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DESIGN AND FABRICATION OF ARDUINO BASED PNEUMATIC PUNCHING MACHINE

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A B S T R A C T

Pneumatic system is noted for their simplicity, reliability, and ease of operation .Also they are suitable for fast and rapid application of force. The purpose of this project is to therefore design a simple, easily operated pneumatic punching machine that is sturdy and strong. The pneumatic press tool has an advantage of working in low pressure, that is even a pressure of 6 bar is enough for operating the unit. The pressurized air passing through the tubes to the cylinder, forces the piston out whose power through the linkage is transmitted to the punch. The work piece thus is for required dimensions and the piece can be collected through the land clearance provided in the die. The die used in this is fixed such that the die of required shape can be used according to the requirement. This enables us to use different type punch dies resulting in a wide range of products. Different types of punch as requirement can be thus got. According to the work material the operating pressure can be varied.

Keywords*: Pneumatic, Punching Force, Automatic, Solenoid Valve, Simple, Cost Efficient,*

1. INTRODUCTION

1.1 Pneumatic

Pneumatic is the science and technology of pressurized air—using piped, compressed air (or a similar gas, such as nitrogen) to transmit force and energy.Pneumatic Systems operates on a supply of compressed air which must be available in sufficient quantity and at a pressure to suit the capacity of the system when the pneumatic system is being adapted for the first time however it will indeed be necessary to deal with the section of compressed air supply.A pneumatic system controlled through manual or automatic solenoid valves is selected when it provides a lower cost, more flexible, or safer alternative to electric motors, and hydraulic actuators.

Pneumatic also has applications in dentistry, construction, mining, and other areas.

1.2 Punching Machine

A punching machine is a machine tool for punching and embossing flat sheet-materials to produce form-features needed as mechanical element and/or to extend static stability of a sheet section. Punching is a forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. Punching is applicable to a wide variety of materials that come in sheet form, including sheet metal, paper, vulcanized fibre and some forms of plastic sheet.

Types of punching machine:

1) Flywheel Drive
2) Mechanical Punch Press
3) Hydraulic Punch Press
4) Servo drive turret punch press
5) Pneumatic Punching Machine

1.3 Pneumatic-Punching Machine

In the Pneumatic Punching machine the force required to punch a hole on the work piece lets say a sheet metal of Aluminium is given by a pneumatic actuator.Pneumatic actuators are devices that convert the energy of compressed air or gas into a mechanical motion that regulates one or more final control elements. Pneumatic actuators are devices that convert the energy of compressed air or gas into a mechanical motion that regulates one or more final control elements.The Pneumatic actuator works by means of compressed air which makes the Air compressor an important component of the machine in order to operate .The compressor can be directly connected to the machine or the compressed air can be stored in a tank which is movable and in turn increasing the flexibility of this machine.

The flow of the compressed air is controlled by a Solenoid valve (220V AC). A Solenoid valve is an electromagnetically operated valve.Solenoid valves differ in the characteristics of the electric current they use, the strength of the magnetic field they generate, the mechanism they use to regulate the fluid, and the type and characteristics of fluid they control. The mechanism varies from linear action, plunger-type actuators to pivoted-armature actuators and rocker actuators. The valve can use a two-port design to regulate a flow or use a three or more port design to switch flows between ports. Multiple solenoid valves can be placed together on a manifold.Solenoid valves are the most frequently used control elements in fluids. Their tasks are to shut off, release, dose, distribute or mix fluids. They are found in many application areas. Solenoids offer fast and safe switching, high-reliability, long service life, good medium compatibility of the materials used, low control power and compact design.

The Punch and die system is the most important part of the machine because the shape of the hole that has to be made on the work piece depends on the shape of the Die.By using a circular hole die we can produce a circular hole on the work piece and hence by replacing the die with another shape lets say a rectangle we can produce a rectangular shaped hole on the work piece.In this way we can produce various various shaped holes on the work piece.

The sheet metal is guided by a set of rollers which are connected by means of a chain and sprocket arrangement and are driven by a 12V DC Torque Motor of 100 RPM which is powered by a 12V 9 amp Battery .The continuous rotation of the rollers facilitates the movement of sheet along the machine which makes this automatic and thus minimizing the manual work which makes this machine efficient and easy to use.

