Design and Development of Autofeed Pneumatic Punching and Riveting Machine.

Dr G Arunkumar¹,* Tison Antonio J² and Velayutham Pon²

¹ Professor and Head of the Department of Mechanical Engineering, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India.

² Student, Department of Mechanical Engineering, Sathyabama Institute of Science and Technology, Chennai, Tamil Nadu, India.

*Email: garun55@gmail.com

Abstract: Metal as sheets are more significant. However, metal as sheets can’t be straightforwardly utilized, activities like punching, blanking, twisting, riveting, and so forth are should be done on the metal sheets. For these activities, most enormous scope fabricating businesses utilize powerfully worked machines which are not savvy, generally little and medium scale enterprises utilize hand-worked machines for completing sheet metal activity which are moderate. 6 bar pressure is enough for these machines to work. The compressed air is going through the cylinders to the chamber powers the cylinder out which thus incites the cylinder down which thus does the way toward punching or riveting. This empowers us to utilize various kinds of hardware to perform various tasks. After the consummation of punch or rivet in the sheet metal the compressed air flows to the lower part of the chamber which incites the cylinder upwards so the metal is liberated from the tool and the following punch or rivet measure is made accessible. As per the functioning material the functioning pressing factor can be changed. This empowers us to utilize various kinds of punch or rivet apparatus which helps in bringing about a wide scope of items.

1. Introduction

In manufacturing industry, the punch or rivet is done by using press. The press is traditional machine which is used to perform the punch or rivet in the metal sheets. Using the press required dimensions of the punch or rivet is done. And presses are used for mass production, this the efficient and fastest way by which the finished punched or riveted product is obtained. Press tools are used and changed according to the user’s requirement. The press tool is simplified by using the die at the bottom, by using die the punch or rivet is done without any deformation in the metal sheets. There are various types of presses used in the industry for performing punching or riveting based on the requirements. We are interested to use pneumatic in the presses to increase the efficiency and decrease the work load. By using pneumatics, the press tool can be actuated even at low pressure of 8 bar. In early days, industries use thousands of people for the production because those days no machines were invented. Thousands of people are working in every department, they spend their lot of energy to finish the work which is given to them. In industry lots of departments are available namely design, material selection, assembling section, testing section, delivery, etc. Due to these lot of sections more amount is needed in the industry to finish the work in right way and also in particular period of time. While using these much of people in the industry, they should schedule that at particular time certain amount of people should work. After
that next batch people should come to the industry and they should resume the work where the previous batch workers left and do it in right manner

1.1. Need for Automation

Automation plays a major role in the manufacturing industries, world economy and daily experience. The automation is the combination of both control systems and information technologies. In this automation most of the work is done by the machine itself so no human power is involved. In industry while using automation, most of the work is automatically done by the machines human should watch whether it is doing correctly. In the scope of industrialization, automation is very important part of the manufacturing department. When industries are converted to automation it will be beyond mechanization. In mechanization, lots of humans and their muscular power is needed to do the certain work. And the work should be completed within the particular date and the finished product should be satisfying the customer’s requirements and also profitable to the industry. And using automation in the industry the percentage of error while manufacturing is greatly decreased, or else the production will be affected. While using automation the error in the particular department is found when it occurs. If automation is not available the error is not found and also carried to the next department this the time waste and also the cost is wasted. By using automation in the industries, 90% of the work will be completed by the machines itself and rest 10% work will be completed by the workers. Due to this automation workers need is reduced and the work is done perfectly.

1.2. Objective

1. To use compressed air for actuating the piston for punching and riveting.
2. To Minimize the setting time and operating time.
3. To save man power.
4. To make a cost-effective product.

2. Design Calculations

The design calculations are presented in this section.

Cutting Force = L * t * Tmax
L - perimeter of the punch hole.
t - thickness of the sheet.
Tmax – max tensile strength.

