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The Construction and the Working of the TTT Type Manipulator Used for the Actuation of the Light Tubular Material

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Abstract

In this article are presented the results of the theoretical-experimental research concerning the construction and functioning of the TTT type manipulator (Transition - Transition - Transition) used for the actuation of the light tubular material. The manipulator, conceived by the authors, is considered to be a first generation robot, has a electro-pneumatic driving and supports a rigid programming.

Key words: *TTT (Transition - Transition - Transition) manipulator, tubular material, robot, degrees of mobility, degrees of freedom.*

Introduction

The evolution of the automation processes led to production efficiency, acquiring the concept of „Factory Automation" (FA). Implementation of such a philosophy implicates development of some new technologies where the complex technological systems of industrial robots, flexible manufacturing systems (FMS) and the software programs CAD / CAM type (Computer Aided Design / Computer Aided Manufacturing) have been imposed. Industrial robotics is carrying on with automation of the discontinuous industrial processes and is sighting, firstly, the improvement of the quality / price ratio.

This paper presents the functional characteristics of the cartesian manipulator TTT type (Transition - Transition - Transition) utilized in one manufacturing flexible line for actuation of the light tubular material (actuation – the assembly of the work motions to ensure the displacement and correct setting off the blanks and / or the parts along one technological operation).

General description of the TTT manipulator

The articulated mechanical system, equipped with the transmission and drive systems, is gifted with sensors for knowing, every moment, the position of cylinders pistons to coordinate and control their movements. The major components of the manipulators mechanical structure are: the base, pneumatic cylinders, the wrist, the mechanical axis and the prehension device.

The industrial robot analyzed in this paper enter in the category of the first generation robots, being characterized by using it in many actuation operations, working after a preset program, and the pieces to manipulate must be very precise positioned [5]. It is a stationary robot, lifter –

conveyer type, which accomplish operations of attendance, stacking and / or equipments attendance.

The manipulator is a Cartesian type, with pneumatic drive, rigid programming and a self contained structure. This is a portal construction, being characterized by an arm which allows transition by two normal directions [3]. This robot presents 3 liberty grades of the three transition motions (Transition - Transition - Transition) corresponding to the axis x, y and z.

The component elements of the TTT type manipulator

The energy source utilized for the robot action is pneumatic. This is recommended to be used by the industrial robots which are working in explosive environments.

The pneumatic drive is remarked through constructive simplicity and easy maintenance. The drive energy is assured by the pneumatic work characteristics: pressure and air feed. This is characterized by higher reliability, but presents a raised level of the noise [5, 6].

The pneumatic drive scheme of the TTT type manipulator is presented in Figure 1.

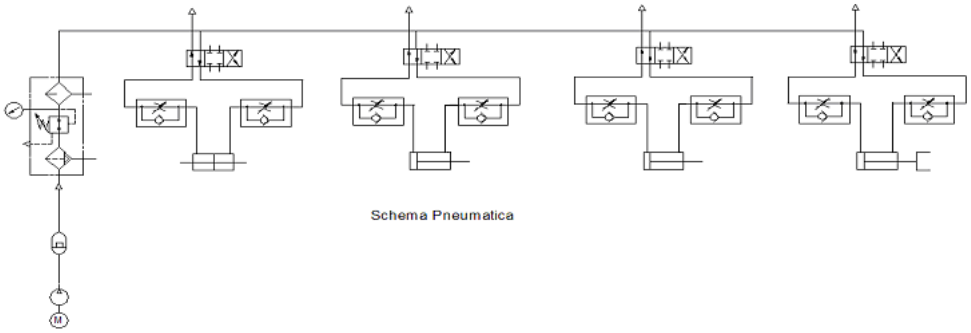

Fig. 1. The pneumatic drive scheme of the TTT type manipulator.

The air of the industrial network gets over the filter, pressure regulator and lubricator, then through air manifold to pneumatic cylinders. The existent impurities and the water resulted from condensation are separated of the air, by the filter. The pressure regulator is adjusting and maintaining the work pressure to a constant value. The work pressure used in this application is 0,6 MPa. The lubricator is spraying oil particles in the air current for lubrication of the cylinders' pistons. The electro-pneumatic distributors are placed between the preparation group and cylinders, whose function is to command the pistons motion into cylinders.

