Fluid Power Elements

Laboratory of Pneumatics

Instruction set

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Subject 1: Components data sheets

1. How to use catalogues?

Take catalogue of pneumatic components and elaborate most important data including following components:

- two different types of cylinders, e.g.: single-acting and double-acting cylinder
- three different types of directional control valves - they should have different number of ports and positions, different types of actuation and principle of operation,
- one type of maintenance unit (compressed air preparation unit).

2. Report

Report should take into consideration:

- a name of component e.g.: double-acting cylinder, three-port two-position directional control valve operated manually by pushbutton and return spring, etc.,
- graphic symbol in according ISO 1219-1 standard,
- elaborated data sheets.

Notice!

Do not copy detailed technical parameters like: *piston diameter is 10, 25, 40, 50 etc*. Instead write that: *manufacturer declare piston diameter range*.

Do not forget check and write what kind of drawings, charts and characteristics has been published, as well as accessories could be used with mentioned component.

3. References

1. Asco Joucomatic: Catalogue of pneumatic components for industrial automation. http://www.ascojoucomatic.com/
2. Bosch Rexroth Group: Pneumatics. Industrial applications. http://www.boschrexroth.com/
3. CPP Prema: Oferta. http://www.prema.pl/
4. Camozzi: Products catalogue: http://www.camozzi.com/
5. Festo: Products catalogue. http://www.festo.com
6. Metalwork: Products catalogue. http://www.metalwork.it/
7. SMC: Products catalogue. http://www.smc.eu

Subject 2: Circuits with single-acting cylinders

1. Direct control system

Principle of operation: After push button is pressed single-acting cylinder extends. As long as the push button is actuated, the cylinder remains in this position. If the push button is released cylinder retracts to its previous position.

Instruction: Develop pneumatic direct control system using:

- one single-acting cylinder,
- one directional control valve operated manually by push-button,
- hoses fastened to the laboratory stand.

Complete flow diagram of developed system in the Figure 1 a) using graphic symbols in accordance with ISO standard.

2. Indirect control system

Principle of operation: After push button is pressed single-acting cylinder extends. As long as the push-button is actuated, the cylinder remains in this position. If the push-button is released cylinder retracts to its previous position.

Instruction: Develop pneumatic indirect control system using:

- one single-acting cylinder,
- one directional control valve operated manually by push-button,
- one directional control valve operated pneumatically,
- hoses fastened to the laboratory stand.

Complete flow diagram of developed system in the Figure 1 b) using graphic symbols in accordance with ISO standard.

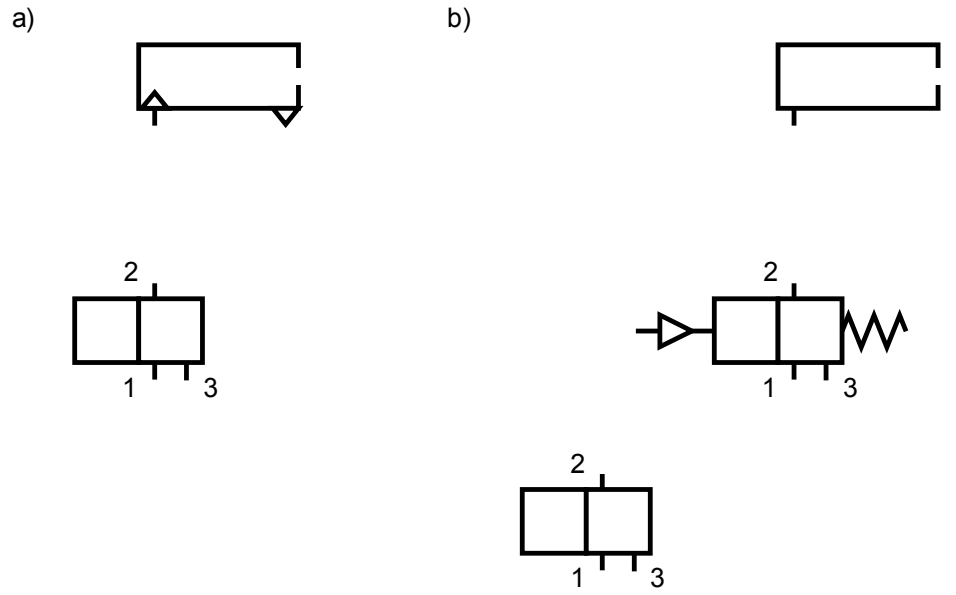

Fig. 1. Flow diagram with single-acting cylinder:
a) direct control system; b) indirect control system

3. Speed adjusting of single-acting cylinder

Instruction: Use hydraulic circuit has been built recently and add one-way flow control valves to develop single-acting cylinder speed control:

- when the cylinder extends (complete flow diagram in the Figure 2a),
- when the cylinder retracts (complete flow diagram in the Figure 2b),
- in both directions (complete flow diagram in the Figure 2c).

