LINEAR AND ROTARY PNEUTRONIC UNITS

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Abstract - Pneumatic actuating systems are met in a large number of applications, in various areas. The explication of this fact results from undeniable qualities of this type of actuating systems, as: robustness, constructional simplicity, productivity, high reliability and not the last low cost. Usually, such systems are used when: we need high level forces and torques; actuated object speed does not exactly follow a certain rule; high precision positioning of actuated object is not required; some rules must be strictly respected, like sanitary rules (robots operating in the food, pharmaceutical, nuclear industry, etc.). Keywords – pneumatic units, systems

1. Pneutronics

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- we need high level forces and torques;
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- some rules must be strictly respected, like sanitary rules (robots operating in the food, pharmaceutical, nuclear industry, etc.).

We have to mention that while in some areas pneumatic actuating systems are competing with other systems (electric, mechanic, hydraulic systems), in other applications are used almost exclusively, being irreplaceable.

In classic pneumatics, the power control was made via discrete operated equipments, like the “on-off” ones. From this point of view the actuating systems that are containing such equipments provides few possibilities in the area of controlling the speed of moving parts of the actuator, their position, forces and torques produced. In this way we cannot ensure the required precision either fastness of this actuation. In the same time, the change of the operating system program is made with difficulty and sometimes requires introduction in the system structure of additionally equipments. That is why, many times, high complexity actuating systems are used.

Disadvantages mentioned before, regarding actuating precision, actuating system complexity, as well as its reliability, are solved by the modern structured actuating systems which are using proportional adjustment and power control equipments. It is said that the equipment is proportional if the value obtained at its output (pressure or flow) is proportional with an input signal, generally compute and remote transmitted by a potentiometer, controller, etc. Usually, proportional equipment term is associated with equipments which have as a convector a proportional electromagnet. In this class of equipments can be included, without any mistake, equipments which has as a convector a torque engine, a force engine or other types of convectors.

Advancements obtain in electromagnet design and especially in electronics, opened a new way in proportional equipments design in which the power control is obtained by actuating a slide with one or two proportional electromagnets. Efforts have successfully been made for improvement of these equipments, principally in the following directions:
- designing equipments at which the mobile element (usually a slide with a linear movement) has to have a small weight, known that his weight is the factor who determines reacting speed of the equipment and so its frequency response,
- reducing specific global hysteresis for a proportional electromagnet; mechanical component of this hysteresis can be diminished by reducing the friction between bearings of the mobile rod, and the magnetic component by selecting the right ferromagnetic material, as well as superposition of a Dither signal over the command signal; but better results were obtained by using automatic positioning for the mobile rod.

Today, this type of equipments are reliable and precise, can be remote controlled and there are real perspectives in their perfection.

Remarkable is that proportional pneumatics is not yet present in all applicable areas, being unlimited possibilities in this way. But it is necessary to train some experts with mechanic inclination, with solid mechanical, electronically and informatics knowledge’s.
Control interface of this equipments are made under the form of cards or modules. An actual tendency in development consists in integrating the electronic interface into the equipment body (built-in electronic interface). There are new problems regarding the operating environment, specially operating temperature, which decisive influence the operating in optimal parameters of electronic components.

Pneumatic system automation marks a significant qualitative leap of this area. Naturally, “Pneutonic” concept was developed by the synergetic union of three areas: pneumatics – electronics – informatics [1]. In this way, pneutronic system was developed. These system structures can vary from simple actuating circuits to complex structures, controlled by programmable logic controllers or computers (PC’s), which gives the command, regulate, optimize and simulate internal system processes. Servo-pneumatic proportional units represent the base element around which pneumatic system design is made. Beside these elements, in the system structure are also included mechatronical origin equipments like: sensors, traducers, electronic boards designed for signal computing, A/D and D/A converters, controllers and microprocessors. Pneutronic systems are developed by an advance control theory: process values required become data set that must be real-time computed with a control strategy resulted from entire process simulation and modeling. Electronic control unit (based on a controller or a microcontroller) gather system information by sensors, compute and arrange them, decide by a build-in program, and then intervenes in the system for command signals generation, signals which are transmitted to the electromechanical converters located near the proportional-controlled pneumatic systems. In this way, pressures and flows, speeds, displacements, accelerations, forces and torques can be controlled. Energetic and informational system fluxes can take discrete or analogue values. Because, in numerical systems information processing is realized in superior conditions, it’s impose for the system analog values to be converted in digital signals. Digital technique development influence designing methods, as well as the utilization area of pneumatic systems trough application possibilities of modern control techniques, superior to the classic ones. Configured like this, a pneutronic system becomes more stable, precise and faster, having a certain characteristic level of intelligence. Simultaneously, utilization area becomes wider from actuating systems design for robots, tool machines, automatic lines, machine winding, presses, chemical, metallurgic and miner equipments, until military and aerospace technique.

