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Managed Friction Variator

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ABSTRACT: The article cites the results of the research on the new construction of the toothed rod, which is used for soil treatment before planting.

KEYWORDS: Friction mechanism, variable speed, friction force, ultrasound, high-frequency oscillations, piezoceramics, torque.

I. INTRODUCTION

Nowadays, mechanisms with controlled parameters and connections, which have a number of advantages and advantages over known constructions, are increasingly being developed and applied. Such mechanisms include, for example, controlled friction mechanisms, through which it is possible to solve a number of applied issues. In particular, precision positioning and scanning, as well as the possibility of obtaining controlled movements of the output links in the plane and in space.

Friction variators are widely used in modern machines and devices. They are designed to transmit motion, as well as regulating gear ratios during his work.

Despite their popularity, these mechanisms have several disadvantages. For example, in the construction of a conical variator between the input and output links, an intermediate link in the form of a roller, a ring, etc., is necessarily installed. The transmission is inoperative without these elements. Regulation of gear ratios is carried out by the movement of intermediate links along the longitudinal axis.

II. LITERATURE SURVEY

The use of vibration in engineering and technology has allowed in recent years to obtain significant technical and economic effects in a number of industries. The effect of vibration on systems with dry friction and mathematical approaches to the study of these phenomena are widely covered in scientific literature.

High frequencies of vibrations, especially those lying in the ultrasonic range, lead to a qualitative change in a number of parameters of devices and mechanisms. This is apparently due to the specific features of ultrasonic vibrations and waves. Although the physical nature and the basic laws governing its propagation are the same as for sound waves of any frequency range, it has several features that are due to its relatively high frequencies (15-20 kHz and above) and small amplitudes (the maximum amplitudes are 0 , 2 mm). The nature of ultrasound and its importance in science and technology are quite widely described in the reference book [1].

As is well known in the friction mechanisms of motion transmission or braking, this is due to the friction forces arising between the friction-conjugate elements of the links. The friction force F depends mainly on the friction coefficient f and the normal component of the force P, with which one link is pressed against the other.

If in one of the contiguous links to initiate tangential or normal ultrasonic vibrations, the friction force decreases. When normal oscillations are excited as the amplitude of ultrasonic oscillations increases, the amplitude of the oscillatory force F increases. If the value of F exceeds the force P, then a periodic separation of the contacting bodies from each other occurs. The force of the normal reaction N becomes a function of the oscillating force F, the friction force F does not work all the time. We can assume that in these conditions there is an effective friction forceF^1, the value of which is less than F.

When tangential vibrations are excited, the contact of the bodies is not interrupted, and the force N has a constant value. When the oscillatory speed $\dot{x}$ more body speed v, then the direction of the friction force during one half of the oscillation period coincides with the direction of body movement reducing the external force necessary for this. In this case, you can also enter the effective friction force F^{I} <*F*.True friction coefficient valuef all the time remains constant. But, guided by the principles of vibration mechanics (where, without noticing fast forces and fast motions), the vibration force is added to the system, described in [2], it could be considered $F^{I} = f^{I}N$, (f^{I} –coefficient of dry friction under the action of high-frequency vibrations) coefficient of dry friction under the action of high-frequency vibrations...

The scope of ultrasound is very extensive, in particular they are used to solve a variety of technical problems.

To obtain ultrasonic vibrations, ultrasound emitters (transducers) are used. They can be divided into two large groups. The first includes emitters-generators: oscillations in them are excited due to the presence of obstacles in the path of a constant stream of gas or liquid jets. The second group of emitters electro acoustic transducers. They convert the already specified oscillations of an electrical voltage or current into mechanical oscillations of a solid, which emit acoustic waves into the environment [3].

Piezoceramic and magnetostrictive vibration transducers, included in the second group of emitters, are widely used in modern devices, such as vibromotors, vibration dampers, etc. in precision technology. These vibration transducers have the property of inverse piezoelectric effect, i.e. they deform in proportion to the applied voltage and magnetic fields.

Piezoceramic materials are solid solutions in which the introduction of modifying additives, achieved the optimal properties of materials. These materials are cheap and available for wide use, are well processed and formed [3].
The geometric shape of the piezoceramic element determines its purpose and type of vibrations. They are available in the form of a disk, ring, rod, plate, cylindrical tube, etc. On flat opposite surfaces there are electrodes for polarization and voltage supply.

III. METHODOLOGY

To obtain elastic ultrasonic vibrations in the contact zone of friction mechanisms, piezoelectric transducers are mounted in a link, depending on design considerations. Their attachment is carried out using adhesives based on epoxy resins ED. In piezoelectric transducers, hubs of various types of vibrations made of solid material are used to amplify oscillatory velocities or displacements.

