

Design and Fabrication of Pneumatic Punching Machine

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Abstract-Pneumatic is a branch of engineering that deals which study of air/gas characteristic and also their use in engineering appliances either in atmospheric or above atmospheric pressure. Now a day number of application increases in pneumatics system due to high carrying capacity, low maintenance cost and most important not dangerous. Either compressed air or inert gas are generally used. This importance is due to its accuracy and cost. This convenience in operating the pneumatic system has made us to design and fabricate this unit as our project. This unit, as we hope that it can be operated easily with semi-skilled operators. 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. This enables us to use different type punch dies resulting in a wide range of products. According to the work material the operating pressure can be varied.

Keywords: pneumatic, pressure, punch, force

I. INTRODUCTION

Pneumatic systems are power systems using compressed air as a working medium for the power transmission. Their principle of operation is similar to that of the hydraulic power systems. An air compressor converts the mechanical energy of the prime mover into, mainly, pressure energy of the compressed air. This transformation facilitates the transmission, storage, and control of energy. After compression, the compressed air should be prepared for desired work. This project is about the design and fabrication of pneumatic punching tool which shows capability to design more than one concept and fabricate the machine using a variety of machine. Other than that, it is important for studies on pneumatic for punching tool and design of punching tool which are the main topic for this project. This project are provided for familiarize about the technology on sheet metal forming which is used pneumatic concept yet has rapidly grown especially in the automotive and electrical industry. Furthermore, the strong concern is to obtain better product quality with lower cost. Using pneumatic systems is economical and environmentally friendly, as air is inexpensive, plentiful and easily compressed and stored in tanks.

II. OBJECTIVES

The main objectives of this project study are to design and fabricate a simple punching tool that used pneumatic system.

i. To design mechanical system of a punching tool.

ii. To fabricate a pneumatic punching tool machine through several fabrication techniques.

III. LITERATURE REVIEW

Anandkumarsingh [2017] An air compressor converts the mechanical energy of the prime mover into, mainly, pressure energy of the compressed air. This transformation facilitates the transmission, storage, and control of energy. After compression, the compressed air should be prepared for desired work. Pneumatic systems are used in controlling train doors, automatic production lines, mechanical clamps etc. Pneumatic cylinder(s) (sometimes known as air cylinders) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. Like hydraulic cylinders, something forces a piston to move in the desired direction. The piston is a discor cylinder, and the piston rod transfers the force it develops to the object to be moved. Engineers sometimes prefer to use pneumatics because they are quieter, cleaner, and do not require large amounts of space for fluid storage. Because the operating fluid is a gas, leakage from a pneumatic cylinder will not drip out and contaminate the surroundings, making pneumatics more desirable where cleanliness is a requirement. Pneumatic motors generally convert the compressed air energy to mechanical work through either linear or rotary motion. [1]

P. Goyal, [2015] This project work deals with the design of pneumatically controlled small scale punching machine to carry out piercing operation on thin sheets (1-2 mm) of different material (aluminum and plastic). Reduction in punching force requirement being the main aim of this project work is obtained by modification in punch tool design i.e. by provision of shear on punch face. Subsequently it results in reduction in amount of punching force requirement. And further a CATIA model of the machine is developed on the basis of calculations with respect to punching force requirement. [2]

Amit M. Gedam, [2014] In today world, due to advance manufacturing process and advance machining process the time of production is reduces. Thus the productivity increases which effect on mass production and batch production. So it is essentially to products name plate parts to be the manufacture. There are a variety of crafts for an embossing machine that

allow you to create unusual, signature pieces of artwork. Embossing machines come in several varieties. You can also use embossing machines that feature Custom-made thick rubber dyes secured with hand-held or desk-mounted metal handles. These machines allow you to create personal monogrammed or logoed designs with a raised surface, and they can be ordered through office and business supply stores.[3]

