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SEQUENCES IN PNEUMATICS CIRCUITS, WITH COUNTER AND TIMERS

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1. RESUMEN:

Los sistemas neumáticos son de vital importancia en diversos procesos que una empresa realiza, debido a que con ellos se pueden realizar muchos tipos de aplicaciones que permiten una facilidad de implementación y una cantidad de recursos y complejidad menor que realizando el mismo proceso con otro sistema. El aire, permite lograr distintos tipos de movimientos, entre ellos el movimiento de cilindros neumáticos que funcionan como pistones dependiendo el lugar donde se le inyecte aire a él, como se podrá observar en esta práctica se implementarán temporizadores y contadores para cumplir las distintas secuencias.

2. PALABRAS CLAVE:

- Compresor
- Automatización
- Contador
- Presión
- Aire
- Neumática

3. ABSTRACT:

Pneumatic systems are of vital importance in various processes that companies performs, because that can be many types of applications that allows for ease of implementation and a number of resources and lower complexity that doing the same process with other system with them. The air, allows to achieve different types of movements, including the movement of pneumatic cylinders which operate as piston depending on the place where inject air to it, as you can see in this practice will be implemented timers and counters to meet the different sequences.

4. KEY WORDS:

- Compressor
- Automation
- Accountant
- Pressure
- Air
- Pneumatics

5. INTRODUCTION:

Pneumatics is a technology that manipulates compressed air as an energy transmitting medium to perform movements and obtain the operation of various processes. The techniques consist of increasing the air pressure and through the energy accumulated on the elements of the pneumatic circuit such as cylinders, valves, limit switch, 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 in which timers and counters will be incorporated that will be responsible for various characteristics according to the sequence.

6. OBJECTIVE

GENERAL OBJECTIVE:

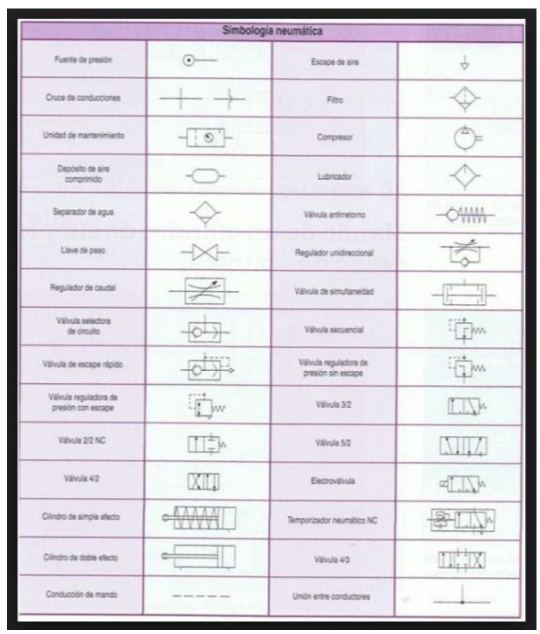
- Perform pneumatic sequences, eliminating interference through the various methods.

SPECIFIC OBJECTIVES:

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

7. THEORETICAL FRAMEWORK:

- **Pneumatics:**
  "Pneumatics is the technology that uses compressed air as a mode of transmission of the energy necessary to move and operate mechanisms. Air is an elastic material and, therefore, when a force is applied to it, it is compressed, maintains this compression and returns the accumulated energy when it is allowed to expand.
  The basic pneumatic circuits are formed by a series of elements that have the function of the creation of compressed air, its distribution and control to carry out a useful work by means of actuators called cylinders." [3]



Graph 1. Pneumatics simbology.

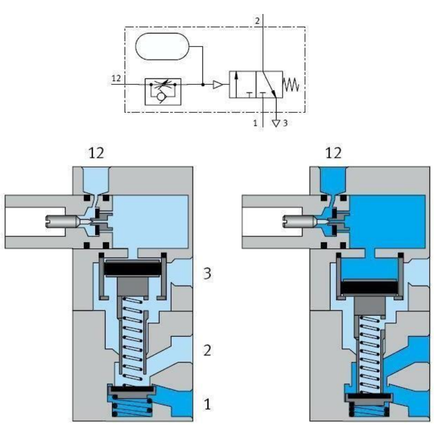
- **Pneumatic timer:**

“It is a pneumatic valve, the result of the combination of others. Specifically, it consists of two valves and an air accumulator element.