Then remove all flow control valves and use quick exhaust valve. Check if the cylinder retraction speed has changed.

Draw respectively circuit diagrams of developed systems using graphic symbols in accordance ISO standard.

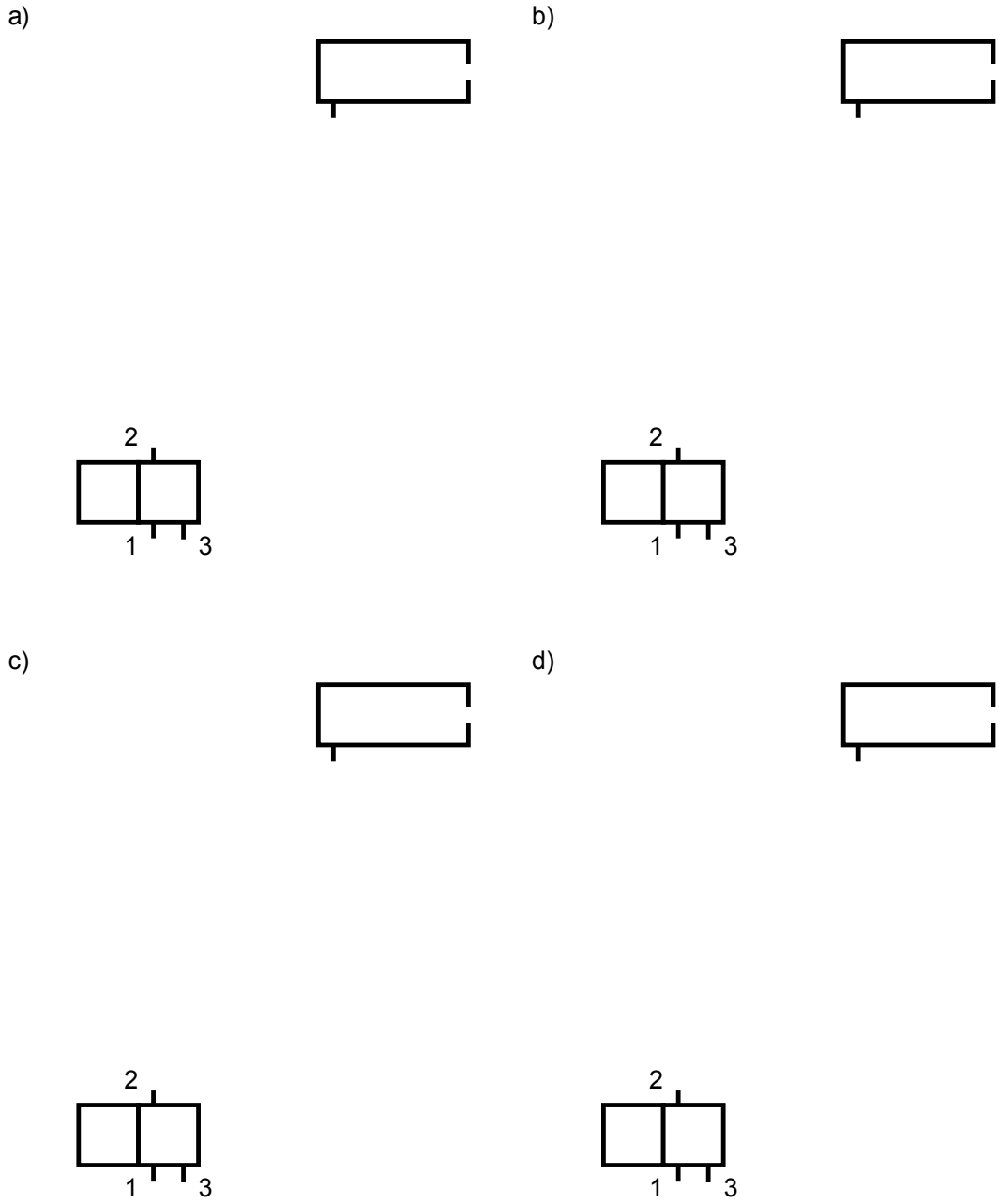

Fig. 2. Speed adjusting of single-acting cylinder. Flow diagram with: a) and b) one flow control valve; c) two flow control valves; d) quick exhaust valve

4. Conclusions

Among others, conclusions should take into consideration:

- description of single-acting cylinders features,
- short description including principle of operation and application area of direct and indirect control systems,
- short description including principle of operation and features of pneumatic speed adjusting control systems drown on the circuit diagrams.

