electropneumatics,
electropneumatic control systems

KRZYSZTOSZEK Konrad[1]
PODSIADŁY Dariusz[2]
PIETRUSZCZAK Daniel[3]

REVIEW OF SELECTED ELECTROPNEUMATIC CONTROL SYSTEMS

This paper presents possibilities of a FESTO DIDACTIC-manufactured ELECTROPNEUMATICS TP201 workstation for investigating and testing electropneumatic components and systems. The workstation has been implemented in the Laboratory of Mechatronics at the Faculty of Transport and Electrical Engineering of the Kazimierz Pułaski Technical University of Radom and used for laboratory classes.

The paper gives examples of laboratory classes carried out with the use of electropneumatic components.

PRZEGLĄD WYBRANYCH ELEKTROPNEUMATYCZNYCH UKŁADÓW STEROWANIA

Artykuł jest prezentacją możliwości stanowiska ELEKTROPNEUMATYKA TP201 firmy FESTO DIDACTIC do badania i testowania elementów i układów elektropneumatyki. Stanowisko zostało uruchomione w Laboratorium Mechatroniki na Wydziale Transportu i Elektrotechniki Politechniki Radomskiej i jest wykorzystywane do zajęć laboratoryjnych.

Podano przykłady realizacji ćwiczeń laboratoryjnych z wykorzystaniem elementów elektropneumatycznych.

1. INTRODUCTION

In modern machinery electropneumatic devices play a very important role [5,6,8]. A large number of machines manufactured today have a more or less developed electropneumatic control or power supply equipment and in many of them this equipment is their most vital part.

[1]Kazimierz Pułaski Technical University of Radom, Faculty of Transport and Electrical Engineering, Malczewskiego 29, Radom, POLAND, e-mail: k.krzysztoszek@pr.radom.pl
[2]Kazimierz Pułaski Technical University of Radom, Faculty of Transport and Electrical Engineering, Malczewskiego 29, Radom, POLAND, e-mail: d.podsiadły@pr.radom.pl
[3]Kazimierz Pułaski Technical University of Radom, Faculty of Transport and Electrical Engineering, Malczewskiego 29, Radom, POLAND, e-mail: d.pietruszczak@pr.radom.pl

The paper presents possibilities offered by the FESTO DIDACTIC-manufactured TP201 workstation [1,2,4,7] during laboratory classes dealing with the issues of electropneumatic control.

2. SELECTED ELECTROPNEUMATIC CONTROL SYSTEMS

In electropneumatics, control signals are processed and dispatched in the electrical signal control section constituting the information part of an electropneumatic directional control valve. The power stream transfer and control of the receiver are accomplished in the pneumatic section of the directional control valve. The speed of the electrical signal transfer over long distances in conjunction with the speed of the pneumatic actuators enables the use of electropneumatic valves for controlling the course of fast production processes. The DC or AC fed solenoid coils are used for construction of electropneumatic valve control systems.

This section presents selected electropneumatic control systems.

- Direct and indirect control of a single-acting cylinder with the use of a 3/2 electropneumatic valve (pushbutton)

