An Overview of the Linear Drive with Solenoid Coupling

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Abstract: *The paper presents an overview of the economic efficiency for linear drive with solenoid coupling. Moreover, the linear drive with solenoid coupling is also a pneumatic device. Thereby in this article, we are studying two pneumatic and one electro-pneumatic installation, which contains the linear drive with solenoid coupling. The first pneumatic circuit contains the following devices: compressed air supply, start-up valve with filter control valve, 4/2-way valve with spring, throttle valves, linear drive with solenoid coupling (LD 1-1). The second pneumatic circuit contains the following components: linear drives, throttle valves, 5/2-way valve, air service unit, compressed air supply. The last circuit which is actually an electro-hydraulic circuit contains the following components: compressed air supply, 5/2-way solenoid valve with spring, linear drive with solenoid coupling (LD 3-1), relays, valves solenoid and magnetic proximity switch.*

Keywords: *Linear, drive, solenoid, coupling, magnetic*

1. Introduction

The linear drive with solenoid coupling is an actuator that creates motion in a straight line. At the linear drive with solenoid coupling, the loads can be directly mounted on the slide.

Fig. 1. Linear drive with solenoid coupling

Adjustable parameters and symbol of multiple position cylinder are shown in the table below and in Fig. 2.

Table 1: Adjustable parameters of linear drive

Designation	Range	Value	Unit
Piston diameter	10^{-3}...1	$4 \cdot 10^{-2}$	m
Piston rod diameter	10^{-3}...1	$6 \cdot 10^{-3}$	m
Total stroke	10^{-3}...2	$2 \cdot 10^{-1}$	m
Piston position	10^{-3}...5	0	m
Damping length	10^{-3}...10^{-1}	0	m

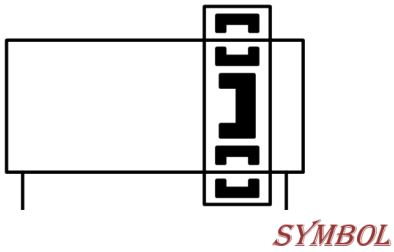

Fig. 2. Linear drive with solenoid coupling - Symbol

In the design of pneumatic or electro-pneumatic installations, the linear drive with solenoid coupling is represented by a specific symbol [1].
For linear drives with solenoid coupling three types of depreciation are available:
- elastic cushioning;
- pneumatic cushioning;
- hydraulic cushioning.
However, in this manuscript we only study actuators that contain pneumatic cushioning.

2. The linear drive with solenoid coupling in circuits

As an actuator, the linear drive with solenoid coupling can be easily monted according to needs in various pneumatic and electro-pneumatic installations [2].
The first pneumatic circuit made in this paper is designed as a simple pneumatic scheme which contains the linear drive with solenoid coupling, Fig. 3.

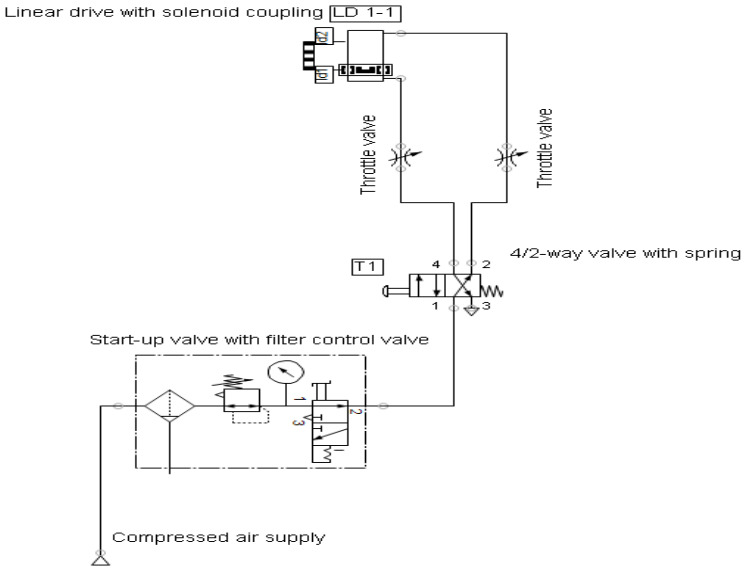

Fig. 3. Pneumatic scheme with linear drive (LD 1-1)

In the table below there are given six devices used in the pneumatic scheme, [3].

