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An overview of the double-acting hydraulic cylinder with cushioning

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Abstract
This paper work presents aspects related with the use of double-acting hydraulic cylinder. In fact, the double-acting cylinder with cushioning is a hydraulic actuator. In the article there are presented two hydraulic circuits and one electro-hydraulic circuit. All circuits are equipped with double-acting cylinder with cushioning. The first hydraulic circuit contains of the following devices: pump unit, tank, 4/3-way hand-lever with spring, throttle valves, double-acting cylinders (Da 1-1). Furthermore, the second pneumatic circuit contains of the following devices: pump unit, 4/3-way hand-lever valve, pressure relief valves, check valves, double-acting cylinders (Da 2-1 and Da 2-2) and 2-way flow control valve. Finally, the electro-hydraulic circuit has the contain of the following devices: pump, tank, 4/2-way solenoid valve with spring, throttle valves, double-acting cylinder (Da 3-1), relays, lamp and valves solenoid.

Keywords: Cushioning, Double-acting, Cylinder, Hydraulic, Button

1. Introduction

Double action at hydraulic actuator with cushioning means the cylinder has containing two ports. These ports are usually located at the bottom and top of the cylinder, the oil in the system is pumped into the lower port to expand the piston rod [1].
A double-acting hydraulic cylinder can be used for various object push and pull systems, as shown in Fig 1.

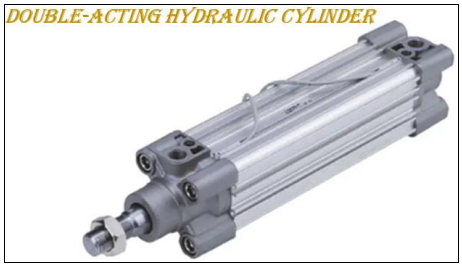

Fig 1: Double-acting hydraulic cylinder with cushioning

Adjustable parameters of double-acting cylinder are as shown in table 1 below.

Table 1: Adjustable parameters of double-acting hydraulic cylinder

Designation	Value	Unit
Bore	$63 \cdot 10^{-3}$	m
Stroke	$25 \cdot 10^{-3}$	m
Length	$44.4 \cdot 10^{-3}$	m
Width	$77 \cdot 10^{-3}$	m
Height	$77 \cdot 10^{-3}$	m
Weight	3.5	kg
Minimum operating temperature	253.15	K
Maximum operating temperature	343.15	K

The double-acting hydraulic cylinder has a specific symbol that is used in the specialized literature and they are as shown in Fig 2 below.

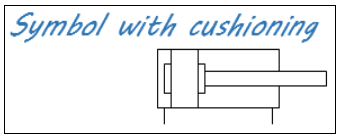

Fig 2: Symbol of double-acting hydraulic cylinder with cushioning

2. Hydraulic circuits with double-acting cylinders

The hydraulic installations uses compressed oil under pressure from the pump, to produce mechanical movement for devices.

The first hydraulic circuitis are made for a simple installation [2].

The first hydraulic circuit studied by authors has double-acting cylinder, as presented in Fig 3.

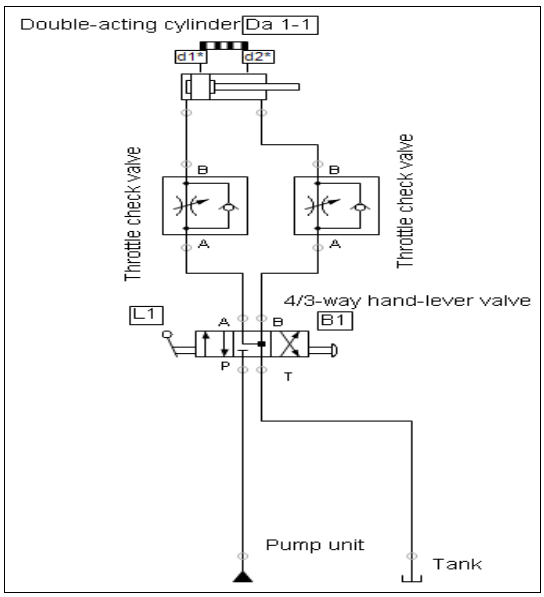

Fig 3: First pneumatic circuit with double-acting cylinder (Cl 1-1)

In the table below shows six component devices used in the first hydraulic scheme [3].

Table 2: The devices of the first hydraulic installation

Description	Number of components
Pump unit	1
Tank	1
4/3-way hand-lever with spring	1
Throttle valve	2
Double-acting cylinder (Da 1-1) with cushioning	1

First time, the operator presses L1 lever [4].

