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Design of Automatic Pneumatic Hole Punching Machine

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Abstract - ***The use of aluminum has increased significantly now days in many industries line automobile, food packaging, pharmaceuticals, etc. The reason behind this is that aluminum products are easy to manufacture, reliable and easy to handle. The aluminum products manufacturing industries are striving hard to produce quality goods at cheaper costs. Hydraulically operated machines are expensive and their maintenance cost is high, which makes the manufacturing of aluminum goods a challenge for small scale industries. This paper deals with pneumatically operated hole punching machine. The designing was done on the SolidWorks software. In the end, the conclusion is made and several suggestions are made to make scope for improvements in future.***

Key Words : Punching, Shear on material,Pneumatic system, IC Timer Circuit, Solenoid Valve, Solar Panel, Modelling in SolidWorks

1. INTRODUCTION

This project is a study about the designing of pneumatic hole punching machine, which shows the capability to design a concept using variety of components. As the name implies, pneumatic systems use pressurized gases to transmit power. Typically, pneumatic systems use air as the fluid medium, because it is low cost, safe and easily available fluid.

The automatic pneumatic hole punching machine is designed using various components. The components are pneumatic cylinder, pressure regulator, solenoid valve, solar panel, compressor. The application of solar panel is to charge the battery that runs the compressor. The pneumatic cylinder is used to obtain the ramming action to punch holes, and the compressor provides the compressed air to the cylinder due to which the movement of piston cylinder takes place.

Different pneumatic systems works efficiently at different operating pressure conditions. Therefore, the selection of suitable pressure regulator is important for efficient working of pneumatic system.

2. DESIGNING PROCESS

To make any machine part, the material should be properly and carefully selected, considering safety. The selection of materials for engineering applications is governed by the factors like availability, cost of the material & the suitability of the material required for the components.

2.1 Selection of material

I have selected mild steel, because it is readily available in the market, economical for use and is available in standard sizes. Its mechanical properties are good i.e it is easily machinable, has moderate factor of safety. It also has high tensile strength and low coefficient of thermal expansion.

The sheet metal which I have assumed to be punched are aluminum and plastic as I have designed the machine keeping these two as reference.

Material of sheet metal	Aluminium
Thickness (t)	0.5 mm
Dia of hole to be punched (d)	10 mm
Max. shear strength of aluminium (T)	30 N/mm^2

2.2 Force Requirement

Force required to punch the hole = d×t×T

For a sheet of 0.5 mm thickness,

force required, f = 10×0.5×30 = 150 N

Therefore, now we have selected 12 volt DC air compressor, which develops a pressure of 10.35 bar(around 150 psi)

For designing cylinder :

Force applied by the cylinder, $F = (\pi/4) \times d^2 \times f$

D = 13.5 mm

For safe design, I have taken cylinder diameter as 20mm.

2.2 Solenoid Valve

Commonly known as DCV, this valve is used to control the direction of air flow in the pneumatic system. The directional valve does this by changing the position of its

internal moving parts. This valve was selected as it provides speedy operation.

A solenoid is an electrical device that converts electrical energy into straight line motion and force. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one in which the plunger is pulled when the solenoid is energized.

2.3 IC Timer Circuit

The IC 555 circuit is a highly stable controller capable of producing accurate time delays or oscillations. In this timing operations, the time is precisely controlled by one external resistor and a capacitor, by the operation as an oscillator, the free running frequency accurately contributed with the external RC constants. The internal resistors act as a voltage divider network, providing (2/3)Vcc at the noninverting terminal of the upper comparator and (1/3)Vcc at the inverting terminal of the lower comparator. In most applications, the control input is not used, so that the control voltage equals +(2/3) VCC. Upper comparator has a threshold input (pin 6) and a control input (pin 5). Output of the upper comparator is applied to set (S) input of the flipflop. Whenever the threshold voltage exceeds the control voltage, the upper comparator will set the flipflop and its output is high. A high output from the flipflop when given to the base of the discharge transistor saturates it and thus discharges the transistor that is connected externally to the discharge pin 7. The complementary signal out of the flipflop goes to pin 3, the output. The output available at pin 3 is low. These conditions will prevail until lower comparator triggers the flipflop. Even if the voltage at the threshold input falls below (2/3) VCC, that is upper comparator cannot cause the flipflop to change again. It means that the upper comparator can only force the flipflop's output high. To change the output of flipflop to low, the voltage at the trigger input must fall below + (1/3) Vcc. When this occurs, lower comparator triggers the flipflop, forcing its output low. The low output from the flipflop turns the discharge transistor off and forces the power amplifier to output a high. These conditions will continue independent of the voltage on the trigger input. Lower comparator can only cause the flipflop to output low. it is concluded that for the having low output from the timer 555, the voltage on the threshold input must exceed the control voltage or + (2/3) VCC. This also turns the discharge transistor on. To force the output from the timer high, the voltage on the trigger input must drop below +(1/3)VCC. This turns the discharge transistor off.