Subject 3: Circuits with double-acting cylinders

1. Direct control system

Circuit 1:
Principle of operation: After push button of the valve V1 is pressed double-acting cylinder extends. If the push button of the valve V2 is pressed cylinder retracts to its previous position. Check what happen if push-buttons of both valves are pressed simultaneously. Try pull piston rod out when non of valves V1 and V2 is actuated and make notes.
Instruction: Develop pneumatic direct control system using:

- one double-acting cylinder,
- two 3/2-way valves,
- hoses fastened to the laboratory stand.

Complete flow diagram of developed systems in the Figure 3 a) using graphic symbols in accordance ISO standard.
Circuit 2:
Principle of operation: After lever or push button is pressed double-acting cylinder extends. As long as the lever or push button is actuated, the cylinder remain in this position. If the lever or push button is released cylinder retracts to its previous position.
Instruction: Develop pneumatic direct control system using available double-acting cylinder, 4/2-way or 5/2 valves and hoses fastened to the laboratory stand.
Complete flow diagram of developed systems in the Figure 3 b) using graphic symbols in accordance ISO standard.

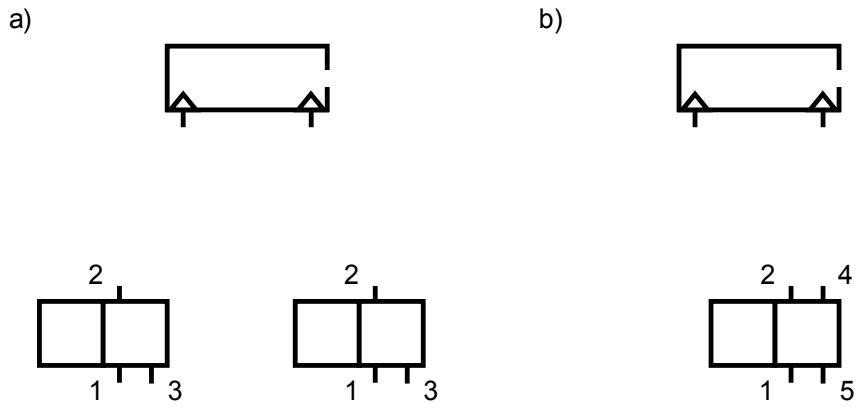

Fig. 3. Flow diagram of direct control system with double-acting cylinder controlled by: a) two 3/2 valves; b) one 4/2 or 5/2 valve

2. Indirect control system

Circuit 1 (ask if available):
Principle of operation: After push-button is pressed double-acting cylinder extends. As long as the push-button is actuated, the cylinder remain in this position. If the push-button is released cylinder retracts to its previous position.
Instruction: Develop pneumatic indirect control system using

- one double-acting cylinder,
- one monostable 5/2-way valve actuated traumatically,
- one 3/2-way valves,
- hoses fastened to the laboratory stand.

Complete flow diagram of developed systems in the Figure 4 a) using graphic symbols in accordance ISO standard.

Circuit 2:
Principle of operation: After push button of the valve V1 is pressed double-acting cylinder extends. If the push button of the valve V2 is pressed cylinder retracts to its previous position. Check what happen if push-buttons of both valves are pressed simultaneously.
Instruction: Develop pneumatic indirect control system using:

- double-acting cylinder,
- one bistable 5/2-way valve actuated pneumatically,
- two 3/2-way valves,
- hoses fastened to the laboratory stand.

Complete flow diagram of developed systems in the Figure 4 b) using graphic symbols in accordance ISO standard.

