RESEARCH OF MOVEMENT OF THE MECHANISM SUFFICIENT WITH ELASTIC PART.

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Summary In the given work some principles of drawing up of mathematical models of transfer and executive mechanisms of independent movement with elastic parts are resulted. The system of the equations describing the movement of 2-rocker mechanism with elastic connecting-rod.

The mathematical modeling of complex mechanical systems, especially of multi-mass torsional oscillatory systems with concentrated and distributed masses, in which we have many settlement circuits of technological machines and automatic transfer lines, is connected with constructions of general dynamic models and local models of the executive or transfer cam-lever mechanisms with nonlinear state functions.
In mechanisms with considerable elastic parts the complete cycle of their movement is supposed to be considered as separate periods. In the various periods of movement the elastic parts are represented both as communication, and as source of movement, i.e. movement is carried out at the expense of the potential energies of elastic parts [1].
The movement of a link of reduction of the executive and transfer mechanism can be described by elastic parts with one degree of freedom by such an equation:

$$J_n(\varphi)\ddot{\varphi}(t) + 0{,}5J_n'(\varphi)\dot{\varphi}^2(t) \equiv M_\Pi(\varphi), \tag{1}$$

In the period of accumulating, i.e. in process of compression of springs or rotating of the elastic shaft the given moment of forces is represented as the sum of driving M_q and moment of resistance to elastic deformation M_c. The latters depend on the statement of a link of reduction. Inertial parameters - the given moment of inertia of the mechanism ./ n (φ) is always a positive function.
The return task of dynamics of mechanisms with considerable elastic parts is formulated. The law of movement of the executive mechanism in the period of accumulation is determined by the speed of rotation of the main shaft, which is possibly approximately to consider as constant
α (t) = const. In such case the equation (1) can be written down concerning the given moment of inertia, as the linear differential equation of the first order.

$$\dot{\varphi}^2(t)J_n'(\varphi) + 2\ddot{\varphi}(t)J_n(\varphi) = K\varphi(t), \tag{2}$$

Where $\dot{\varphi}(t)$, $\ddot{\varphi}(t)$ - are angular speeds and acceleration of entrance link of the executive mechanism.
These transfer functions can be determined through functions of the situation between the main shaft of machines — of automatic devices and entrance part of the executive mechanism.

From the equation (2) at $\dot{\varphi}(t) \neq 0, J_{n0} = J_n(\varphi_0)$ the analytical expression of the given moment of inertia is defined $J_n = A(\varphi, \dot{\varphi})$

The decisions of a return task allows to construct mathematical model of the executive mechanism, and by the decision of the equation (1) the law of movement of the mechanism with elastic parts in process of re -accumulating is defined, i.e. in the period of re- twisting of the elastic shaft or release of springs.
The mechanisms of making of duck thread of weaver's machine tools such as STB [2], such as the dashing mechanism, 4-color and 6-color mechanisms of change of duck, the mechanisms of braking construction represent cam-lever mechanisms with elastic parts and connections. And movement in these mechanisms is carried out at the expense of potential energy of twirled torso platen or compressed cylindrical springs. In connection with research of movements of such mechanisms there is a necessity to account final elastic movements of its parts.
In flat 4-part mechanism (fig. 1) the elastic connecting-rod can be considered as well as non-stationary connection. The mathematical expression of deformation of an elastic link allows to unit in one system equations of movement of firm bodies located till both parties of an elastic link. We got differential equation for defining the movement of elastic connecting-rod as following:

$$\frac{d\lambda}{d\varphi_1} - a_1\lambda^2 - b_1\lambda = F(\varphi_1, \dot{\varphi}_2), \tag{3}$$

where $\lambda = l_2 - l_2^0$ change of length of connecting-rod .

