A Double-Acting Pneumatic Cylinder with Cushioning: A New Approach

Dipl. Eng. **Cătălin FRĂȚILĂ[1],** PhD. Eng. **Tiberiu AXINTE[1],** Dipl. Eng. **Mihai DIACONU[1],**
Dipl. Eng. **Lidia CALANCEA[1],** Dipl. Eng. **Roxana DAMIAN[1],** PhD. Mat. **Elena CURCĂ[1],**
Dipl. Eng. **Diana DUMITRAȘ[1]**

[1] Research and Innovation Center for Navy, Romania

*tibi_axinte@yahoo.com

Abstract: *The aim of the work is to present aspects related to the use of a double-acting cylinder with cushioning. In this manuscript two circuits using a double-acting cylinder with cushioning are presented: on one hand, a pneumatic circuit, and on the other, an electro-pneumatic circuit. The first pneumatic scheme contains the following devices: a double-acting cylinder with cushioning (Duacy 1), two throttle valves, 4/2-way valve type, an air filter and the compressed air supply. The second one is an electro-pneumatic circuit which consists of the following devices: double-acting cylinder (Duacy 2), two throttle check valves, a start-up valve with filter control valve, compressed air supply and two solenoid valves.*

Keywords: *Pneumatic, cylinder, cushioning, circuit, valve*

1. Introduction

Double-acting pneumatic cylinders have one hole at each end. In any double-acting pneumatic circuit, a piston moves the cylinder forward and backward by alternating the hole that receives the high-pressure air. This device is needed when a load is to be moved in both directions, such as, for example, opening and closing a gate. For the double-acting cylinder with self-adjusting damping, the air pressure is applied alternatively to opposite ends of the piston [1].
The pneumatic cylinders can have the following cushioning types: external, mechanical, adjustable and self-adjusting, Fig. 1.

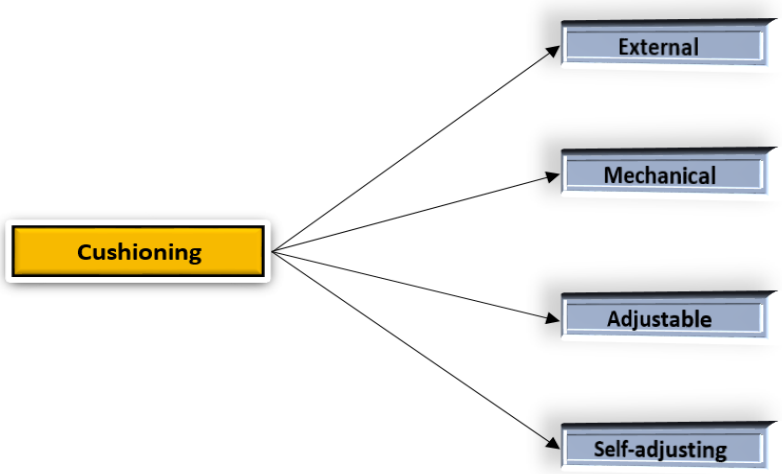

Fig. 1. Types of cushioning

In this manuscript, only cylinders with adjustable cushioning were studied. The adjustable air cushioning technology limits the air volume released at the pneumatic cylinder stroke's end. Any construction of cushioning includes a variable orifice and spuds, which are small metal rods mounted on either side of the piston. They close off the airflow to the main piston chamber, trapping fluid in the cylinder's end cap. This trapped fluid is then bled off through a small passage controlled only by a throttle check valve [2].
In specialized literature, a double-acting cylinder with cushioning and position sensing has a specific symbol, Fig. 2.

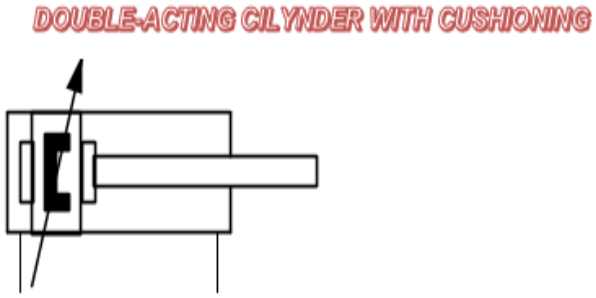

Fig. 2. Symbol of double-acting cylinder with cushioning

2. Analysis of the functioning of a double-acting cylinder with cushioning

In practice, different types of double-acting cylinder with cushioning are used. In our case, some double-acting cylinders with cushioning of type DNC-50-50-P-A were used, Fig. 3.

