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Resonance regimes in the non-ideal system having the pendulum as absorber

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Abstract: Resonance behavior of the system with a limited power-supply (or non-ideal system) which contains a pendulum as absorber is studied. The system dynamics is described using the multiple scales method. Resonance steady state and frequency responses are constructed. Stability of this stationary regime is studied by the analysis of the state neighborhood. Besides, transient is studied for initial times of the system dynamics.

Keywords: non-ideal system, resonance dynamics, transient

1. Introduction. The principal model

The systems with limited power supply are characterized by interaction of source of energy and elastic sub-system which is under action of the source. Such systems are named also as non-ideal systems. For the non-ideal systems the external applied excitation is a function of coordinates of excited elastic sub-system. The most interesting effect appearing in non-ideal systems is the Sommerfeld effect [1], when in the elastic sub-system it is appeared the stable resonance regime with large amplitudes, and the big part of the vibration energy passes from the energy source to these resonance vibrations. Resonance dynamics of the non-ideal systems was first described by V.Kononenko [2]. Then investigations on the subject were continued in numerous papers. Different aspects of the NIS dynamics are discussed in few books and overviews, in particular, in [3-5].

It is known that nonlinear vibration absorbers permit to reduce essentially amplitudes of resonance elastic vibrations. Here the non-ideal system having the pendulum as absorber (Fig.1) is considered. Such absorber permits to evaluate a decrease of amplitude of resonance vibrations of the elastic sub-system, and to select such parameters of the system when the large amplitude resonance regime is not appearing.

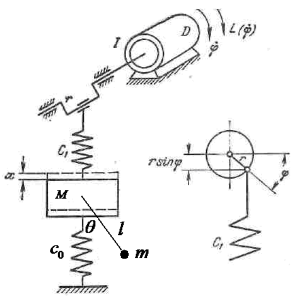

Fig. 1. The model under consideration

2. Results and Discussion

The multiple scales method is used to describe dynamics of the system under consideration with respect to variables *x*, φ and θ described by the following system:

$$\begin{cases} (M+m)\ddot{x}+(c_0+c_1)x=c_1 r\sin\varphi - ml\left(\ddot{\theta}\cos\theta-\dot{\theta}^2\sin\theta\right); \\ I\ddot{\varphi}=\varepsilon\left(a-b\dot{\varphi}+c_1 r\left(x-r\sin\varphi\right)\cos\varphi\right); \\ ml\left(l\ddot{\theta}+g\sin\theta+\ddot{x}\cos\theta\right)=0, \end{cases} \tag{1}$$

where I is the inertia moment of the rotating masses, $L=a-b\dot{\varphi}$ describes the driving moment of the energy source, and the moment of the forces of resistance to the rotation.

. Analysis of modulation equations permits to construct the steady state near the region of the resonance between frequencies of the motor and the elastic sub-system. Choice of the system parameters gives a possibility to decrease essentially amplitudes of the elastic vibrations. Besides, the analysis of the modulation vibrations permits to study a behavior of the system near the resonance regime, and the state stability can be determined. Besides, we can study dynamics of the system at initial times of the dynamical process to analyze an evolution of the system to the steady state.

3. Concluding Remarks

It is shown that the multiple scales method permits to describe the resonance steady state of the system having the pendulum as absorber. A use of the absorber permits to reduce large amplitudes of the system resonance vibrations.

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