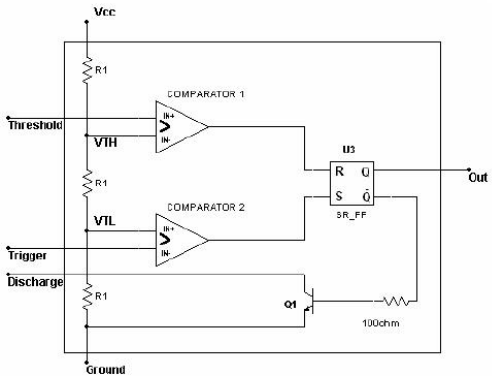

Fig 1 : Block Diagram of IC555 circuit

2.4 Solar Cell/ Solar Panel

The solar cell is used to supply 12 V power to the battery, when sun rays falls on the solar panel.

Solar panels generate power from the sun by converting sunlight into electricity. It is a clean source of energy, available abundantly. It requires no maintenance and has zero emissions. There are 3 types of solar panels namely mono Crystalline Solar PanelPoly Crystalline Solar PanelAmorphous Solar Panel

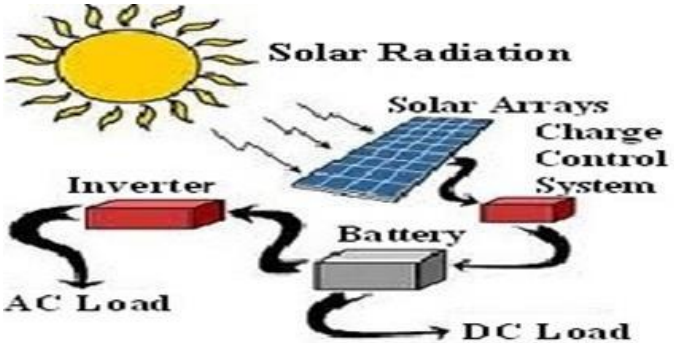

Fig2: Basic Solar Power Generating system

2.5 Battery

To run the 12v dc compressor, we have the requirement of battery of 12 v capacity. It is required to store the energy harvested by the solar cells to run the compressor. It is crucial requirement for the charging system

3. WORKING PRINCIPLE

The compressed air from the compressor in the pressure range of 7-10 bar is passed through a pipe connected to the solenoid valve with one input. The solenoid valve is actuated by the timer unit. The solenoid valve has 2 outputs and one input. The air entering the input goes out through the two outputs when the timing unit is actuated.

As the air pressure is high at the bottom of the piston, the air pressure below the piston is more than above it. The material is placed on the die, which is fixed on the base of the machine and the punch.As the exhaust valve is opened, the pressurized air pushes the piston downwards which in turn is connected to the punch. Due to this the punch travels down on the metal sheet kept over die, punching the hole.

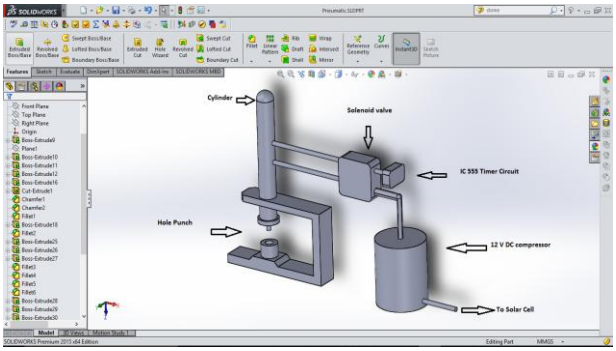

Fig 3: Deign of Model in SolidWorks

4. CONCLUSIONS

After the designing of automatic pneumatic hole punching machine using solar energy, it was concluded that the machine running using solar energy, which is unconventional source of energy, may be used in small scale industries, thus eliminating the use of electricity to run the machine..

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