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# Automation of Process Station Using Electro-Pneumatics

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**Abstract**

During the past decade numbers of applications have been developed based on Pneumatics. Here we are introducing Electro-Pneumatics. With the help of this system it is easier to automate various process stations since today every organization have different needs. This accomplishes the aim of reduced labor cost, time of operation, better flow of product from one station to other, maintenance cost and simulation provides with the feasibility of operation.

*Keywords: Electro-Pneumatics, Direction Control Valves (DCV), Cylinder, Switch, Relay/Contactor, Valve Solenoid, Optical Proximity Switch*

## 1. Introduction

During few decades various automation techniques has been introduced in order to enhance the overall industrial productivity. Among the various technologies that are playing important role in rapid growth of industries, Fluid power is unique. Pneumatics is based on fluid power system principle, which states that gases and liquids under pressure are used to transmit energy over the long distances, such system are referred as fluid power system. Pneumatic is the study of system operated by air under pressure. "Pneuma" is a Greek word which means "Breath". In breathing air is sucked into the body and after some time it gets delivered to the atmosphere and on the same principal Pneumatics works. The air taken from the atmosphere is compressed in a compressor, and this compressed air is worked to act on a specially designed surface like a piston where in the resultant motion of the piston is utilized as a part of machine.

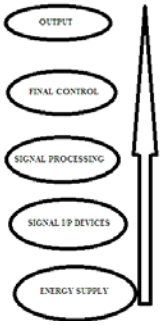


Figure 1 Structure of Electropneumatics

### 1.1 Electro-Pneumatics

Except for the compressor motor, no other part or device uses electricity. But for industrial uses, use of electrical energy in pneumatic circuits is more common such as solenoid-operated valves, relays for operating solenoids, starter/pushbuttons, make/break switches. Amongst the above, the solenoid operated directional control valves functions as a valve providing alternate paths for the compressed air to reach the pneumatic actuator. The movement of spool of valve is through a solenoid, and thus such motion of spool provides path for the controlled air to reach the pneumatic actuator. Generally, in pneumatics, air moves the spool but in Electro-pneumatics, instead of using air to move the spool of Direction control Valve we apply voltage to a solenoid coil. This voltage will generate an electromotive force, resulting in the shifting of spool.

### 1.2 Relay

A Relay is an electromagnetically actuated switch, which when a voltage is applied to the solenoid coil an electromagnet field results. This causes the armature to be attracted to the coil core. The armature actuates the relay contacts, either closing or opening them, depending on the design.

### 1.3 Pushbutton and Control Switches:

Switches are installed in circuits to apply a current to a load or to interrupt the circuit. Control switches are mechanically detented in the selected position. The switch position remains unchanged until a new switch position is selected. For example a Light switches in the home. Pushbutton switches only maintain the selected position as long as the switch is actuated .For example a Bell push.

Many research articles are published till date by various research scholars in the field of automation. And still researches are going on in this field due to huge extent of scope. Bharath et al. 2013[1] used this technology to convert the conventional shaper machine into semiautomatic shaper thus increasing the productivity with reduced human intervention. Shanmukha Nagaraj et al. 2013[2] had also used automated sequential controlling for greater efficiency, provided with the study of simplifying the process for modular workstations. M. Jaivignesh et al. 2012 [5] operated Riveting machine by pneumatics and studied the reduction in cost and ease of operation along with optimization. Vyasraj Koppar et al. 2013[3] developed an Electro-Pneumatic circuit of conventional Planer and automated all its operations using Electro-pneumatic devices and analysed the productivity of conventional Planer i.e. 6 minutes to produce 1 flate plate as

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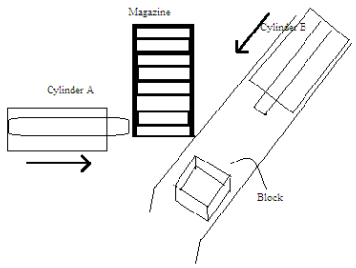
compared to automated Planer i.e. 1 minute to produce 1 flate plate (increased by six times).Thus, achieved high production rate with automation. Mohamed S. Bayoumi 2014 [9] has introduced a chart model for designing any sequential logic and constructed such system to stop actuator intermediately.

