Review Paper

International Journal of Research and Review
Vol. 10; Issue: 7; July 2023
Website: www.ijrrjournal.com
E-ISSN: 2349-9788; P-ISSN: 2454-2237

Pneumatic Stopper Cylinder: A Brief Overview

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DOI: https://doi.org/10.52403/ijrr.20230712

ABSTRACT

The present article aims to increase knowledge of stopper cylinders with return spring. A stopper cylinder with return spring works in an ambient temperature of between 253.15K and 353.15K. The stopper cylinder used in this article is only a pneumatic actuator. After introduction, the authors analyse two pneumatic circuits using stopper cylinders. The first pneumatic scheme contains the following devices: stopper cylinder (STC 1-1), throttle check valves, 5/3-way valve, air service unit and compressed air supplies. The second pneumatic circuit contains the following devices: stopper cylinders (STC 2-1 and STC 2-2), throttle valves, 5/2-way impulse valve, 3/2-way valves and compressed air supplies. Moreover, the authors study two more electro-pneumatic schemes with stopper cylinders.
Thus, the third circuit contains the following devices: stopper cylinder (STC 3-1), throttle valves, relays, 5/2-way solenoid impulse valve, pressure switch, lamp, relay counter, valves solenoid, magnetic proximity switches and compressed air supply. Finally, the fourth circuit contains the following devices: stopper cylinder (STC 4-1), throttle valve, 5/2-way solenoid valve, logic module, valves solenoid, relay and lamp.

Keywords: pneumatic, stopper, cylinder, trunnion, valve

INTRODUCTION

In pneumatic installations, the stopper cylinders can be used to stop movements in machines or work piece supports for transport systems with damping. Moreover, the stopper cylinder can stop large loads (up to approx. 800 kg). There are three versions of the stopper cylinder: trunnion, roller or toggle lever[1], (Figure 1).

Figure 1: Versions of stopper cylinders

In this article, we use only the trunnion version of the stopper cylinder. This pneumatic cylinder operates in a double-acting mode. In this manuscript, the stopper cylinder with elastic cushioning rings is of type DFSP-20-15-F-PA, (Figure 2). This pneumatic cylinder is made by Festo[2].

Figure 2: Stopper cylinder type DFSP-20-15-F-PA

The details of the main parameters of a stopper cylinder are shown in Table 1.

Table 1. Parameters of a stopper cylinder

Designation	Value	Measurement unit
Stroke length	0.015	m
Piston diameter	0.020	m
Permissible impact force	1370	N
Permissible lateral force during switching operation	228	N

The stopper cylinder with return spring is represented by a specific symbol, (Figure 3).

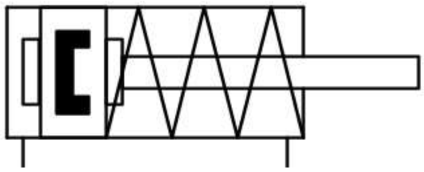

Figure 3: Symbols of stopper cylinder with return spring

PNEUMATIC CIRCUITS WITH STOPPER CYLINDER

A pneumatic circuit is a system that uses compressed air to transmit and control energy.

In our case, this pneumatic circuit uses one stopper cylinder, (Figure 4).

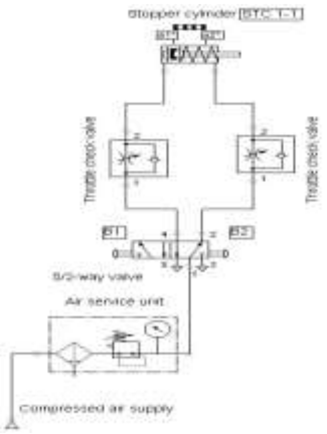

Figure 4: Pneumatic circuit with one stopper cylinder

The details about the number of components used in the first pneumatic circuit are presented in Table 2.

Table 2. Devices in the first pneumatic circuit

Description	Number of components
Stopper cylinder (STC 1-1)	1
Throttle check valve	2
5/3-way valve	1
Air service unit	1
Compressed air supply	2

The first pneumatic circuit operates if the operator presses B1 button of the 5/2-way valve[4]. Thus, the piston of stopper cylinder (STC 1-1) moves from point a1* to point a2*, (Figure 5).

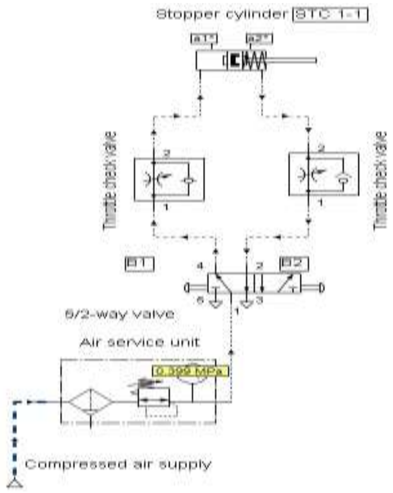

Figure 5: Pneumatic circuit with one stopper cylinder. Simulation I.