The controlling of the Punches (No of Punches to be made) is done by using Arduino Uno which is a popular Micro-controller which is based on At-mega 328P and has a very important role in this project .The Solenoid valve and the DC Motor a connected to the Arduino Micro Controller and the Required code is made and dumped into the Arduino in order to operate The Arduino works at very low voltage (5V) so A dual channel relay Module is used to control the input voltage to the Arduino .The Coding can be done in the Arduino application and can be compiled for any errors and the final code can be dumped directly into the controller using a cable .The coding is nothing but just denoting the pins assigned to our components and setting Up the time limit to operate for each component. Thus the rollers and the punches of the actuator are coordinated by this Arduino.

The flow of compressed air among the machine is facilitated by an air hose which is a poly utherene tube of 8mmx6mm dia and plays a vital role in operating this machine.

All the above parts are Equipped to a metal Frame which is designed and Fabricated to host all the above mentioned mechanisms.

2. COMPONENTS

1) Pneumatic Actuator
2) Solenoid Valve (AC 220V)
3) Torque Motor 100RPM(12V DC)
4) Chain
5) Sprockets
6) Metal Rods of Rectangular Cross section(Frame)
7) Jumper Wires
8) Normal Wires
9) Push Fit Connectors
10) Pressure Gauge
11) One Way Valve (Pneumatic)
12) Air Tank
13) Punch Head
14) Air Hose
15) Arduino Uno Micro controller
16) Dual Chanel Relay (5V)
17) 12V 9amp Battery Rollers

Software's Used:

1) Auto cad 2) Catia 3) Arduino IDE

Fig.1.(a)Pneumatic Actuator

Fig.1.(b)Solenoid Valve

Fig.1.(c)Push Fit Connectors

Fig.1.(d)Air Hose

Fig.1.(e)12V DC Torque Motor

Fig.1.(f)Pressure Gauge

Fig.1.(h)Air Tank

Fig.1.(g)Base Frame

Fig.1.(i)One way Pneumatic Valve

Design and Drawings :

Fig.2.(a)Left Side View

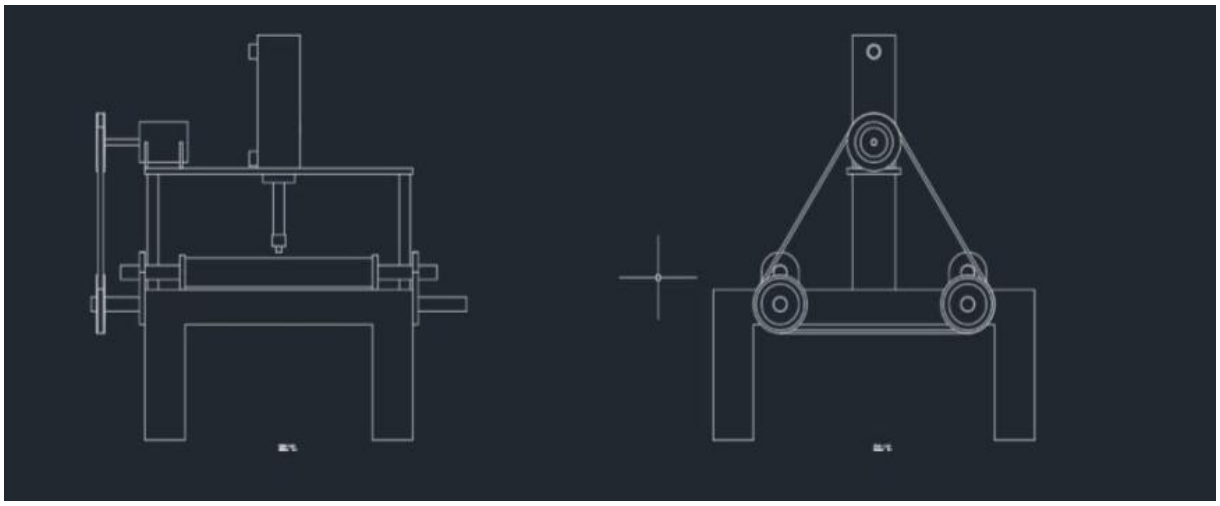
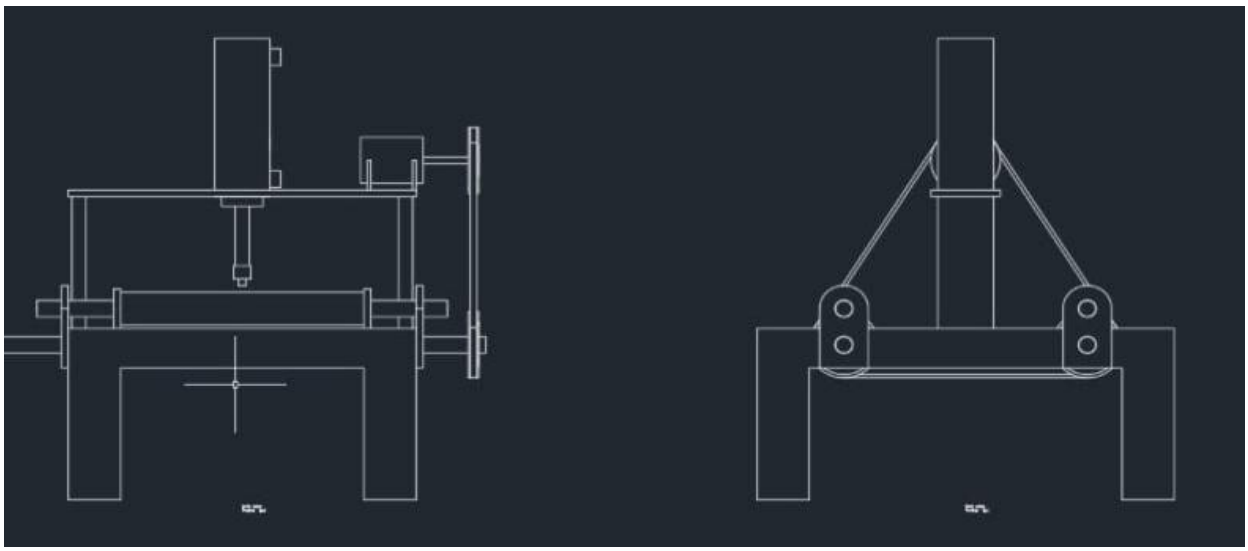


