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Conceptual Modelling and Fabrication of Pneumatic Operated Self Centering Four Jaw Machine Chuck

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***Abstract:** In current scenario, with globalised market, Industries are in need to produce products with lower costs and also they are in need to give quality components. Hence they are in need to reduce the manufacturing costs by automating smaller works which increases the lead time and setup time. This research work deals with conceptual modelling and fabrication of four machine chuck which is used to hold the cylindrical components firmly during machining. Automization is achieved through pneumatic power using compressed air. Instead of using chuck keys to tighten the jaws of four jaw chuck here we utilize pneumatic force through double acting cylinders to hold the work piece firmly. Solenoid valves are used to direct and control the double acting cylinders to adjust the jaws of chuck to be moved forward or backward directions. This Research greatly emphasis in reduction of setup time and also helps in safety of operator by holding the job firmly against high speed machining operations.*
***Keywords:** Pneumatic Chuck, Solenoid Valve, Double Acting Cylinder, Ball Bearing and valve, DC Motor.*

I. INTRODUCTION

The lathe is a machine tool which holds the work piece between two rigid and strong supports called centers or in a chuck or face plate which revolves. The cutting tool is rigidly held and supported in a tool post which is fed against the revolving work. The normal cutting operations are performed with the cutting tool fed either parallel or at right angles to the axis of the work .The cutting tool may also be fed at an angle relative to the axis of work for machining tapers and angles. Turning is one of the most common of metal cutting operations. In turning, a work piece is rotated about its axis as single-point cutting tools are fed into it, shearing away unwanted material and creating the desired part. Turning can occur on both external and internal surfaces to produce an axially-symmetrical contoured part. Compressed air can cause serious damage to the human body if they enter the body through ducts like the oral cavity or ears. Never spray compressed air onto anyone. Under high temperature, compressed air can pass through human Skin. Compressed air released from the exhaust contains particles and oil droplets, which can cause damage to eyes. Even though the pressure of compressed air in pipes and reservoirs is relatively low, when the container loses its entirety, fierce explosions may still occur. Before switching on a compressed air supply unit, one should thoroughly inspect the whole circuit to see if there are any loose parts, abnormal pressure or damaged pipes. As the force produced by pneumatic cylinders is relatively large, and the action is usually very fast, you may suffer serious injuries if you get hit by a cylinder. Switches should be installed on the compressed air supply unit to allow easy and speedy control of air flow. In case of a leakage, the compressed air supply unit should be turned off immediately. The compressed air supply unit must be turned off before changes can be made to the system. Stay clear of the moving parts of the system. Never try to move the driving parts in the mechanical operation valve with your hand.

II. LITERATURE SURVEY

Normally in 4 jaw chucks the work piece is centred by operator by just seeing it in eye. It is a difficult task to be done; it can be only done by an experienced operator. It has grooves on it in order to assemble the work piece at centre. Setup time will get increased by this manual work. By setting a dial indicator against the work piece will helps to reduce the time for setting and also it will make the exact centre of work. Dial indicator will have a magnetic base in order to fix with the machine bed. Jaws of Chucks are individually tightened by the operator with help of a chuck key made up of iron. . Write down the high reading and the low reading from the indicator. Calculate the average reading of the dial indicator by adding the high reading to the low reading and then dividing by two.

Average = (High Reading + Low Reading)/2

Adjust the jaw that is aligned with the dial indicator plunger and the opposite jaw so the indicator reads zero. Indicator plunger may be aligned with jaw of chuck by rotating the chuck to 90 degrees. Adjust the jaw that is aligned with the dial indicator plunger and the opposite jaw so the indicator reads zero.