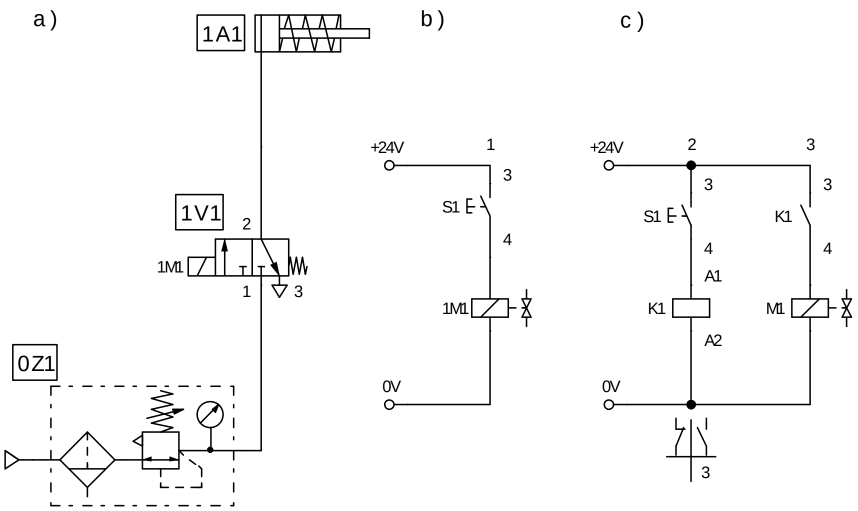

Fig.1. Direct control system of a single-acting cylinder with a pushbutton: a)pneumatic circuit diagram, b) electrical circuit diagram with direct control, c) electrical circuit diagram with indirect control.

List of components:
1) O1Z – compressor together with a compressed air preparation unit
2) 1V1 – a spring-return 3/2-way solenoid valve (1M1), normally closed
3) 1A – single-acting cylinder
4) S1 – switch (without backup)
5) K1 – relay

Pressing and holding the S1 pushbutton (Fig.1.) causes the flow of the 24V current to the 1M1 solenoid coil. Overloading of the 3/2-way directional control valve entails an air flow from the O1Z power supply block to the 1A cylinder chamber. The increased pressure in the cylinder chamber makes the piston rod move forth. The piston rod retracts after the current has been cut-off in the 1M1 solenoid coil which happens when the S1 pushbutton is released. The directional control valve returns to its initial position as a result of a spring operation. The indirect control differs from the direct control in the use of a relay in the electrical system by means of which the electropneumatic valve is overloaded.

- Direct control of a single-acting cylinder with the use of a 3/2 electropneumatic valve (detent switch)

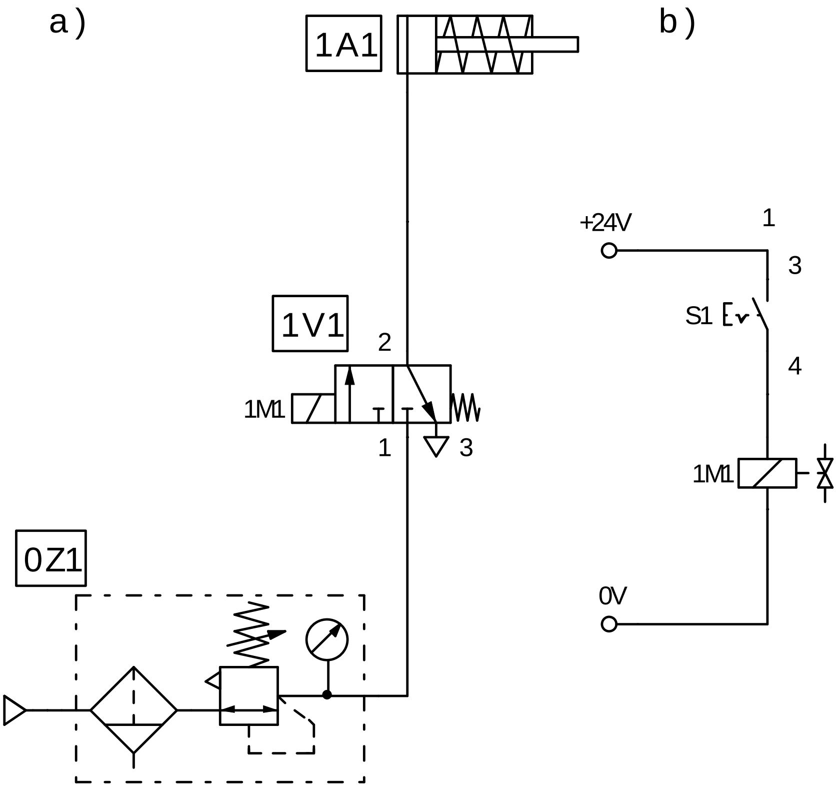

Fig.2. Direct control system of a single-acting cylinder by means of a detent switch: a) pneumatic circuit diagram, b) electrical circuit diagram.