The functional characteristics of the regulator lubricator filter BL72-2 2 8 G are: B – combination of filter, regulator, lubricator; 2 – series; 2 (G ¼) – the orifice dimension for air admission; 2 – spraying and manual evacuation; 8 – without belongings.

The typo-dimensions and the constructive characteristics of the regulator lubricator filter (BL72-228G) are presented in Table 1 [6].

Table 1. Typo-dimensions and constructive characteristics of the regulator lubricator filter (BL72-228G)

Technical data			***Materials***		
Work environment	*Maximum pressure*	*Work temperature*	*Case*	*Filter / Regulator*	*Lubricator*
Compressed air	1 MPa	-20...-50 ^{0}C	Polycarbonate Case-zinc Other materials	Synthesized elements of polypropylene Valve of brass	

The constructive scheme of the regulator lubricator filter is illustrated in Figure 2. The functional characteristics of the Lintra-Rodless cylinder M/460 40/M/250 are: 0 – internal guiding system; 40 – cylinder diameter, mm; M – magnetic standard internal guiding; 250 – piston stroke, mm. The typo-dimensions and the constructive characteristics of the pneumatic cylinder M/46040/M/250 are presented in Table 2 [6].

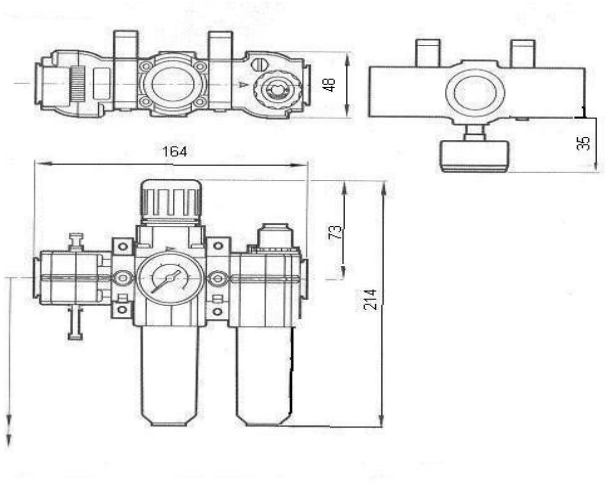

Fig. 2. The constructive scheme of the regulator lubricator filter.

Table 2. Typo-dimensions and constructive characteristics of the pneumatic cylinder M/46040/M/250

Technical data				
Work environment	*Operation*	*Work pressure*	*Work temperature*	*Stroke*
Compressed air – filtrated and lubricated	Double effect, controlled quenching, magnetic piston	0,1...1 MPa	-30...-80 ^{0}C	250 mm

Materials					
External covers	*Yoke*	*Inside of cylinder*	*Pistons packing*	*Cover strip*	*Packing*
Aluminum anodal	Aluminum anodal	Aluminum alloy, anodal, extrusion	Polyurethane	Polyamide	Nitrate rubber

The functional characteristics of the cylinder guides' M/60132/M/150 are: 32 – the cylinder diameter, mm and 150 – the stroke, mm. The typo-dimensions and the constructive characteristics of the M/60132/M/150 cylinder are illustrated in Table 3 [6].

Table 3. Typo-dimensions and constructive characteristics of the M/60132/M/150 cylinder.

Technical data					***Materials***		
Work environment	*Operation*	*Work pressure*	*Work temperature*	*Stroke*	*Pistons' rod*	*Body and external covers*	*Packing*
Compressed air – filtrated and lubricated	Double effect, magnetic piston	0,1...0,8 MPa	0...80 ^{0}C	150 mm	Steel chromium-plate	Aluminum anodal	Nitrate rubber

The constructive scheme of the pneumatic cylinder Lintra-Rodless is presented in Figure 3, a general view of the pneumatic cylinders – in Figure 4, and the constructive scheme of the pneumatic guides' cylinders – in Figure 5.