Fig. 3. Pneumatic cylinder DNC-50-50-P-A

Pneumatic cylinders DNC-50-50-P-A are in accordance with standard ISO 15552 (which corresponds to the withdrawn standards ISO 6431) [3].
Parameters of a double-acting cylinder DNC-50-50-P-A are shown in the table below.

Table 1: Double-acting cylinder with cushioning specification

Parameters	**Value**	**Unit**
Piston diameter	$50 \cdot 10^{-3}$	m
Stroke	$50 \cdot 10^{-3}$	m
Operating pressure	$8 \cdot 10^{5}$	Pa
Impact energy in end positions	0.2	J
Cushioning length	$22 \cdot 10^{-3}$	m
Basic weight	$1260 \cdot 10^{-3}$	kg

The pneumatic circuit studied has one double-acting cylinder with cushioning, Fig. 4.

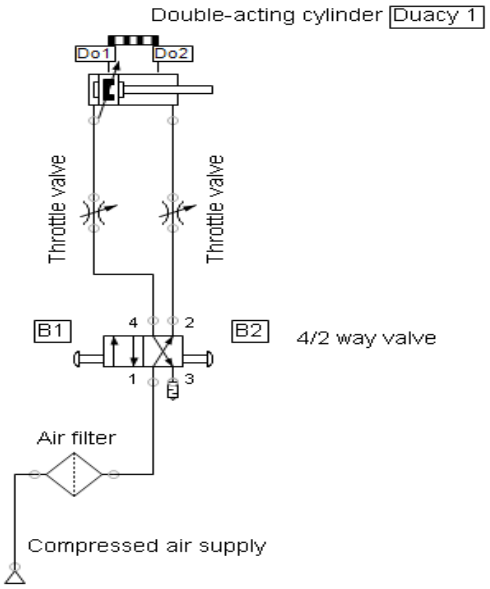

Fig. 4. Pneumatic circuit using double-acting cylinder (Duacy 2)

The components used in the pneumatic circuit are presented in the table below [4].

Table 2: The devices of the pneumatic circuit

Description	Number of components
Double-acting cylinder with cushioning (Duacy 1)	1
Throttle valve	2
4/2-way valve	1
Air filter	1
Compressed air supply	1

Operator presses the B1 button to the 4/2-way valve. Then, the piston rod moves from point Do1 to point Do2, Fig. 5.

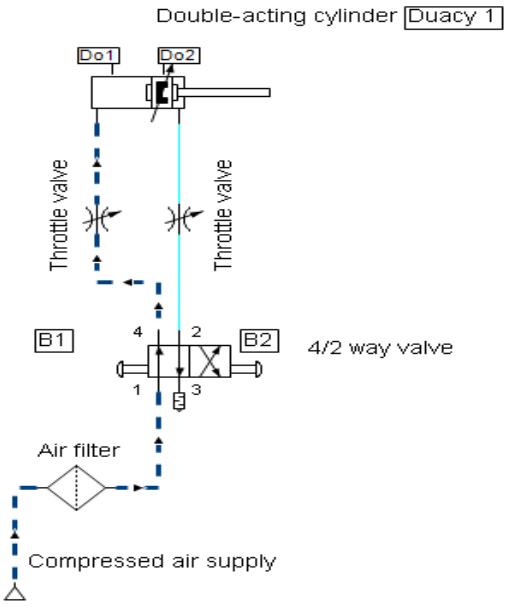

Fig. 5. Pneumatic circuit using a double-acting cylinder (Duacy 1). Simulation I.

If operator presses B2 button belonging to the 4/2-way valve, the piston rod moves from point Do2 to point Do1, Fig. 6.