- A throttle valve with anti-return.
- A pressurized air accumulator.
- One 3/2 distributor valve, pneumatic piloting.

FUNCTIONING:

Time regulation is achieved by strangling the passage of fluid that arrives through line 12 to the accumulator. When the amount of air introduced to the accumulator generates sufficient pressure to overcome the spring, the distribution valve is activated to allow the passage of air and establish communication between 1 and 2. When line 12 is discharged, the fluid leaves the accumulator through the anti-return, without strangulation, allowing the switching of the distribution valve quickly.”[3]

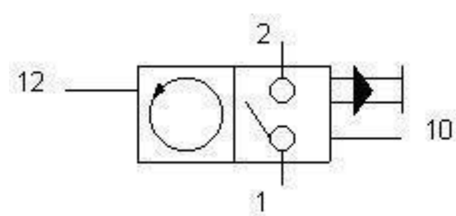


Graph 2. Pneumatic timer.

- **Pneumatic counter:**

“The counter records pneumatic and countdown signals from a previously selected number. Once it reaches zero, the counter emits an output pneumatic signal. This signal is maintained until a number is re-selected. This pre-selection is done by simultaneously pressing the initialization key (which is located next to the peephole) and the counter roller key. when initializing the counter the number previously chosen is always maintained”[4]

Graph 3. Pneumatic counter FESTO.



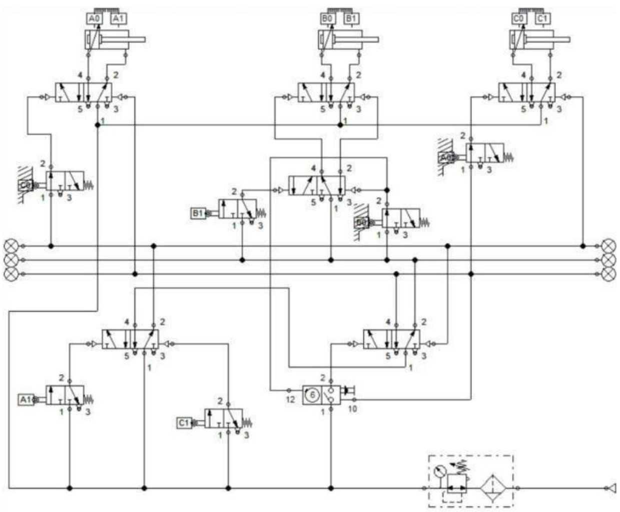
Graph 4. Pneumatic counter symbol.

8. METHODOLOGY:

The development of pneumatic sequences will be carried out, where elements such as timers and counters 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 5. Structure.

9. MATERIALS:

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

- FluidSim Festo simulation software.
- Pneumatically operated 5/2 valves.
- Pneumatically operated 3/2 valves.
- Double-acting cylinders.
- Maintenance unit.
- Distributors
- Timers
- Counters
- Limit switch

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.

- Perform the design, simulation and assembly of a circuit that performs this first sequence. The x express the number of times the sequence must repeat.

$$A^{+}(B^{+}B^{-})x5\ times, A^{-}(C^{+}C^{-})$$

- Perform the design, simulation and assembly of a circuit that performs this second sequence.

$$(A^{+}(waits\ T_1)(B^{+}B^{-})x5\ times, A^{-}),$$

$$(C^{+}(waits\ T_2)C^{-})x3\ times$$

- Carry out the design and simulation of a circuit that solves the next problem posed.

A thermal process of a material requires a repetitive sequence by introducing the material into different substances at different temperatures:

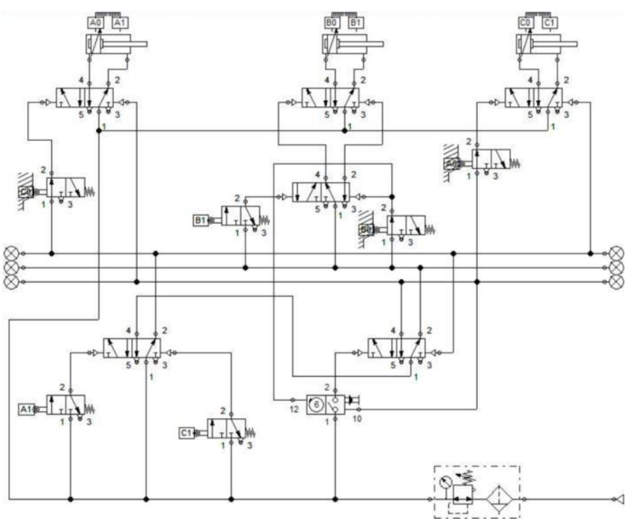
* The material is suspended in the stem of a cylinder.
* It should be introduced into hot oil for a period of 30 seconds.