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III. COMPONENTS REQUIRED

A. Double Acting Cylinder

Pneumatic cylinders are mechanical gadgets which utilize the force of packed gas to process energy for reciprocating straight movement. Pneumatic cylinders, something drives a piston with move inside the bearing. The piston may be a circle or cylinder, and the piston Pole transfers those drive it develops of the protest a chance to be moved. The operating source 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. Double-acting cylinders (DAC) uses the force of air to move in both extends and retracts strokes. They have two ports to allow air in, one for outstroke and one for in stroke. Stroke length for this design is not limited; however, the piston rod is more vulnerable to buckling and bending. A double-acting cylinder is a cylinder in which the working fluid acts alternately on both sides of the piston. It has a port at each end, supplied with hydraulic fluid for both the retraction and extension of the piston. A double-acting cylinder is used where an external force is not available to retract the piston or where high force is required in both directions of travel. The double acting cylinder is more common than the single acting cylinder. It works at any angle and in almost any application where pneumatic power is needed. Even with applications where gravity (or weight) can assist retraction, pneumatic pressure is often applied to control acceleration, change the rate of travel and cushion the stoppage.

B. Rotary Valve

A rotary valve is a type of valve in which the rotation of a passage or passages in a transverse plug regulates the flow of liquid or gas through the attached pipes. The Rotary Valve is used as an air lock between systems with different air pressures. The valve allows material to pass between the two pressure zones without air movement from one zone to the other. Rotary airlocks are important components of pneumatic conveying, and batching systems. Rotary airlock is also known as rotary valve, rotary feeder or airlock feeder. The main function of a rotary valve is to control flow of air under gravity, pressure and vacuum conditions. The common stopcock is the simplest form of rotary valve.

C. Pressure Gauge

Instruments used to measure and display pressure in an integral unit are called pressure gauges or vacuum gauges. Bourdon tube pressure gauges are the most frequently used mechanical pressure measuring instruments. Their pressure element is often referred to as a Bourdon tube: The French engineer Eugene Bourdon made use of this functional principle in the middle of the 19th century. It is based on an elastic spring, a c-shaped, bent tube with an oval cross section. The effect of pressure on a Bourdon pipe, when the internal space of the Bourdon tube is pressurised, the cross section is thus altered towards a circular shape. The hoop stresses that are created in this process increase the radius of the c-shaped tube. As a result, the end of the tube moves by around two or three millimetres. This deflection is a measure of the pressure. It is transferred to a movement, which turns the linear deflection into a rotary movement and, via a pointer, makes this visible on a scale

D. Base Plate

Base plate is made up of hardened mild steel that has enough sturdiness and strength in order to act as a surface for other parts to be supported firmly. It also has to withstand the wear and tear during heavy operations.

E. Ball Valve and Ball Bearing:

A ball valve is a form of quarter-turn valve which uses a hollow, perforated and pivoting ball to control flow through it. It is open when the ball's hole is in line with the flow and closed when it is pivoted 90- degrees by the valve handle. The handle lies flat in alignment with the flow when open, and is perpendicular to it when closed, making for easy visual confirmation of the valve's status. A ball bearing is a type of rolling-element bearing that uses balls to maintain the separation between the bearing races. The purpose of a ball bearing is to reduce rotational friction and support radial and axial loads. It achieves this by using at least two races to contain the balls and transmit the loads through the balls. In most applications, one race is stationary and the other is attached to the rotating assembly.

F. Shaft

A shaft is a rotating machine element, usually circular in cross section, which is used to transmit power from one part to another, or from a machine which produces power to a machine which absorbs power. The same power to be transmitted and same material of both shafts, a hollow shaft is lighter than the solid shaft. Stiffness of hollow shaft is more than solid shaft. Strength of hollow shaft is more than solid shaft.

G. DC Motor

A DC motor is any of a class of rotary electrical machines that converts direct current electrical energy into mechanical energy. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism; DC Motor is any of class of rotary electrical machines that converts the direct current electrical power into mechanical power. The 12V DC Motor is more than enough to produce the required vacuum inside the Vacuum cleaner. The DC Motor is fixed on the backside of the vacuum cleaner. The wings are mounted on the front end of the motor. A simple DC motor has a stationary set of magnets in the stator and an armature with one or more windings of insulated wire wrapped around a soft iron core that concentrates the magnetic field. The ends of the wire winding are connected to a commutator.