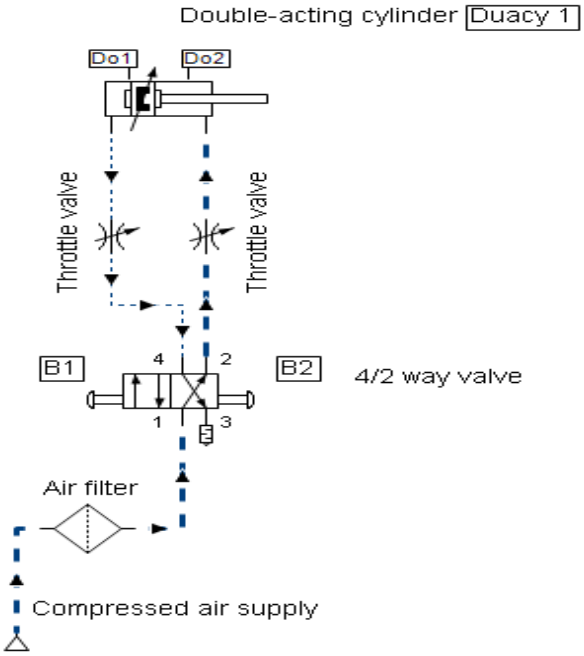

Fig. 6. Pneumatic circuit using double-acting cylinder (Duacy 1). Simulation II.

The diagrams show variation of the following functional parameters of the double-acting cylinder with cushioning (Duacy 1), Fig. 7.

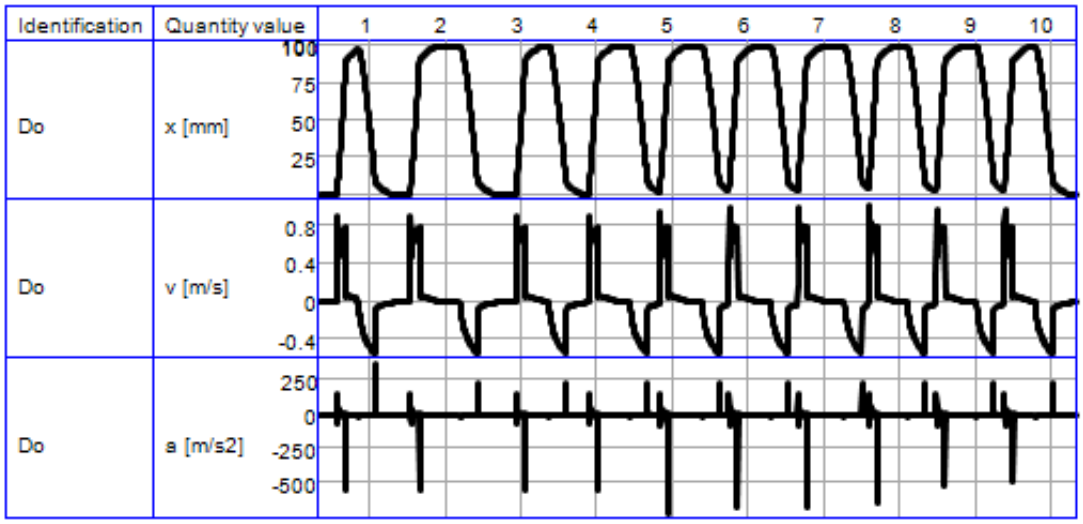

Fig. 7. Diagrams of parameters variations from the double-acting cylinder (Duacy 1)

Furthermore, an electro-pneumatic circuit has a double-acting pneumatic cylinder (Duacy 2) with cushioning [5], Fig. 8.

