NUEVA GRANADA MILITARY UNIVERSITY

ELECTRO-PNEUMATIC CIRCUITS

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1. RESUMEN:

En este laboratorio se presentará un circuito electroneumático que tiene como finalidad utilizar estas válvulas para combinar la energía eléctrica con neumática y poder accionar cilindros neumáticos.

Los elementos que entran en juego en las diversas aplicaciones están constituidos básicamente para la manipulación y acondicionamiento de las señales de voltaje y corriente que deberán de ser transmitidas a dispositivos de conversión de energía eléctrica a energía neumática para lograr la activación de los actuadores neumáticos.

2. PALABRAS CLAVE:

- Relé
- Contactores
- Control
- Energía
- Electrónica
- Neumática

3. ABSTRACT:

In this laboratory, an electropneumatic circuit will be presented whose purpose is to use these valves to combine electrical energy with pneumatics and to be able to operate pneumatic cylinders.

Elements that come into play in the various applications are basically constituted for handling and conditioning of signals of voltage and current that must be transmitted to conversion of electrical energy to power pneumatic devices to achieve the activation of pneumatic actuators.

4. KEY WORDS:

- Relay
- Contactor
- Control
- Energy
- Electronics
- Pneumatic

5. INTRODUCTION:

Electropneumatics is an application where two parts of automation of great importance are combined, such as pneumatics and electronics, to obtain the operation of various processes, which is implemented to achieve an optimization of applications. The techniques consist of increasing the air pressure and through the energy accumulated on the elements of the electropneumatic circuit such as cylinders, relays, solenoid valves, end of stroke, among others, generate useful work.

In this case it will be used to develop different sequences and thus achieve an approach to this technique, analyzing the behaviors of the system.

6. OBJECTIVE

GENERAL OBJECTIVE:

- Perform a sequence using electropneumatic devices.

SPECIFIC OBJECTIVES:

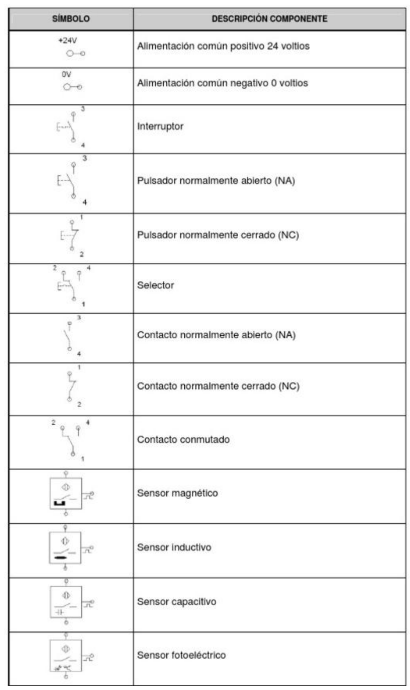
- Recognize the elements to be implemented, such as cylinders, solenoid valves, relays, end of stroke among others.
- Develop the simulation and assembly of an electropneumatic circuit capable of performing the sequence.
- Understand and solve the problems presented.
- Develop the different simulations and analyze the behavior of the circuits.

7. THEORETICAL FRAMEWORK:

- **Electropneumatics:**

  "In electropneumatics, electrical energy replaces pneumatic energy as the natural element for the generation and transmission of control signals that are located in command systems.

  The new and/or different elements that come into play are basically constituted for the manipulation and conditioning of the voltage and current signals that must be transmitted to devices for the conversion of electrical energy to pneumatic energy to achieve the activation of pneumatic actuators". [3]



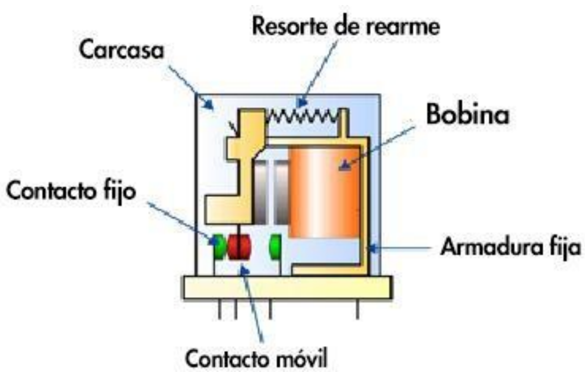
SÍMBOLO	DESCRIPCIÓN COMPONENTE
+24V	Alimentación común positivo 24 voltios
0V	Alimentación común negativo 0 voltios
3 4	Interruptor
3 4	Pulsador normalmente abierto (NA)
1 2	Pulsador normalmente cerrado (NC)
2 4 1	Selector
3 4	Contacto normalmente abierto (NA)
1 2	Contacto normalmente cerrado (NC)
2 4 1	Contacto conmutado
	Sensor magnético
	Sensor inductivo
	Sensor capacitivo
	Sensor fotoeléctrico

Graph 1. Pneumatic simbology.