IV. DESIGN OF BASE PLATE AND SHAFT

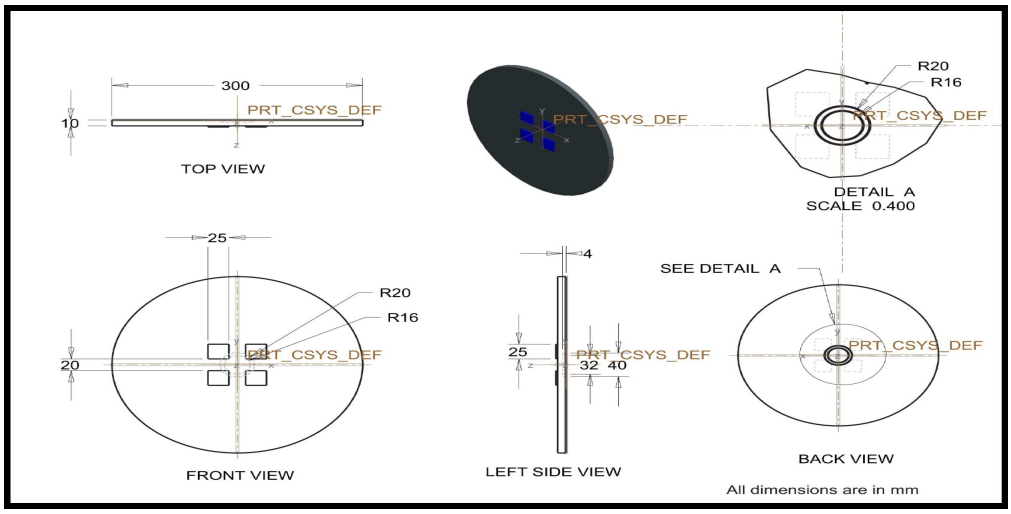

Fig. 1. Design of Base Plate

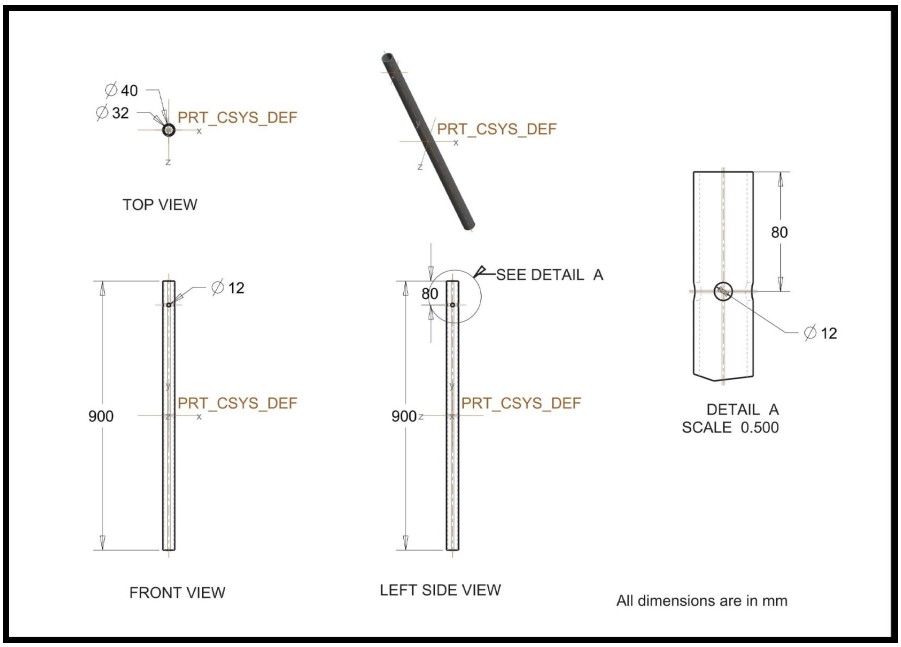

Fig. 2. Design of Shaft

V. DESIGN CALCULATIONS

A. Cylinder Thrust

This is set by the cylinder design. In order to clamp the load, it is need a cylinder that provides force greater than the load. So the design will safe.

