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DEVELOPMENT OF MECHATRONIC MODULES FOR PACKAGING MACHINES ON THE BASIS OF SYNERGETIC INTEGRATION ELEMENTS

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Abstract: *A number of local automation tasks in the technological lines of packaging products, the creation of personal packaging, group, attach cardboard strips between layers, installation of more valves or dispensers for packaging, etc. – requires intelligent, productive and adaptive systems move with the functions of robotics. The development of soft robots and new materials to drive is an important way in the development of robotics. In this, work a new design of the Tripod based on the theory of soft robots. This ensures efficient use of resources and materials in the production of food, including operations of packing. Research methods this tripod is based on the theory of plates and shells, the main section of solid mechanics. Possibility of use in the design of the drive control and measuring devices, feedback - allows you to support the values of the specified technological parameters. The analysis and design of process system tripod based on separate functional modules. The authors created and experimentally investigated the model of the parallel mechanism - tripod with drive on bellows pneumatic cylinders. The Tripod control system is based on a new type of programmable relays and closed-loop pressure regulators in the range of 0..10V. To ensure the laws of motion of the base platform, the design decided to use bellows pneumatic cylinders in conjunction with ejectors. The solution described in the work controls the drive with the help of alternating pressure, reduces the disadvantages of the operation of systems with pneumatic cusps, in particular the need for antagonistic kinematic pairs with tension springs.*

Keywords: *Model, tripod, packing, drive, bellows, feedback, pressure.*

INTRODUCTION

The pneumatic actuators of the vibration-inertial trays for transportation, distribution to flows, reorientation of artificial products showed that currently quite effective in actuating the use of pneumatic systems with feedback. Provided small displacements of the working surface of the tray - you can use pneumatic muscles as actuators for actuators (D.C. Roberts, 2002). Before pneumatic cylinders, they have several advantages: absence of frictional force and high forces at the same dimensions (K.-M. Lee, S. Arjunan, 1991). However, pneumatic cylinders are characterized by the presence of hysteresis over the displacement of the working link, with the growth and reduction of pressure in the working chambers of the cylinder, or alternating load per stem (shaft). This leads to the need to form a feedback system in place of the position of the working link. Existing systems with an actuator on pneumomaks can realize a frequency of movement up to 20 Hz with a reduced

load on the friction in the drive (O. Yaglioglu, Y.H. Su, D.C. Roberts, 2002). At the first stage of design, the calculation of the tray for moving artificial products was carried out according to static parameters. As a replacement for pneumatic muscles, we have proposed a design of pneumatic cylinders with a bellows body (bellows pneumocylinders).

EXPOSITION

Features of constructing a physical model

According to the task, creating a new drive for a vibration-inertial tray to move and split artificial products into streams requires the oscillating motion of the platform platform with three degrees of freedom. The drive of this platform is realized on pneumatic cylinders with bellows housing, which contains 5 corrugations.