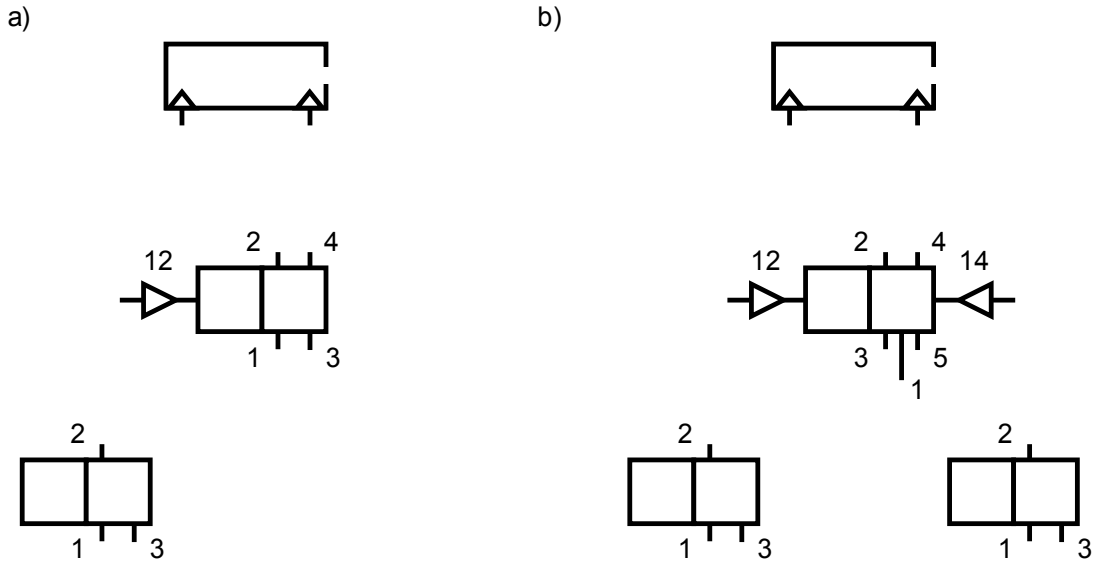

Fig. 4. Flow diagram of indirect control system with double-acting cylinder: a) bistable; b) monostable

3. Speed adjusting of double-acting cylinder

Instruction: Use one-way flow control valves to develop double-acting cylinder control system witch allow independent control of speed in both directions:

- when supplied air is controlled (complete flow diagram in the Figure 5a),
- when exhausted air is controlled (complete flow diagram in the Figure 5b).

For each circuit adjust speed of a piston as low as possible and check manually stiffness of whole system by pushing and pulling out a piston rod during operation. **Maintain operational safety!**

In next circuit use quick exhaust valve to make the cylinder retraction faster and flow control valve throttling exhausted air to reduce cylinder extension speed. Complete flow diagram of developed system in the Figure 5c).

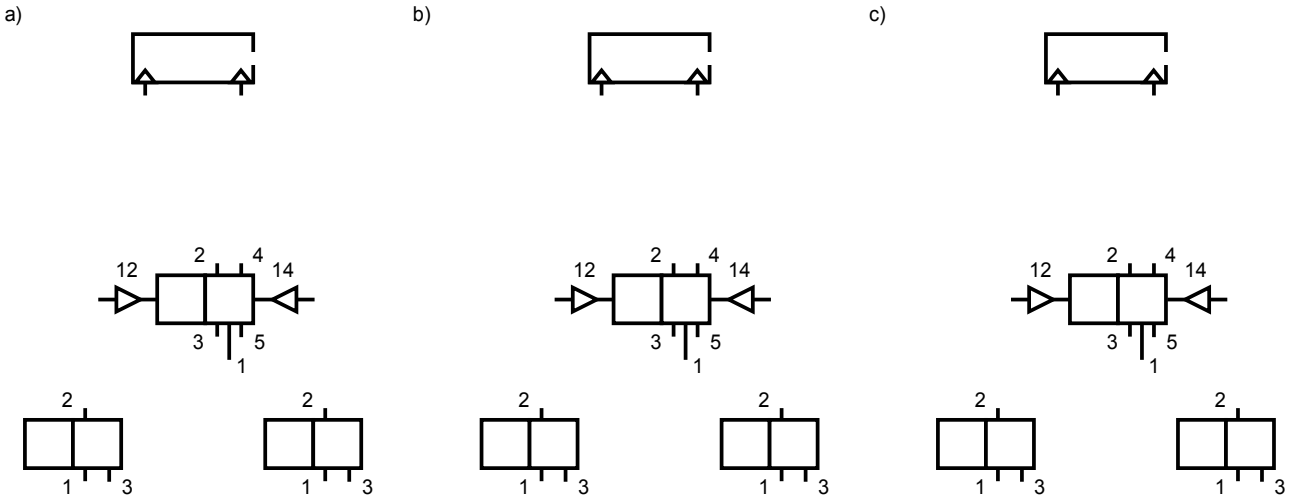

Fig. 5. Speed adjusting of double-acting cylinder. Flow diagram with: a) flow control valves throttling supplied air; b) flow control valves throttling exhausted air; c) quick exhaust valve and flow control valve throttling exhausted air

4. Conclusions

Among others, conclusions should take into consideration:

- description of double-acting cylinders features,
- short description including principle of operation and application area of direct and indirect control systems,
- short description including principle of operation and features of pneumatic speed adjusting control systems drown on the circuit diagrams.

Subject 4: Development of pneumatic circuits based on displacement-step diagram

4. Develop circuits

Circuit 1:

Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure 6. Valves V1 and V2 cause respectively extension or retraction of double-acting cylinder. Notice that cylinder displacement is caused by impulse valves actuating.

