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METHOD FOR RESEARCHING BELT TRANSMISSIONS WITH A DRIVEN COMPOSITE PULLEY AND WITH ELASTIC ELEMENTS

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Abstract: The article presents the design diagram and operating principle of the developed belt drive with a composite driven pulley with elastic elements. The results of experimental studies on the load of shafts and the rotation speed of transmission pulleys for various brands of rubber used in composite pulleys are presented. The results of full-factorial experiments to optimize the parameters of the belt drive are presented, as well as the results of production tests of a cleaning machine, the drive of which uses the recommended belt drive.

Keywords: Belt drive, composite pulley, rubber bushing, tension roller, rigidity, vibration, frequency, amplitude, drive, torque load, elongation, gear ratio, testing, cotton cleaning efficiency.

1. Introduction. The purpose of the experimental studies is to determine the dependence of the influence of the parameters of a composite tensioning roller with an elastic element on the change in the torque of the drive and driven shafts, the change in their rotation frequency, taking into account belt slippage [1,2,3,4,5].

During the development of the experimental installation, a number of disadvantages were eliminated that were not taken into account in previous designs of experimental installations used for research [6,7]. The experimental setup allowed measurements to be carried out in the operation of the machine with simultaneous processing of the results obtained on a computer, for which an LTR-154 type digital converter was used.

In most of the above studies, strain gauges with load cells glued to the shafts are used to measure torques on drive shafts [8,9,10]. But, in our case, the shafts have a cantilever part and with this method it became necessary to develop a device that allows measurements to be made with a minimum error. The design diagram of such a device is shown in Fig. 6. The device consists of a hub 1 for mounting on a shaft and transmitting torque to a pulley 3 mounted on a rolling bearing 2. Also, two leashes 4 are fixed on the hub, on one of which load cells 5 are glued. Leashes 4 on one side grooves 6 are recessed in the drive pulley, and on the other side they are fixed on the hub1. To transfer force to the shaft or from the shaft to the pulley, the leash 4 is both a drive and a beam for labeling load cells.

A pulley 3 for belt transmission is installed on the hub 1 using a rolling bearing 2. The pulley 3 mounted on the rolling bearing 2 has the ability to rotate around the axis within the elasticity of the beam 6 with load cells 5 glued to it. Since the beam is

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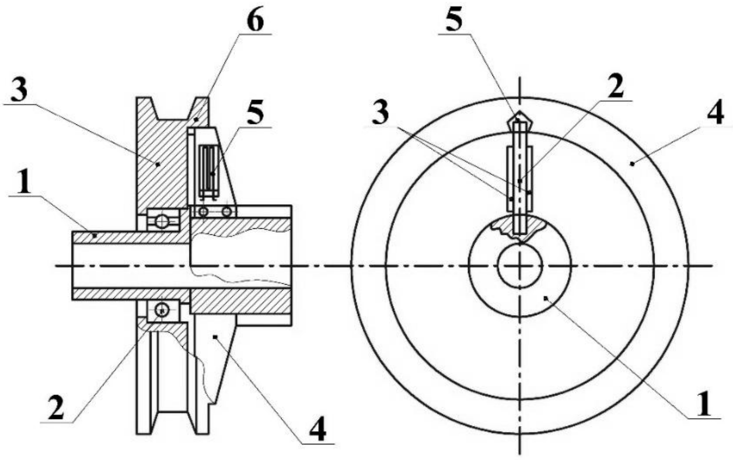
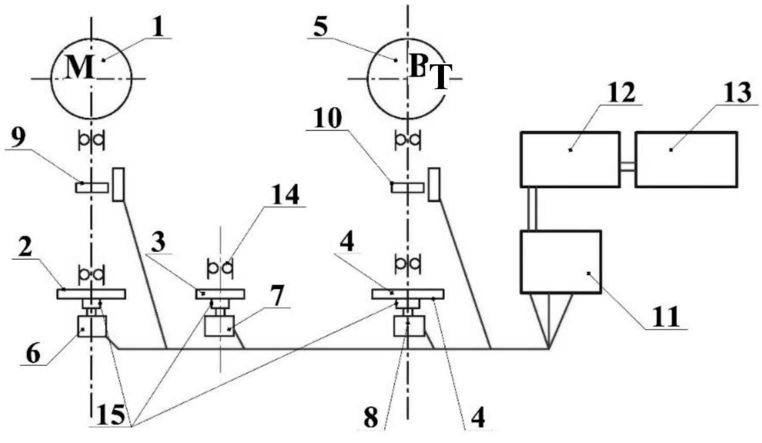