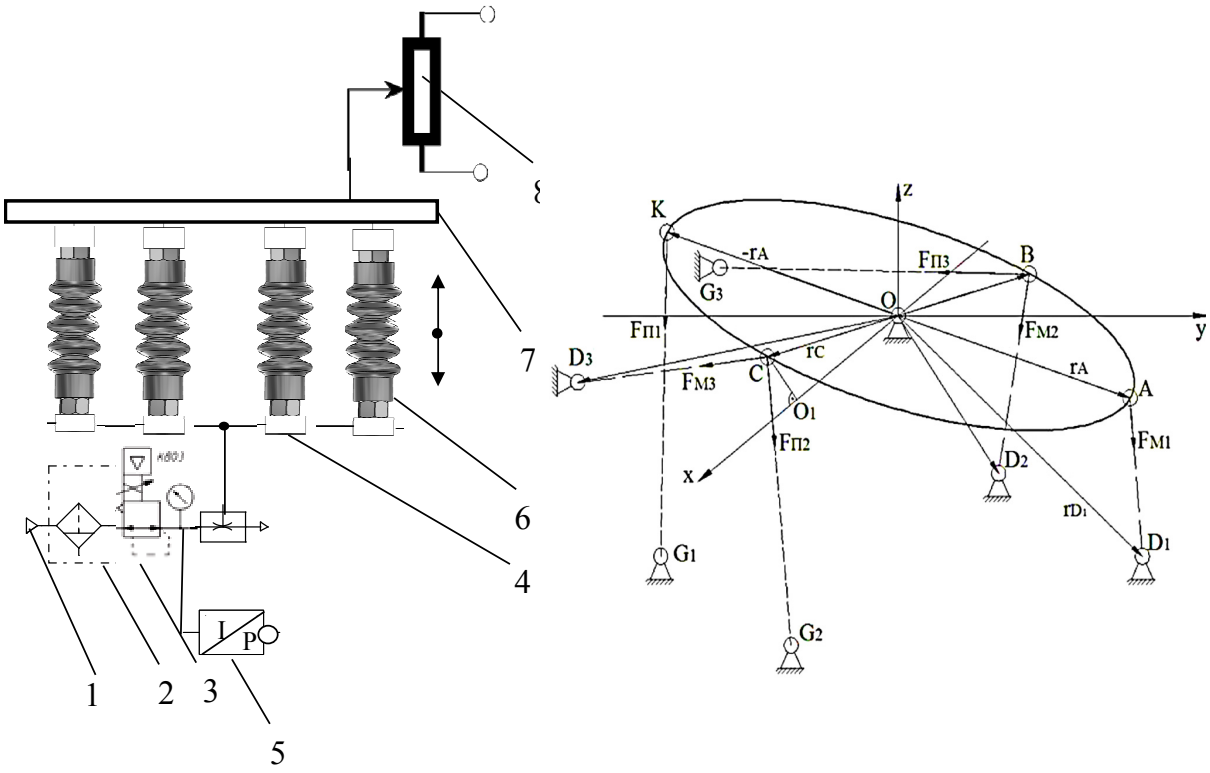
This drive has the ability to control by means of alternating pressure. This distinguishes the proposed construction (Fig. 1) from existing analogues, including pneumomyces. An actuator based on bellows pneumatic cylinders (Fig. 1) is capable of operating at frequencies up to 20 Hz . It was assumed that for the experimentally set range of frequencies from 0.2 to 5 Hz, the dynamic properties of the bellows pneumocylinder (SP) can be neglected. The calculation of the drive for static characteristics of the muscles was given in. After conducting of experimental researches on the work of the proposed drive of the vibration-inertial tray at the given frequencies, a significant deviation of the obtained values of kinematic and dynamic parameters was revealed. In this connection, experimental studies of the SP dynamics with an inertial load were carried out when the pressure was changed according to the harmonic law.

Pneumatic muscles (PM) are devices of unidirectional action, therefore they are used in pairs or in an antagonistic pair with pre-stretched springs. Thus, to ensure harmonic oscillations in the PM, some pressure is pre-applied, causing the initial displacement of the object, which ensures the possibility of its further movement in opposite directions. Before conducting tests of the vibration-inertial tray, an analysis of the dynamics of bellows systems was carried out. Already mentioned design has an external diameter of 25 mm, length L0 = 40 mm at static position. The frequency of the vibration of the platform is set up by means of a program control through a programmable logic controller when the frequency of the oscillation of the tray is limited: f = 0,2 ... 10 Hz.

The maximum frequency of 10 Hz was the threshold for the applied control system HN1M-000-2BK-4C (CAMOZZI). Pressure of the previous voltage of the SP is determined on the basis of the requirement to achieve the maximum displacement amplitude at the pressure change amplitude P_A = -0.5 bar to P_1 = 1.5 bar.

The size of the inertial load of the joint venture is m = 200; 300; 500; 800g, taking into account the groups of artificial products during research. During the review and analysis of literature on this topic, no experimental studies or mathematical models have been found that describe the dynamics of the SP with inertial load in the range considered. For example, there are no experimental data confirming the validity of the linearized mathematical model of the shell pneumocylinder (the cylinder, operating on the same principle as pneumatic muscles).

And also the lack of clear input data in the mathematical model of PM, proposed by S.A. Gadsden in the paper (T.V. Minh, 2010). In this model, the behavior of PM constructs McKibean in the frequency range from 0.05 to 0.95 Hz is investigated. The proposed model with an accuracy of up to 10% describes the results of experiments.



a) b)

Fig. 1. Schematic image of the measuring unit for studying the dynamics of the bellows pneumatic cylinder with inertia loading:

a - control scheme: 1 - pressure source, 2 - air preparation unit, 3 - pressure reducer with proportional control MX PRO, 4 - fitting of pressure supply, 5 - sensor pressure, 6 - bellows pneumatic cylinder; 7 - inertial load (tray), 8 - potentiometric position sensor.