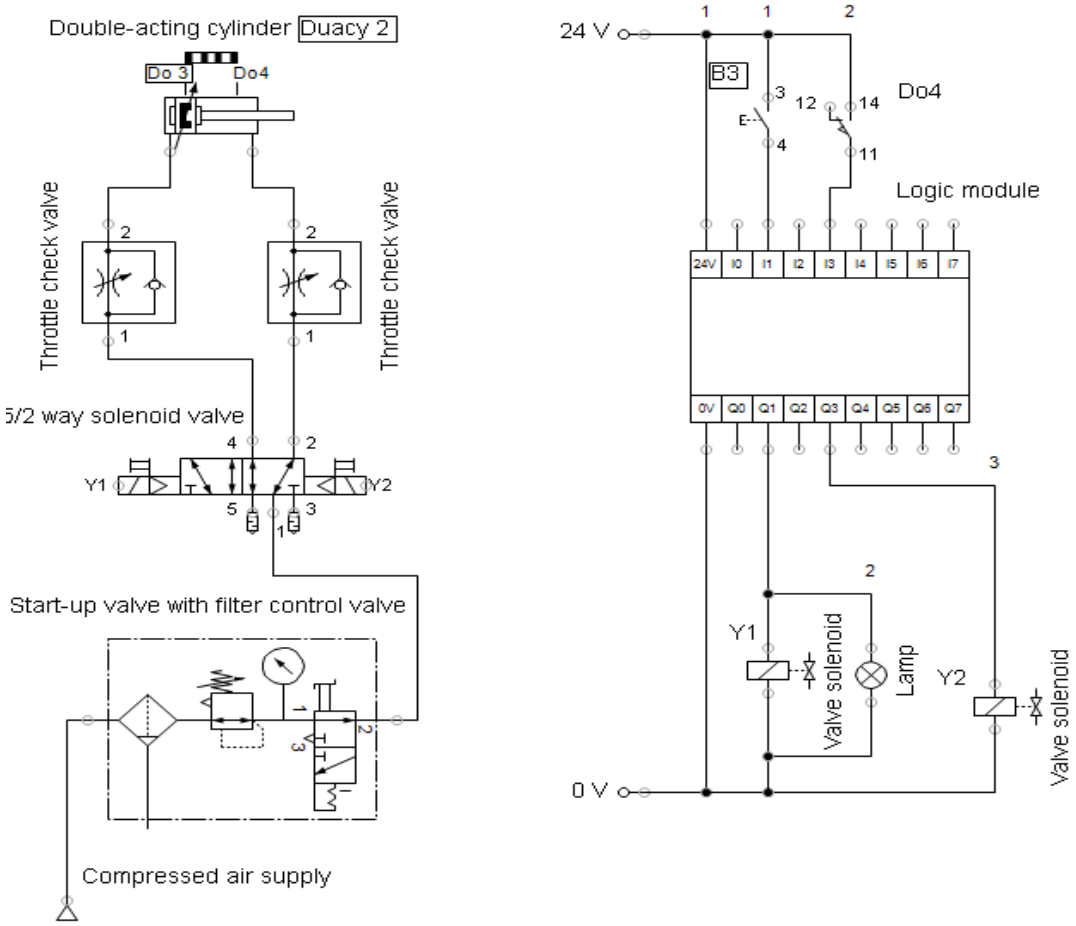

Fig. 8. Electro-pneumatic circuit using cylinder (Duacy 2)

Table 3 below shows nine component devices used in the electro-pneumatic circuit [6].

Table 3: The devices of the electro-pneumatic circuit

Description	Number of components
Double-acting cylinder (Duacy 2)	1
Throttle check valve	2
5/2-way solenoid valve	1
Start-up valve with filter control valve	1
Compressed air supply	1
Logic module	1
Solenoid valve	2

If operator presses button B3, the piston rod of the double-acting cylinder (Duacy 2) moves from point Do3 to point Do4 and a lamp shows an orange signal, Fig. 9.