Then, piston rods of the hydraulic cylinder (Da 1-1) moves from point d1* to point d2*, as in Fig 4 below.

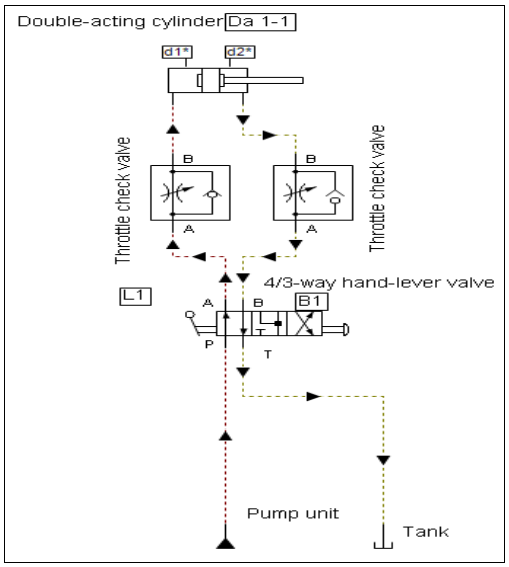

Fig 4: Hydraulic circuit using an actuator (Da 1-1). Simulation 1

After that, the operator push B1 button. Then, piston rods returns from point d2* to point d1*, as in Fig 5.

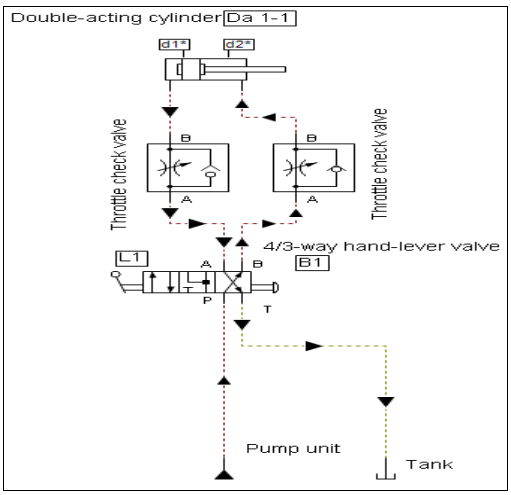

Fig 5: Hydraulic circuit using an actuator (Da 1-2). Simulation 2.

The parameters of double-acting with cushioning (Da 3-1) are: position (x), velocity(v) and acceleration (a), as shown in Fig 6 below.

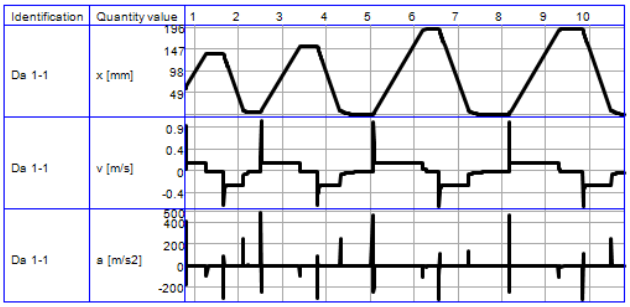

Fig 6: The diagrams of double-acting cylinder with cushioning

The following hydraulic scheme is made of two actuators (Da 2-1 and Da 2-2), as shown in Fig 7 below.

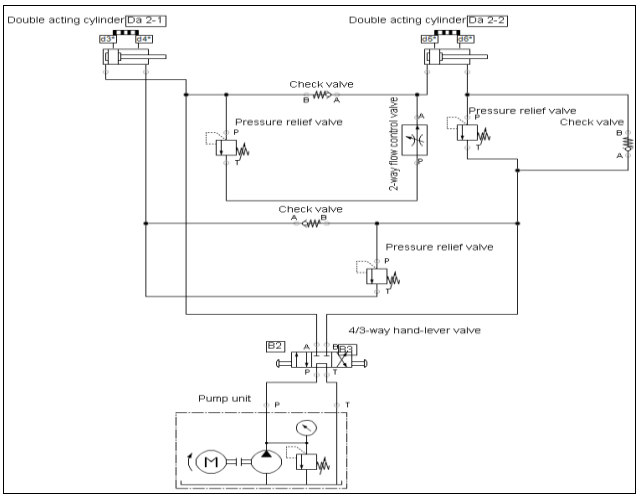

Fig 7: Hydraulic scheme circuit which is using two actuators (Da 2-1 and Da 2-2)

In the table below shows eleven component devices used in the second hydraulic circuit [5].