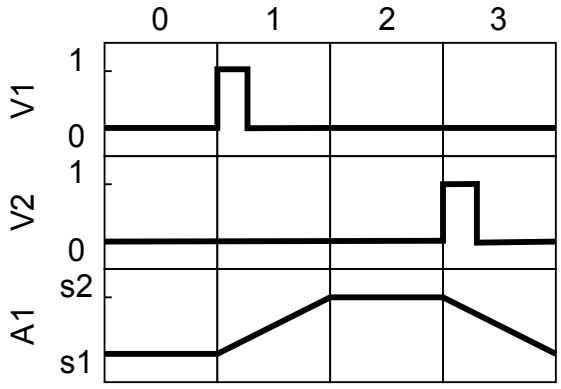

Fig. 6: Displacement-step diagram

Complete flow diagram of developed systems in the Figure 7 using graphic symbols in accordance ISO standard.

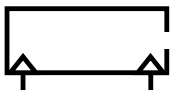

Fig. 7. Flow diagram

Circuit 2:

Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure 8. Valve V1 cause extension of double-acting cylinder. Use 3/2-way valve actuated with roller lever as a limit switch for detecting piston rod in their end position. When a cam fixed to the end of piston rod reaches position of a limit switch cylinder should return to one's previous position automatically.

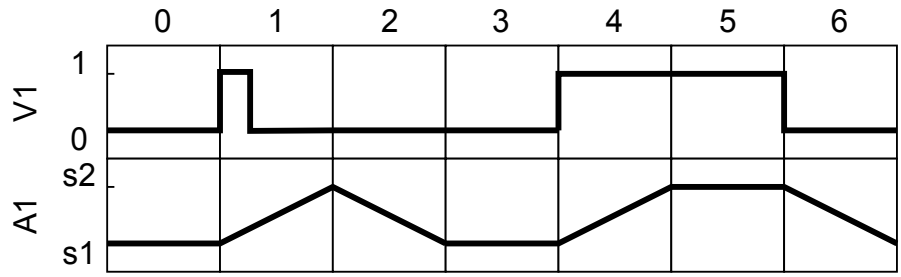

Fig. 8. Displacement-step diagram

Complete flow diagram of developed systems in the Figure 9 using graphic symbols in accordance ISO standard.

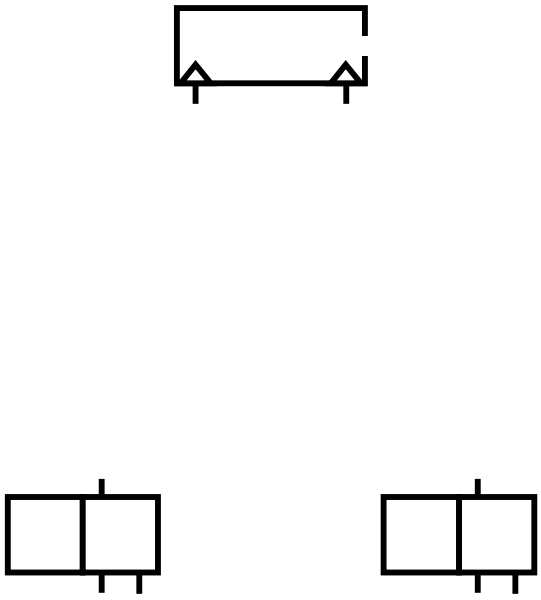

Fig. 9. Flow diagram

Circuit 3:

Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure 10. Valve V1 cause extension of double-acting cylinder. Use two roller lever 3/2-way valves as a limit switches s1 and s2. Actuation of the roller lever valve s2 cause the cylinder return to one's previous position even push button of the valve V1 is still holding.

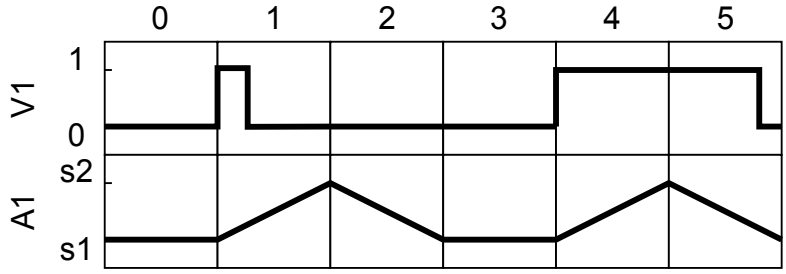

Fig. 10. Displacement-step diagram

Complete flow diagram of developed systems in the Figure 11 using graphic symbols in accordance ISO standard.

