be 'Wood'. The kind of wood available in local area is mostly teak. The Base of the frame would be made up of 'Plywood' as it provides High strength and it is available in large sheets.

Shearing Blade: To choose the material for 'Shearing blade' would be 'High speed steel or iron blade'.This type of hot work steel provides better Toughness and resistance to Thermal Fatigue cracking

Connecting Link: The material for 'Connecting Link' would be 'Mild steel'. The connecting link should provide high strength during to and from motion of the connecting rod. Also, the connecting Link needs to be welded properly with the Upper blade to make a linkage as shown in the figure.

Pneumatic cylinder: The material for 'Pneumatic Cylinder' would be 'High carbon steel'. As we are not manufacturing this cylinder, we don't focus on what material it is based on.

8.FORCE CALCULATION FOR CUTTING OPERATION:

For Aluminum sheet of thickness".5mm"

Thickness = .5 mm
Length of cut = 25mm
Maximum Shear Strength of Aluminum = 30 N/mm2

Force Calculation:

Force required to cut the sheet, F= 25*.5*30
F= 375N

This is the force required to cut the sheet.
The Compressor pressure should be 15bar

Compressor and cylinder:

Since max force required to cut the sheet= 375N
Applied Max pressure= 15bar, (Converting the unit 1 bar= $10^{-1}\ N/mm2$

So, Force applied by the cylinder, F= (3.14/4)*(d^2)*p
F=0.7854*(20^2)*15*0.1
F=471.24N

Since, the force required will be 10-20 % less of calculated value. (Due of losses)

that is, F'=471.24*15%= 70.686N

Therefore, Actual force on cutting blade= 471.21-70.686 = 400.56N
Here, force 400.56>375. So that cutting is taken place

9.FORCE CALCULATION FOR DRILLING OPERATION:

For Aluminum sheet of thickness".5mm"

Thickness = .5 mm
Maximum Shear Strength of Aluminum = 30 N/mm2

Force Calculation:

Force required to drill the sheet, ={(22/7)*D*}*.5*30
=471.24N

This is the force required to drill the sheet.

Since, the D.C. motor has speed 86rpm and drill bit diameteris 10mm.

So, w={(2*3.14*N)/60}
or w={(2*3.14*86)/60}
orw= 9rad/s
And, power P=V*I=F*U

Therefore, F=(V*I)/U
F=(12*2.04)/(9*.005)
F=544N

Since,3-8% losses occur during this process.
So, Actual force= 544-(544*.05)
= 516.8N

Hence,516.8>471.24N, SO that drilling operation taken place.

10.CONCLUSION:

- This Pneumatic cutting machine is very cheap and less cost as compared to hydraulic cutting machine.
- The range of the cutting thickness can be increased by arranging a high-pressure compressor and installing more hardened blades.
- This machine is advantageous to small sheet metal cutting industries as they cannot afford the expensive hydraulic cutting machine.
- It has almost no pollution that affect the environment.

11.FUTURE SCOPE:

- In this machine, compressed air is used to move the cutting tool for carrying out cutting operation using solar energy. After the completion of the cycle the air moves out through the out port of Solenoid valve. This air is released to the atmosphere. In future, the mechanism can be developed to use this air again for the working of cylinder(utilization of compressed air that loss in atmosphere).
- It can be made hydraulically power operated by installing the gear oil pump at the place of air compressor and pneumatic cylinder arrangement.
- The place where there is scarcity of the electricity the electric motor operate compressor is replaced by an I.C. Engine installed compressor.

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