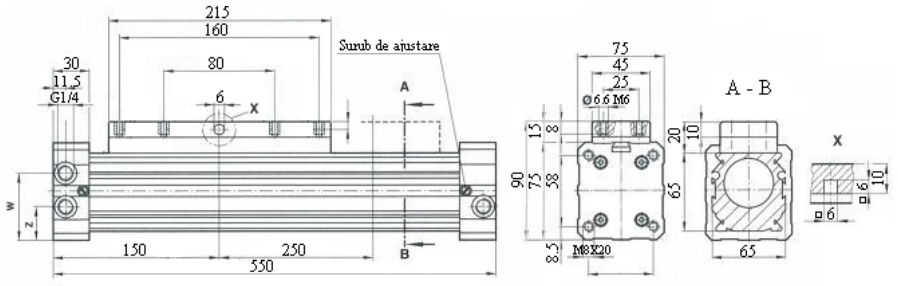

Fig. 3. The constructive scheme of the pneumatic cylinder Lintra-Rodless.

Fig. 4. The general view of the pneumatic cylinders.

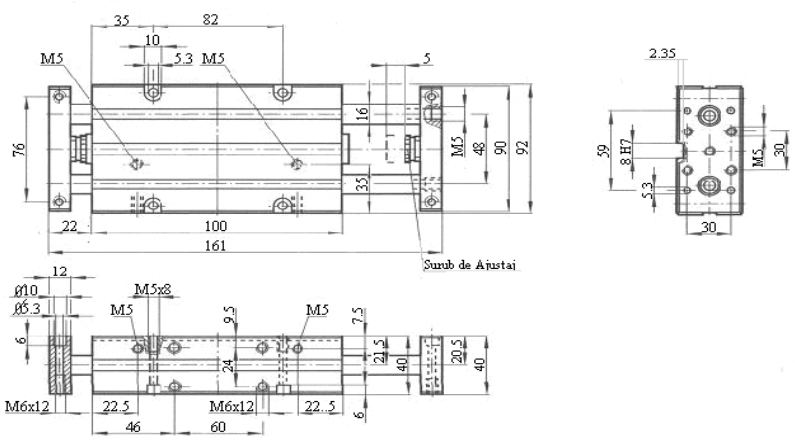

Fig. 5. The constructive scheme of the pneumatic guides' cylinders.

Between the components elements of the TTT type manipulator are 3 pneumatic cylinders, among 2 are guides' cylinders and one without rod. The Lintra-Rodless cylinder has a diameter of 40 mm and a stroke of 250 mm. This is a double-effect cylinder, and the cylinder piston is magnetic. The work domains of this cylinder type are; pressure values of 0,1 … 1 MPa and temperatures of -30 ^{0}C ... +80 ^{0}C. The work pressure of this cylinder achieved by the air compressed source is between specified limits (0,6 MPa).

The pneumatic distributors drive the pistons motion of cylinders and the speed regulators control the gear.

The constructive scheme of the electro-pneumatic distributors is presented in Figure 6 and the general view of these distributors in Figure 7. The pneumatic distributors (V60A511A-A213J – type) were chose, each of them with a mass of 0,33 kg.

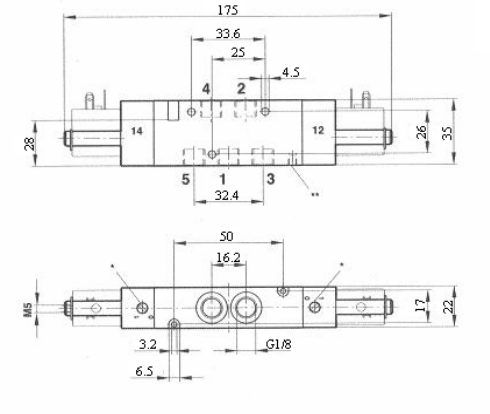

Fig. 6. The constructive scheme of the electro-pneumatic distributors.

Fig. 7. The general view of the electro-pneumatic distributors.

The main functions of the prehension device (Figure 8) are the following:

- catching the piece to be manipulated;
- keeping the direction of the carrying piece;
- recognizing the piece position in proportion to the prehension device.

The prehension device is independent of the manipulator mechanical structure (from the point of view of its mobility degree) and has the role to catch and to manipulate the light tubular material [4, 5].

