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DESIGN AND DEVLOPMENT OF AUTOMATIC PNEUMATIC PUNCHING MACHINE

Shubhangi.S.Shetake[1]

[1]*Professor(Dept of Mechanical Engineering, RMD Sinhgad college of Engineering, Pune, Maharashtra, India)*

Sumeet.A.Padwalkar[2], Abhishek.S.Gunje[3], Advita.A.Ingale[4], Sushil.V.Rawale[5]

[2-5]*Student ((Dept of Mechanical engineering, RMD Sinhgad college of Engineering, Pune, Maharashtra, India)*

Abstract - *The sheet metal punching process is a main part of the all industries. Usually the sheet metal punching machine is hand operated for small scale industries. The design used involves the properties such as mechanical and automation which uses microcontroller. This project deals with the design of pneumatically controlled punching machine to carry out punching operation on thin sheets of 1-2 mm for different material like aluminium and plastic. Punch force reduction is the main aim of this project and is obtained by modification in punch tool design. Subsequently it results in reduction in amount of punching force requirement and further a PNEUAMTIC CNC machine is developed. The secondary aim of the project is to reduce the setup. While changing the pitch distance between two holes during punching there is lot of time is wasted to set up the machine for new pitch design. In this project we reducing this time by controlling the machine by microcontroller through which we can change the pitch distance automatically without changing the setting of the machine by feeding the pitch distance changes via computer programming*.

***Key Words*: Compressed Air, Solenoid Valve, Polyurethane tubes, Pneumatic Cylinder, Economical.**

1. INTRODUCTION

Today's world is more practical and thinks more of cost reduction, so the punching process for sheet-metal has to be done in economical way of operation, easier implementation for mass-production, as well as greater control on the other technical parameters. In most of the sheet metal operations punching is the main operation in the process sequence. Automating this operation results in reduced time and also can reduce human effort. Automation is a process in which combination of mechanical work, electronic work is carried out. Automation systems to operate and control production with help of computer and commanding software. The reason for automating this process may be to reduce manufacturing lead time, to increase labor productivity or to improve the worker safe. In these unit high-pressure air is used to move piston with required pressure and piston consist of punch with modified design to punch sheet metal into required shape and size. Thin and flat pieces of sheet metal are then obtained. It is one of the fundamental forms used in metal working and can be cut and bent into variety of different shapes. Sheet metals are available in flat pieces or as a coiled strip. Sheet metals has wide range of applications in car bodies, airplane wings, medical tables, roofs of buildings and many other things.

1.1 PROBLEM STATEMENT

In traditional pneumatic punching machine all operation is controlled manually and due to this the production rate is reduced and due to this the accuracy of the product may be reduced. In traditional pneumatic punching machine, the lot of time is wasted in to change the setting of the machine for new pitch distance. To overcome the above problem then the solution is to use the CNC Punching machine but the cost of the CNC Punching is high and the small-scale industries cannot afford the cost of the CNC Machine.

1.1 OBJECTIVE

1. Make the system user friendly.
2. Minimise the setting time of the machine.

3. Develop machine which will require less labour and easily operated by unskilled labour.

4. Develop the machine at minimum cost.

2. METHADALOGY

Initially we tend to style machine by considering all parameters of standard punching machine and also the producing necessities of the merchandise like thickness of the sheet and diameter of holes to be punched. once taking the merchandise info conniving the specified press force and as per the calculated forces designated the gas cylinder from catalogue. once choosing the gas cylinder choosing the opposite gas elements like DV Valve and gas hoses. once choosing all gas elements and dealing elements we tend to choose alternative electrical and electronic elements like DC Motor and Microcontroller, Sensors. once finalizing the elements and style of the machine we tend to create 3D cad model.

2.1 MATERIAL SELECTION

2.1.1 FRAME

The frame is created of steel material. Because, steel is quickly on the market in market and is economical to use. it's sensible mechanical properties like high plasticity and high toughness. steel has carbon content starting from zero.15% to 0.25%. the final word strength and compressive of this steel will increase with increase within the carbon content.

2.1.2 SHEARING BLADE

The cutting off blade is created of hot-work steel material. The blade needs to stand up to the high cutting forces and this will be achieved by victimization high speed steel as a blade material. High speed steel offers reliable toughness and it retains sensible wear resistance. A typical composition is: eighteen of metallic element, four-dimensional of metallic element, I Chronicles of V, 0.7% of carbon and also the rest is iron.

2.2 DESIGN CALCULATIONS

2.2.1 PRESS FORCE CALCULATIONS

Press force = cutting force + stripping force

Sample Calculation for Aluminum Sheet

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

• Perimeter, L =31.41 mm. (For D = 10mm)

• If Sheet thickness, t = 1mm.