Fig.2.(b)Right Side View



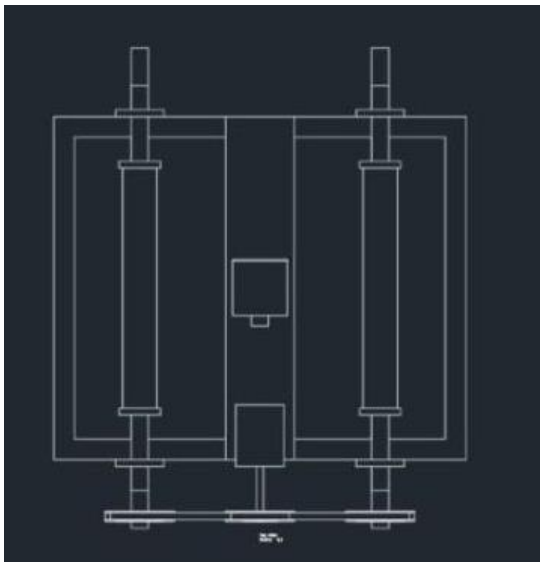


Fig.2.(c)Top View

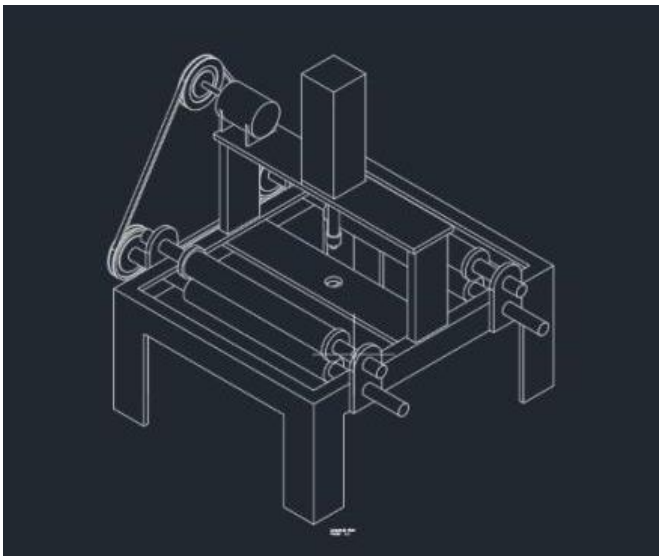


Fig.2.(d)3D View

3. WORKING PRINCIPLE AND PROCEDURE

[1] The compressed air from the compressor in the pressure Range of 75-115 psi is passed through a pipe connected to the solenoid valve with one input.

[2] The solenoid valve is actuated by the timer unit.

[3] The air entering the input goes out through the two outputs when the timing unit is actuated .

[4] As the exhaust valve is opened, the pressurized air pushes the piston downwards which in turn is connected to the punch..