Table 2: The devices of first pneumatic circuit

Description	Number of components
Compressed air supply	1
Start-up valve with filter control valve	1
4/2-way valve with spring	1
Thtrottle valve	2
Linear drive with solenoid coupling (LD 1-1)	1

The 4/2 – way directional control valve with spring makes the connection between start-up valve with filter control valve and throttle valves, Fig. 4.
If the operator presses T1 button; this button belongs to the 4/2 - way solenoid valve with spring, [4].
Then, piston rod moves from point ld1 to point ld2. After that, those both piston rods returns from point ld2 to point ld1, because the 5/2 way valve has a spring, Fig. 4.

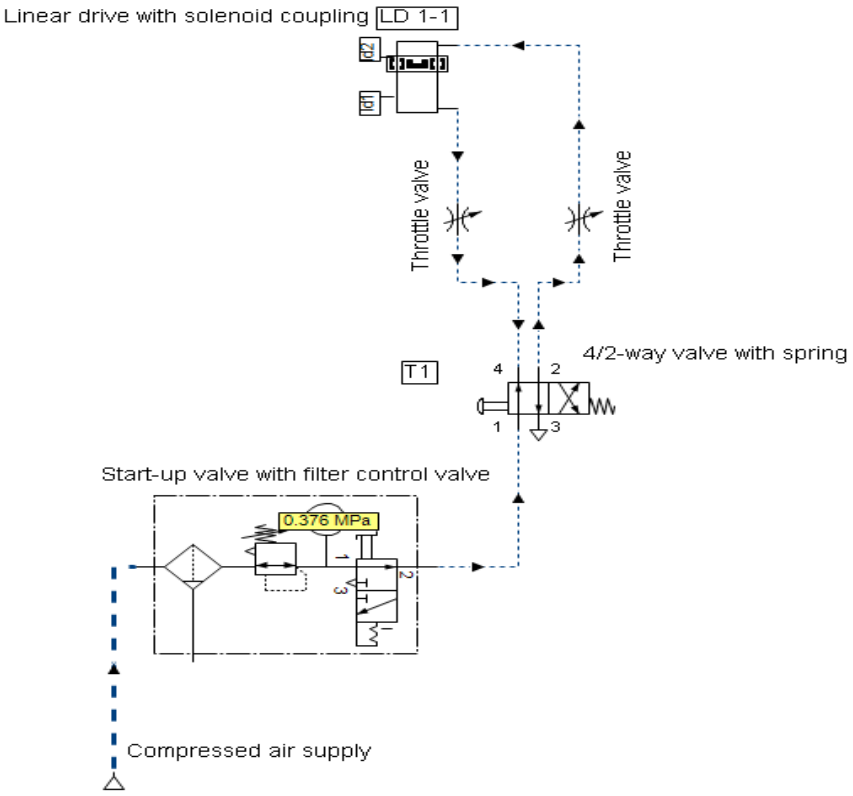

Fig. 4. Pneumatic scheme with linear drive (LD 1-1)

The parameters of linear drive with solenoid coupling (LD 1-1) are: position (x), velocity (v) and acceleration, Fig. 5.

