



Developing a Pneumatic Actuating System to Illustrate the Functioning of an AND Logic Valve

Daniela Voicu¹, Radu Vilău², Ramona-Monica Stoica³

Abstract: This paper presents the functioning of an AND logic valve, by developing a pneumatic model in the FluidSim modelling-simulation program. Also, the research by simulation will constitute the basis for implementing and developing on a test bench, the pneumatic actuation system. AND logic valves are mostly used in factories, on technological assembly lines, for an increase in security and protection of the working personnel, because the functioning of such logic valves implies that the operative uses both hands or executes two operations at the same time. Therefore, a practical example for the usage of such valves is when there is actuated a press, when, for labour protection reasons, in order to eliminate the possibility that the operative may harm himself, the press can only be actuated by pressing the actuation element with both hands. Yet again, another application of an AND logic valve is when the pressure within the circuit comes from two separate circuits.

Keywords: logic valve; pressure; pneumatic; simulation

1. Introduction

Within the actuation scheme, between the source of energy and the motor, either pneumatic or hydraulic, there are placed different elements, for the distribution, adjustment or control of the system, with the role to ensure the distribution of liquid for the actuation cyclogram and the flow adjustment (changes in actuation speed) and pressure (control of force and torque). In addition to those devices, there are also used auxiliary equipments, to filter, purge, cool-heat the fluid, lubricate etc. In real

¹PhD Eng., “Dunărea de Jos” University of Galati, Romania, Address: 47 Domneasca Street, Galati, Romania, E-mail: daniela.voicu@mta.ro.

²PhD Eng., Military Technical Academy “Ferdinand I”, Bucharest, Romania, Address: Blvd. George Cosbuc 39-49, Bucharest 050141, E-mail: radu.vilau@mta.ro.

³PhD Eng., Military Technical Academy “Ferdinand I”, Bucharest, Romania, Address: Blvd. George Cosbuc 39-49, Bucharest 050141, Corresponding author: ramona.stoica@mta.ro.

conditions, almost 30% of the equipment within an actuation system is safety devices, used to protect the personnel or to prevent from performing activities which may endanger him. There are two different approaches, meaning that the European legislation prevents dangerous activities for the personnel through the use of safety equipments and the American legislation imposes a better training of the operator. One way to solve the issue of probable dangerous activities, is to equip the system with AND logic valves, which imply the simultaneous actuation of two or multiple circuits by the operator. In electric actuation, an equivalent of AND logic valves might be the series connection of two normally-open contacts (NO- normal open) (Costache, 1985; Vilău, 2014; Research report CR-1485 / 25.09.2019, “Ferdinand I” Military Technical Academy, 2019) . The use of an AND logic valve implies two simultaneous commands, the same way as the usage of three or four will lead to a compulsory actuation of all, respectively. For example, in case of cupping press, there can be used two manual commands, or even three: two actuated by hand, one by foot, leading up to five simultaneous commands in case of high risk activities: 2 actuated by hand, 2 by foot and 1 under its proper weight.

2. Experimental Research

It was designed the following pneumatic model, in order to highlight the functioning of an AND logic valve (FluidSim 5 software documentation; Research report CR-1543 / 17.12.2019, “Ferdinand I” Military Technical Academy):

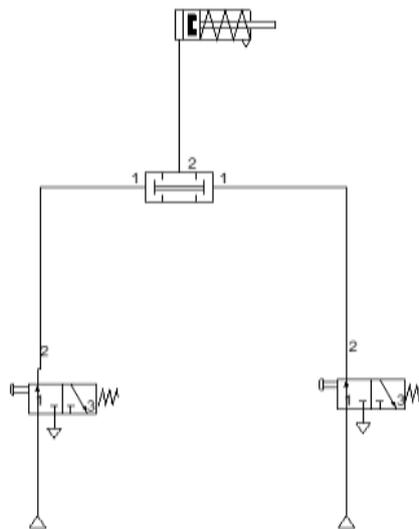


Figure 1. Pneumatic Model Used to Show the Working Mode of an AND Logic Valve

The pneumatic model comprises of:

- two normally closed 3/2 way valves, manually actuated by push button and spring based expansion;
- AND logic valve;
- single acting pneumatic cylinder;
- two compressed air sources (air compressors).