[5] In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force as the effective area of the piston is small.

[6] A die is located on the opposite side of the work piece and supports the material around the perimeter of the hole and helps to localize the shearing forces for a cleaner edge.

[7] Due to this the punch travels down on the metal sheet kept over die, punching the hole.

[8] The Arduino Gives signal to the motor to rotate.

[9] Thus the Sheet Moves Forward and Next Hole is made and the Cycle repeats

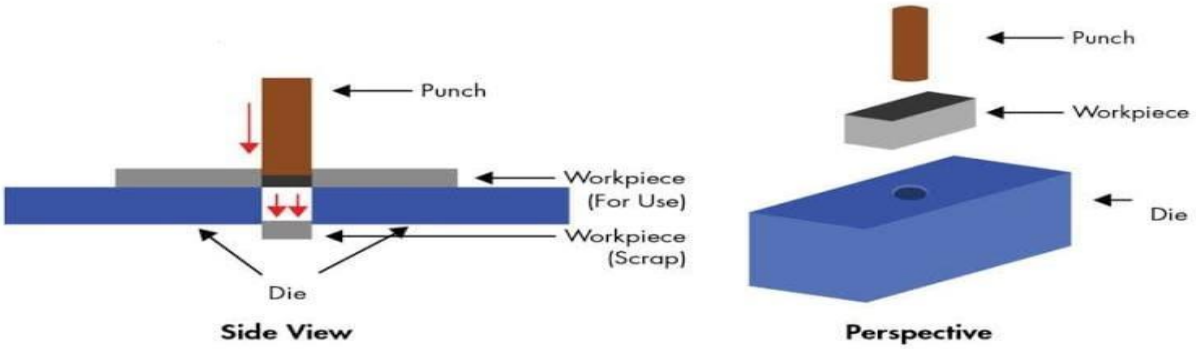
[10] The Co-ordination among the rollers Movement and the punching is carried out by this Arduino uno Micro Controller which needs a dual channel relay In order to operate at the required Voltage.

[11] The working of the Arduino is just giving signals to the relay module whose job is to just on or off the specified component for a specified time.

[12] In order to operate the Arduino requires a bit of coding that can be done using Arduino IDE Application.