- **Relay:**

“An electronic device that, interspersed in a circuit, produces certain actions in the same or another connected to it; by opening or closing your contacts, the relay can influence the operation of another.” [4]

Graph 2. Relay



Graph 3. Structure of a relay.

8. MATERIALS:

To carry out the practice, the following materials are used:

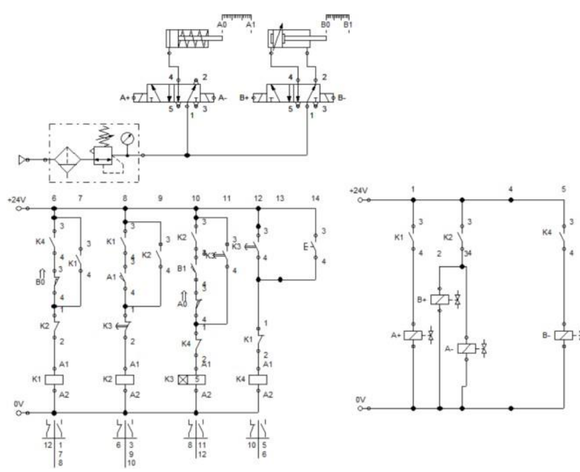
- FluidSim Festo simulation software.
- Electrically operated valves.
- Double-acting cylinders.
- Cylinders of simple effect.
- Maintenance unit.
- Distributors
- Timers
- Counters
- Limit switch

9. METHODOLOGY:

The development of electropneumatic sequences will be carried out, where elements such as relays, solenoid valves and end of stroke will be used.

To perform the control of the sequences, it is necessary to decide the most appropriate configuration to implement, and that, of course, requires fewer elements, being more optimal for the development of the circuits.

The structure to be implemented for development will be as follows:



Graph 4.Structure.

10. PROCESS:

- Perform simulations to determine the correct configuration to use.

- Determine the components necessary to develop the practice, such as valves, hoses and an adequate pressure to work.

$A^+ \quad B^+ \quad T1 \quad B^-$

A^-

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- Perform simulation and assembly of an electro-pneumatic circuit consisting of 1x single effect cylinder (A), spring return and a double effect cylinder (B), which performs the following sequence:

$$A^+ \quad \begin{matrix} B^+ \\ A^- \end{matrix} \quad T1 \quad B^-$$

- simulation of an electropneumatic circuit consisting of 1x cylinder of single effect, return by spring and 2 x cylinder of double effect, which performs the following sequence:

$$A^+ \quad B^+ \quad B^-T_1 \quad A^-$$

$$A^-T_2 \quad C^+ \quad C^-$$

$$A^+$$

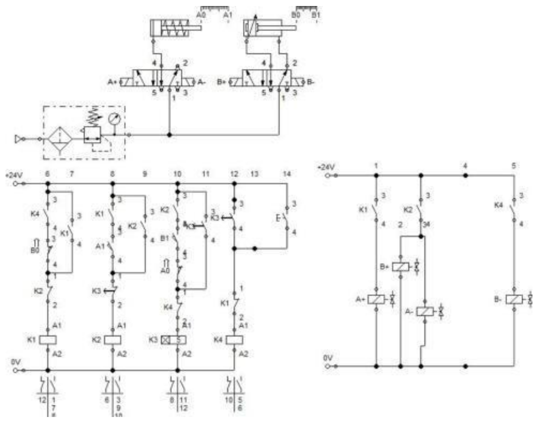
- Perform the simulation of an electropneumatic circuit that performs the following sequence:

$$(A^+B^+T_{espera1}B^-A^-)T_2$$

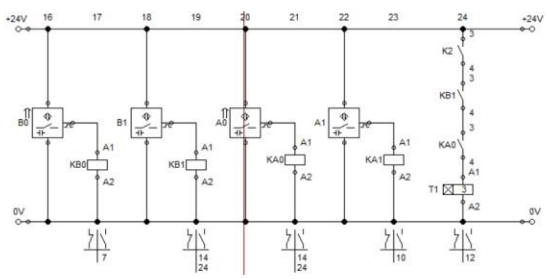
The sequence must be repeated 3 times, at the end wait for a T2 time and start again.

11.

SIMULATIONS:



Graph 5. Simulation of sequence #1



Graph 6. Sensors circuit of sequence #1

- For this sequence 2 cylinders will be used, the first cylinder (A) is a single effect cylinder with spring recoil. And a second cylinder (B) of double effect, both cylinders will have their respective control valves, either 3/2 or 5/2. These valves are double piloted by current, that is, by means of electropneumatics they will be controlled. The following sequence must be met:

$$A^+ \quad \begin{matrix} B^+ \\ A^- \end{matrix} \quad T1 \quad B^-$$

The drive of the cylinders is through the solenoid valves, controlled by coils that are excited by relays.

