

# AUTOMATION OF PNEUMATIC PRESS WITH CLAMPING DEVICE

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**ABSTRACT:** In today's world we are surrounded by Automation, right from a switch to turn on the fan to complex robots in industries. Pneumatics is very basic element of automation, and then there are hydraulics, electro pneumatics and PLC's. In this paper basic concept of pneumatics, components of pneumatic press, design of a pneumatics press along with its circuit diagram and force calculations are discussed. The Pneumatic press device is having a double acting cylinder actuator to clamp the work piece and another double acting cylinder for pressing. The time delay valve is used to hold the press in extended position for 3seconds. This circuit could replace the heavy and manually operated press machines used in industries. By this circuit complete Automation of clamping, pressing and unclamping can be done.

**KEYWORDS:** Automation, Pneumatics, Pneumatic press. Clamping, Direction Control Valves, Pneumatic Circuit

## I. INTRODUCTION TO PNEUMATICS

Pneumatics is a branch of Automation which makes use of gas or pressurized air to transmit and control energy. Pneumatic systems are used in operating bus or train doors, automatic production lines and pneumatically operated clamps. Although Pneumatics is mostly used to carry out simple tasks but in the recent times it has become an important part of automation. Compressed Air has following function in pneumatics.

- To enable sensors to determine the status of the procedure
- To allow switching of actuators by using final control elements
- To carry out work

Pneumatics finds various applications in material handling like Clamping, Indexing, Positioning and orienting. Other applications include packaging, feeding, metering, Door or chute control, transfer of materials, sorting, stacking, stamping and embossing etc. Application in manufacturing industry includes Drilling, Turning, Milling, Sawing, Forming, finishing etc. [1][2]

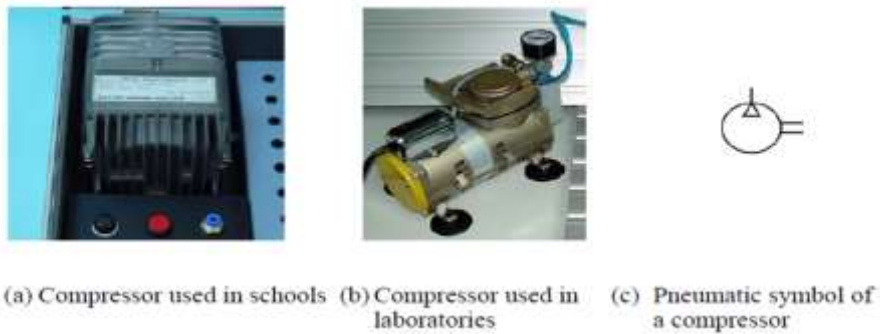
## III. PNEUMATIC COMPONENTS USED IN PRESSING MACHINE

Pneumatic components used in designing a pressing machine can be classified into two categories:

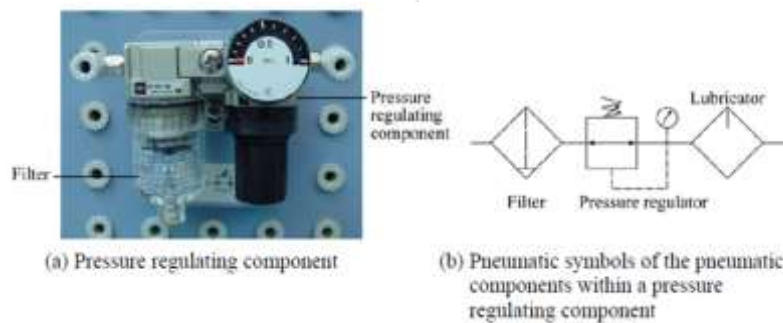
- 1) Components that produce and transport compressed air.
- 2) Components that consume compressed air.

The production and transportation of compressed air.