The aim or focus of all these studies is just to create an automated environment to achieve better results and to carve out the old traditional techniques.

## 2. Automated Approach for Various Process Stations

### Task 1

Using a Transfer station blocks are to be transferred from a magazine to a processing station .The blocks are pushed out of the magazine by cylinder A and transferred to the processing station by cylinder B. The piston rod of cylinder B may only return when the piston rod of cylinder A has reached the retracted end position.

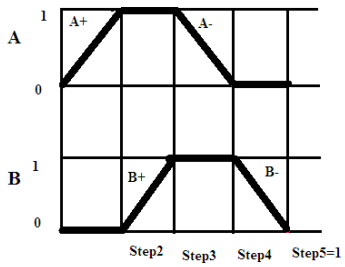



Positional Diagram 1

the sequence of cylinders A and B required is as following:

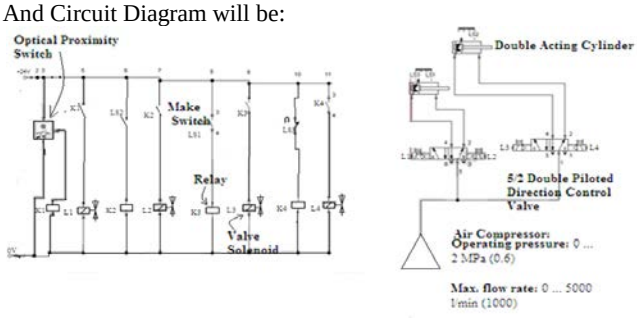
A+ B+ A- B-

Thus ,we will have functional diagram as following




Displacement-Step Diagram 1

And Circuit Diagram will be:

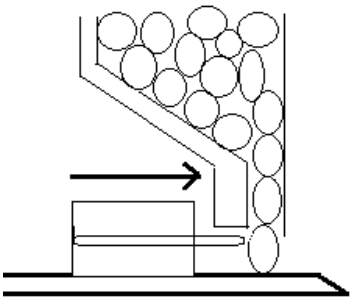



Electro-Pneumatic Circuit 1

In the given circuit both electric and pneumatic circuit diagrams are shown. Both double acting cylinders are actuated by 5/2 Directional control valves. The valve 1 has solenoid L1 and L2, similarly L3 and L4 for valve 2.When signal voltage is applied to K1(Relay) it will actuate valve solenoid L1 and cylinder A extends and when it reaches limit switch LS1,K3 will get charged and actuate L3 and cylinder B extends. Similarly when cylinder B reaches LS2 it actuates K2 and L2 will actuate results in cylinder A retracting to initial position and when cylinder A reaches LS3, K4 will actuate L4 and cylinder B retracts to initial position. Here Optical Proximity Switch is used which can also be actuated by clicking on it.

### Task 2

Pins are to be fed to the next processing station using a cylinder. The pins are fed continuously using a start button by to and fro motion of the cylinder. The feeding can be stopped by a separate stop push button.



Positional Diagram 2

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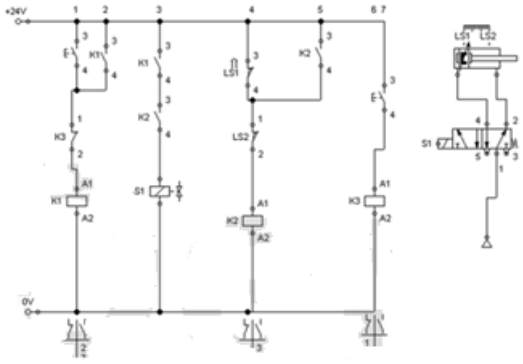
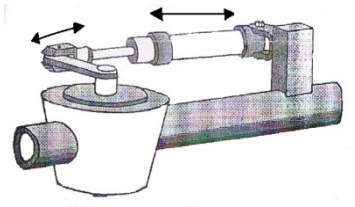