As a result, these systems are found in a large area of applications were automatic process control, force, torque, displacements an speed planning is required; ensures a various transit function from a speed level to other necessary for high precision positioning, easy programming and flexibility.

2. Hardware structure of a pneutronic system

Base structure of a pneutronic system is presented in figure 1.

Component units carry out following functions:
- **Load programming system** generates the desired movements and theirs sequences in conformity with the demands or transmitted commands. This unit is materialized by the microprocessor and microcontroller;
- **Sequence and movement controller** compare present system parameters with the required ones, and make necessary adjustments;
- **Power amplifier** amplifies the signal in conformity with the actuator necessity;
- **Sensors** take’s information’s regarding system parameters and sends the corresponding signals to the movement control unit; this information’s can be about: pressure, downstream and upstream flow, force, torque, linear/angular speed obtain at the actuator axle, position, etc..
- **Signal conditioning unit** includes filters, boosters, etc., which process signals in concordance with the requirements of the movement controller input;
- **Compressor** generate pneumatic energy for the system; can be met two situations:
  - when we have a compress air network, situation in which we use this network by connecting it to one of our stations;
  - when we haven’t got compress air network, case when we use a compressor;
- **Regulate and control equipments**, who carry out next functions:
  - directs under pressure fluids, controlling in this way movement direction of the actuator and its stopping;
  - regulates the flow to the value required by actuator and with this the movement speed;
  - regulates systems pressure, in correspondence to the load;

In this equipment category it can be found:
- classic electrically actuated pneumatic directional control valves;
- proportional-control pneumatic directional control valves;
- proportional-control pneumatic regulators;
- proportional-control pneumatic flow control valves;
- pneumatically operated check valve, pressure control valves, directional control valves, etc.;
- manually controlled equipments.

- **Pneumatic actuating devices** change pneumatic energy into mechanical energy.

3. Conclusions

Precise pneumatic actuating system design is hard to obtain because of air compressibility and air lower viscosity.

In present special efforts are made for systems performances improvement. A special attention it's offered to positioning system. These systems are having some advantages in comparison with electric or hydraulic actuating systems: simplicity, robustness, high and very high operating speeds, which means high productivity, uses a totally ecologic supply fluid – compress air, electric or magnetic fields insensitivity, secure from explosive, inflammatory environments, radiation or vibrations. Positioning precision remains an unsolved problem in pneumatics. Pneumatic positioning systems began to be associated with the “precision” term in the last two decades.

A careful analysis of the principal achievements in this area shows three structure of the positioning system that can satisfy us in the precision problem, as follows:

- Positioning unit having in it’s components, besides the established equipments (linear and rotary pneumatic actuators, transducers, proportional valves, controller) and perturbation transducers;
- Incremental positioning unit; at this variant, the actuator is a special construction one, which allows incremental load movement, and the positioning transducer can miss, the unit working in open loop;
- Pneumo-hydraulically positioning unit; in this case for the position control is used an hydraulic circuit with an proportional equipment; this one will ensure a strict control moving liquid flow; in this way will be precisely controlled the speed of the unit, and by blocking the hydraulic circuit will ensure firm stopping.

From the point of view of construction these units must respect the following conditions:

- units construction will be a nodular one;
- position transducer will be integrated in actuator construction;
- valve equipment will be placed on the fix part (stator) of the actuator; connection circuits with the actuator active rooms will be made trough the stator;
- electronic command board will be also implemented in the system structure;
- unit command will be made trough an electronic control system (based on a controller or a PC);
- for compensating perturbations influence (supply pressure, temperature, load variations, etc.) transducers will be provided for gathering information about these factors; electronic control unit compute and arrange this information, decide by a build-in program, and then intervenes in the system for command signals generation, signals which are transmitted to the electromechanical converters located near the proportional-controlled pneumatic systems; so in this way real-time corrections of the command signals will be made, so the unit can operate after a well known program.

To be functional, these units need proper software, which also will represent one of these project objectives.

**Bibliography**