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*A.K.Gupta,[2013]*The pneumatic press makes an important contribution to the output of engineering work shops and is indispensable for the cheap production of large quantity of similar articles when the type of articles concerned is suited of this method of production. It works on the principal of compressed air. A compressor plant, pipe lines control valve, drive-members and related auxiliary application. The air is compressed in an air compressor and for the compressor plant, the flow medium is transmitted to the pneumatic system, it is of vital important that the pressure drop between generation and consumption of compressed air is kept very low, it has been seen that pipeline fittings and joints are mostly responsible for drop in pressure, if any in pneumatic system.[5]

*SuleymanYaldiz,[2007]*High speed forming technique is divided into two groups; the first group covers the forming desired components with sufficient kinetic energy being imparted to the hammer as suddenly releasing compressed gas, the second group covers the forming of metals in machines or devices in which the force necessary to form the materials is obtained directly from such energy sources as the pressure of an explosive charge or a sudden electrical discharge. In this case, the energy is transferred directly to the metal to be formed without any intermediate stage. Nevertheless, in many cases, there are certain advantages of using high speed. The products manufactured by conventional methods can be manufactured at high speed forming in same cost, with higher quality and they do not need finishing process. It is observed that the quality of shear-fractured surface improved and the amount of distortion was reduced as a result of the use of high punch speeds.[6]

IV. PROBLEM STATEMENT

This project will focus on build of low force punching tool with using a pneumatic system. It is because, in the real industry, most company needs to buy a hydraulic machine whether they only need a small force to punch. Whether hydraulic machine can used for low or high force, high cost of machine and maintenance are needed. Therefore, this pneumatic punch also can help small company to use semi auto puncher than using manual puncher. Pneumatic punching machine give us high accuracy with before time completion and second most important, it is not dangerous.

V. DESIGN PROCEDURE

$W =$ Force applied by Cylinder = 60N

$h =$ lift of falling mass = 20 mm

$A =$ Area of respective components in mm^2

$E =$ Young's modulus for steel = $2.1 \times 10^5 \text{ N/mm}^2$

$P =$ dynamic load in N

Thickness of the circular disc = 20mm

Height of spring = 20mm

Thickness of collar = 5mm

Length below the circular disc = 20mm.

Total length of punch holders = 65mm

Size of punches which we are using = $7.90 \times 62 \text{mm}$

Size of hole required to accommodate punch = 9.5mm

Minimum Diameter of shank required = 15mm

Let, $K =$ Stiffness of spring in N/mm (assume 7.5N/mm)

$L =$ length of shank

$d =$ Diameter of shank = 15mm

1. deformation in punch holder in mm

$D_s = W/K = 60/7.5 = 8 \text{mm}$

2. Total static deflection due to 60N = D_t

$D_t = D_s + D_p = D_s + (W \cdot L) / ((0.7854d^2) \cdot E) = 8 \text{mm}$

3. Total dynamic load p is given by

$P = W \cdot (1 + 2h/D_t) = 6 \cdot (1 + 2 \cdot 20/0.8)^2 = 216 \text{N}$

Consider, factor of safety as 20.

Total load = $216 \cdot 20 = 4320 \text{N}$

4. Induced stress in punch holder,

$$\text{Stress} = \text{Load} / \text{Area} = 4320 / (n/4) * (15^2 - 10^2) = 13.824 \text{ N/mm}^2$$

Parts to be designed-

1. Circular Disk

n = Number of punch = 10

w = collar width = 24mm

D = Pitch circle diameter on which punch holder are held in position

D=130mm

Outside diameter of disk = 160mm

Thickness of disk = 20mm

2 Design Of Bracket

Dynamic load due to falling weight, 260N

Weight of punching unit, 32N

Self-weight, of bracket, 36N

Maximum shear load = $p_a = 216 + 32 + 36 = 284\text{N}$

Maximum B.M = $(216 * 165 + 68 * 100) = 42440\text{N}\cdot\text{mm}$

Section modulus, $Z = bt^2/6$

$Z = M/S_b$ (Assume $b = 0.7 * t$)