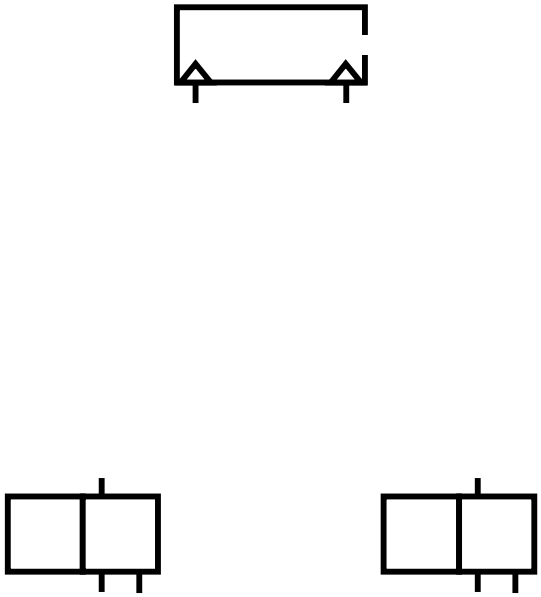

Fig. 11. Flow diagram

Circuit 4: (not obligatory)
Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure . Valve V1 cause extension of double-acting cylinder. Use roller lever 3/2-way valves as a limit switches. The cylinder execute single working cycle (extension and retraction) even push-button of the valve V1 is still holding.

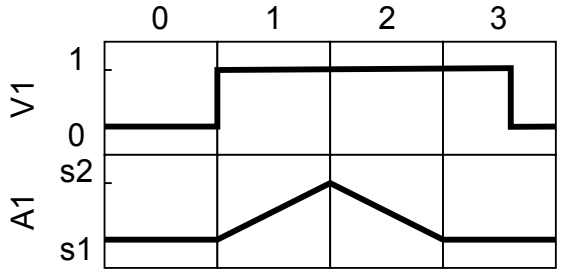

Fig. 12. Displacement-step diagram

Complete flow diagram of developed systems in the Figure 11 using graphic symbols in accordance ISO standard.

5. Conclusions

Among others, conclusions should take into consideration:

- explanation of terms: displacement-step diagram, limit switch,
- short comment to principle operation of pneumatic systems develop in according circuit 1 when push-buttons of valves V1 and V2 are actuated simultaneously,
- similarities and differences between system from circuit 1 and circuit 2 (Subject 2),
- short comment how long holding of push-button of the valve V1 flow in to the shape of displacement-step diagrams for circuits 2 and 3,
- explanation why the cylinder execute single working cycle (extension and retraction) even push-button of the valve V1 is holding all the time,

Subject 5: Logic functions

1. Non-return valves

Develop pneumatic circuit that make possible to specify logic functions realising by shuttle valve and dual pressure valve. Additionally use two 3/2-way valves actuated by push-buttons and pressure indicator, gauge or single-acting cylinder instead.

Complete the truth tables (Table 1), draw corresponding graphic symbols in according ISO1219-1 standard and write name of respective pneumatic valves. Make an assumption that the High Pressure corresponds to logic 1 and the Low Pressure corresponds to logic 0.

Table 1. Truth table

a)

Graphic symbol	Inlet 12	Inlet 14	Outlet 2

Logic function: _____

Valve name: _____

b)

Graphic symbol	Inlet 12	Inlet 14	Outlet 2

Logic function: _____

Valve name: _____

2. 3/2-way valves

Some pneumatic directional control valves could operate as logic gates. Use 3/2-way valve operated pneumatically with return spring to implement four main logic functions:

a) $y = x_1$

b) $y = \bar{x}_1$

c) $y = x_1 + x_2$

d) $y = x_1 \cdot x_2$

Complete graphic symbols in the Figure 13. Use $\mathbf{x_1}$ and $\mathbf{x_2}$ as a description of input ports as well as graphic symbols of pressure supply and exhaust to develop logic function described respectively by formulas a), b), c) and d). Make an assumption that the graphic symbol of pressure supply corresponds to logic 1 and the graphic symbol of exhaust corresponds to logic 0.

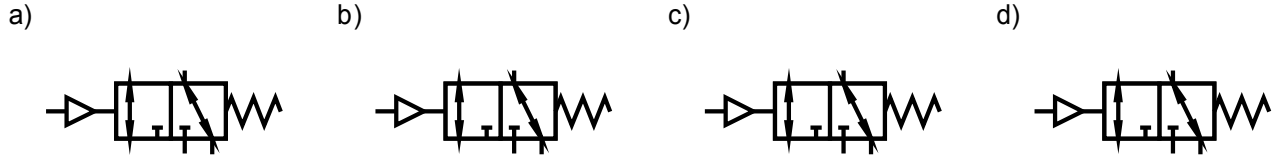

Fig. 13. Logic functions realised by 3/2-way valve: a) YES, b) NOT, c) OR, d) AND

3. Conclusions

Among others, conclusions should take into consideration:

- cross-section figures of logic valves,
- description of logic functions available in pneumatic,
- examples of logic valves applications.