1-hub for mounting on the shaft; 2 –rolling bearing; 3-pulley; 4-habits with load cells glued to it; 5-load cells; 6- groove for installing the beam.

Fig.1. The diagram of the torque meter with a
leash 4 for the pulley 3, one end of which is fixed to the hub 1, and the other ends enter the groove 6, milled on the rim of the pulley 4. From the impact, the beam 6 bends as the torque transmitted by this transmission increases, leading to a change in the parameters (resistance) of the load cells 5 glued on the surface 4. After carrying out the appropriate calibrations, the true values of the torque of the transmitted belt drive are calculated on the computer.
The electrical measurement circuit was adopted as a classic one with a digital converter and an amplifier, the circuit of which is shown in Fig. 2. According to the results of the experiments, oscillograms were obtained characterizing the angular velocity of the shaft of the drive pulley, the torques on the shafts of the drive and driven pulleys and the loading of the axis of the tensioning transmission roller.



1-electric motor, 2-drive drive pulley, 3- tensioning roller, 4- driven pulley, 6-7-8- current collectors,9-10 Hall sensors with gloves, 11 strain gauge amplifier-4-1,12- digital converter LTR-154, 13- computer.
Fig. 2. Measuring block diagram of the installation

According to the results of the experiments, oscillograms were obtained characterizing the angular velocity of the shaft of the drive pulley, the torques on the shafts of the drive and driven pulleys and the loading of the axis of the tensioning transmission roller. An analysis of the law of loading of the shaft of a driven composite pulley with an elastic shock absorber in comparison with the

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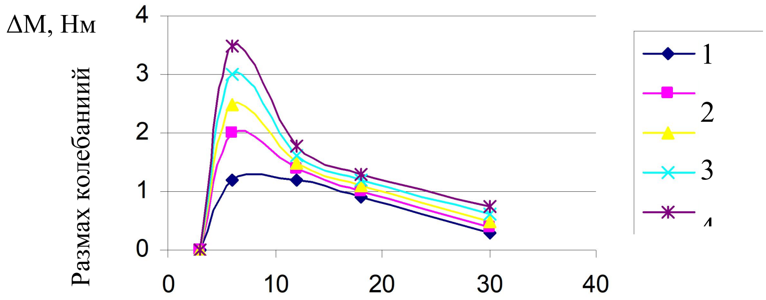
loading of the shaft of the driven pulley of the existing belt drive showed that the peak torque values in the recommended version of the belt drive are reduced 1.5-2.0 times [12,13,14]. This allows the necessary uniformity of movement of the working body of the technological machine, as well as reducing the load of the electric drive. It should be noted that if it is necessary to ensure the required uneven rotation of the output shaft, we recommend changing the eccentricity of the tensioning roller of the recommended belt drive (or the stiffness of the rubber sleeve of the tensioning roller).

The analysis of the obtained oscillograms shows that with an increase in the eccentricity of the tensioning roller, the amplitudes of fluctuations in the loading of the tensioning roller axis and torques on the pulley shafts, as well as the angular velocity of the drive pulley, increase [15,16].