• Maximum tensile strength of aluminium, Tmax = 180 N/mm2

• Total cutting force = L x t x Tmax

= 31.41 × 1 × 180

= 5654.86 N

• Stripping force = 15% of the cutting force

= 848.229 N

• Press force = Cutting force + Stripping force

= 5654.86 N + 1350 N

= 6503 N

2.2.2 REDUCED PUNCH FORCE CALCULATIONS

Force required is reduced which can be seen by the formula,

F=Fmax.K.tK.t+1

Where,

F= Reduced force after providing shear in Newton (N)

Fmax= Maximum force required to punch the sheet of thickness t in Newton (N)

K= Percentage Penetration

t= Thickness of sheet in mm

I= Amount of shear given to the tool (in terms of t) in mm

Aluminum Sheet

1) For I=t/5 & K=0.6 F=0.75Fmax

2) For I=t/4 & K=0.6 F=0.705Fmax

3) For I=t/3 & K=0.6 F=0.643Fmax

4) For I=t/2 & K=0.6 F=0.545Fmax

5) For I=t/1 & K=0.6 F=0.375Fmax

We are taking selecting empirical relation as, F=0.375Fmax

Therefore, I = t/1 and K = 0.6 and F= 0.375Fmax

Therefore, F = 0.375 X 6503 N

F = 2500 N

Therefore reduced force after giving shear to the punch is 2500 N.

We are selecting the punching force range from 2000N – 2500N.

2.2.3 Pneumatic Cylinder Calculations

- For Double Acting Cylinder
- For Extension Stroke (Working Stroke)
- F = P x A

Where, F = Punching Force

P = Working Pressure

A = Area of the cylinder

Therefore, 2500 = (12 x 10^5) x (π/4 x D^2)

D = 25mm

Therefore we are selecting 25mm x 40mm double Acting Cylinder from catalogue.

2.2.4 Modification in Punch Design

If the face of the punch is traditional to the axis of motion, the complete perimeter is cut at the same time. By tilting the punch face on angle, a feature referred to as shear, the cutting force is reduced considerably. The edge is currently cut in a very progressive fashion, almost like the action of a try of scissors.

2.2.4 Design

CATIA V5R20 code is employed for coming up with and modelling. The blade style issues are:

- Clearance is usually a pair of to 100% of the fabric thick-ness.
- The higher blade is angulate so because the cutting progresses from one finish to alternative finish, so reducing the re-quired force.
- Cut kind cutting blade is employed.
- Sq. edged blade is most popular instead of knife edge.

Frame style issues are:

- supported the length of the cutting blade used, the dimension of the frame is chosen.
- The length of the frame is meant to create the ma-chine compact and conjointly to accommodate the length to cut.

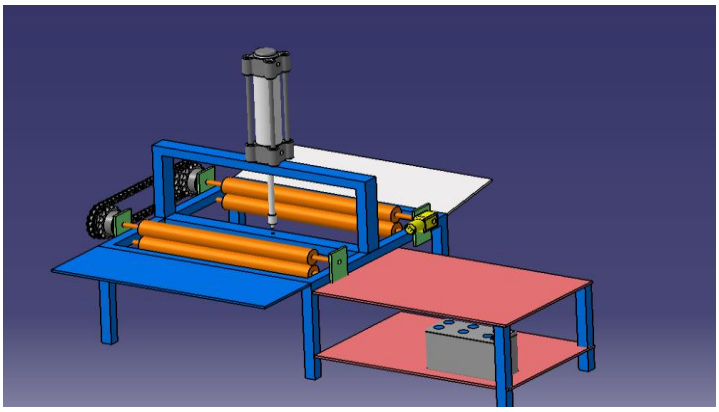

fig 2.2.4

3. COMPONENTS

3.1 MICROCONTROLLER

- A microcontroller is a compact microcircuit designed to control a particular operation in system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on one chip. The Atmega328 is a very fashionable microcontroller chip made by Atmel. it's AN 8-bit microcontroller that has 32K of non-volatile storage, 1K of EEPROM, and 2K of internal RAM. The Atmega328 is one in all the microcontroller chips that area unit used with the favored Arduino boards.

- Microcontroller ATmega328P

- Operating Voltage: 5V
- Digital I/O Pins
- 14 (of which 6 provide PWM output)
- PWM Digital I/O Pins 6, Analog Input Pins 6,Flash Memory 32 KB (ATmega328P) of which 0.5 KB used by boot loader.

