ANALYSIS OF THE SMOOTH STROKE OF THE WAVE END KINEMATIC GEARBOX

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Annotation. The article presents an analysis of the characteristics of a wave gearbox with a new type of multi-pair gearing. A relationship has been established that determines the uniformity and smoothness of gearing

Key words: multi-pair gearing, kinematic accuracy, wave gearbox, virtual model, gear, eccentric shaft, rotation angle, gear tooth.

Introduction

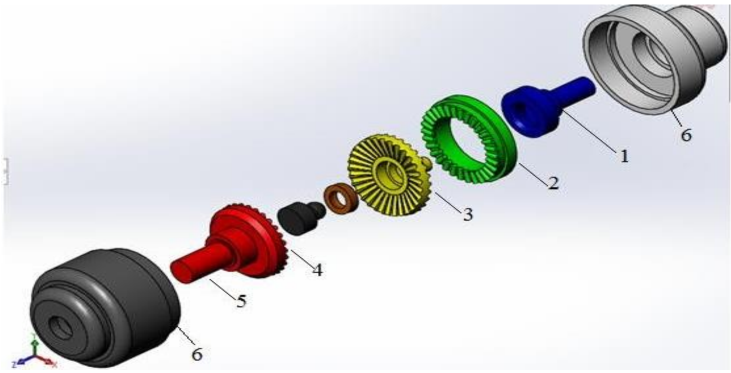
Analysis of modern trends in improving gearing systems, numerical characteristics and consumer requirements for the technical level of manufactured gearboxes has shown the feasibility of research and development of wave gearboxes with a new type of multi-pair gearing [1,2]. Multi-pair gearing ensures an increase in the load-bearing capacity of the gearbox as a whole, improves energy and weight-size indicators, increases kinematic accuracy, reduces the level of stress in contact and improves the geometric and hydrodynamic conditions for lubrication of interacting teeth, etc. Therefore, the use of wave gearboxes with multi-pair gearing in power drives of machines is very effective [6]. The high kinematic accuracy of wave gearboxes with a convex-concave tooth profile, their compactness and a wide range of transmission functions, as well as the ability to completely eliminate gaps in engagement and even create some preload make their use beneficial in mechanisms used in the mining industry, actuators of industrial robots and manipulators, in metal-cutting machines, and other mechanisms that require high positioning accuracy of working parts].

Main part

In Figure .1. shows a 3D virtual model of a wave end kinematic gearbox, which contains an input shaft (eccentric shaft) with an eccentric e (1); Input wheel with number of teeth Z1 (2); the gear has teeth at two ends Z 2 (3); output wheel with number of teeth Z3 (4); output shaft (5); body (6).

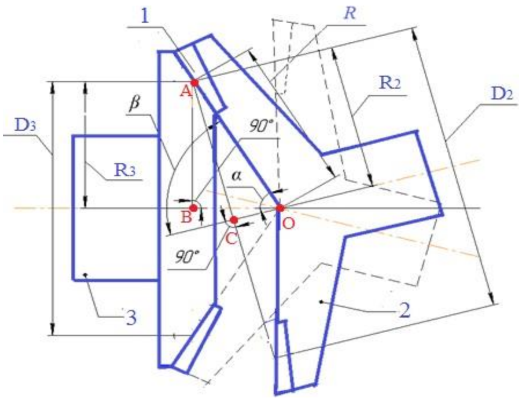
The operating principle of this gearbox is as follows:

The rotation of the input shaft (eccentric shaft) 1 sets in motion gear 3, which performs a spatial oscillatory motion between wheels Z1 and Z3. Thanks to the complex movement of gear 2, which is transmitted to the output wheel 3.



Rice. 1. Virtual model for research

Using the Solidworks program, we built a virtual model of the wave end kinematic gearbox (Fig. 1). And with the help of this model we will conduct a study, which consists of identifying at what angle the wheel rotates when the gear is rotated 360°. To do this, it is necessary to rotate the input shaft on which the gear is mounted, which in turn is meshed with the wheel. When the input shaft rotates, the angle of rotation of the wheel may be uneven. By turning the shaft to a certain angle and measuring the angle at which the wheel has turned, you can analyze the smooth operation of the gearbox during one full revolution of the shaft. The data obtained and based on them a graph of the dependence of the wheel rotation angle on the shaft rotation angle was constructed.



Rice. 2. Kinematic diagram of the end kinematic wave gearbox.

