BALL MECHANISMS USED IN METAL CUTTING MACHINES

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Abstract: The article contains information about the ball mechanisms used in metal cutting machines, their structure, kinematic schemes and principles of operation.

Key words: Lathe mechanisms, Metal cutting machine, Disk lathe, Automatic and semi-automatic lathes.

Cam mechanisms are used as a traction device in metalworking machines, mainly in the drive of automatic machines. Cam mechanisms used in metal-cutting machines serve to convert the uniform rotational motion of the cam into a forward-reciprocating motion in various patterns. Such mechanisms also serve as an information carrier. Due to the limitation of the amount of movement of the cam in terms of dimensions, the use of cam mechanisms is also limited. An example of the cam mechanisms most often used in metal-cutting machines is the flat cam mechanism. Due to the simplicity of the design and compact location of such mechanisms, they are convenient for implementing various control functions.

In drum-type cylindrical cam mechanisms (Fig. 1.6, a) or end-type cam mechanisms (Fig. 1.6, b), the grooved cam 1 is the leading link, and the roller of the pusher 2 moves in this groove. The maximum length of the movement (along the cam curve) in drum-type cam mechanisms is 300 mm, and in disc-type flat cam mechanisms it is 100-120 mm.

The principle of operation of the disc-type cam mechanism (Fig. 1.6, c) is as follows: the cam 1 rotates at a constant speed around the axis 0_1, which is driven by the drive. A slider is attached to the other end of the lever, which is attached at one end to the roller 2 moving along the cam profile surface, and the slider, in turn, is attached directly to the working body. The roller 2 oscillates in accordance with the profile of the bush and transmits forward-reverse movement to the working body through a lever mechanism and a pulley.

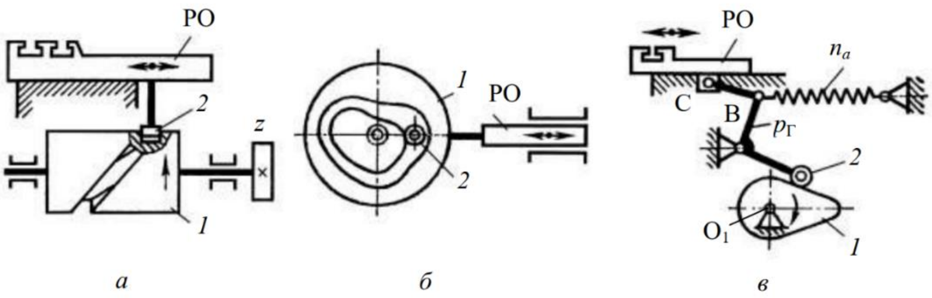

Figure 1.6. Kinematic schemes of roller mechanisms used in metal cutting machines.

In metal cutting machines, cam mechanisms with a force-driven or kinematic connection are most often used. In cam mechanisms with a force-driven connection, the constant contact between

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the cam profile and the actuator is achieved due to the compression force of the spring (Fig. 1.6, a, b). In this case, the amount of spring compression force is determined by the following formula:

$$P=1,5\ (Q+ma)$$

Here: Q – gravity;
m – displacement node mass;
a – the maximum amount of acceleration.

The coefficient, whose formula is equal to 1.5, is the amount that ensures that the pusher does not leave contact with the cam profile (permanent contact). In cam mechanisms with a kinematic connection, permanent contact between the cam and the pusher is achieved due to the groove along which the pusher moves in the cam (Fig. 1.6, f, b).

The sleeve in the sleeve mechanisms used in metal-cutting machines must provide sufficiently high contact strength and wear resistance. Sleeves operating under relatively low stress are made of high-quality cast iron or steel grades 40 and 45X, heat-treated by heating with high-frequency current to bring the hardness of the working surfaces to HRC 52÷58. Sleeves operating under high stress are made of low-carbon steel grades 15, 20X, 20XG, cemented to a depth of at least 0.8÷1.0 mm on the surface and tempered to bring the hardness to HRC 56÷62.

The bearings, which are subject to very high wear resistance, are made of nitrided steels and heat treated to bring their hardness to HRC 60÷67. The thrust roller is made of 20X or SHX15 steels, cemented and heat treated to bring their hardness to HRC 56÷62.

When calculating the mechanisms with bearings, it is necessary to determine the contact force in the contact zone of the bearing and the thrust.