A standard model of parallel gripper was adopted (M/160344/M/12 – type), with piston diameter of 40 mm. The work pressure domain is 0,1 … 0,7 MPa and the work temperature is 0 … 60 ^{0}C.

The prehension device of the TTT type manipulator is with two-way action and pneumatic drive.

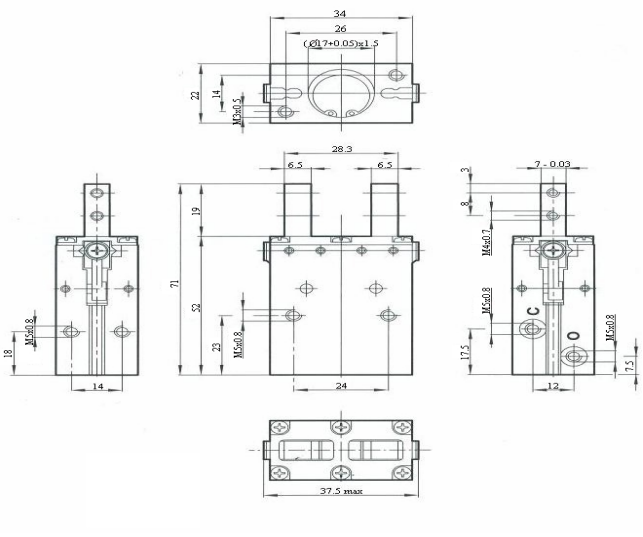

Fig. 8. The constructive scheme of the prehension device.

The prehension device is used for catching, at least with two fingers with smooth-faced or flute-type dies [3]. The gripper has an exploitation endurance of approximately 5 millions of cycles and presents a magnetic piston and incorporated magnets, to ensure closing or opening of the application [2].

The command and control system is represented by a programmable automaton, which supply the manipulator the controls to actuation the light tubular material. This system has a transmission of data like an electric impulse to the electro – pneumatic distributors, and the air flow rate is injected into cylinders to accomplish the motion to the established direction. The programmable automaton is an Alpha 2 type, according to the manufacturer specifications (Mitsubishi Electric). The automaton allows a flexible programming and a distance command through internet or phone (graphic connections between necessary functions assembly).

The TTT type manipulator has a rigid programming, because this is a first generation robot which is characterized by the following: it is used for actuation, which it implicates the environment matching; it drives on a preset program base, which it cannot be changed while it is functioning; the manipulated pieces must be positioned accurately [5].

The application (the TTT type manipulator) supposes catching and moving of the light tubular material inside of a flexible line of manufacturing.

Therefore, the piece weight must be placed between 1/30 ... 1/50 of the effective force of the gripper:

- for piece catching resulted from fingers remoteness, the allowable weight of the piece is 0,816 … 1,36 N;
- for piece catching resulted from fingers approach, the allowable weight of the piece is 0, 612 … 1,02 N.

In the case of the sensory system, the function of the internal sensors from the TTT type manipulator is to limit and/or control the pistons motion on the trajectory barred by the command program.

The pneumatic cylinders structure is equipped with magnetic sensors to make linear movements. These sensors provide the programmable automaton with information about the motion of the cylinders' pistons, to accomplish the programming function. The knowledge of the initial positions and the movements' values of these elements every moment of the manipulator charge are necessary.

Conclusions

This paper presented the construction and the working of a TTT type (Transition - Transition - Transition) manipulator, conceived by the authors, which it is used for the actuation of the light tubular material. The component elements of the TTT manipulator have been presented, as well as their working on and the connections between them. All these elements are used together on a flexible line of manufacture.

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Construcția şi funcționarea manipulatorului tip TTT utilizat pentru manevrarea materialului tubular uşor

Rezumat

În acest articol sunt prezentate rezultatele cercetărilor teoretico-experimentale privind construcția şi funcționarea manipulatorului tip TTT (Translație - Translație - Translație) folosit pentru manevrarea materialului tubular uşor. Manipulatorul conceput de către autori se consideră a fi un robot de primă generație, are o acționare electro-pneumatică şi suportă o programare rigidă.