* It is then introduced into ash at room temperature for 20 seconds.
* This process is repeated 3 times.
* It is then introduced into water at 100 degrees Celsius for 25 seconds and the process ends.

- Analyze the characteristics of the cylinders in the simulations, such as speed, acceleration, pressure and position.

11. SIMULATIONS:

$$A^{+}(B^{+}B^{-})x5\ times, A^{-}(C^{+}C^{-})$$

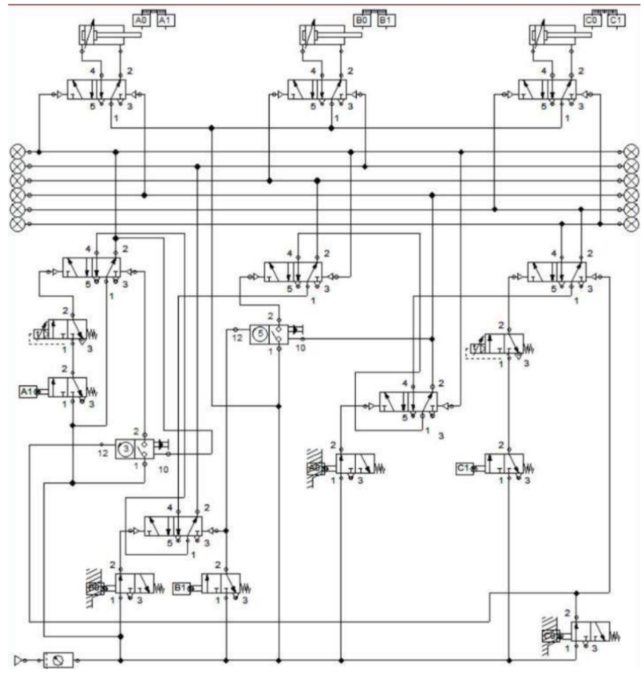


Graph 6. Simulation of sequence #1.

- For this case conventional pneumatics will be used, in addition to this three double effect cylinders will be used (A, B, C), for each of them there will be two race endings, the first one that indicates when the stem is inside (A- B- C-) and when the stem is outside (A+ B+ C+), in addition to them a counter was used to repeat the sequence (A+ B+ B- A-) Para este caso son cinco veces, luego de terminar este contador se activará el cilindro (C), realizando su secuencia (C+ C-)

$$(A^{+}(waits\ T_1)(B^{+}B^{-})x5\ times, A^{-}),$$

$$(C^{+}(waits\ T_2)C^{-})x3\ times$$

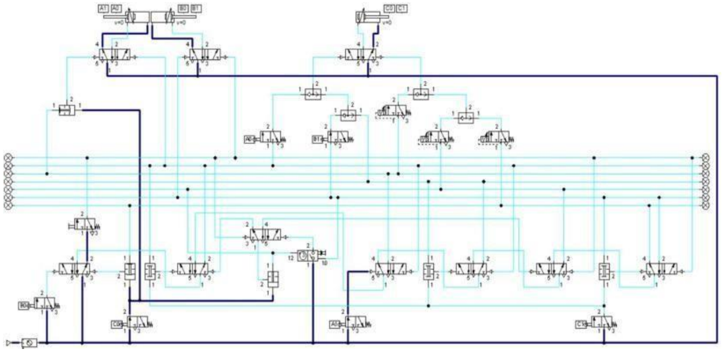


Graph 7. Simulation of sequence #2.

- This sequence has the same logic of the previous sequence, but has two timers that will be activated when the previous end of stroke is met, so timers that use the same tank filling pressure line with the same valve pressure line will be used, therefore, until the tank is filled, will not move to the next phase, in this case at the beginning of the corresponding group.

- A thermal process of a material requires a repetitive sequence by introducing the material into different substances at different temperatures:

  * The material is suspended in the stem of a cylinder.
  * It should be introduced into hot oil for a period of 30 seconds.
  * It is then introduced into ash at room temperature for 20 seconds.
  * This process is repeated 3 times.
  * It is then introduced into water at 100 degrees Celsius for 25 seconds and the process ends.