In [4], the concept of a transformer (concentrator) of oscillations of the "traveling wave" type was introduced (Fig. 1). In the simplest case, this is a cylindrical waveguide 1 of flexural vibrations, with a height of 2h and a variable cross-sectional area S (y). Excitation of bending oscillations of the "traveling wave" type is performed in the extreme section of the waveguide, for example, by a piezoelectric transducer 2. At S (y) = const, the radius of the neutral surface r can be expressed,

$$r(y,\varphi) = r_o + \frac{\varepsilon_1}{h} yCosn(\varphi - \omega t), \qquad n = 2,3\ldots, \qquad (1)$$

if a

$$r(\varphi)|_{y=-h} = r_o + \varepsilon_1 Cosn(\varphi - \omega t),$$

where φ - angular coordinate, ε_1 – amplitude of normal displacements in cross section *y=–h*, those. in cross section *y=0*; *r(y,φ)=0* – displacement node, which can be used as a place for fixing the converter.

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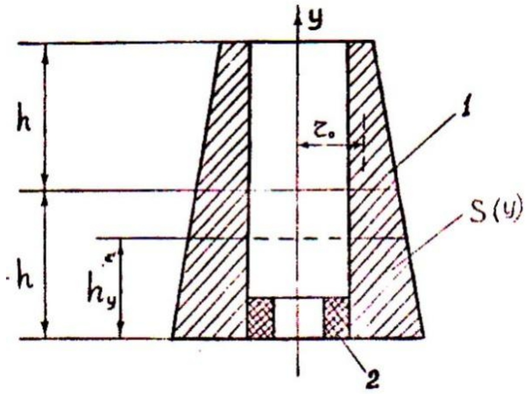

Fig.1. Explanation of the concept of a "traveling wave" type oscillation concentrator

Denoting the amplitude of the normal displacement of the section y = h through ε_2, we have

$$\varepsilon_2/\varepsilon_1=1;\ S(y)=const, \qquad (2)$$

it is clear that

$$r(y)\,|_{y=\pm h}=r_o\mp\varepsilon_1, \qquad (3)$$

that is, the normal displacements are shifted by angle φ by π/n.

If S (y) ≠ const and gradually decreases with increasing y, then the oscillation node shifts down, and

$$\frac{\varepsilon_2}{\varepsilon_1}\rangle 1 \quad ; \quad S(y)\neq const. \qquad (4)$$

Note that oscillator concentrators of the type of traveling waves also solve the problem of attaching the converter to the housing.

IV. RESULTS

A new cone variator scheme has been developed, which works without an intermediate element, and it is also possible to control the movement of the output link. The creation of this mechanism is based on the use of high-frequency oscillations in the designs of the concentrator of concentrators [5].

In the new scheme of the friction variator (Fig. 2), it is the displacement of the vibration nodes that changes the gear ratio of the transmission. The variator consists of two cone-shaped links, the master 1 and the slave 2. They have piezoelectric transducers 3, 4 installed, which are electrically connected to the control unit 5 and the generator 6.

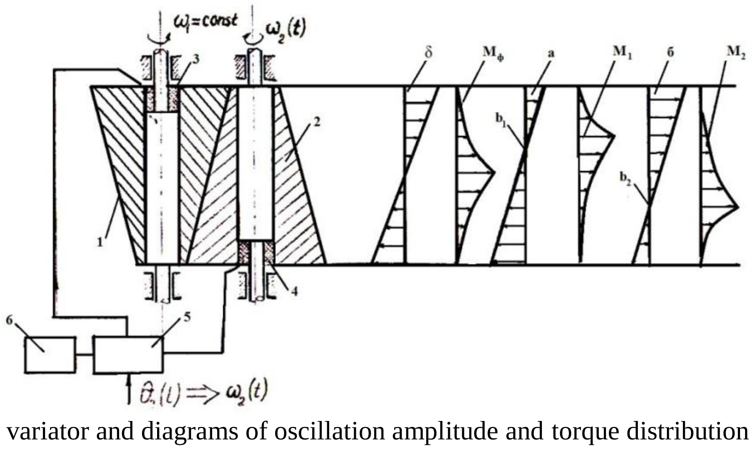

Fig.2. Friction variator and diagrams of oscillation amplitude and torque distribution during operation

Friction variator works as follows. Leading link 1 rotates with a constant angular velocity ω_1=*const*. Due to the moment of the friction force between the surfaces of the links, the driven link 2 will rotate, and a relative slip of the links occurs, the value of which increases from the middle of the contact zone to its edge. Therefore, the moment of friction force, rotating the driven wheel 2, will act from the middle of the contact zone. The control unit 5 sets the required law of rotation of the slave link $\theta_2(t)$. The control unit processes this signal and connects an oscillator 3 and 4 to generator 6. If a converter 3 is connected, it begins to emit high-frequency radial-bending oscillations. Lead link 1 will oscillate as a vibration concentrator. Due to the taper of the cross section of the leading link 1, the oscillation unit b_1 does not coincide with the middle of the contact zone. It is at the point M_1 that the friction force has its maximum value and the moment of force M_1 will rotate the driven member 2.

When converter 4 is connected to the generator, a similar process also takes place, but now the friction force has its maximum value at the point b_2 and the moment of force M_2 will rotate the driven link 2, i.e. the moment of friction force is shifted to another place, thereby changing the gear ratio of the transfer.

V. CONCLUSION

Thus, from the above studies the following conclusion follows: the use of ultrasonic vibrations in the structures of friction mechanisms, you can control the value of the force of dry friction. Consequently, to control the law of motion of the output link of the mechanism.

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