The system (Fig.2.) operates in a similar way as the previous one. The piston rod remains extended until the S1 button is pressed again.

- Direct and indirect control of a double-acting cylinder with the use of a 5/2 electropneumatic valve (pushbutton)

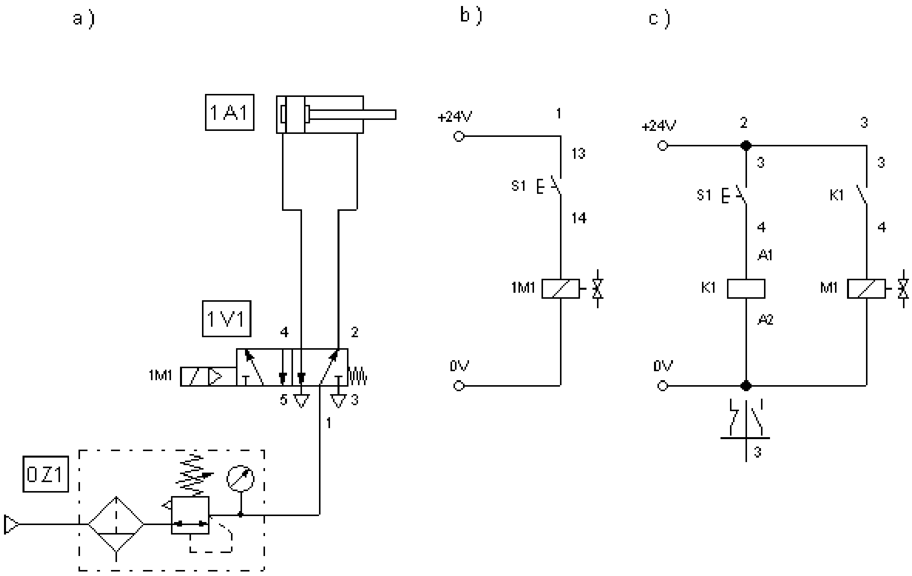

Fig.3. Direct and indirect control system of a double-acting cylinder with a pushbutton:
a) pneumatic circuit diagram, b) electrical circuit diagram with direct control,
c) electrical circuit diagram with indirect control.

List of components:

1) O1Z – compressor together with a compressed air preparation unit
2) 1V1 – 5/2-way solenoid valve directly controlled by 1M1 solenoid
3) 1A1 – single-acting cylinder
4) S1 – switch (without backup)
5) K1 – relay

Pressing and holding the S1 pushbutton (Fig.3.) causes supply of the 24V current to the 1M1 solenoid coil. The overload of the 1V1 directional control valve entails an air flow from the O1Z power supply block to the 1A1 cylinder chamber. The increased pressure in the cylinder chamber makes the piston rod advance. The piston rod retracts to its initial position when the current is cut off in the 1M1 solenoid coil, which is triggered off by the release of the S1 pushbutton. The return of the directional control valve to its initial position results from the operation of the spring. The indirect control differs from the direct control in the use of a relay in the electrical system.

- Double-acting cylinder control with the use of an electropneumatic 5/2-way solenoid impulse valve.