L = 2πr (D=10mm) = 2*3.14*5 = 31.41mm

t = 0.5mm

Maximum tensile strength of aluminium (Tmax) = 180 N/mm²

Cutting force = 31.41 * 0.5 * 180 = 5654.86678 N.

Stripping Force = 10% - 20% of cutting force.
15% of cutting force = (15/100) *5654.86678 = 848.2300 N

Press force = Cutting force + stripping force
= 5654.86678 N + 848.23 N
= 6503.097N

Reduced force = 0.37 * press force
= 0.37 * 6503.097 N = 2438.66137 N
For selecting cylinder bore diameter, the calculations involved are:

\[ F = P \times A \]

\[ P = \text{Working pressure} = 8 \text{ bar} \]

\[ A = \text{area of the cylinder} = (\pi/4) \times d^2 \]

\[ 2438.66137 = 0.8 \times (3.14/4) \times d^2 \]

Hence, \( d = 62.99 \text{ mm} = 63 \text{ mm} \) (Standard size)

Force realised by the cylinder at 8 bar \( F = P \times A \)

\[ F = 0.8 \times (3.14/4) \times 63 \times 63 \]

\[ F = 2492.532 \text{ N.} \]

2.1. Design

Figure 2. 3D Design

Based on the design calculation, the 3D model (as shown in the figure 2.1) of the auto feed pneumatic punching and riveting machine is done in solid works software. With this 3D model, the fabrication of the auto feed pneumatic punching and riveting machine is done. The project work has provided a great opportunity and experience to use our limited knowledge. Gained lot of knowledge while doing 3D model in solid works software.
3. Components

3.1. Compressor

A compressor is the mechanical device used to increase the pressure of the air by decreasing the volume of the air. The capacity of the compressor also varies it is different based on the amount of air that can be compressed at a unit time. Compressor capacity depends on the amount and also the volume of the air that is to intake. The condition of the air to be intake is also important because when the air is free from moisture is easy to compress. But when the air warm and moist the compressed air is condensed and not up to the mark. Pneumatic system operates on the supply of compressed air to the machine and the components. And mainly the compressed or pressurized air should be at a certain quantity and also at particular pressure which is based on the capacity of the system. Based on the capacity of the pneumatic system compressed air should be supplied and for the compression of air compressor is needed.

![Compressor](image.jpg)

**Figure 2.** Compressor

3.2 Pneumatic Cylinder

Pneumatic cylinders are the mechanical gadgets which utilizes the force of the compacted air to create a power which is required by responding direct movement. At the point when the packed air at high pressing factor is provided to the chamber because of this high pressing factor the cylinder inside the chamber moves downwards and the power required is gotten. While contrasting pneumatics over water power, engineers like to utilize pneumatics since they are practical, straightforward and work, don't need huge measure of room for the capacity reason. The primary benefit of pneumatics is that working liquid is the gas so no spillage will occur and upkeep is likewise less. Albeit pneumatic cylinders are of different sorts dependent on the size, appearance and capacity they all go under a specific class. Notwithstanding, there are different sorts of pneumatic cylinders accessible on the lookout, they all are intended to satisfy the particular and wanted capacities. Double acting pneumatic cylinder (appeared in fig 3.2) utilizes the compacted air to activate the cylinder inside. The packed air
permitted into the pneumatic cylinder through one port at the highest point of the chamber. When the packed air enters the chamber because of the great pressing factor the cylinder moves from top flawlessly focused to the base right on and the power needed for the punch and rivet is thus got. At the point when the cylinder head arrives at the most extreme stroke length, the packed air is passed into the chamber during that time port at the lower part of the cylinder. At the point when the compacted air is passed to the lower part of the chamber because of the great pressing factor the cylinder moves from the base perfectly focused to the top. The double-acting pneumatic has two strokes to be specific pressure stroke and development stroke. During the pressure the power needed to punch or bolt the sheet metal is gotten through responding movement of the cylinder. During the extension stroke once the punch is done the cylinder is settled to its unique situation with the assistance of the packed air.