After that, if the operator presses B2 button of the 5/2-way valve, than the piston returns from point a2* to point a1*, (Figure 6).

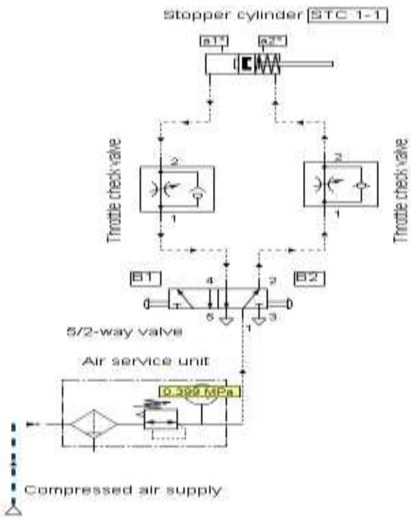

Figure 6: Pneumatic circuit with one stopper cylinder. Simulation II.

The second pneumatic circuits studied uses two self-adjusting stopper cylinders (STC 2-1 and STC 2-2) as shown above, (Figure 6).

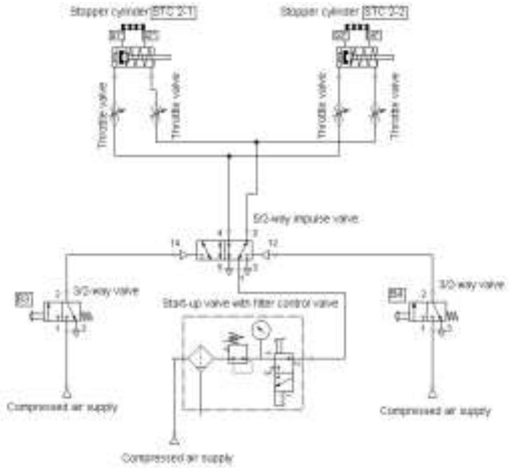

Figure 7: Diagrams of functional parameters variations of the double-acting cylinder

In this case, the operator presses button B3 with spring and the stopper cylinders open together[5]. This means, the piston of the stopper cylinder (STC 2-1) moves from point b1* to point b2*, respectively the piston of stopper cylinder (STC 2-2) moves from point b3* to point b4*, (Figure 7).

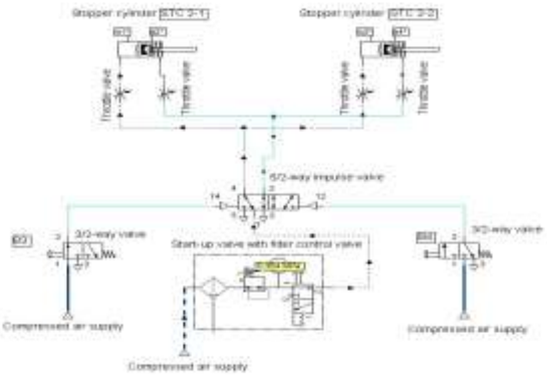

Figure 8: Second pneumatic circuit using two stopper cylinders

In total, there are fourteen components used in the second pneumatic circuit are presented in Table 3.

Table 3. Devices in the second pneumatic circuit

Description	Number of components
Stopper cylinder (STC 2-1 and STC 2-2)	2
Throttle valve	4
5/2-way impulse valve	1
3/2-way valve	2
Compressed air supply	3

After that, if operator presses button B4, both pistons return to their starting points[6]. Thereby, the piston of stopper cylinder (STC 2-1) moves from point b2* to point b1*, respectively the piston of stopper cylinder (STC 2-2) moves from point b4* to point b3*, (Figure 9).

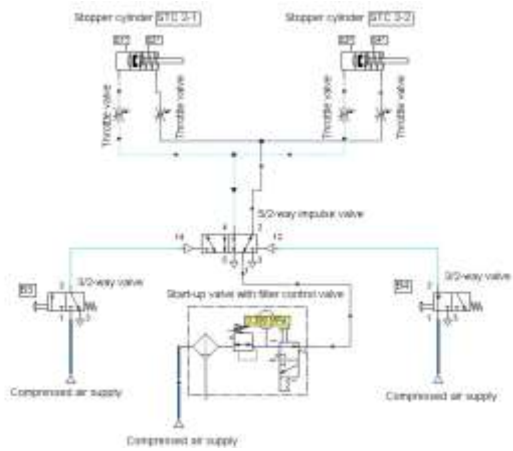

Figure 9: Pneumatic circuit using two stopper cylinders. Simulation.

