

## PLANETARY PRECESSION GEAR WITH THIN-LAYERED RUBBER METAL

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**ABSTRACT:** In connection with spatial - spherical movement of one of gear wheels, the sliding friction appears between the gearing teeth of precession gear. In power precession-planetary gear, the decrease of sliding friction is obtained by executing the teeth of one wheel (as a rule the block satellite of gear) similar with that including conic-rollers, which are established with possibility to rotate round their axes. In precession gear cases, versions with rollers are not possible for using because of the small sizes of this gear. For this reason, one of more effective methods is a method proposed in the paper, which is based on the use of the thin-layered rubber-metal laminates between the gearing teeth.

**KEYWORDS:** power precession-planetary gear, sliding friction, thin-layered rubber-metal laminates, toothed wheel.

### 1. THEORETICAL CONSIDERATION

Planetary precession gear requires specific spatial movements of one of the wheels; sliding friction is present between teeth in their relative movement. In power planetary precession transmission, sliding friction shrinks by executing one of the wheels (usually the satellite wheel) with tapered roller bearings, fitted on the axles for rotation about their axes.

In kinematical planetary precession transmissions, this is difficult to perform, due to its small size; therefore, the question of reducing power losses in cinematic precession gear is very important.

One method that ensures minimum power loss in precession gearbox unit is reasonable choice criteria - minimum sliding velocity of non-standard teeth profile and change of the profile [1]. A more efficient method is the method described in [2]; this method is based on the use of thin-layered rubber-metal laminates placed between the meshing teeth. This method is more effective for kinematic precession gear due to:

- meshing multiplicity (simultaneous gearing up to 100% pairs of teeth), which allows reducing local pressure by redistributing simultaneously loads engaged between the teeth;
- tooth profile form provides a slow transition from the active to the passive part and allows a continuous coating of elastic material;
- use of thin-layered rubber-metal laminates placed between the meshing teeth leads to reducing vibration and noise level during gearing process with relatively low cost;

- tooth profile shape allows the use of relatively simple technologies for fixing the elastic material on tooth surfaces and automation of these processes.

### 2. APPLICATION DEVICE FOR FIXING THE ELASTIC THIN-LAYERED RUBBER METAL ON THE TEETH SURFACE

The problem solved by the proposed devices is widening functional possibilities and increasing the quality of gluing surfaces [3,4].

Formulated goals are achieved in the process of gluing elastic film to metal surfaces, by applying intermittent adhesive substance on the thin-layered rubber-metal.

Adhesive substance is continuously fed through the distributing device which applying glue on the adhesive material substance at least one glue application roller and at least one press roller, due to fixed thin elastic layer.

Cogwheel performs a spatial sphere movement (precession) around of the point of intersection of the wheel and roller press axis generators, which has also a conical shape; the wheel performs rotation movement around its axis, coordinated with the precession movement.

The device for gluing the elastic thin layer on the non-linear surfaces includes a reservoir for adhesive, at least one press roll, the width of which is greater than the width of the teeth, made in the form of a bevel wheel with non-standard profile of the teeth, which glued elastic film.

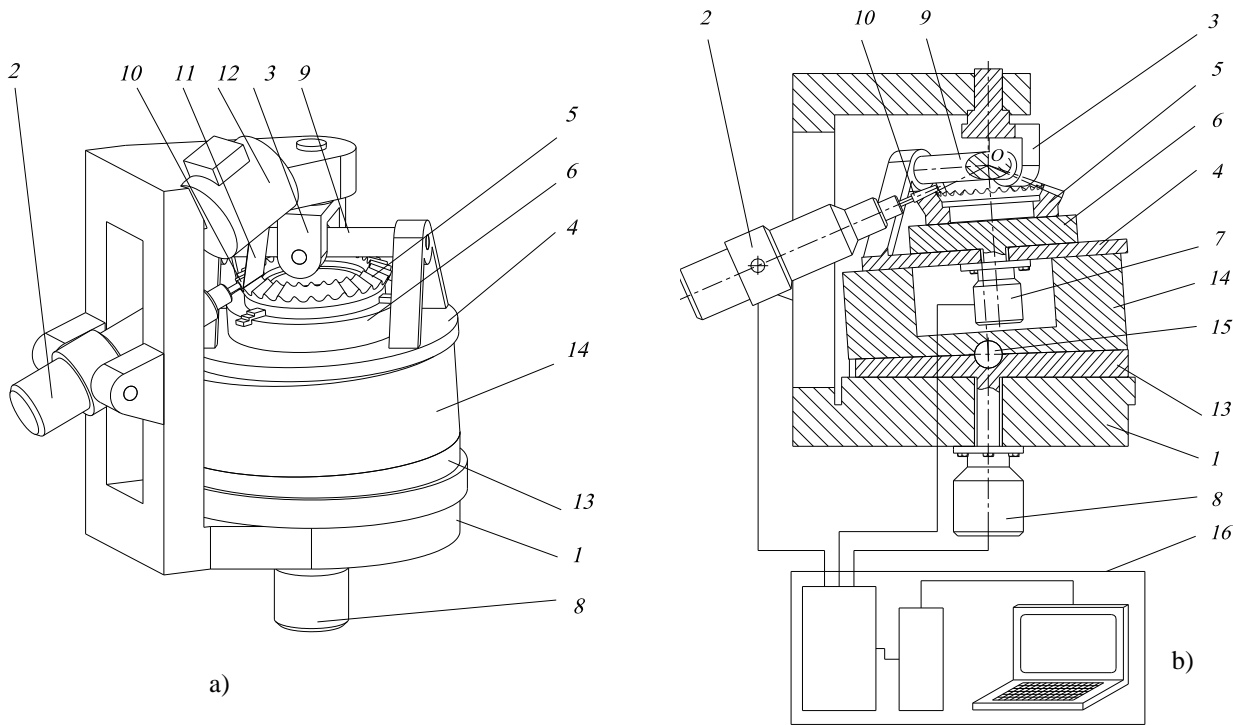
The device is installed on a table, performing sphero-spatial (precession) motion around the point of intersection of the generators teeth and rotation

