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Department "Fundamentals of Machines Design"

Generation of precessional gearing with convex-concave contact

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Project description:

Mechanical transmission consumers impose more and more demands on increasing the energy efficiency and their load bearing capacity. If about 80% of the global energy is transmitted to the drive mechanisms of the machines through mechanical transmissions, then the increase of their mechanical efficiency by only 1% leads to the saving of 0.8% of the energy produced on a global scale.

The development of the robotics and mechanical systems with compactness restrictions impose to the gear ever more stringent requirements regarding the mass and gauges, the quality of the gear material, the technological efficiency measured during the manufacturing operations, the cost of production, etc.

These requirements taken as a whole lead to the need to diversify and modernize the toothed gears A° in the form of the tooth contact of the gear geometry and toothed wheels manufacturing technology.

These requirements can largely be met by precessional transmissions with a new toothed gear concept with „congruent" concave-concave contact.

Ensuring the competitiveness of PT with specific constructive-kinematic features of the toothed gears with gear with *"congruent"* concave-concave contact needs research in the following directions:

- Development of a new toothed gear concept with *"congruent"* concave-concave contact with small difference of the curvatures of the flanks
- Elaboration of the generation processes by spatial tumbling-rolling of the convex / concave profiles and in a circle arc on numerically controlled machines and of the additive technologies with prototyping in 3D printers.
- Creation of the CAD/CAM/CAE platform for designing, manufacturing and researching the congruent contact and the precessional gear as a whole with major functional characteristics.

The foreseen researches have a complex multidisciplinary character with a pronounced opening to the patenting of inventions, including all the aspects necessary for the manufacture of industrial products for the purpose of their commercialization.

The expected results of the researches will be expressed in the elaboration of new A° toothed gears with straight $A^{\circ}_{cv\text{-}cv}$ and inclined $A^{\alpha,\beta}_{cv\text{-}cv}$ toothed gears with *"congruent"* concave-concave contact of the teeth, of new generation technologies by spatial tumbling-rolling of the convex/concave profiles and in a circle arc and expanding the field of applications.

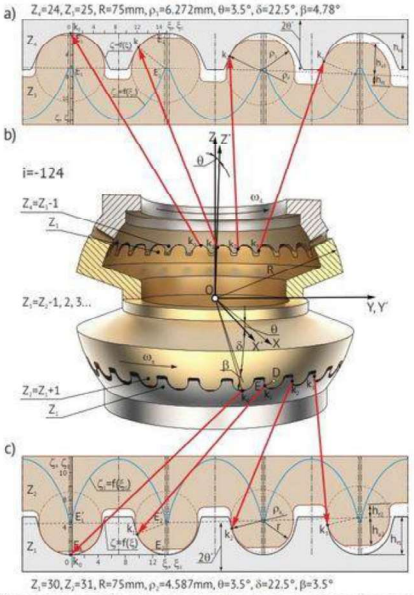
The mathematical model and the synthesis of the precessional gearing

The executory coordinates of the tooth profile are:

$$X_{E_0} = k_{2_0} \cdot z_{E_0} + d_{2_0}$$

$$Y_{E_0} = k_{1_0} \cdot z_{E_0} - d_{1_0}$$

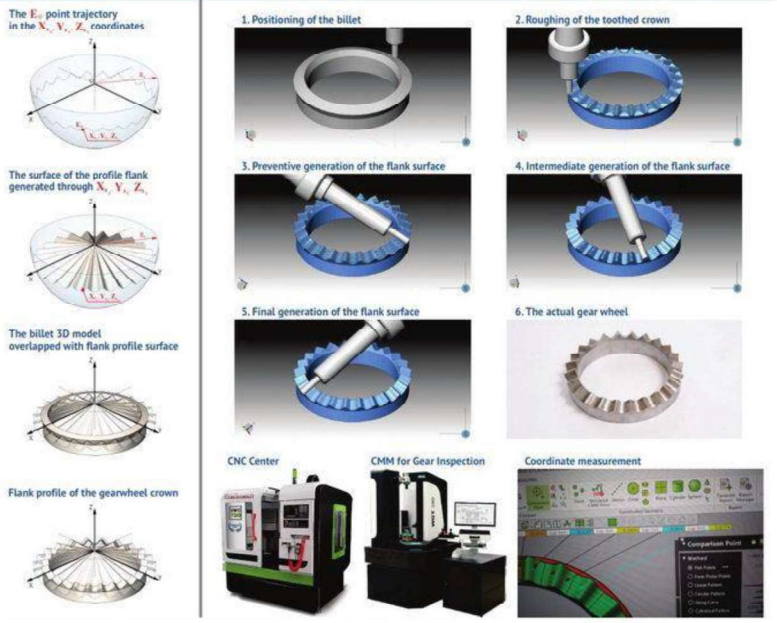
$$Z_{E_0} = \frac{(k_{1_0} \cdot d_{1_0} - k_{2_0} \cdot d_{2_0}) - \left[(k_{1_0} \cdot d_{1_0} - k_{2_0} \cdot d_{2_0})^2 \cdot \left[(k_{1_0})^2 + (k_{2_0})^2 + 1\right] \cdot \left[R^2 - (d_{1_0})^2 - (d_{2_0})^2\right]\right]^{\frac{1}{2}}}{\left[(k_{1_0})^2 + (k_{2_0})^2 + 1\right]}$$

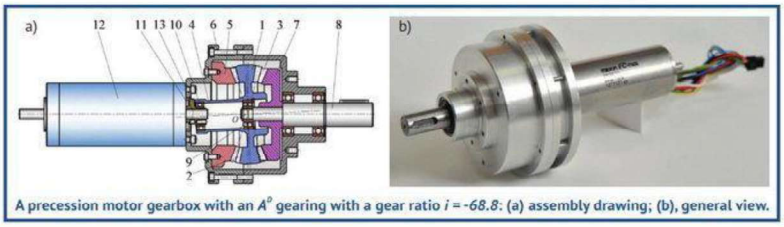


Precessional gear 2K-H with reduced relative slip in the teeth conform contact:
a, c - teeth gearing (Z_3-Z_4) and (Z_1-Z_2) with conform contact;
b - gearing with sphero-spatial movement.

The profile of the teeth in the precessional gear, unlike the classic ones, is variable depending on the parametric configuration $[Z_4 - (\dots) \pm 1]$ which ensures high bearing capacity and mechanical efficiency.

CAD | CAM modeling and manufacturing phases





A precession motor gearbox with an A° gearing with a gear ratio $i = -68.8$: (a) assembly drawing; (b), general view.

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