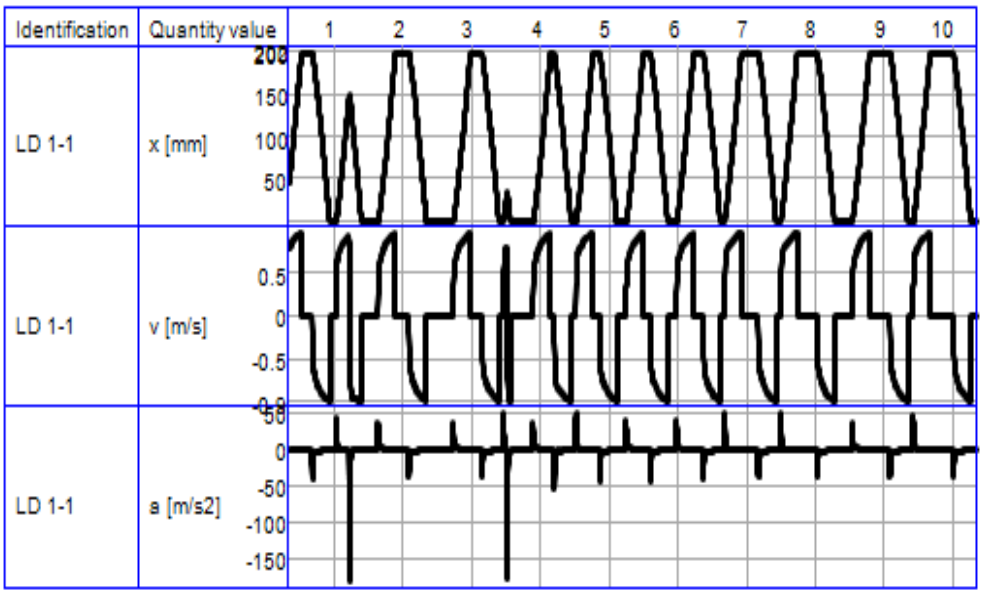

Fig. 5. The diagrams of linear drive with solenoid coupling (LD 1-1)

The second pneumatic installation holds two linear drives (LD 2-1 and 2-2), Fig. 6.
The 5/2 – way directional control valve with spring makes the connection between start-up valve with filter control valve and throttle valves, Fig. 6.

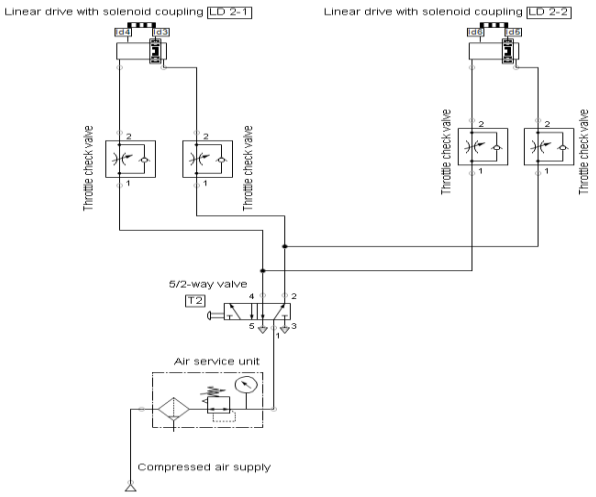

Fig. 6. Pneumatic circuit with a two linear drives

The simple pneumatic system with two linear actuators (LD 2-1 and LD 2-2) have the following eleven devices listed in the table below, [5].

Table 3: The devices of the second pneumatic circuit

Description	Number of components
Linear drives	2
Throttle valves	4
5/2-way valve	1
Air service unit	1
Compressed air supply	1

The second pneumatic circuit with linear drives opens if the operator presses T2 button from 5/2-way valve, Fig. 7.

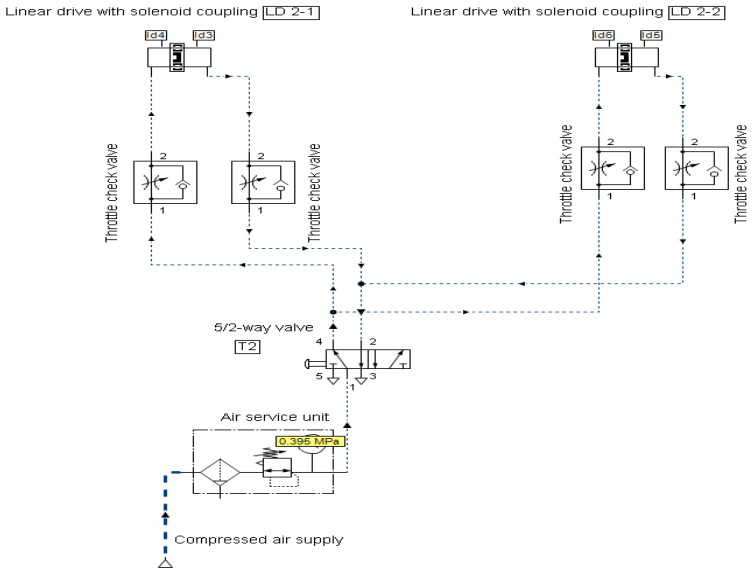

Fig. 7. Pneumatic circuit with two linear drives. Simulation I

Therefore, the piston rod of the linear drive (LD 2-1) moves from point ld3 to point ld4. After three seconds, the piston rod of the linear drive (LD 2-2) moves from point ld5 to point ld6, Fig. 8.