FIG 3.1 MICROCONTROLLER

3.2 DC MOTOR

A DC motor consists of a mechanical device, a coil, a rotor and a electrical switch with brushes. Opposite polarity between the 2 magnetic fields within the motor cause it to show. DC motors area unit the best style of motor and area unit utilized in unit appliances, like electrical razors, and in electrical windows in cars. The DC motor may be a machine that transforms electrical energy into energy in kind of rotation. Its movement is made by the physical behavior of electromagnetism. DC motors have inductors within, that manufacture the field to generate movement.

- RPM: 30 at 12V
- Total length: 92mm
- Brush type: Precious metal
- Gear head length: 21mm
- Output shaft: Centered
- Shaft diameter: 6mm
- Shaft length: 19mm
- Gear assembly: Heavy duty metal gears
- Motor weight: 500gms
- DC supply: 4 to 12V

Fig 3.2 Dc Motor

3.3 5 X 2 SOLENOID VALVE

Solenoid valve is a management unit that, once electrically energized or de-energized, either shut off or permit fluid flow. The mechanism takes the shape of AN magnet. once energized, a field builds up that pulls a plunger or pivoted coil against the action of a spring. 5/2 approach may be a 5 port, 2 position valve which will place a fluid or air into one finish of a double acting device still as permitting the opposite finish vent to exhaust. Direct acting area unit coil valves that area unit activated strictly by the magnetic attraction forces within the valve and don't depend on fluid to assist.

Fig 3.3 5 x 2 Solenoid Valve

3.4 Double Acting Cylinder

Double-acting cylinder includes a port at every finish, provided with hydraulic fluid for each the retraction and extension of the piston. A double-acting cylinder is employed wherever an external force isn't on the market to retract the piston or it is used wherever high force is needed in each directions of travel. Double-acting cylinders (DAC) use the force of air to maneuver in each extend and retract strokes. they need 2 ports to permit air in, one for throw and one for cam stroke..

- Model - SC25x40
- Action type - Double action

- Material - Aluminum Alloy
- Bore Diameter - 25mm
- Stroke length -40mm

Fig 3.4 Double Acting Cylinder

3.5 COMPRESSOR

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. An air compressor is a specific type of gas compressor. Compressors are similar to pumps: both increase the pressure on a fluid and both can transport the fluid through a pipe.

Fig 3.5 compressor

3.6 POLYURETHANE TUBES

Polyurethane tubes are used to transfer pneumatic fluid i.e. compressed air. Polyurethane have the best properties of plastic and rubber. It offers abrasion and tear resistance, high tensile strength and elongation values, and have low compression.

Fig3.6 Polyurethane tubes

3.7 ROLLERS

Rollers are used to support the sheet passing through them. These rollers hold sheet metal plate stiff and pass forward with help of automation through given feed. These rollers are electronically operated with help of dc motor.

Fig 3.7 Rollers

4. WORKING PRINCIPLE

The sheet are going to be fed through feed rollers. The gear arrangement on the rollers is meshed with the DC motor, that feeds the sheet. The inductive proximity switch/sensor are going to be used, it detects the metal sheet and conjointly records the sheet length because the sheet passes over it. once detection, these informations square measure sent as a input to the microcontroller circuit containing series of relays. The microcontroller carries out the computations consistent with the writing done thereon. The output from the microcontroller are going to be sent to electrically controlled magnet valve(solenoid valve). The valve management the mechanism to actuate consistent with the signal received. DC motor meshed with the gear arrangement on the feed rollers receives input from the proximity switch, which can start/stop consequently. This method provides provision to enter variety of sheets along side the desired length that is has to be cut.

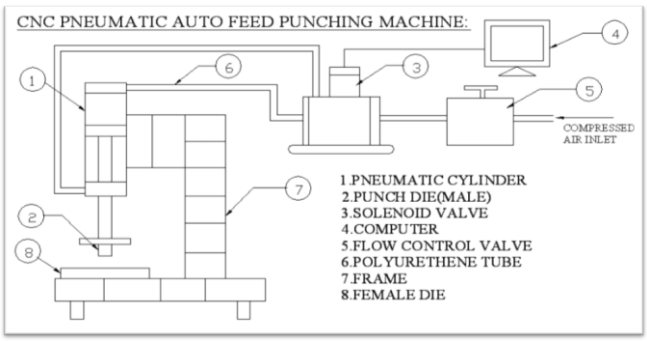

Fig 4 Block diagram

5. CONCLUSION

It is determined that the gas(air) cutting is incredibly low-cost as compared to hydraulic cutting machine. The vary of the cutting thickness will be inflated by mistreatment air mass mechanical device and additional hardened blades. This machine is advantageous to tiny sheet cutting industries as they can't afford the dearly-won hydraulic cutting machine. more with the utilization of automation, it provides provision to enter the quantity of sheets to be cut and needed length of the sheet. Thus human effort is reduced with increase in accuracy operational.

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