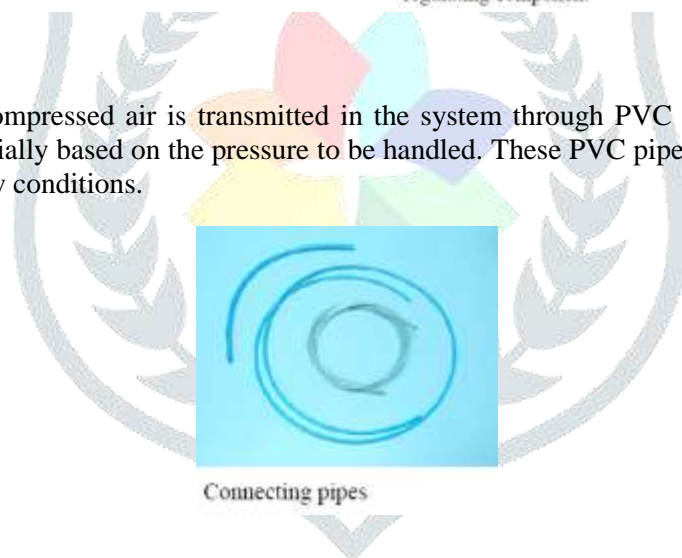
A) Compressor: A compressor is a mechanical device which increases the pressure of air or gas by decreasing its volume. This compressed air or gas can be stored in a cylinder and can be released through pipes and valves. Compressors can be classified as Positive displacement compressors and dynamic compressors. Positive displacement compressors can further be classified as rotary and reciprocating types while dynamic compressors can be centrifugal and axial types. [3]



B) Pressure regulator with air filter: The pressure from the compressor is controlled with pressure regulator. The pressure in the system can be adjusted by regulator knob and set by looking into pressure gauge. The air from the compressor may contain dust particles, oil or moisture, which can be separated by air filter. The filter contains a glass tube which collects the impurities. The water and impurities can be removed from a small tap at the bottom.

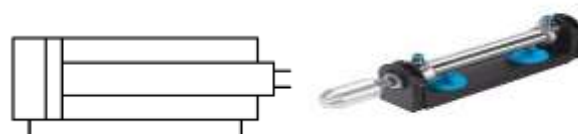


C) Connecting Pipes: The compressed air is transmitted in the system through PVC pipes. There are various sizes which are available commercially based on the pressure to be handled. These PVC pipes are flexible and have smooth inside walls for optimum flow conditions.

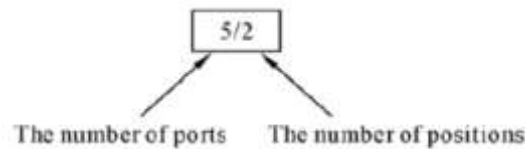


The consumption of air:

A) Execution Components (Actuators): Actuators can be tie rod cylinders, Rotary Actuators, Grippers, Roadless Actuators with magnetic linkage, rod less actuators with mechanical linkage, pneumatic artificial muscle, vacuum generators and special actuators with rotary and linear combined. Linear actuators can be single acting cylinder or double acting cylinder types. In Pneumatic press two double acting cylinders are used one for clamping the work piece and other for pressing. [4]



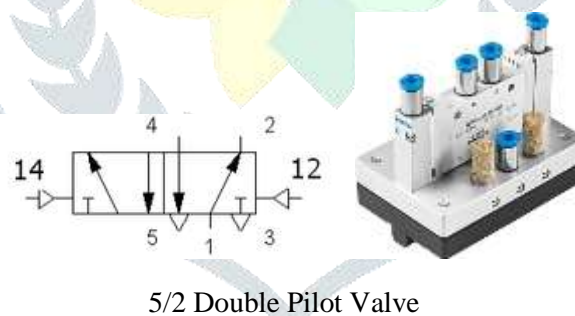
B) Direction Control Valve (DC Valves): The direction control valves are used to change or control the direction of flow of compressed air in circuit. The valves are represented as A/B, where A gives the number or ports in a valve and B gives the number of position in which a valve can operate. The circuit uses four 3/2 DC Valves (Normally Closed) and two 5/2 Double pilot valves.