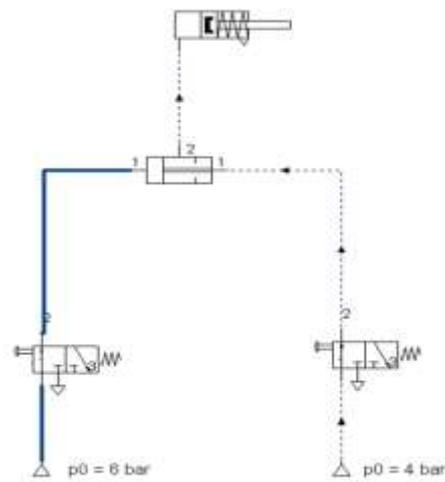


Figure 2. Fuelling inlet (2) by Actuation Connection Pipe, with the Lowest Pressure

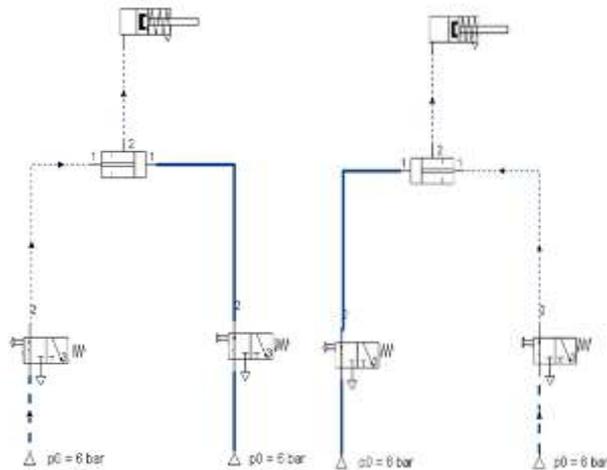


Figure 3. Equal Pressure between Actuating Pipe and Inlet Pipe from (1) or (3)

As an example, AND logic valve is used to actuate a press, where, for safety reasons and protection of the personnel, one must have both hands on the actuation device.

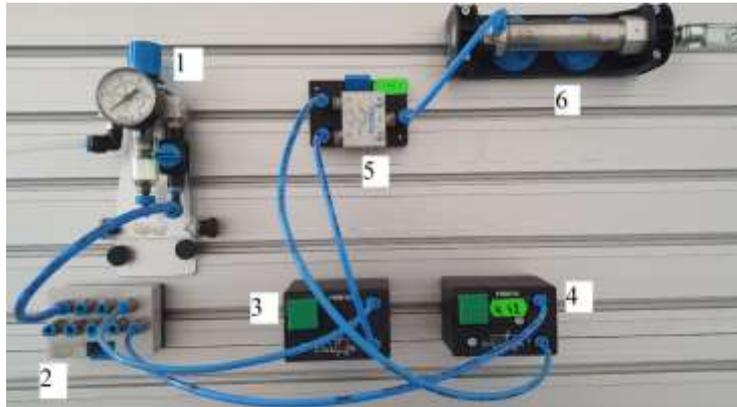


Figure 4. Pneumatic Model on the Laboratory Test Bench

Legend:

1 – air preparation unit;

2 - flow divisor;

3,4 – normally open 3/2 way valve, actuated by push button and spring based extension;

5 – AND logic valve;

6 - single acting cylinder with unilateral rod.