Electro-Pneumatic Circuit 2

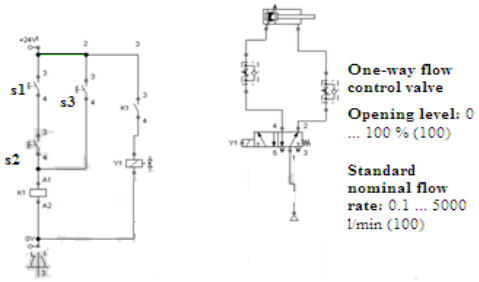
Here to and fro motion of piston cylinder is required and so, we used 5/2 single solenoid spring return valve (S1).By using same approach we can easily develop its Electro and Pneumatic circuit. Here, the only cylinder would actuate just after actuating the start push button and thereafter, the to and fro motion of cylinder will execute until or unless the second pushbutton is pressed.

## Task 3

Using a double acting cylinder, the valve in pipeline is to be opened and closed.The valve is to be opened by pressing push buttons S1 and S2 or S3.When the signal is released, the valve should close. The speed of opening and closing is to be separately adjustable.



Positional Diagram 3




Electro-Pneumatic Circuit 3

In above task we have used three pushbuttons out of which the cylinder will actuate only when S1 and S2 are pressed simultaneously or by pressing S3. The working condition is shown in above figure .When S1 and S2 are plugged K1 relay will excite Y1 Valve solenoid and when S3 alone is pressed it will also similarly actuate S3 and hence, in either cases cylinder will execute its forward operation. Furthermore, for controlling the speed we have used two One-way flow control valves, for varying the speed of piston in both directions.

## 3. Objective and Scope of Study

The overall study is about to automate each and every process involved in manufacturing industry. Results in reduced requirement of man-power or skilled workers, will also eliminate the factor of human error completely. Study of this paper also affects or optimizes labor cost, duration of operation, better flow of product from one station to another, cost of operation i.e. one time cost, simulation provides the feasibility of operation . All these factors are almost enough to raise the overall profit of any organization.

Scope of such study is up to a great extent in units of developing countries like India. At all, this study deals with varieties which a same firm can provide to its customers .Say actuation of multi-cylinders in desired sequence can provide huge varieties of operation with small manipulation .And the major source is compressed air, never a problem, acts as working fluid.

Pneumatics have a huge area of application as in metal cutting and forming ,machine tools, Assembly system, Material Handling, Medical equipments, Plastic Machinery, Petroleum markets, Process industry and many more. There are uncountable advantages of such automation like explosion proof, environment friendly, no requirement of reservoirs, etc. along with very few limitations like quite poor stability, and noisy, thus it's a cool negotiation.

## 4. Results and Discussion

Thus, all the tasks are performed efficiently. There is a reduction in human interface and operations are optimized and feasible. Different configurations can be achieved through modules for different workstations. Study of functional diagram enables to understand the operation easily. We can even adjust the parameters of assembling components like velocity of piston or stroke length for cylinders, types of cylinders (single acting and double acting), operating pressure, valve type (3/2,4/2,5/2 or spring return, piloted) etc. We can also use Stepper Module to eliminate the problem of signal overlapping in case of more than 1 signal for multi actuating cylinders.

## 5. Conclusion

- This paper is presented to show the automation of different process stations according to variable needs of any organization.
- Aim of this paper is to make an approach towards automation.
- Electrical and Pneumatic Circuits are developed in Festo-Fluidsim 4.2 version software.
- Labor costs, maintenance cost, time of operation are decreased to a great extent.
- We can also use sensors to make our system highly automated and to completely eliminate human intervention. Finally, the product output will enhance with greater reliability.

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