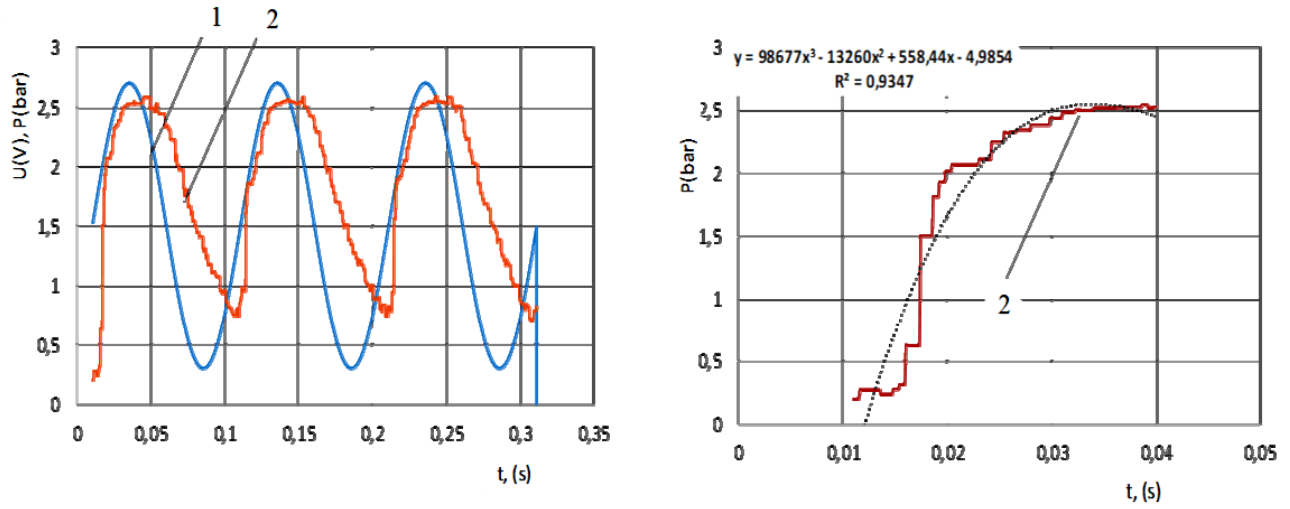
b - Kinematic scheme of the platform for the separation of piece food products: AD_1 - bellows cylinder 1; BD_2 - bellows cylinder 2; CD_3 - bellows cylinder 3; KG_1 - spring 1; CG_2 - spring 2; BG_3 - spring 3; D_1, D_2, D_3, - fixing points of the fixed part of the drive; A, B, C - the points of fastening of pneumobars to the platform; G_1, G_2, G_3 - points of attachment of springs to the base; K, C, B - points of attachment of springs to the platform.

The amplitude-frequency characteristics of the SP in the range of frequencies up to 10 Hz were experimentally constructed at a pressure variation amplitude up to PA = 1 bar. Logarithmic amplitude and phase frequency characteristics for displacement for a dynamic system with a transmitting function of the form:

$$W_{PX}(s) = \frac{x(s)}{p(s)},$$

x - movement of the upper lid of the bellows pneumatic cylinder, , p - sinusoidal pressure changes in bellows pneumatic cylinder.

The platform with drives was decided to be executed in the form of a disk, constructively hinged in the center.



a) b)

Fig. 2. Amplitude and phase frequency characteristics of the bellows pneumatic cylinder: a - for the frequency of the vibration of the tray up to 10 Hz; b - section of the extremum of frequency characteristics with the curve of approximation of the result; 1 - the amplitude characteristic is given by MX PRO (U, B), 2 - the reverse signal in the form of controlled pressure at the output of MX PRO (P, bar).

CONCLUSION

On the basis of the work done, we can draw positive conclusions about the possibility of using pneumatic bellows pneumatic cylinders in the drive of the vibration-inertial tray. The experimental analysis of the peculiarities of the SP dynamics suggests the permissible hysteresis and stable work in the studied range of kinematic and dynamic characteristics. The obtained results of the reliability of the approximation R_2 (Fig. 2, b), confirm the reliability of the result. Frequency response by effort confirms the use of JVs in technical systems, where small displacements at frequencies up to 10 Hz are realized. An example of such systems can be drives guides, shafts, cutting knives on the bundles of packages, configured for a fixed size.

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