![Figure 3. Pneumatic Cylinder](image)

3.3. 5|2 Directional control valve

Directional control valves are the most basic and fundamental parts of the pneumatic and hydraulic systems. Directional control valves are mainly used for guiding the fluids or air to the corresponding parts respectively. It may vary depending on the workers or the customers need. Every directional control valve will have a spool inside it which can be actuated mechanically or electrically based on the requirements and the need. The spool inside the directional control valve will decide the direction of the fluid or air to be supplied based on the requirements respectively. The spool inside the cylinder of the directional control valve consists of lands and grooves. This lands and grooves will decide the flow of the air or fluid. The lands will block the flow of the air or fluid where it should not flow. The grooves will allow the fluid or air along the ports and the entire spool where it should be supplied. In directional control valve there are two positions normal and working positions. In normal position, the valve returns on removal of the actuating force. In the working position the valve won’t return when the actuating force is applied.
3.4. DC Motor

One of the forms of rotary electrical motors is the DC motor (shown in fig. 3.4). The DC motor is a system that transforms electrical energy into mechanical energy. The most important aspect of a DC motor is that the electrical energy supply should be in direct current. Per DC motor has an internal mechanism that converts electrical energy to mechanical energy. To periodically alter the direction of the current in the motor, it may be electrochemical or electrical. It is the first and most widely used kind of motor in the world. Direct current electrical systems can be used to power this DC motor. The DC motor speed may be adjusted by adjusting the supply voltage or the frequency of the current in the windings, depending on the application. Small DC motors, for example found in toys, tools, and furniture, and we can see a wide variety of DC motors in use. This universal motor can be used anywhere that direct current is available. Because of the advantages of lightweight power tools and equipment, brushed DC motors are commonly used. Larger DC motors are seldom used in truck propulsion, elevator and hoist drives, or steel rolling mill drives.

- Type: Brush type DC motor.
- Supply voltage: 4 to 12 Volts.
- RPM: 30 RPM at 12 Volts.
3.5. Pneumatic Hose Pipes

The basic function of pneumatic hose pipes (shown in fig 3.5) is to transfer the compressed from the compressor or from one to another parts where the air needed without losing the pressure of the air. In market there are several number of pneumatic hose pipes are available for sales. The engineers in the manufacturing industries will select the pneumatic hose pipes according to the requirements. Engineers will mainly consider the construction of the pneumatic hose pipes. The tubing of the hose pipes may be extruded with single material, or the outer layer is done with one material and the inner layer is finished with the help of another material. Most of the pneumatic hose pipes are made up of textile fibres, for higher strength. The inner tube layer of pneumatic hose pipes is made up of one or more layers of reinforcing braided or spiral wound fibre. The outside layer of the pneumatic hose pipe is made up of protected cover to prevent the external damage. The polyurethane tubing is extremely solid, adaptable to the needs of the consumer, and abrasion resistant. It can also withstand contact with fuels and oils. Robotics, pneumatic actuation, logic systems, and vacuum equipment all use polyurethane tubing. Polyurethane tubing is also commonly used in semiconductor processing, as well as medical and laboratory applications. Nylon tubing also used in the tubing of pneumatic hose pipes but it is not much effective as polyurethane tubing.

![Image of Pneumatic Hose Pipes](image)