i) 3/2 DC Valves (Normally Closed): It has Three ports P (1) Inlet, A (2) Outlet and R (3) Exhaust. The valve works in two positions. In Right Box or normal condition the supply is closed (Hence named normally closed) and all the air in the system is released through exhaust port R. In left Box or set condition the air is supplied from port P to Port A. [4][5]

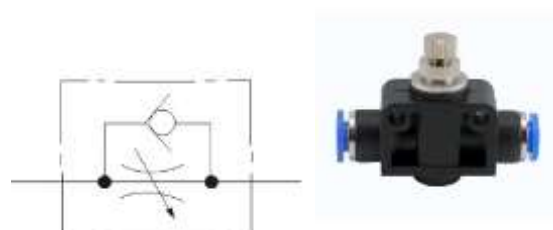


ii) 5/2 Double Pilot Pneumatically controlled Valve: It has five ports (1) Input, (2,4) Output, (3,5) Exhaust. It is controlled by two pneumatic signals (12) and (14). The air supply can be switched from port 1 to port 2 by pneumatic signal in port 12 and from 1 to 4 by port 14. [4][5]



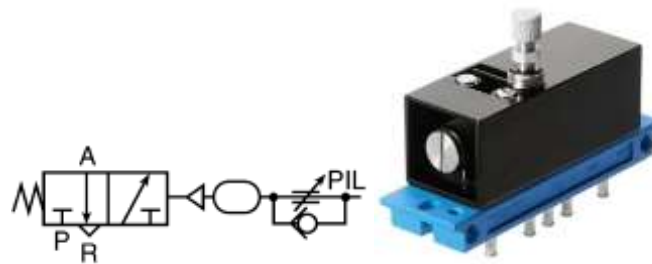
C) Flow Control Equipment: Flow control equipment's are used to control the flow of compressed air in the system. There is flow control valve, shuttle valve, dual pressure valve, time delay valve, pressure sequence valve etc. Here in the designed a flow control valve and a time delay valve is used.

i) Flow Control Valve: A flow control valve acts like a tap. The flow of compressed air can be reduced or increased by tightening or loosening the valve. It can work as meter in flow control valve or meter out flow control valve. Here in the circuit the flow control valve is used to smoothen the extension of cylinder responsible for Applying force in press.[5][8]