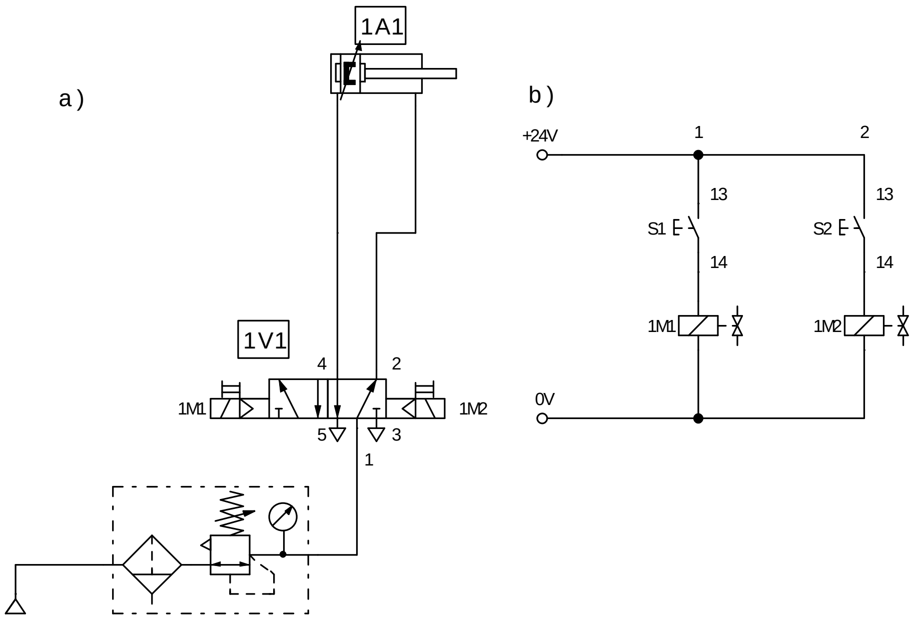

Fig. 4. Double-acting cylinder control system by means of two5/2-way solenoid impulse valve: a) pneumatic circuit diagram, b) electrical circuit diagram.

List of components:

1) O1Z – compressor together with a compressed air preparation unit
2) 1V1 – 5/2-way solenoid impulse valve
3) 1A1 - single-acting cylinder
4) S1, S2 – switches (without backup)

Pressing and holding the S1 pushbutton (Fig.4.) causes the flow of the 24V current to the 1M1 solenoid coil. The overload of the 1V1 directional control valve entails an air flow from the O1Z power supply block to the 1A1 cylinder chamber. The increased pressure in the cylinder chamber results in the piston rod's movement forward. The piston rod's retraction is triggered off by pressing the S2 pushbutton causing the current supply to the M2 solenoid coil. The use of the 5/2-way solenoid impulse valve is a very practical solution to the piston rod movement control as switching the valve when the piston rod extends and retracts follows a momentary pressing of a pushbutton.

3. FESTO'S TP 201 LABORATORY WORKSTATION

The Festo company [7] based in Janki near Warsaw is a manufacturer of automatic elements in the field of pneumatics and electropneumatics. It is an important supplier of equipment for both industry and school and university laboratories providing the latter with learning equipment. The TP 201 Laboratory workstation (Fig.5.) is a set of a dozen or so automatic elements consisting, among others of a:

- compressor (0-4 bar)
- compressed air preparation unit
- electropneumatic valves of different types
- volumetric, inductive and pressure sensors, and proximity detectors
- electrical, left- and right-actuated limit switches
- operation components – single- and double-acting cylinders
- aluminium mounting/profile plate
- set of make- and break-, detent- and changeover switches mounted on a block
- set of switches and changeover switches, and signal lamps mounted on a block
- pneumatic and electrical cables

Fig.5. View of the ELEKTROPNEUMATYKA TP 201 laboratory set manufactured by FESTO DIDACTIC.

During laboratory classes students get familiarized with the structure and operation principles of linear movement pneumatic cylinders and pneumatic valves as well as their circuits. Next, they get acquainted with the conditions of single- and double-acting cylinder control. Finally they build the cylinder control systems as indicated by the person in charge of laboratory classes [1,2,3,4].

4. CONCLUSIONS

The learning packages offered by Festo Didactic allow schools and universities to fully equip their laboratories with electropneumatic systems.

The learning package ELEKTROPNEUMATYKA TP 201 allows us to teach students how to assemble and operate actual electropneumatic systems. This, in turn, enhances the would-be engineers' confidence in operating the equipment which they may encounter in their future careers.

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