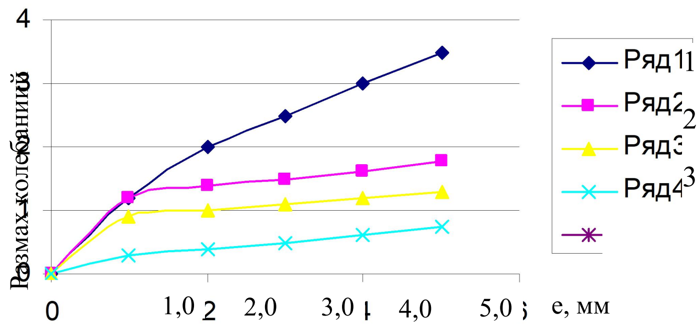
For the recommended belt drive, it is important to obtain the law of motion of the driven pulley with the required change in angular velocity, allowing the efficient execution of the technological process by the working bodies associated with the shaft of the driven pulley. Figure 3 shows the obtained graphs based on the processing of waveforms. In this case, the value of the eccentricity of the tensioning roller is taken as a constant value of the deformation of the elastic sleeve of the roller, that is Δ=e.



а) Нагрузка, Нм

Graphs of the dependence of DM on the transmitted load at different values of the eccentricity of the tensioning roller (mixing of the roller axis, Δ = e).

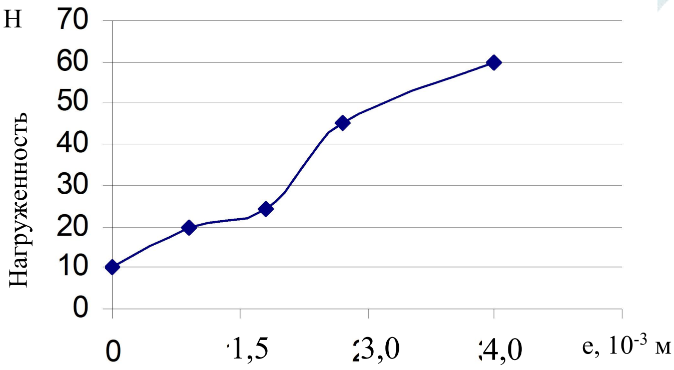
1-e=1мм, 2-e=2мм, 3-e=3мм, 4- e=4мм



б) Eccentricity

Graphs of the dependence of the change in the magnitude of the torque fluctuations on the shaft of the driven pulley on the change in the eccentricity (or axis shift) of the tensioning roller

1-M=6 Нм, 2- M=12 Нм, 3- M=18 Нм, 4- M=30 Нм



в) Eccentricity

The dependence of the load change on the axis of the tensioning roller on the change in the values of eccentricity

Fig. 3. Dependences of the parameters

The analysis of the graphs in Fig. 3 shows that an increase in the eccentricity from 1.0 mm to 5.0 mm leads to torque fluctuations on the shaft of the driven pulley, the range of which reaches 1.2 Nm at a technological resistance of 12 Nm, and at a load of Ms = 30 Nm, the DM reaches 2.5 Nm. At the same time, the load on the axle of the tensioning roller increases to 60 N with an eccentricity of 2.5 mm (Fig. 3b). Taking into account the operating conditions of the cotton gin, the drive of which has the recommended belt drive with a tensioning roller with an eccentricity of (2.5-3.5) mm. It is important to study the effect of deformation of the rubber sleeve of the roller (Δ) or eccentricity (e). [17,18] Figure 4 shows experimentally obtained graphical dependences. With increasing eccentricity, the range of torque fluctuations on the driven pulley shaft increases to 3.45 Nm. With an eccentricity of 5.0 mm tension roller.

Eccentricity

1-at C =100 Nm/rad; 2-at C =200 Nm/rad; 3-at C=300 Nm/rad.

Fig. 4. Dependences of the torque change on the driven shaft on the eccentricity of the tensioning roller at different values of the circular stiffness of the rubber

Conclusions. The patterns of changes in the load of the belt drive shafts are determined. Graphical dependences of changes in the range of torque fluctuations on the shaft of the driven belt drive pulley on various values of the eccentricity of the tensioning roller, on the external technological load when changing the rotation speed and stiffness of the rubber shock absorber are constructed. The patterns of loading of the tensioning roller with a change in the values of eccentricity are obtained. The technique and electrotensometric scheme of an experimental installation for changing the load and driving modes of a recommended belt drive with a composite driven pulley with a rubber shock absorber are presented.

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