**Figure 6.** Pneumatic Hose Pipes

3.6. Microcontroller

A microcontroller (shown in fig 3.6) is integrated compact circuit designed to govern a specific operation in an automated system. The important components of a micro controller include a processor, memory, input connections, output connections in a single chip sometimes these micro controllers are referred as microcontroller unit and it is also called as embedded controller these micro controllers are found in vehicles, mobiles, radios, vending machine, and these micro controllers are also found in home appliances and in another daily device that we use. These micro controllers are miniature personal
computers which are essential to carry out certain processes which involves in automation or controlling of large components small features without a complex algorithmic process or a complex operating system. Most of the automated devices will contain a microcontroller these micro controllers are low in cost and also low in weight when compared to the old programmable logic controller which are twice its size and the algorithm used in this is so complex when compared to the modern micro controller that are being used now a days. In which mixed signal micro controller are being used common now a days due to its capacity to work with different out signals like the microcontroller get signal from different sensors in different signal format like light, sound, movement all these signals are of different types so the micro controller converts all these different signals into one signal to perform the desired operations the input signal may be analog signal or digital signal. Micro controllers are cheap data collecting tool which uses the information that it gathered from the sensors and use these data to perform action like actuation and other sensing operations.

4. Working Principle

The atmospheric air is collected by the compressor and with the help of the compressor parts the atmospheric air filtered and cleaned in order get good efficiency. The atmospheric air is compressed, the pressure of the atmospheric air is increased by decreasing the volume of the atmospheric air. The compressed air can be regulated at particular pressure rate with help of pressure gauge according to the requirements. The compressed air at the pressure of 8 to 10 bar is supplied to the solenoid valve with the help of pneumatic hose pipes. The pneumatic hose pipes are used since they do not lose the pressure of the compressed air need to be supplied. The pneumatic cylinder is supplied with compressed air through the solenoid valve. Solenoid valve can be actuated in both either automatic or manual. The solenoid valve is connected to the microcontroller for the auto feed mechanism. The microcontroller is connected with the timer and the relay, because the timer is used to count the number of seconds the
feed needs to be done and the relay is used to actuate the DC motor for the auto feed for the required timing. The DC motor is a kind of electric motor that converts electrical energy into rotational energy. And the rotational energy obtained by the DC motor is supplied to the rollers by adjusting the speed of the motor using mechanical gears. The solenoid valve used in this is 5/3 directional control valve which has one input and two outputs and two exhausts. The inlet port is used to receive the compressed air from the compressor, and the two output ports are used to supply the received compressed air to the pneumatic cylinder based on the requirements. The two exhaust ports are used to supply the compressed air to the atmosphere after the work is done. As compressed air at a pressure of 10 bar is delivered to one end of a pneumatic cylinder, the pressure below the piston is smaller than the pressure above the piston, causing the piston to travel from top dead centre to bottom dead centre, completing the punch or rivet. The punch or the rivet tool is attached to the piston end with the help of the three-jaw chuck. The advantage of three jaw chuck is once the punching is finished then the rivet tool is attached to it for riveting. The punch or rivet tool is guided to the sheet metal using a die at the bottom. The die is also used to prevent the bending of the sheet metal and also to prevent the deformation of the sheet metal. When the piston head reaches the maximum stroke length the compressed air is supplied to another end of the pneumatic cylinder, due to this the pressure above the piston is less when compared to the below. This high pressure of the compressed air moves the piston from bottom dead centre to the top dead centre and the punch or rivet tool is now free from the sheet metal. And the pneumatic cylinder is ready for the next corresponding punch or rivet. Once the punch or rivet is finished then the microcontroller, timer and relay will get ready for the feed of the sheet metal for next punch or rivet through automation. The time duration of the consecutive punch or rivet can be adjusted with the help of microcontroller, timer and relay.

![Figure 8. Full View](image)

5. Conclusion

The Auto Feed Pneumatic Punching and Riveting Machine can be used as a replacement for convectional Punching machines like handheld ones which are not precise and Hydraulic machines
which are not cost-efficient and the maintenance cost will also be high. But the pneumatic auto feed punching and the riveting machine is low in cost and have less maintenance. Thus, the fabrication of this model helps to achieve low-cost automation. The procedure for operating this machine is very easy when compared to others, so any one can operate it. This model can be modified and developed based on our requirements. In addition to this the model can be improved to further extend like

- It can be modified based on the requirements.
- Multiple cylinder systems can be put into action according to the need of pressing effort.

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