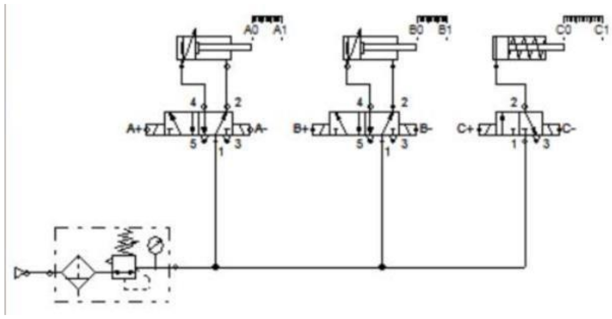
For this simulation, 4 different groups are created that will properly control the sequence. 2 stroke ends are located for each cylinder, one at the beginning and the other at the end. These race ends are also handled with electricity.

For the creation of the groups of this sequence the step-by-step logic of the pneumatics is used, this says that the previous group must be finished, and that the current group takes out the previous one. Group 3 is made up of a delay or timer, after the time in which the coil is activated passes, it will give way to the next group to continue with its normal operation. The working voltage in the simulation is 24v.

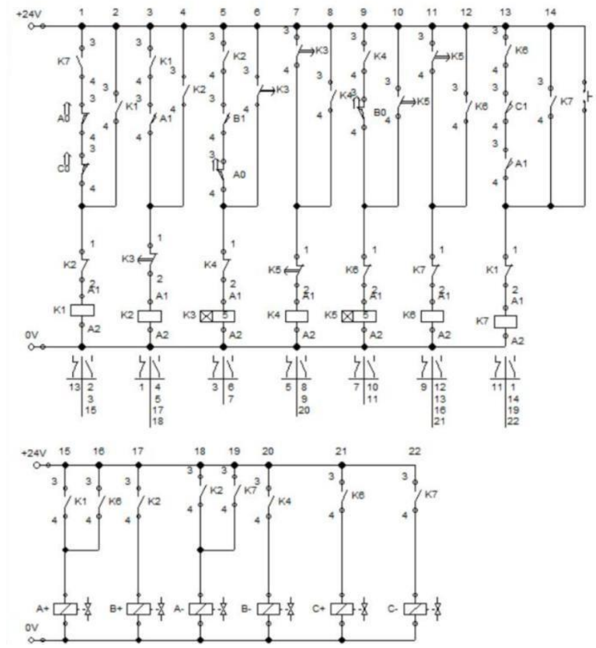
$$A^{+} \quad B^{+} \quad B^{-}T_1 \quad A^{-}$$

$$A^{-}T_2 \quad C^{+} \quad C^{-}$$

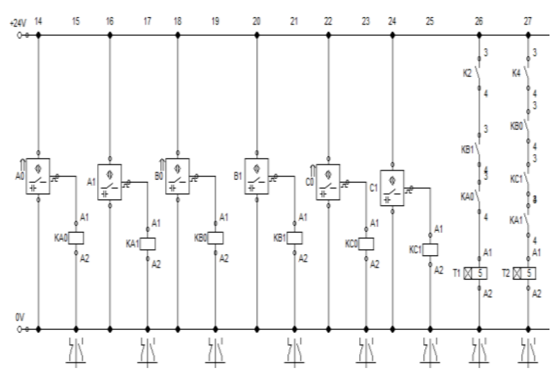
$$A^{+}$$



Graph 7. Simulation of sequence #2



Graph 8. Simulation of sequence #2



Graph 9. Sensors circuit of sequence #2

For this sequence 3 cylinders will be used, the first cylinder (A) is a double effect cylinder just like the second cylinder (B) and the third cylinder (C) is of simple effect with spring return, these cylinders will have their respective control valves, either 3/2 or 5/2. These valves are double piloted by current, that is, by means of electropneumatics they will be controlled.

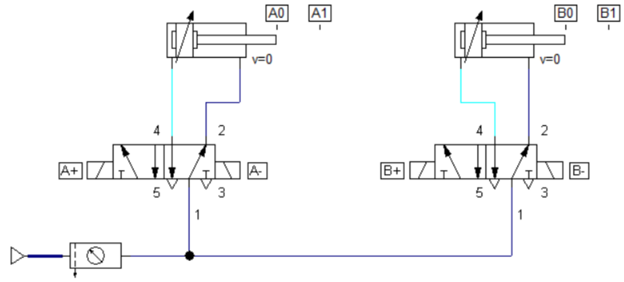
The drive of the cylinders is through the solenoid valves, controlled by coils that are excited by relays.