Another application of an AND logic valve is using pressure within a system, from two separate circuits. As an example, it is presented the following pneumatic model:

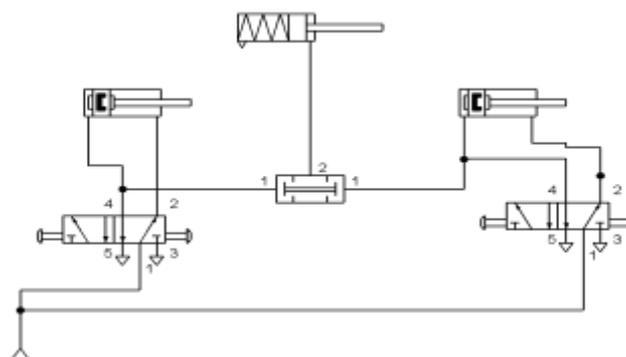


Figure 5. Example of Usage for an AND Logic Valve, with Pressure from Two Separate Circuits

The pneumatic model comprises of:

- two 5/2 bistable way valve, manually actuated by push button and spring based extension;
- AND logic valve (selector valve with two pressures);
- two double acting pneumatic cylinder, with holding brake;
- single acting pneumatic cylinder, spring based extension;
- compressed air source (air compressor).

Functioning mechanism: when the air compressor starts, both circuits are pressurized because both pistons are at the end of stroke [1,3,6].

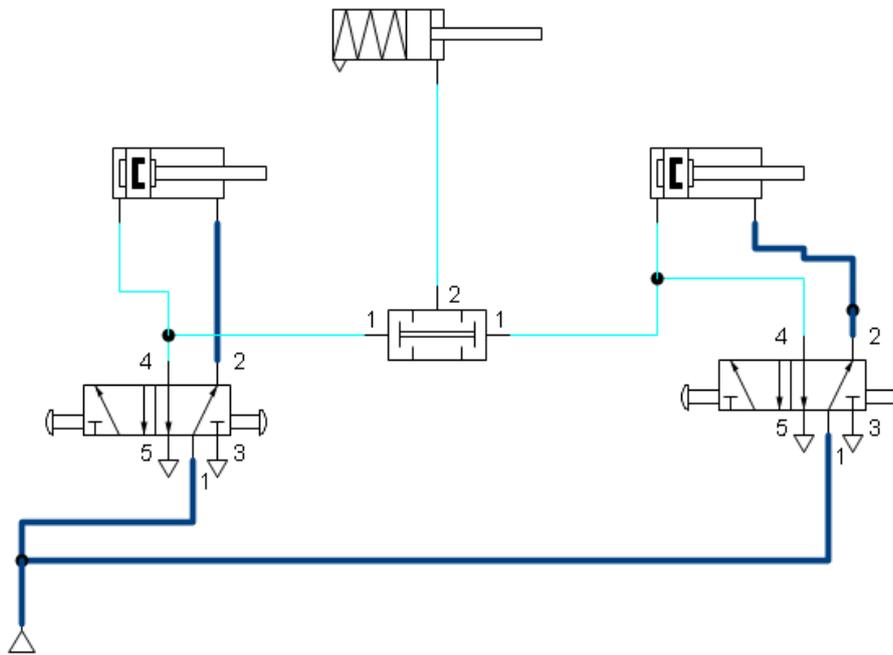


Figure 6. Phase 1: Starting Point of the Air Compressor

After actuating the first pneumatic valve, the compressed air is sent to the first cylinder, which will result in a displacement of the piston, towards the head end of the cylinder (extension stroke).