Subject 6: Time-delay valves and counter in pneumatic circuits

1. Develop following circuits

Circuit 1:
Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure 14. Valves V1 cause extension of double-acting cylinder. When the cylinder achieve position of the limit switch, valve V2 starts measure time to retraction.
Circuit 2:
Principle of operation: Behaviour of the system describes displacement-step diagram shown on the Figure 15. Valves V1 cause extension of double-acting cylinder. The cylinder starts retracting after the delay measured by valve V2 pass. Counting out of time is started with moment of actuating the valve V1.
Instruction: Develop pneumatic control system using available double-acting cylinder, 5/2-way valve, 3/2-way valve, time delay valve and limit switch if necessary as well as pneumatic hoses.
Draw circuit diagrams of developed systems using graphic symbols in accordance ISO standard.

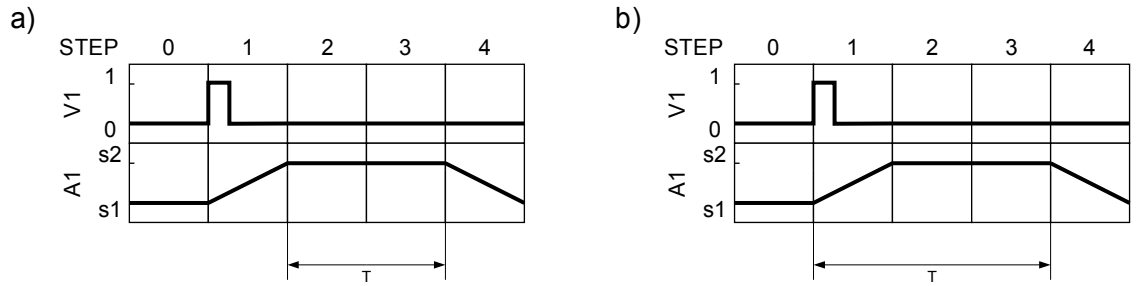

Fig. 14. Displacement-step diagram of a system with time-delay valve

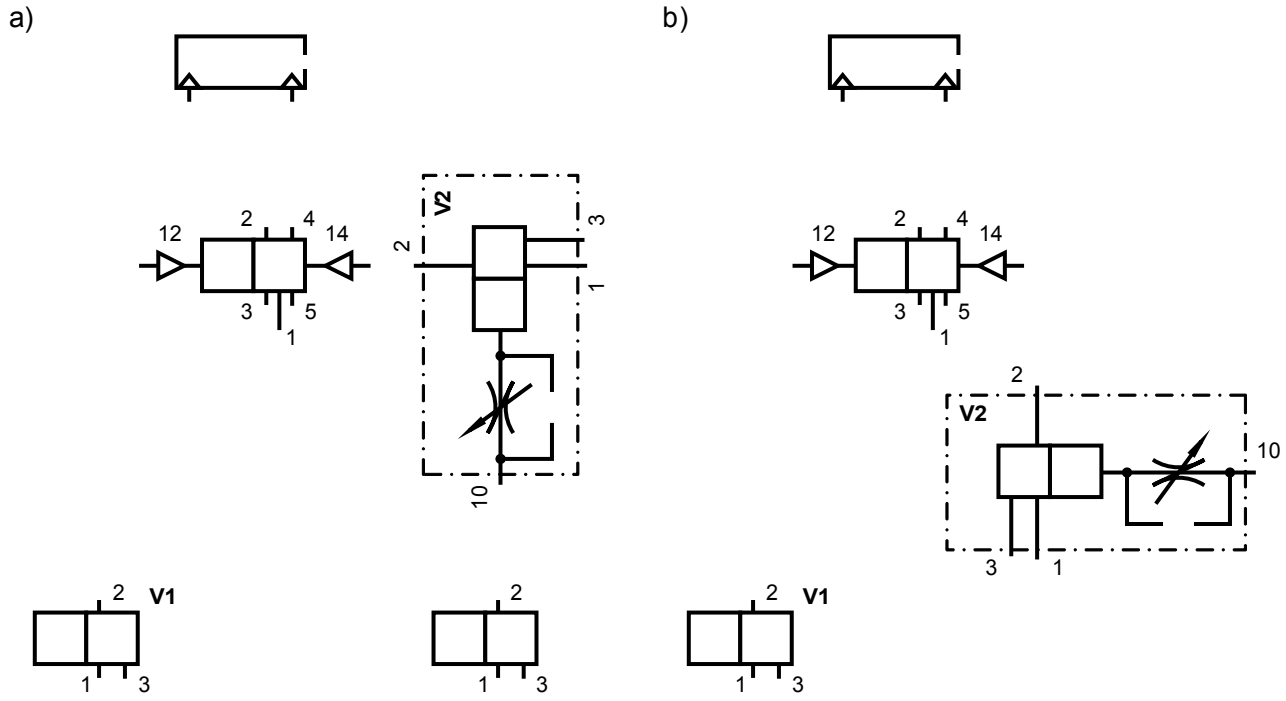

Fig. 15. Flow diagrams with time-delay valves: a) with limit switch, b) without limit switch

Circuit 3:

Principle of operation: After push button of the valve V1 is pressed double-acting cylinder perform a work cycle (extension and retraction) three times and stops waiting for next actuation of the valve V1. Number of working cycle should be adjusted by predetermining counter.