Graph 8. Simulation of sequence #3.

For the process of preparing a material, which is by immersing it in different containers at different temperatures and in each one for a specific time, it is necessary to use a design of a multiposition cylinder that changes the position of the material to be able to alternate it between the containers. It is a few words, the cylinder that submerges and removes the material from each container will be subject to a multiposition cylinder that will move it between the containers.

For the design of the multiposition cylinder, two double-acting cylinders were coupled opposite by the back of the cylinder (referring to the side where the stem does not come out).). One of the cylinder rods is embedded in the wall, which allows that when putting that cylinder in advance the whole system will move, that is, the two opposing cylinders will move. This system has three race endings, three positions, the initial one when the two stems are retracted, the second when a stem comes out no matter which stem, and the third when the two stems are outside. They will be cylinders with enough force, so they will have large diameters and a large stroke to be able to simulate an industrial process, where the containers have large size. The cylinder that has the material hanging will also have a great stroke, but I do not need great force compared to the other two cylinders.

Once the multiposition system is designed, each cylinder is given names to be able to make a sequence and then its design. A and B will be the letters of the cylinders of the multiposition system, where the stem of A is embedded in the wall, and C for the cylinder that immerses the material in the vessels. As it is a process of a product, it has to be placed and removed from the preparation system, so the sequence will not begin until a new product is placed to be processed, and at the end it leaves the system completely still.

This process start will be represented by a button. Then, the sequence when cylinders A and B have their stem outside, and their valves are activated, that is, they are in the state that the cylinders place in advance, so the sequence must begin once the material is placed with the recoil of A and B. The sequence to be performed is: *B- (A- C+ T1 C- A+ C+ T2 C-) x3 B+ C+ T3 C-*

Using cascade method, the sequence will be separated as follows *B-/ (A- C+ T1/ C- A+/ C+ T2/ C-/) x3 B+ C+ T3/ C-/.* There are 7 groups, and the phases of cylinder C are repeated in different, so the actuations of the valve 5/2 that controls cylinder C, will be with selector valves.

But this implies that the end of the stroke of cylinder C will activate its valves at several points, and at each point they give way to a different phase, then it is necessary to use simultaneity valves so that when activated the end of the race is of a specific group, which is pressurized, so that same end of stroke does not belong to another group because only one group can be pressurized.

As the counter allows a subsequence to be repeated up to a specific number of times, it will be connected to the actuation of a 5/2 valve, fed by the end of stroke of the last phase of the subsequence, so that end of stroke will give way to the first phase of the subsequence to repeat until the counter reaches 0, so that same end of career will activate the phase following the subsequence.

In order to be able to carry out the waiting times of the material in each container, pneumatic timers are placed normally closed, and for this case they are placed in series at the end of the advance stroke of cylinder C so that when pressure reaches the timer, it does not pass to the phase until the necessary time can have passed, then they are timers that with the same pressure line that they must let through, fill the internal tank of the timer.

12. ANALYSIS OF RESULTS:

As can be seen in all the pneumatic circuits used, the use of valves of logical functions allows to have a control of the sequence by means of the counters and timers, making that different conditions are needed to operate or on the contrary, that several actions can be executed at the same time.

For sequences that start with a counter, it should be noted that at the time of starting the sequence, the count decreases. Such is the case of the first simulation, so a condition must be given to make the counter not take the start of the process as a step to be.

13. CONCLUSIONS:

The valves that perform the function of counters or timers, allow to make the repetitive processes optimally, reducing implementation costs, in addition to that if an application is needed where the process must be left a leisurely time through these components can be achieved.

It was possible to identify the speed with which a pneumatic system manages to work; given the pressure that the compressor provides, very efficient and very fast applications can be achieved that can solve problems of companies that have not found a new system that replaces a machine that is in constant maintenance or that requires a very high energy expenditure compared to the production that it generates.

Pneumatic systems allow to generate greater efficiency in many applications that were previously thought with different energies such as electrical energy; pneumatics allows simpler processes that will most likely require lower costs and better gain because according to the characteristics of the air, pistons can be moved or it can also be achieved to move heavy loads of holds taking advantage of the air pressure and manipulating it in a correct and optimal way according to the need required to supply the company or the user.

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