[13] The source Code for the working of this Punching machine is as follows

Fig.3.Punch and Die Arrangement



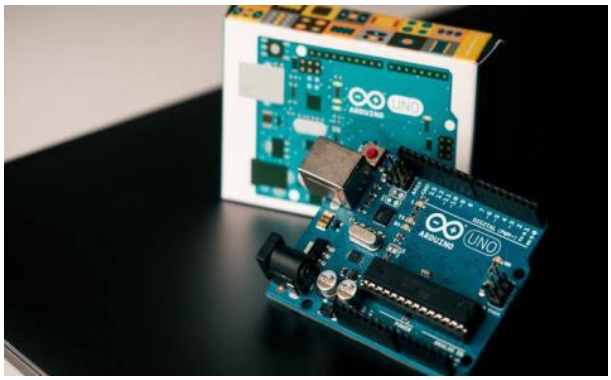


Fig3.(a)Arduino Uno

Fig.3.(b)Dual Channel Relay

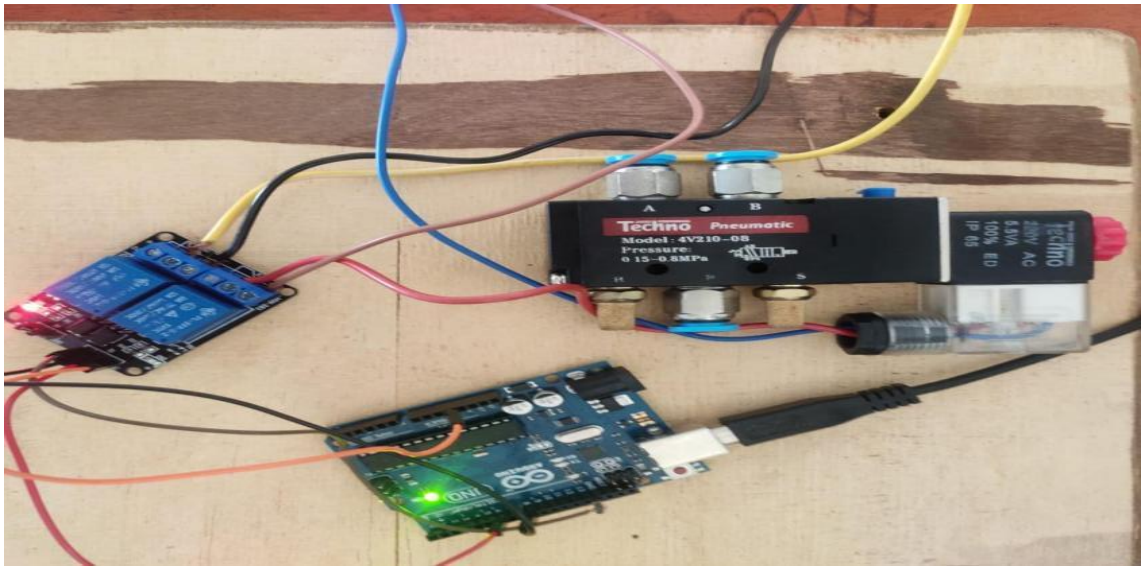


Fig.3.(c)Connections For Functioning

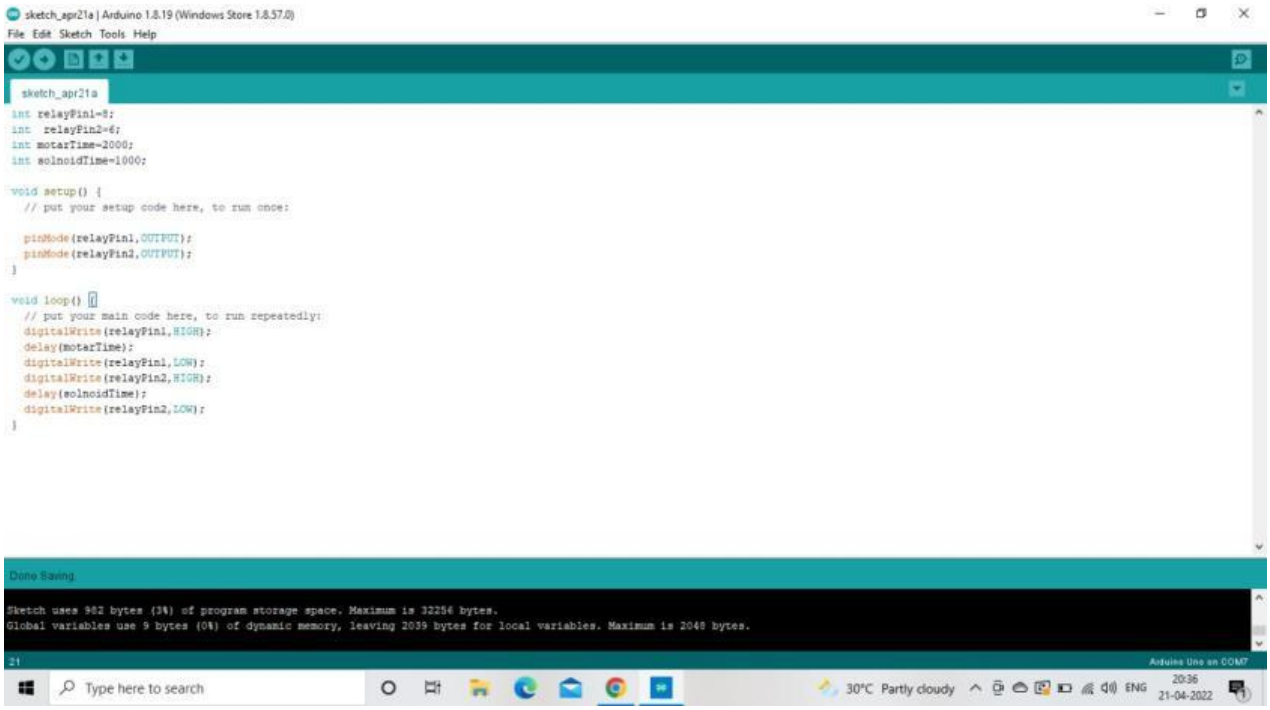


Fig.4.Arduino IDE Interface

Source Code For Working of Arduino:

```
int motorPin=8;

int  solnoidPin=6;

int motarTime=200;//increase to decease holes

int solnoidTime=1000;

String input;

void setup() {

  // put your setup code here, to run once:

    pinMode(motorPin,OUTPUT);

  pinMode(solnoidPin,OUTPUT);

  digitalWrite(motorPin,HIGH);

  delay(1000);

  }

void loop() {

  // put your main code here, to run repeatedly:

  digitalWrite(motorPin,HIGH);

  delay(motarTime);

  digitalWrite(motorPin,LOW);

  digitalWrite(solnoidPin,HIGH);

  delay(solnoidTime);
```

```
  digitalWrite(solnoidPin,LOW);
  delay(solnoidTime);
  digitalWrite(solnoidPin,HIGH);
  delay(solnoidTime);
  digitalWrite(solnoidPin,LOW);
}
```