Double acting in forward stroke

$F = \{\pi/4 \times D \times P\}$

Double acting in return stroke

$F = \{\pi/4 \times (D2 - d2) \times P\}$

F = Cylinder thrust in N.

D = Dia of piston in mm

D = Dia of piston rod in mm.

p = Operating air pressure in "bar"

Double acting in forward stroke

$F = \{\pi/4 \times D2 \times P\}$

$F = (\pi/4 \times (262) \times 0.5)$

F = 265.33 N

Double acting in return stroke

$F = \{\pi/4 \times (D2 - d2) \times P\}$

$F = (\pi/4 \times (262 - 102) \times 0.5)$

F = 226.08 N

B. Air pressure

Need consistent air flow at the minimum effective pressure to maintain the desired velocity, operating the cylinder at too high a pressure accelerates seal wear and creates stress on the cylinder. Inconsistent pressure can cause system malfunction or failure.
o get minimum velocity of 15 mm/sec, Needed load to clamp the work piece is 1.3789 N/mm2.
So, Assume the Minimum pressure = 7 bar.

C. Bore Size

Dividing the Load (1.3789N/mm2) by the pressure (7 bar) gives a power factor
Power factor = Load / Pressure
Power factor = 1.3789/7
Power factor = 0.196
Since,

$F=P \times A$

Here,

F = Force

P = Power factor

A = Area of cylinder

$F = P \times A$

$265.33 = 0.196/ \pi/4 \times D2$

Bore diameter D = 13mm
Availability Bore size double acting Cylinder in market is 25 mm.
Bore diameter D = 25mm
To consider stroke length for 25mm diameter piston is 30 mm.
Stroke Length L = 30 mm
Finally,
Base plate thickness = 10mm
Base plate diameter =300 mm

VI. EXPERIMENTAL SETUP AND WORKING PRINCIPLE

An air compressor is a device used to maintain and storing pressurized air inside a cylindrical tank which converts power into potential energy. By one of several available methods, an air compressor tends to forces more and more pressure of air into a storage tank tends to increase the pressure. Compressor will get cut off automatically when tank pressure reaches the upper limit. The compressed air will withstand inside the compressor until it is used. Kinetic energy of air inside the compressor is then

released and tank depressurizes. Whenever the compressor tank reaches the lower limit compressor turns on automatically and re-pressurizes. Compressed air inside the tank is then transferred to a solenoid valve. A solenoid valve is an electromechanically operated valve that is used to control to open valve and close the valve. The pressure of the air is controlled by the pressure gauge. When the solenoid valve is opened the compressed air is passed to the double acting cylinder through hose.

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. Working area of the piston is relatively smaller and the thrust produced during retraction will be smaller. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction. By using the double acting cylinder we can control or adjust the jaws for holding the work piece. After the operations are done in lathe machine, the material is removed from the jaws by closing the solenoid valve so that the flow of compressed air is stopped and the piston retracts to its original position.

Fig. 3.a. Side View of Pneumatic Chuck

Fig. 3.b. Front View of Pneumatic Chuck

VII. CONCLUSION

Current scenario in Manufacturing Industries greatly emphasis on automation in order to reduce the set up time and also to reduce the manufacturing costs incurred during the operation. This Research had attained a step towards automation by fabricating a four jaw Machine chucks operated through pneumatic. During this research we had operated the pneumatic chuck with higher speed that of a normal machine chuck and it has been noted that it yields an effective result comparatively. Pneumatic chuck helps the operator to mount the work piece easily within a short span of period and it also ensures the safety to operator as tightening the jaws of chuck is automatically done with help of pneumatic power rather than tightening manually.