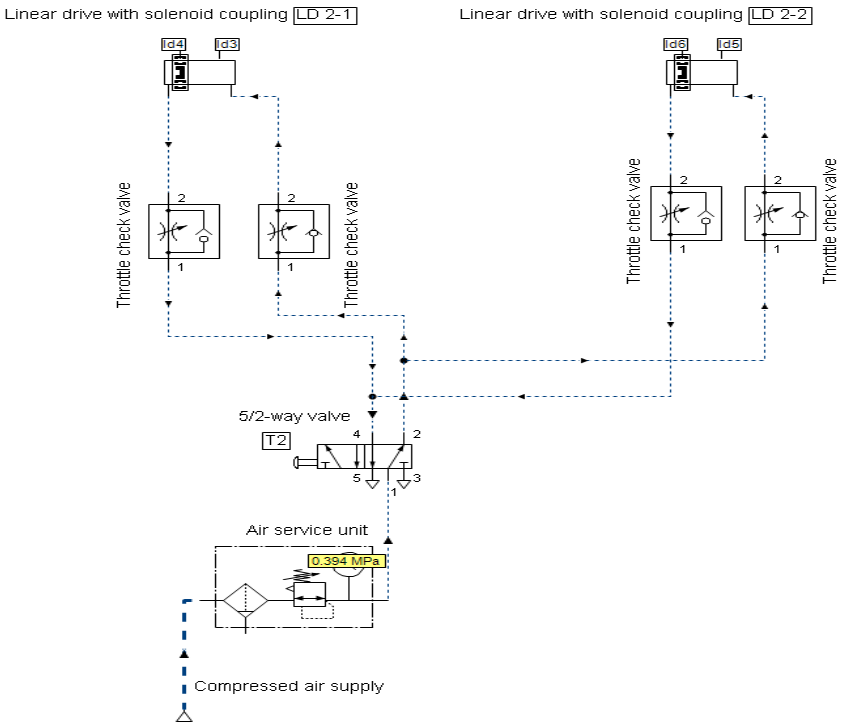

Fig. 8. Pneumatic circuit with two linear drives. Simulation II

If the operator presses T2 button again, the piston rod of the linear drive (LD 2-1) moves from point id4 to point ld3, [6].
Also, the piston rod of the linear drive (LD 2-2) moves from point ld6 to point ld5. With electro-pneumatic circuit with linear drive, the pneumatic components are controlled by electrical components, Fig. 9.

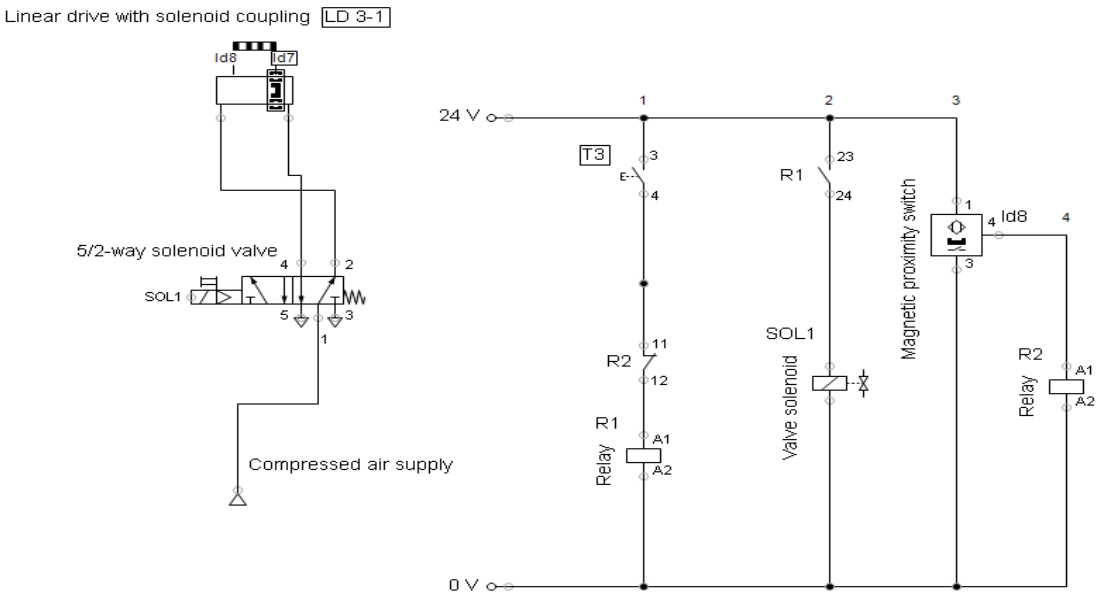

Fig. 9. Electro-pneumatic circuit with linear drive (LD 3-1)