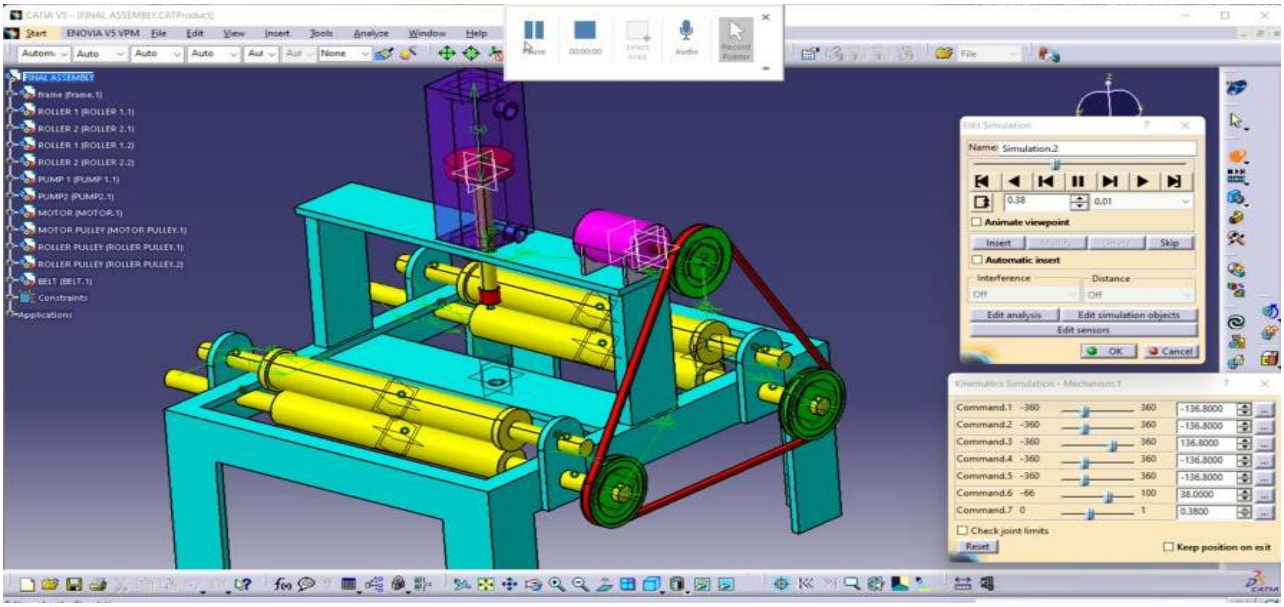


Fig.5.Working model Design (CATIA)

Fig.6.Final Fabrication

Fig.6.Final Assembly

4. CALCULATIONS

Force calculation for existing design:

- Cutting force: - The force which has to act on the stock material in order to cut the blank or slug.
- Stripping force: - The force developed due to the spring back (or resiliency) of the punched material that grips the punch.
- Cutting force = L x t x Tmax
- Stripping force =10% -20% of cutting force

Sample calculation for aluminum sheet :

Here is a sample calculation to calculate the punching force required for different thickness of aluminium sheet.

- Total length of cut, L =50 mm.
  If Sheet thickness, t = 1mm.
- Maximum tensile strength of aluminium, Tmax = 180 N/mm2
- Total cutting force = L x t x Tmax
- Total cutting force = 50 × 1 × 180

Force calculation:

- 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, $F = (\pi/4) \times d2 \times f$
- D = 13.5 mm
- For safe design, I have taken cylinder diameter as 20mm

5. CONCLUSION

After designing and Fabricating this Pneumatic punching machine we concluded that the Pneumatics are More powerful and Efficient than the Hydraulics.The overall cost including the travelling charges of this project are approximately 12,000Rs.

This project has a lot of future scope in helping small scale industries which require punching operation in their production procedures .This will facilitate to produce more number of products in a minimal time and that too without much man power and human effort.

The working pressures are also low and can be achieved by using a low cost Air compressor.If one desires to process a punch on a comparatively thick sheet they may need some extra pressure in the air and a bigger actuator depending upon the speed and thickness of the sheet.

By making smaller modifications this machine can also be used for Riveting Process too.

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