around its axis of coordinates, with sphero-space (precession) movements.

Press roller has a conical shape and it is attached to roller holder, with the possibility of adjusting the angular position and the axis roll in relation to the

point of intersection of generators and teeth and axle gear.

Actuators and laser tool directions are coordinated by means of a computerized control system.



**Figure 1.** Application device: a) – main view; b) - section trough the device

Application device (Figure 1, a and b) includes a housing 1, the mechanism roller holder 2, the upper fork 3, the lower fork 4, the toothed wheel 5, fixed on the table 6, the actuators 7 and 8, cross fork 9, the

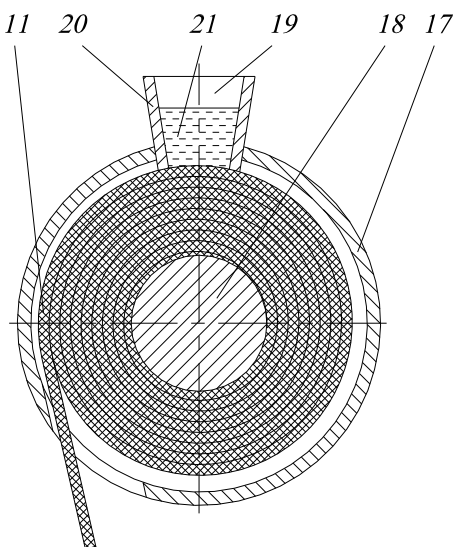
pressing roller 10, the elastic band 11, the supply drum 12, the disc with adjustable inclined board, composed of lower disk 13, the upper disc 14 and ball 15, the control system 16.

Electric signals are received by the control system 16 via actuator 8, gear 5, then turntable table 6 starts a precession motion around a fixed center precession "O".

The precession movement is obtained as a result of the rotation of the disc flange, inclined towards the actuator 8, the upper planar surface of which is permanently in contact with the bottom surface of the yoke bottom 4 which, by means of forks top 3 and the heart crossing 9 is fixed against rotation during precession movement, so it is shown in figure 1.

All axes of rotation, including roller thrust generator 10, which presses the elastic film 11 coming out of the reservoir 12, intersect in the center of precession "O".

As shown in figure 2, the supply drum 12 is composed of the body 17, shaft 18, on which the



**Figure 2.** Supply device

elastic band 11 is wrapped around, the chain 19, the dispenser 20 of adhesive substance 21.

The problem solved by the device shown in figure 2 is broadening the functional possibilities and increase of the quality of gluing surfaces [3,4].

One more advantage of the device is the possibility of performing different types of feed with adhesive film [3].

### 3. CONSTRUCTIVE SOLUTIONS FOR ADESSIVE DEVICE

First considered solution is presented in figure 3. The mechanism for continuous advancement of the thin-layer rubber-material and adhesive material includes a plan support 22 and guidance rollers 23.