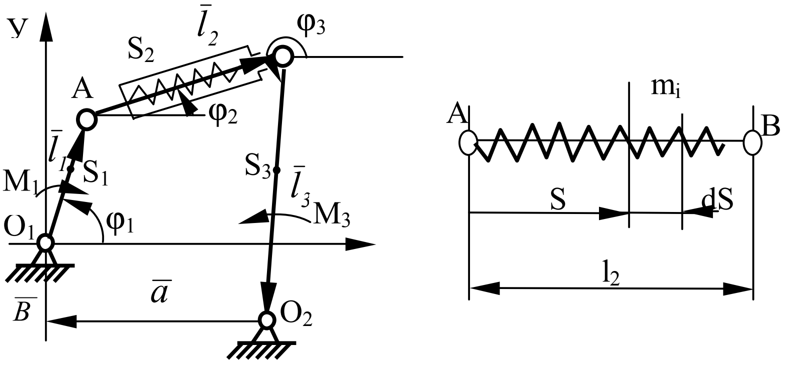

Fig. 1 The mechanism of 4-part machine with elastic connecting-rod.

From the equation (3), as the special case, the well-known expression for small elastic movements will be got [3]. The system of the equations describing the movement of 2-rocker mechanism with elastic connecting-rod is received:

$$\left.\begin{aligned} I_1\ddot{q}_1 + (I_3\ddot{q}_2 + I_3\ddot{q}_3)\Pi' = M_1 - M_3\Pi' \\ I_3\ddot{q}_2 + I_3\ddot{q}_3 + c^* q_2 = -M_3 \end{aligned}\right\}, \qquad (4)$$

where $q_1 = \varphi_1, q_2 = \Delta\varphi_3 = \left(\frac{d\Pi}{dl_2}\right)^0 \lambda, q_3 = \Pi(q_1),$

«0» is a statement at $\Delta l_2 = \lambda = l_2 - l_2^0 = 0$

$I_1, I_3 \quad M_1, M_3$ - moments of inertia and moments of forces.

It is shown, that kinetic energy of elastic connecting-rod is defined from the expression

$$2T = m_2\left(l_1^2\dot{\varphi}_1^2 + \dot{\lambda}^2 + 2l_1^2\dot{\varphi}_1\,\dot{\lambda}\cos\beta\right) + I_2(\varphi_1)\dot{\varphi}_2^2, \qquad (5)$$

where $\dot{\lambda} = V_{S_2 A}$ - is a component of relative speed of a point S_2 along the connecting-rod;

β - angle between vectors and

I_2 - variable moment of inertia of connecting-rod.

The system of the equations describing movement of the flat 4-part mechanism in view of weight of elastic connecting-rod is received as following:

$$\begin{aligned} & I_{11}\ddot{\varphi}_1 + I_{13}\ddot{\varphi}_3 + c\frac{l_1 l_2}{2l_2^2}\cos(\varphi_3 - \varphi_1)\frac{\partial\phi}{\partial\varphi_3} = M_{1,} \\ & I_{31}\ddot{\varphi}_1 + I_{33}\ddot{\varphi}_3 + c\frac{\varphi_3 l_3}{2l_2^2}\cdot\frac{\partial\phi}{\partial\varphi_3}\left(\varphi_3\frac{\partial^2\phi}{\partial\varphi_3^2} + \frac{\partial\phi}{\partial\varphi_3}\right) = M_3, \end{aligned} \qquad (6)$$

where $\phi(\varphi_3, l_2)$ - the equation of connection.

The decision of systems of equations (4) defines the laws of movement of 2-rocker mechanism at known deformation of a center of gravity of an elastic part determined from the equation (3). The specified laws of movement for the periods of compression and re-accumulating are defined from systems of equations (6) in view of weight of elastic connecting-rod.

References

[1] Ualiev G.U.: Dynamics of mechanisms and machines. Almaty, 2001.

[2] Djoldasbekov U.A., Ualiev G.U.: Perfection of mechanisms of weaver's machine tools STB. M., Legpromisdat, 1986.

[3] Bat I.: The equation of movement of flat 4-part mechanism with an elastic intermediate link. *Works of a seminar on TMM*, №3, 1957.