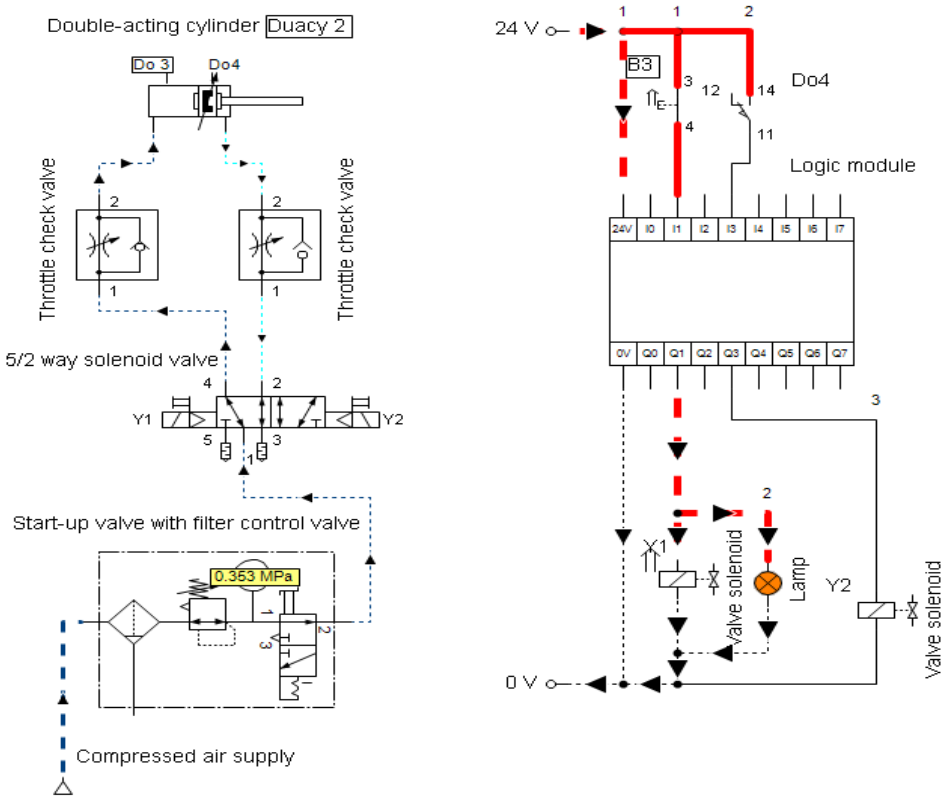

Fig. 9. Electro-pneumatic circuit using cylinder (Duacy 2). Simulation I.

After five seconds, the piston rod of the double-acting cylinder (Duacy 2) moves from point Do4 to point Do3, Fig. 10.

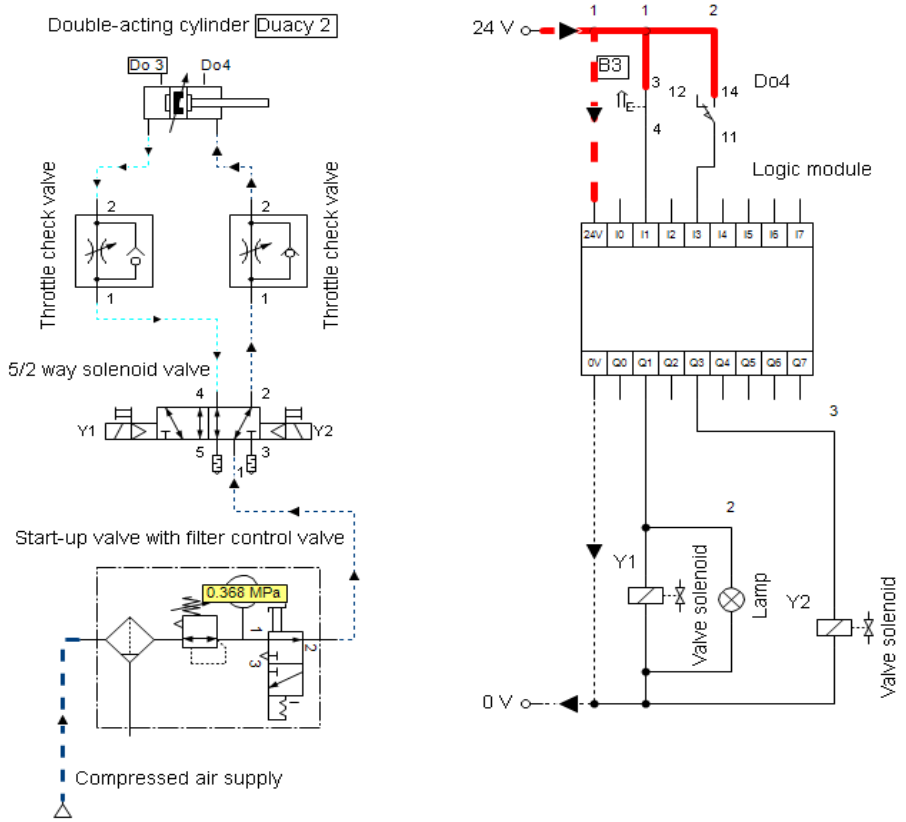

Fig. 10. Electro-pneumatic circuit using cylinder (Duacy 2). Simulation II.

3. Conclusions

The study showed that pneumatic cushioning slows and absorbs the impact of the piston as it reaches the end of its stroke. Nevertheless, if the pneumatic cylinder is without cushioning, the effect of the piston striking the end cap can cause damages in the respective installation. Moreover, adjustable cushioning improves safety by limiting the piston's noise when it hits the end cap. An important thing is that the silencer protects the hearing of operators frequently using such pneumatic installations.
A future manuscript on this topic will focus on the implementation in pneumatic circuits with double-acting cylinders and with several actuators in their construction.

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