An electro-pneumatic scheme consists especially of: a pneumatic scheme, a control circuit and a power circuit, [7].
The table below shows ten devices used in the electro-pneumatic scheme.

Table 4: The devices of the electro-pneumatic circuit

Description	Number of components
Compressed air supply	1
5/2-way solenoid valve with spring	1
Linear drive with solenoid coupling (LD 3-1)	1
Relays	2
Valves solenoid	2
Magnetic proximity switch	1

If the operator pushes T3 button, the piston rod must move from ld7 point to ld8 point. But, after six seconds, the piston rod of the linear drive with solenoid coupling (LD 3-1) should return, because this is done with magnetic proximity switch, [8].

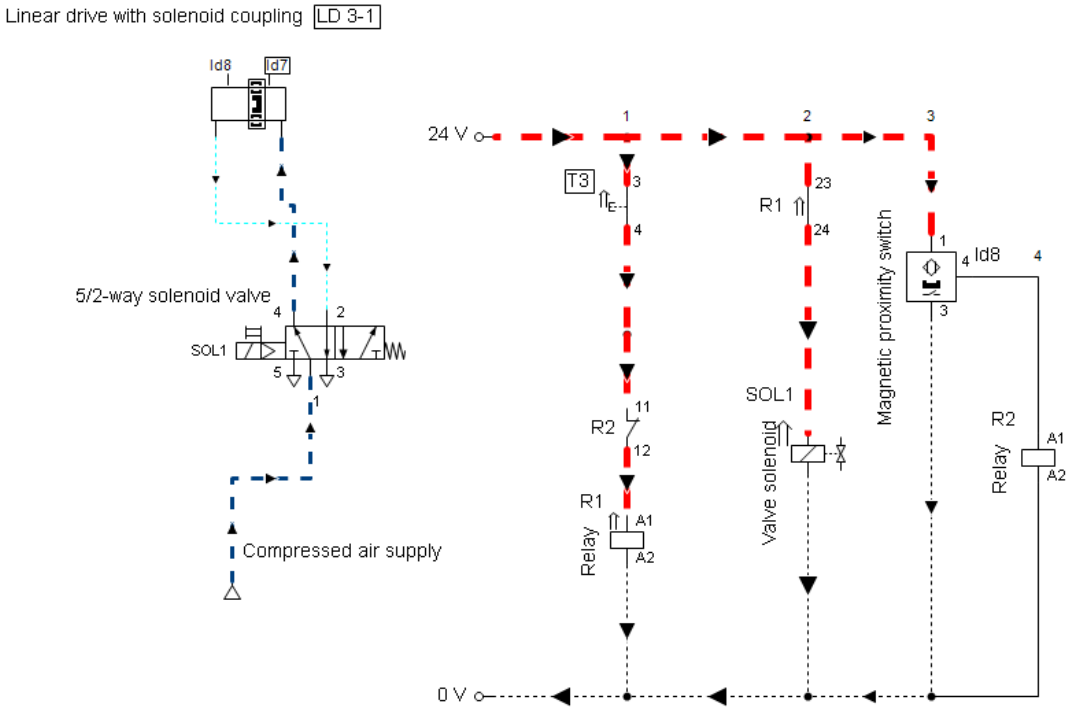

Fig. 10. Electro-pneumatic circuit with linear drive (LD 3-1). Simulation

3. Conclusions

The linear drives with solenoid coupling are actuators which are the most utilised on the penumatic instalations and also on the electro-pneumatic ones. Besides, these actuators have the following economic advantages:

- Low cost of compression.
- Silence.
- High accuracy.
- Easy handling.
- Reduced installation complexity.

In the future, we have planned to develop electro-hydraulic installations that use linear driving with cushioning in education and research.

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