VIII. ACKNOWLEDGEMENT

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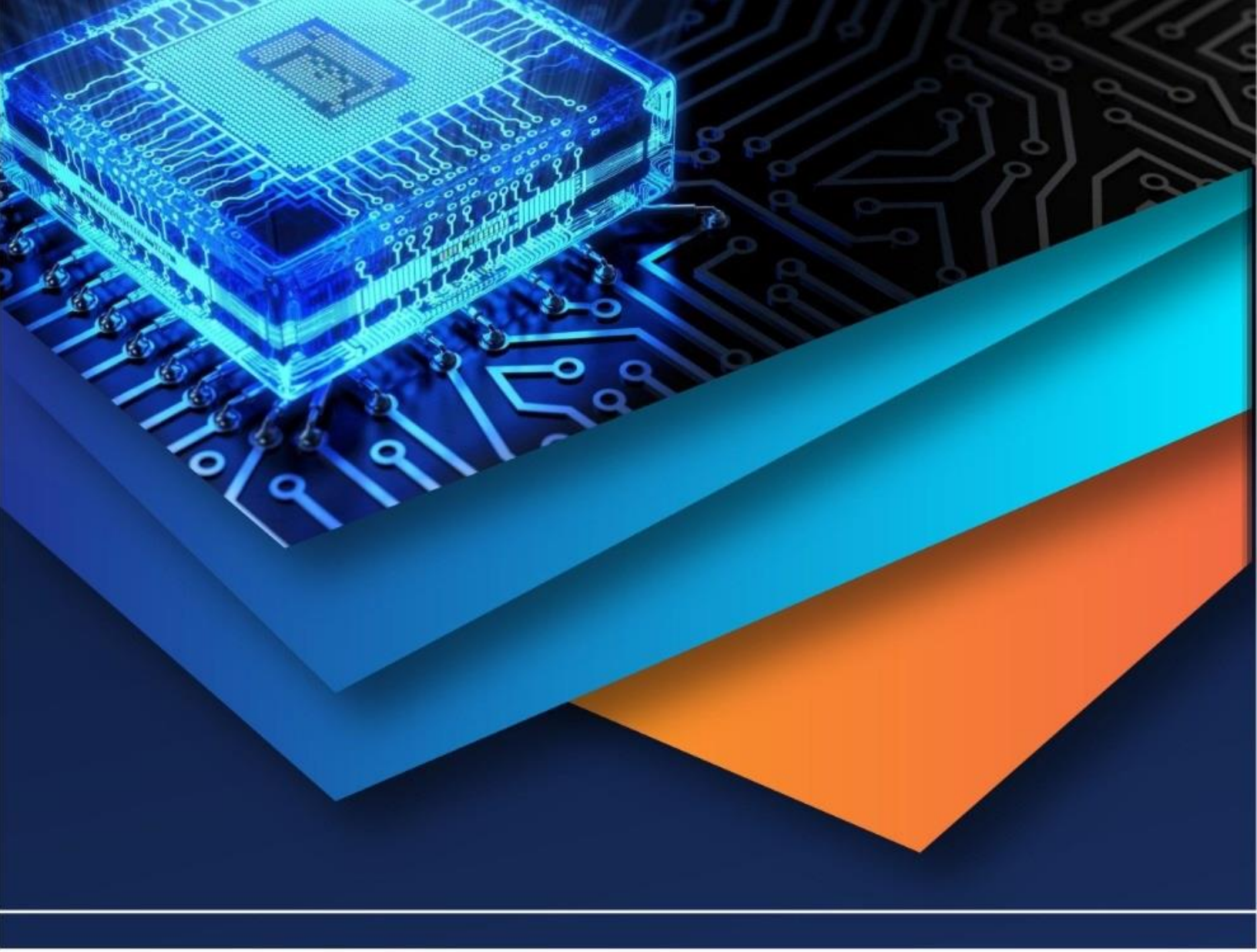

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