The maximum contact force for disc bearings is determined by the following formula:

$$\sigma = 0.0418\sqrt{\frac{N}{b}\cdot E\cdot\left(\frac{1}{r}+\frac{1}{\rho}\right)},\ \text{МПа}$$

Where: N – normal force on the lug profile, N;
b – contact line length, cm;
E – modulus of elasticity, MPa;
r – roller radius, cm;
ρ – minimum radius of the lug profile protrusion, cm.

The permissible value of the contact force depends on the surface hardness of the cam material. For gray cast iron, this value is (HW) 1.5 MPa, for high-quality cast iron (HW) 1.8 MPa, and for tempered low-carbon steels (HRC) 26 MPa.

Cam mechanisms used in automatic and semi-automatic lathes serve to transmit motion from the distribution shaft to the working body (Fig. 2). In cam mechanisms used in such devices, the cam is flat, disc, wedge and cylindrical. The simplest cam mechanism (Fig. 2, a) consists of a cam 1, a roller 2, a pusher 3 moving in the guide and a spring 4 returning the working body to its original position. The transmission of motion from the cam to the working body is often carried out not only through the cam, but also through several kinematic links - levers, rack and pinion, gear sector, etc. To return the working body to its original position, the mechanism is equipped with a fixed groove and a reverse profile cam.

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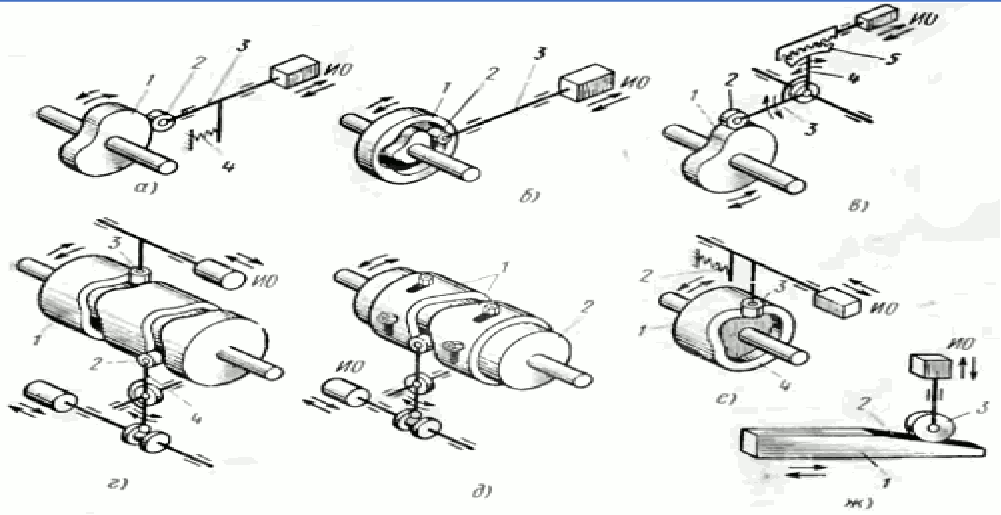

Figure 2. Bellows mechanisms used in lathes.

In the mechanism shown in Fig. 2, b, a disk-shaped wheel 1 and a roller 2 are placed in a closed groove in it, and the movement is transmitted to the working body from the roller 2 through the pulley 3. Returning the working body to the initial (initial) position is carried out using a closed ditch.

Another cam mechanism used in a lathe (Fig. 2, c) consists of: disc cam 1, roller 2, rocker arms 3 and 4, and rack gear 5.

A cylindrical roller mechanism used in some metal cutting machines is illustrated in Fig. 2, g. A curved groove is milled in the sleeve of such a mechanism, and rollers 2 and 3 are placed in these grooves. The movement to the working body is transmitted directly from the roller 3, and from the roller 2 through the oscillating lever 4.

The mechanism shown in Figure 2, e differs from the previous ones in that it has two cylindrical lugs placed one above the other. The position of these lugs can be changed by rotating the housing 2 in its cylinder. In the bell-shaped lug mechanism (Figure 2, e), a working curve 4 is formed on the end of the housing. The movement The transmission is carried out through the roller 3. The roller 2 is pressed by a spring against the curved surface of the cam. Such cams are used in the drive of the spindle head in longitudinal planing machines. In this case, the travel distance of the spindle head is large and expands the technological capabilities of the device.

Flat wedge cam mechanism used in metal cutting machines It is illustrated in Figure 2, j. In such a mechanism, the cam 1 moves and moves the roller 3 with the help of the shaft 2, and the roller 3, in turn, moves the working body. Mechanisms of this type are used to push the support on which the cutting tool is installed in multi-key machines of the 1730 and 1A730 brands.

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