Second solution taken into consideration could be seen in figure 4. The mechanism for continuous

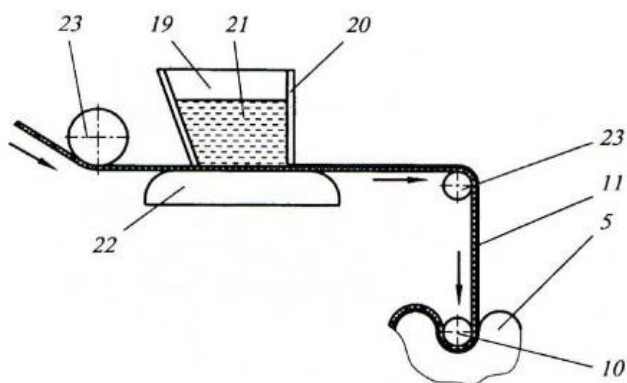


Figure 3. First solution

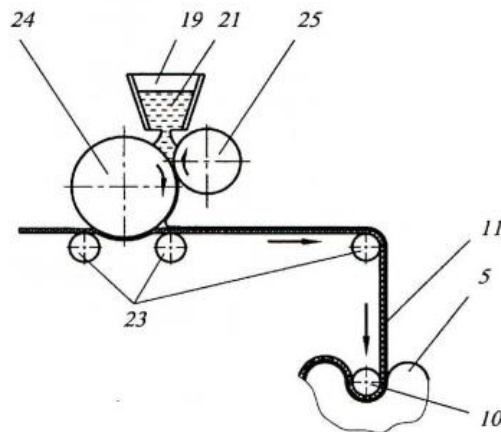


Figure 4. Second solution

advancement of the thin-layer rubber-material and adhesive material includes additionally a lubrication roll 24 and one dosing 25.

The third analyzed solution is that presented in figure 5.

The mechanism for continuous advancement of the thin-layer rubber-material and adhesive material includes supplementary a grooved roller 26 and a leveling roller 27 [5].

In figure 6, the thin-layer rubber material is presented in two versions: ring section 11a and conical ring 11b [5].

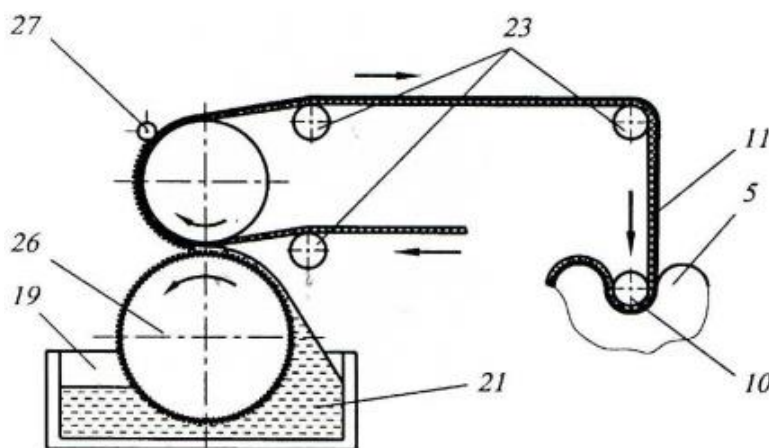
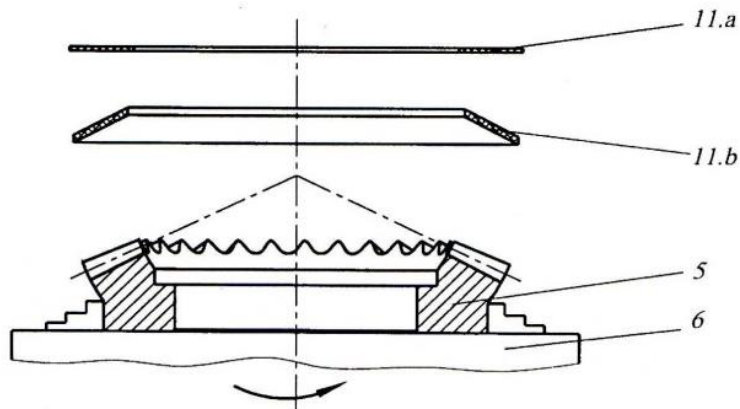


Figure 5. Third solution



**Figure 6.** Thin-layer rubber materials form

#### 4. CONCLUSIONS

The essence of the device and the application (fixing) process of the elastic material consists of the following [3, 4]:

- spatial and rotational movement sphere is conducted by blank with fixed pressing roller;
- movements are achieved by means of numerical controlled actuators;
- the device has a modulated construction, which simplifies the solution of the entire mechanism.

The advantages offered by the protective thin-layers of elastic rubber-material engaging surface of teeth [2] are the followings:

- fixing the elastic thin-layer on the teeth surface eliminates the need of supplementary finishing operations of meshing teeth surfaces;
- elastic laminate material (rubber) has a very high strength and stiffness in compression and a nonlinear compression and hardness while also nurturing the laminate material property as initial properties under shear action;
- these properties offer to the laminates layer a good behavior in the analyzed case (decrease of sliding friction in various couplings, machine parts and gears).

In the future, there is the intention to develop researches in the field of identifying improved solutions for the precession gears and to investigate the behavior of other materials used manufacturing of the precession gear components.

#### 5. REFERENCES

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