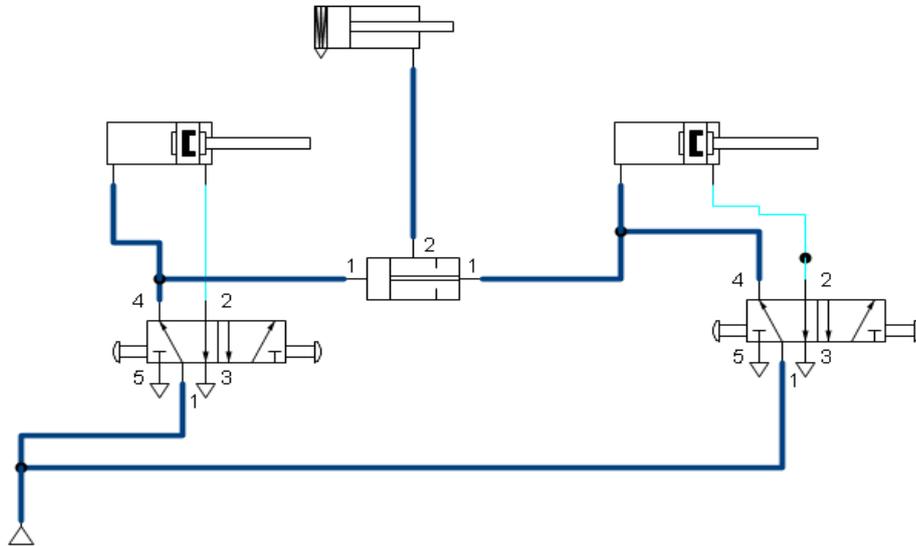


Figure 8. Phase 3: Opening of the AND Logic Valve

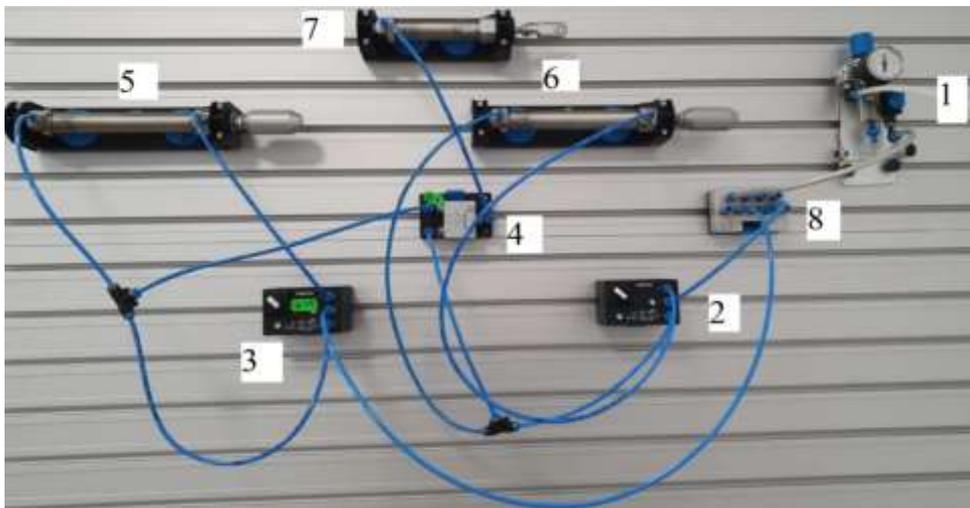


Figure 9. Test Bench Block Model

where:

- 1- air preparation unit;
- 2,3- 5/2 normally open way valve;
- 4- AND logic valve;

- 5,6- double acting cylinder with unilateral rod;
- 7- single acting cylinder with unilateral rod;
- 8- flow divisor.

3. Conclusion

The proposed applications highlighted the safety aspects regarding the usage of AND logic valves. In addition, one actuation can be determined by ensuring certain pressures on circuits (role of sequence valve). The presented schemes are independent of electric circuits, thus avoiding any interruptions during the actuation process, due to the stop of the electric source. For such situations, there can be used alternative air compressed sources, to ensure a small number of actuations.

Acknowledgement

„This work is supported by the project ANTREPRENORDOC, in the framework of Human Resources Development Operational Programme 2014-2020, financed from the European Social Fund under the contract number 36355/23.05.2019 HRD OP /380/6/13 – SMIS Code: 123847.”

References

- *** (2019). Research report CR- 1543 / 17.12.2019, “Ferdinand I” Military Technical Academy.
- *** (2019). Research report CR-1485 / 25.09.2019, “Ferdinand I” Military Technical Academy.
- *** (2020). Raport de cercetare CR- 1565/ 24.11.2020, Academia Tehnică Militară ”Ferdinand I” Costache, D. (1985). *Hydraulic and pneumatic drives for motor vehicles*. Bucharest: Military Academy Publishing House.
- *** FluidSim 5 software documentation.
- Vilău, R. (2014). *Hydraulic and pneumatic drives. Course support*.