Electro-pneumatic circuits with stopper cylinders use electrical technologies to control the compressed air used as working medium[7].
Electrical devices such as relays, solenoid valves, relay counter, magnetic proximity switches are also used, (Figure 10).

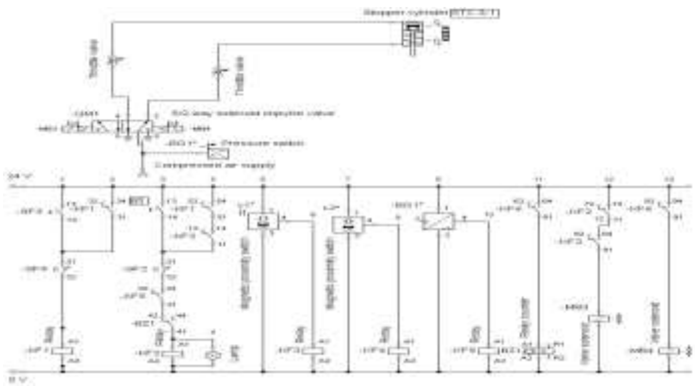

Figure 10: Electro-pneumatic circuit with one stopper cylinder.

Eighteen devices used in the first electro-pneumatic circuit are represented in table 4.

Table 4. Devices in the first electro-pneumatic circuit

Description	Number of components
Stopper cylinder (STC 3-1)	2
Throttle valve	2
Relay	5
5/2-way solenoid impulse valve	1
Pressure switch	1
Lamp	1
Relay counter	1
Valve solenoid	2
Magnetic proximity switch	2
Compressed air supply	1

If the operator presses the button B4 from the third circuit, then the piston rod of the stopper cylinder (STC 3-1) moves from point c1* to point c2* and the lamp shows a green signal, (Figure 11).

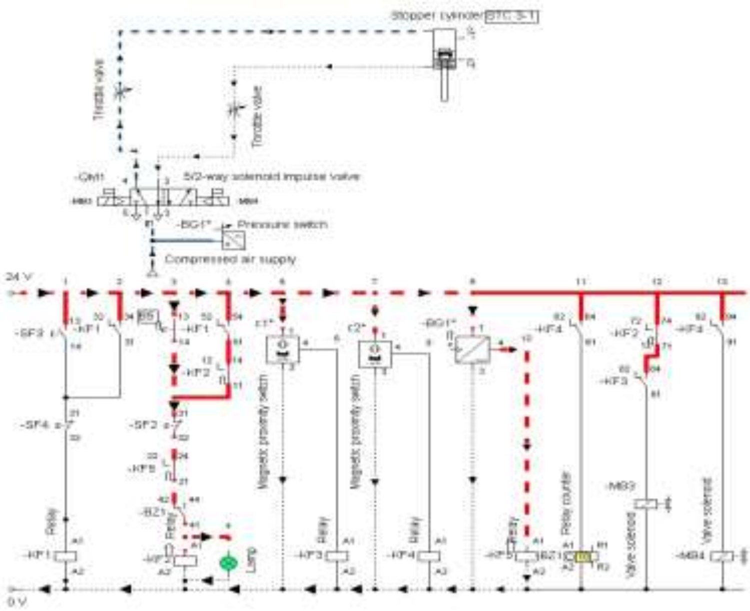

Figure 11: Electro-pneumatic circuit with one stopper cylinder. Simulation.

Figure 12 shows the variation of the following functional parameters of the stopper cylinder (STC 3-1)[8]:

- Position: x [mm];
- Velocity: v [m/s].
- Acceleration: a [m/s^2].

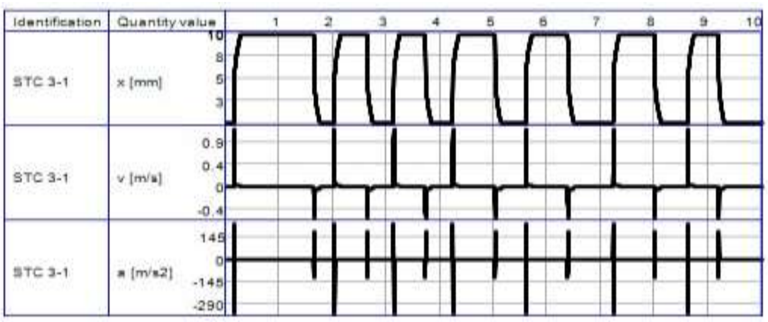

Figure 12: Diagrams of stopper cylinder (STC 3-1).

The last electro-pneumatic circuit is equipped with a logical module, (Figure 13).