$$(0.7t^2/6) = 42440/50$$

$$t = 19.17 \text{ mm}$$

$$t = 20 \text{ mm}$$

$$b = 0.7 * 20 = 14 \text{ mm}$$

$$d_o = 12 \text{ mm}$$

$$D = t + d_o = 20 + 12 = 32 \text{ mm}$$

$$S_b = 2\text{N/mm}^2$$

Breadth of bracket = 46 mm, Depth of bracket = 32mm

Components of Machine-

1. Column

It is circular in cross section. Its main supporting part is mounted on the base and outer surface of it is machined which supports and guides bracket along its rotary and vertical travel.

2. Column Flange

Column flange supports to stud and is placed on the base.

3. Base

It is used to mount the machine and also to place the job on which punching is to be done. It is strong enough to hold the weight of the machine and also to tolerate the pressure while punching.

4. Bracket

It is a rigid rectangular cross section which holds punch assembly in sustentation hold cam assembly, hammer assembly.

5. Circular Disc

It holds and guides the punch holder arranged in circular manner on this component rotated around disc holding rod.

6. Hammer Rod

This is accurately machined scarp for holding weights and which imparts energy to punch holder when dropped from certain height. The rotation of cam lifts it.

7. Punch Holder

This is bolt like structure. Its shank holds no's of punches 0 to 9 and other hold tools to perform specific operation. Collar of Punch holder absorbs dynamic load.

8. Indexing Assembly

It shows exact punch no's and ensures the center of punch holder below the center of hammer rod.

VI. WORKING

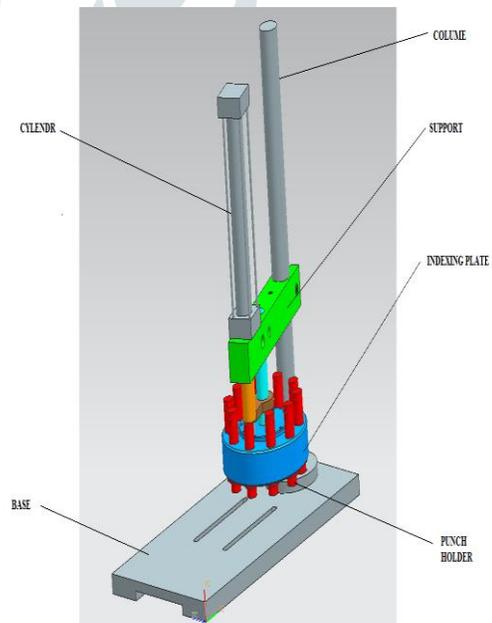


Figure:3D View of Assembly of Pneumatic Punching Machine

The compressed air from the compressor at the pressure of 5 to 7bar is passed through a pipe connected to the manual control valve with one input. The manual control valve has

two outputs and one input. The air entering into the input goes out through the two outputs when unit is actuated. Due to the high air pressure at the top, the air pressure below the piston is less than the pressure above the piston. So these moves the piston rod downwards. This force acting is passed on to punch which also moves downwards. The punch is guided by a punch guide who is fixed such that the punch is clearly guided to the die. The materials are in between the punch and die. So as the punch comes down the materials are sheared to the required profile of the punch and the blank is moved downwards through the die clearance. When the piston is at the extreme point of the stock length, the exhaust valve is opened and the air is exhausted through it and the pressurized air come in at the bottom of the piston and it pushes the piston upwards. So the one side of the air is pulled downwards and the other side is lifted upwards. So the punch is therefore pulled upwards from the die. Now the piston reaches the upper point of the required stroke length. Now the material is fed and the next stroke of the piston is made ready.

VII.CONCLUSION

This study leads to design and manufacture a pneumatic punching machine to punch numbers or letters on a desired workpiece. As Pneumatic system is better in terms of accuracy, cost, and maintenance. Based on calculations project model will work on 8 bar pressure.

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