For this simulation, 7 different groups are created that will properly control the sequence. 2 stroke ends are located for each cylinder, one at the beginning and the other at the end. These race ends are also handled with electricity.

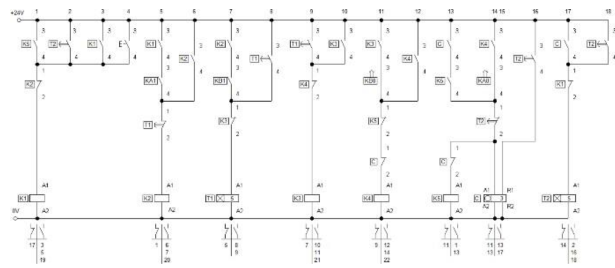
For the creation of the groups of this sequence the step-by-step logic of the pneumatics is used, this says that the previous group must be finished, and that the current group takes out the previous one. Group 3 is made up of a delay or timer, after the time in which the coil is activated passes, it will give way to the next group to continue with its normal operation. The working voltage in the simulation is 24v.

$$(A^+B^+T_{espera1}B^-A^-)T_2$$

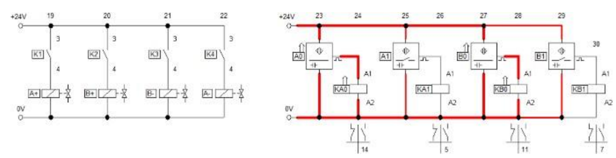
* The sequence must be repeated 3 times, at the end wait for a T2 time and start again.



Graph 10. Simulation of sequence #3



Graph 11. Sensors circuit for simulation #3



Graph 10. Sensors circuit working #3

This electropneumatic circuit carries wait times and finite repeats of sequences. That implies that relays with starting deceleration and electric meter-selector will be used. These relays will function as a phase within the sequence.

The sequence is as follows:

$$(A^+B^+T_1B^-A^-)T_2$$

Where the sequence within the parentheses must be repeated 3 times before moving to T_2.

The order of the circuits and their form of organization is the same: power circuit that will represent the pneumatic part which will only be the feeding of the valves that control the cylinders, control circuit that will carry the order and priorities of the sequence, sensor circuit that is the one that has all the necessary sensors to activate the relays of the points of interest as end of stroke, and solenoid valve circuit that has all the valve actuations used in the power circuit.

The control circuit has a difference, because because it has internal sequences a certain number of times that are repeated before moving to another, a group will have two drives: the first by the last phase of the internal sequence to be repeated and the second by the phase that preceded it. For this case it is the first phase, the phase A^{+}, which is activated when a count of the electric counter-selector relay has occurred or when it has passed T_2.

The electric counter-selector relay will pass at the end of the last phase of the sequence to be repeated, the internal sequence, then the terminal that allows it to count will be connected to the activation of the group that is activated when passing A^{-} , but it has a conflict and is that when reaching the last repetition this group will continue to be activated and will pass to the first phase, phase A^{+}, so the internal sequence will be repeated once again. Even if the electric meter-selector has already finished counting, A^{+} will continue to pass regardless of the last time because the group that gives way will continue to be activated every time A^{-} is activated. As a solution, a contactor of the electric meter-selector normally cascaded to the line of the group that gives way to the A^{+} phase is placed, and so when the counting is finished, that group will not pass again and can be reactivated only when the electric meter-selector relay has been restarted. As each count works as one more phase, we also disable the group from phase A^{-} so that group will carry two contacts normally closed.

Another problem is that normally the sequence start button is placed in the last phase to be able to place the power circuit in the initial position and give way to the first phase of the sequence, but in the last phase you have a starting deceleration relay, the T_2 phase, and therefore placing the button on the power line of this relay the sequence would start with a time, changing the order of the sequence. One solution is to place one more number to count on the electric meter-selector relay so that when the button is pressed leave the counter at the number of repetitions that are needed and give way to the first phase, but if so each time the sequence starts, the internal sequence would have a more unwanted repetition. The only way is to place the button to the group of the first phase, and trust that the actuators are in their initial position.

12. ANALYSIS OF RESULTS:

- It can be observed that electro-pneumatics allows a much simpler understanding than traditional pneumatics; because it allows to perform the respective sequences in a much more orderly and continuous way; each group has a dependency on the previous one, therefore, in case of an error it is easier to find it. The sequences previously made, have a dependence on the coils that are being implemented, therefore, the electronic connections have greater importance in the actuation of the valves.

13. CONCLUSIONS:

Applications with electro-pneumatics are much simpler to simulate and carry out, you simply have to carry out an order and with the step-by-step method. The problem may lie a bit in the physical wiring, because quite a few connections are needed and some systematic errors can be made.

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