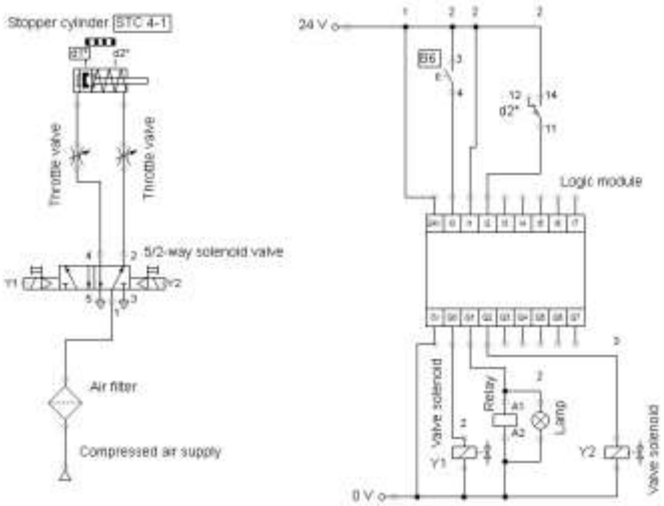

Figure 13: Second electro-pneumatic circuit with one stopper cylinder.

The ten devices used in the second electro-pneumatic circuit are represented in Table 5.

Table 5. Devices in the second electro-pneumatic circuit

Description	Number of components
Stopper cylinder (STC 4-1)	1
Throttle valve	2
5/2-way solenoid valve	1
Compressed air supply	1
Logic module	1
Valve solenoid	2
Relay	1
Lamp	1

If operator presses B6 button, the piston rod of the stopper cylinder (STC 4-1) moves from point d1* to point d2*. After 5 seconds, the piston rod returns from point d2* to point d1* and lamp shows a blue signal[9]. This happens because this operation is programmed using the logic module, (Figure 14).

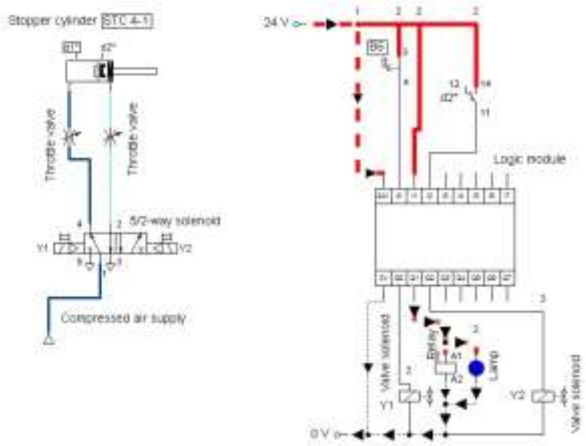

Figure 14: Second electro-pneumatic circuit with one stopper cylinder. Simulation.

CONCLUSION

This article is a contribution to the development of electro-pneumatic circuits that use stopper cylinders.

The following five benefits electro-pneumatic circuits with stopper cylinders:

- Safety.

  Electro-pneumatic circuits are quite safe circuits. Moreover, only compressed air is used, which means that the operator is not exposed to anything toxic.

- Cost.
  Investments made in these installations are relatively small. This is a particularly good news for workshops that cannot afford to invest large amounts of money.
- Low maintenance.
  The stopper cylinders stuck generally only if moisture gets into them, so they do not need much time to trouble shooting them, either. Besides that, stopper cylinders can be quickly replaced in the installation.
- Quiet operation.
  It is well known that excessive sound can lead to damage and hearing impairment of the operators. These installations do not acoustically pollute so this risk is avoided.
- Great power-to-weight ratio.
  In most cases, stopper cylinders produce high forces compared to other technologies. Thus, the high impact forces can be around 1370 N. It should be noted that these stopper cylinders weight with additional weight only almost 0.215 kg.

Thereby, electro-pneumatic installations with stopper cylinder can be successfully used in some industries using robots, such as the bending of sheets is. But, they may also be found in technical universities for research purposes, such as building of certain robots.

In the future, we want to develop electro-pneumatic installations equipped with stopper cylinder types DFSP-20-15-F-PA and STA-20-15-P-AR for educational purposes.

Declaration by Authors

Acknowledgement: The authors are grateful for the support by the University Politehnica of Bucharest, Department of systems biotechnology. The authors especially thanks to Prof. Vasile Nastasescu, Military Technical Academy “Ferdinand I”, Romania for his advice in working out of this manuscript.

Source of Funding: None

Conflict of Interest: The authors declare no conflict of interest.

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How to cite this article: Alexandru Savastre, Catalin Nutu, Iulia Tomozei et.al. Pneumatic stopper cylinder: a brief overview. *International Journal of Research and Review*. 2023; 10(7): 75-81.
DOI: *https://doi.org/10.52403/ijrr.20230712*

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