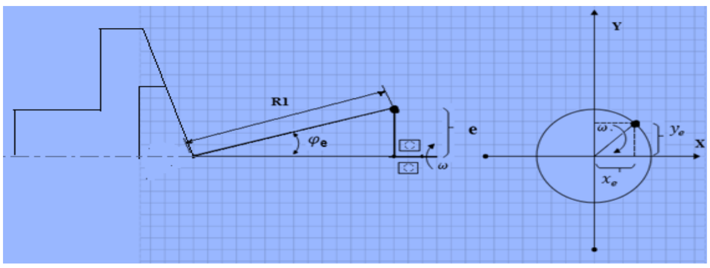


Figure 3. Design diagram of a wave end kinematic gearbox

Figure 3 shows the following parameters:

φ_e– angle of rotation of the eccentric shaft with the eccentric e (from 0 – 360N); N is the number of rotations of the eccentric shaft;

Angle of rotation of the eccentric shaft per gear tooth

$$\varphi_e = \frac{\varphi_ш}{Z_3}$$

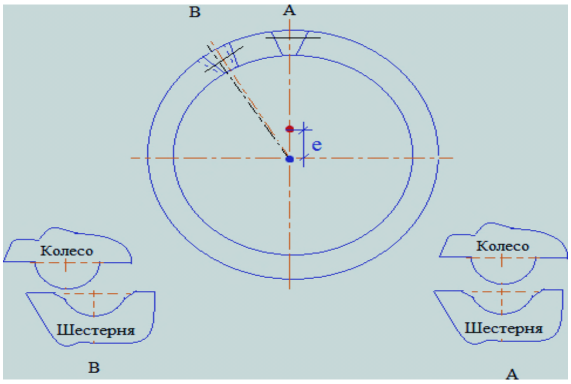
Those. when the eccentric shaft is rotated by an angle φe = 0.4°, the output wheel rotates by an angle

$$\varphi_к = \frac{\varphi_e}{i}$$

In Fig. Figure 4 shows the movement of the teeth as the gear moves.

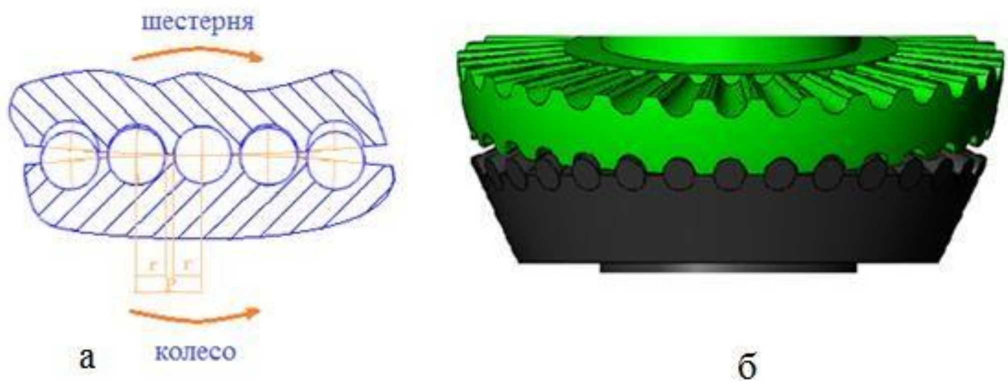
The arrows show the direction of movement of the tooth and cavity (Fig. 4 a).

This position, in which the tooth completely enters the depression, is occupied by the gear teeth alternately, since two teeth cannot simultaneously occupy such a position (Fig. 4 b).



Rice. 4. Meshing of the wheel and gear: a – cross-section in full engagement of the gears; b – cross section of teeth not in mesh.

The remaining teeth are only at different angles, oriented not in the plane, as in Figure 5.a. in space. This can be observed in Fig. 5. b.



Rice. 5. Wheel and gear engagement: a – front view; b – right view.

Per revolution of the eccentric shaft per tooth. We summarize the obtained data in Table 1, using them to construct a graph (Fig. 6) of the dependence of the angle of rotation of the wheel on the angle of rotation of the eccentric shaft [3].

Table 1. Rotation angles of the eccentric shaft and wheel

Table 1.

φ_e(Angle of otation eccentric shaft, Min)	φ_{TO}(Angle of rotation Output wheel, Min)	interference
0	0	No
2	0.066667	No
4	0.133333	No
6	0.2	No
8	0.266667	No
10	0.333333	No
12	0.4	No
14	0.466667	No
16	0.533333	No
18	0.6	No
20	0.666667	No
22	0.733333	No
24	0.8	No

Conclusion

The constructed graph has a linear shape, the nature of which indicates the uniformity and smoothness of the gearing

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