Table 3: The devices of the second hydraulic scheme

Description	Number of components
Pump unit	1
4/3-way hand-lever valve	1
Pressure relief valve	3
Check valve	3
Double-acting cylinder (Da 2-1 and Da 2-2)	2
2-way flow control valve	1

The operator presses B2 button. This button belong of the 4/3-way hand-lever valve [6].
Then, the piston rod of the cylinder (Da 2-1) moves from point d3*to point d4*, after five seconds, the piston rod of the cylinder (Da 2-2) moves from point d5*to point d6*, as presented in the Fig 8 below.

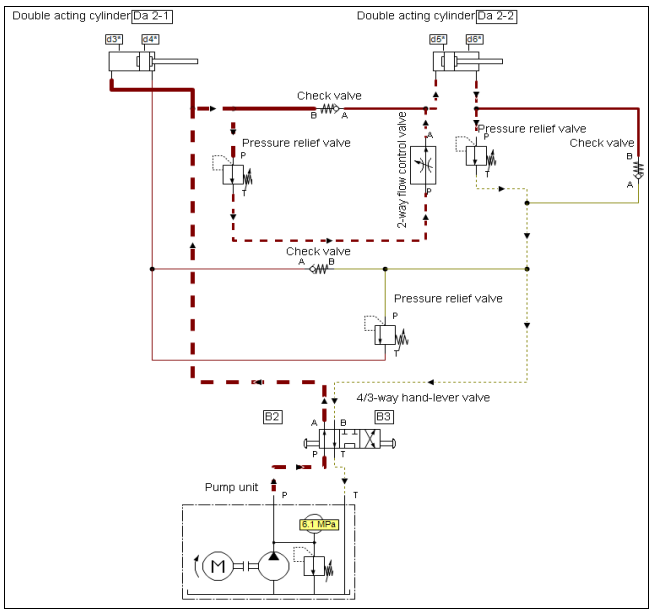

Fig 8: Hydraulic circuit using two actuators (Da 2-1 and Da 2-2). Simulation I

If operator presses B3 button, then, those piston rods must return [7].
There by, the rod piston of the piston (Da 2-2) moves from point d6*to point d5*.
After five seconds the rod piston moves from point d4*to d3*, as shown in Fig 9 below.

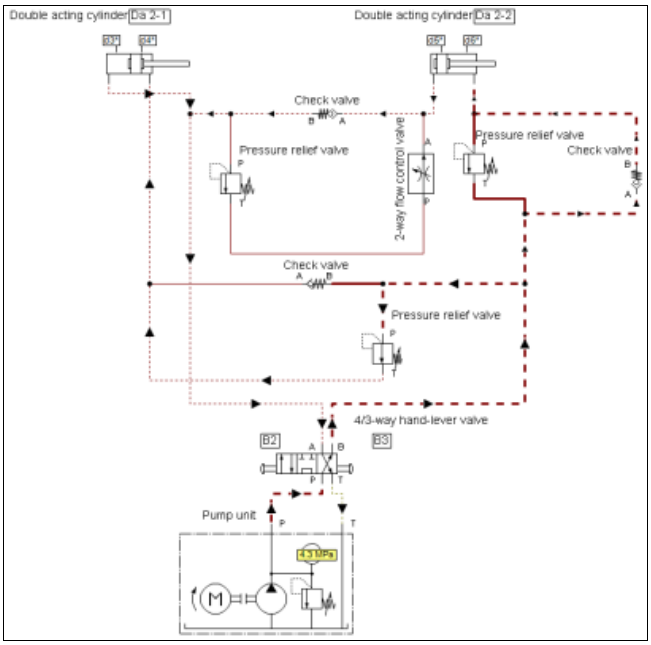

Fig 9: Hydraulic circuit using two actuators (Da 2-1 and DA 2-2). Simulation II

The electro-pneumatic circuit with a double-acting cylinder with cushioning has a low energy consumption, as appears in Fig 10.
The electro-hydraulic scheme from the manuscript consists of different devices. Such as, the pump unit which comverts mechanical energy in to hydraulic energy and the double-acting cylinder with cushioning in to hydraulic energy [8].