Instruction: Develop pneumatic control system using available double-acting cylinder, two 5/2-way valves, 3/2-way valve, predetermining counter and two limit switch as well as pneumatic hoses.

Draw circuit diagrams of developed systems using graphic symbols in accordance ISO standard.

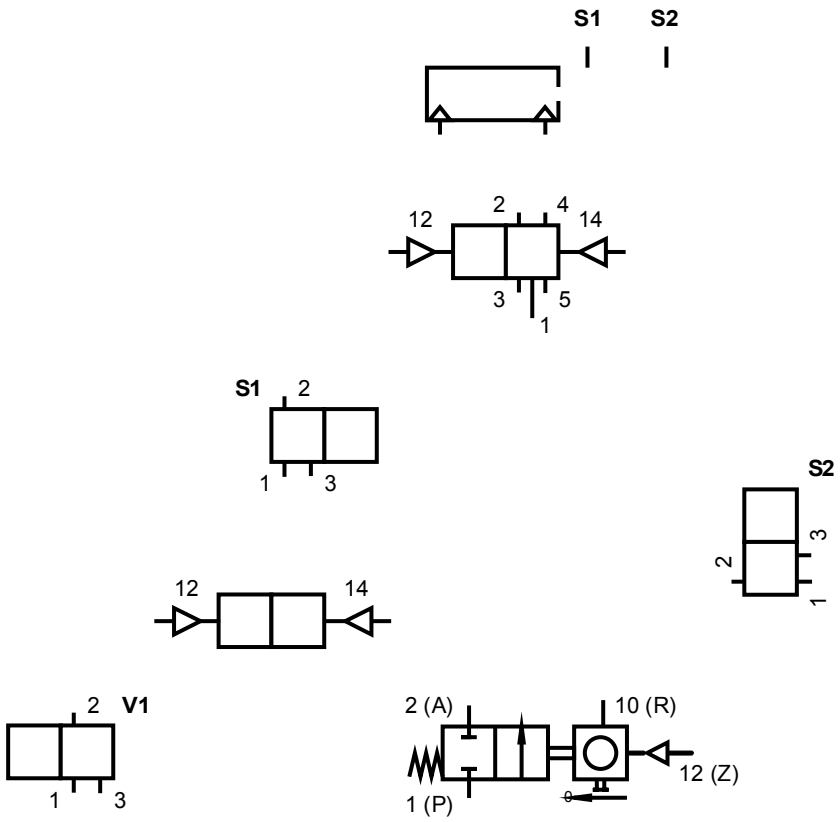

Fig. 16. Flow diagram of a system with working cycle counter

Circuit 4:
Principle of operation: After push button of the valve V1 is pressed double-acting cylinder perform a work cycle (extension and retraction) three times and stops waiting for next actuation of the valve V1. Number of working cycle should be adjusted by time-delay valve.
Instruction: Develop pneumatic control system using available double-acting cylinder, two 5/2-way valves, 3/2-way valve and two limit switch as well as pneumatic hoses. Instead predetermining counter use time delay valve.
Draw circuit diagrams of developed systems (Figure 17) using graphic symbols in accordance ISO standard.

Fig. 17. Flow diagram of a system with time-delay valve

2. Conclusions

Among others, conclusions should take into consideration:

- cutaway diagram of a time-delay valve,
- description of exemplary functions realised by time-delay valve,
- general information about operating principle of a predetermining counter,
- examples of pneumatic systems with time-delay valves and predetermining counters applications.