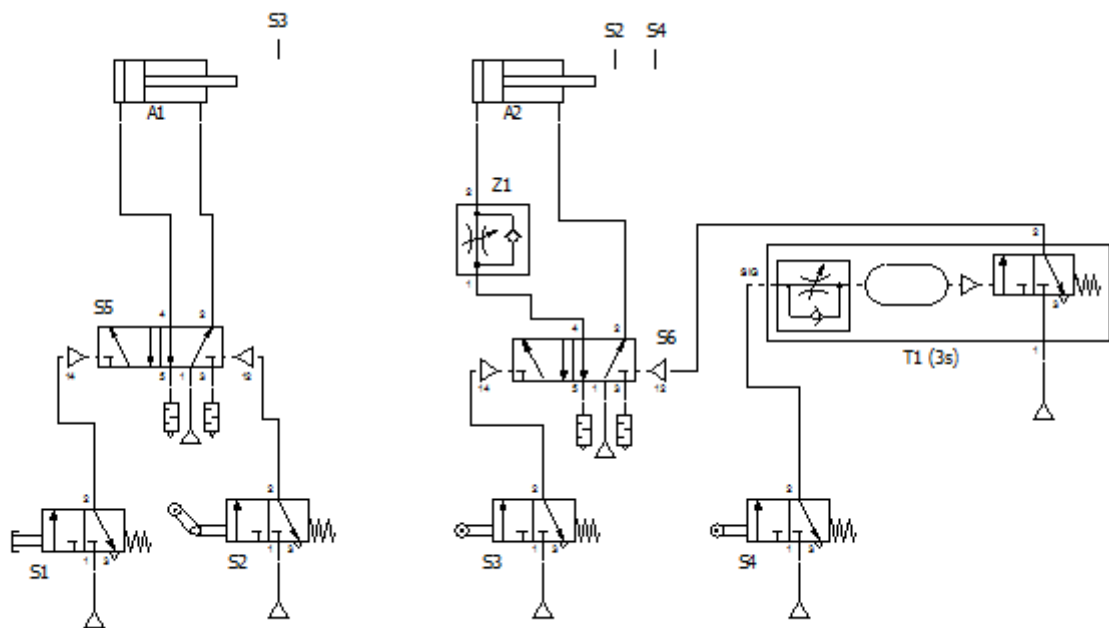
Flow Control Valve

ii) Time Delay Valve: A time delay valve is used to insert time delay response in the system. In pneumatic press circuit diagram the time delay valve is used to hold the cylinder controlling the pressing action, extended for 3 seconds.[8][9]



Time Delay Valve

IV) PNEUMATIC PRESS CIRCUIT DIAGRAM

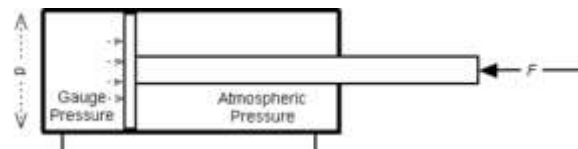


Circuit Diagram [10]

- A1 : Double Acting Cylinder (Controlling the clamp)
- A2: Double Acting Cylinder (Controlling the pressing action)
- S1: 3/2 DC valve (Normally Closed) with Push Button.
- S2: 3/2 DC valve (Normally Closed) with roller with ideal return.
- S3, S4: 3/2 DC valve (Normally Closed) with roller switch.
- S5, S6: 5/2 Double Pilot Valve.
- Z1: Flow Control Valve (Meter Out).
- T1: Time Delay Valve (Set for 3sec Delay)

V) CALCULATON OF FORCE

The force in pneumatic cylinder depends upon the design of the piston and cylinder. The design can be made according to the application. [11]



The force exerted by double acting pneumatic cylinder on outstroke can be expressed as:

$$F = p A$$

$$= p \pi d^2 / 4$$

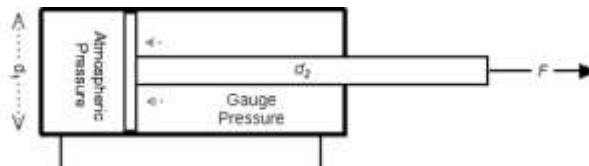
Where,

F = force exerted (N)

p = gauge pressure (N/m<sup>2</sup>, Pa)

A = full bore area (m<sup>2</sup>)

d = full bore piston diameter (m)

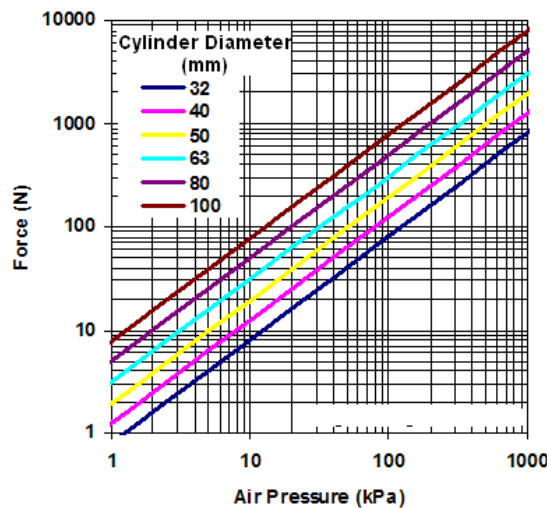


The force exerted on in stroke can be expressed as:

$$F = p \pi (d1^2 - d2^2) / 4$$

Where,

d1 = full bore piston diameter (m) d2 = piston rod diameter (m)



[11]

VI) CONCLUSION:

An automated pneumatic press with clamping of work piece could be developed on the basis of above design. The design of the cylinders can be optimized based upon the force required at the application point. The device can perform clamping, pressing and unclamping, all three actions in sequence with a push of button. Although there are many automated press which are available commercially but this pneumatic press has a clamping device integrated in the circuit itself and that too with very less complexity.

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