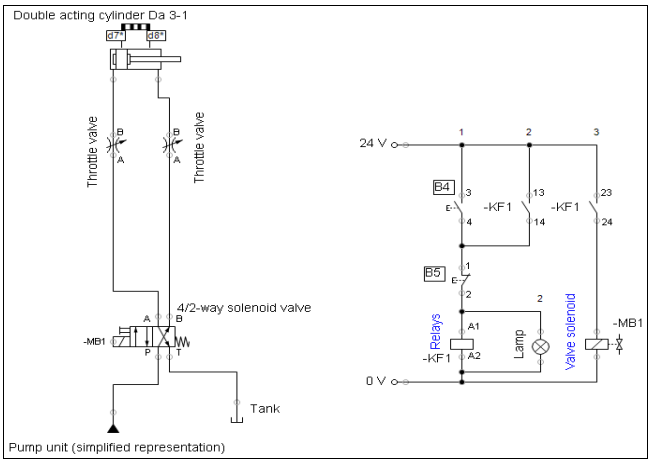

Fig 10: Electro-hydraulic circuit using actuator (Da 3-1)

In the table below shows eleven component devices used in the electro-pneumatic scheme [9].

Table 4: The devices of the electro-hydraulic circuit

Description	Number of components
Pump unit	1
Tank	1
4/2-way solenoid valve with spring	1
Thtrottle valve	2
Double-acting cylinder (Da 3-1)	1
Relay	1
Lamp	1
Valve solenoid	2

When operator presses B4 button, the piston rod moves from point d7* to point d8* and the lamp shows a yellow signal, as it may be seen in Fig 11.

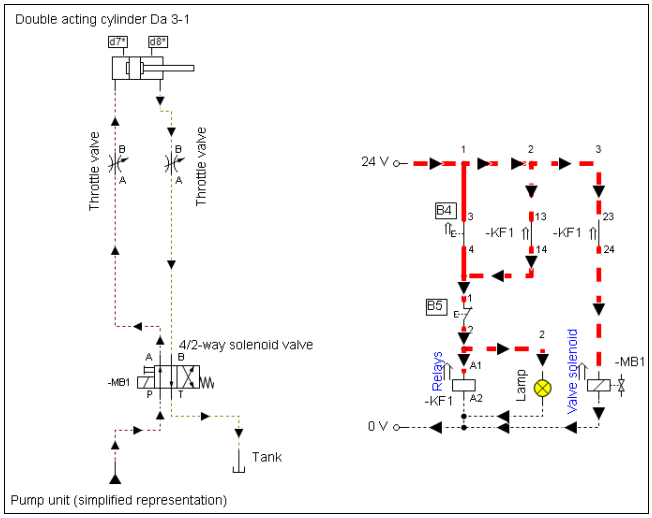

Fig 11: Electro-pneumatic circuit with cylinder (Da 3-1). Simulation I

If operator presses B5 button, then the piston rod of the double-acting cylinder (Da 3-1) it should return, because 4/2-way solenoid valve it is containing the pushing spring [10].

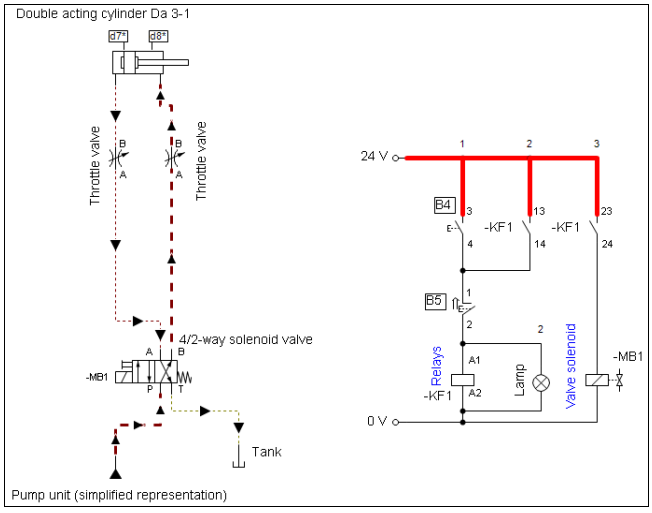

Fig 12: Electro-pneumatic circuit with cylinder (Da 3-1). Simulation II

Meaning, the piston rod moves from point d8*to point d7*. In this case the lamp will be off, as it is presented in Fig 12 above.

3. Conclusions

The double-acting cylinders with cushioning are actuators which are the most utilised on the hyraulic instalations and also on the electro-hydraulic ones. In fact, these actuators have the following economic advantages:

- Less energy consumption during the use of hydraulic and electro-hydraulic installations that use double-acting cylinder with cushioning.
- There is more movement control, because the oil in the double-acting cylinder move in two directions.
- In an installation if the double-acting cylinder breaks down then it can be quickly replaced with another hydraulic actuator.

In the future, we have planned to develop electro-hydraulic installations that use double-acting cylinders with cushioning and their applications in the shipyards.

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