

A NEW TYPE OF EPICYCLIC TRACTION DRIVE

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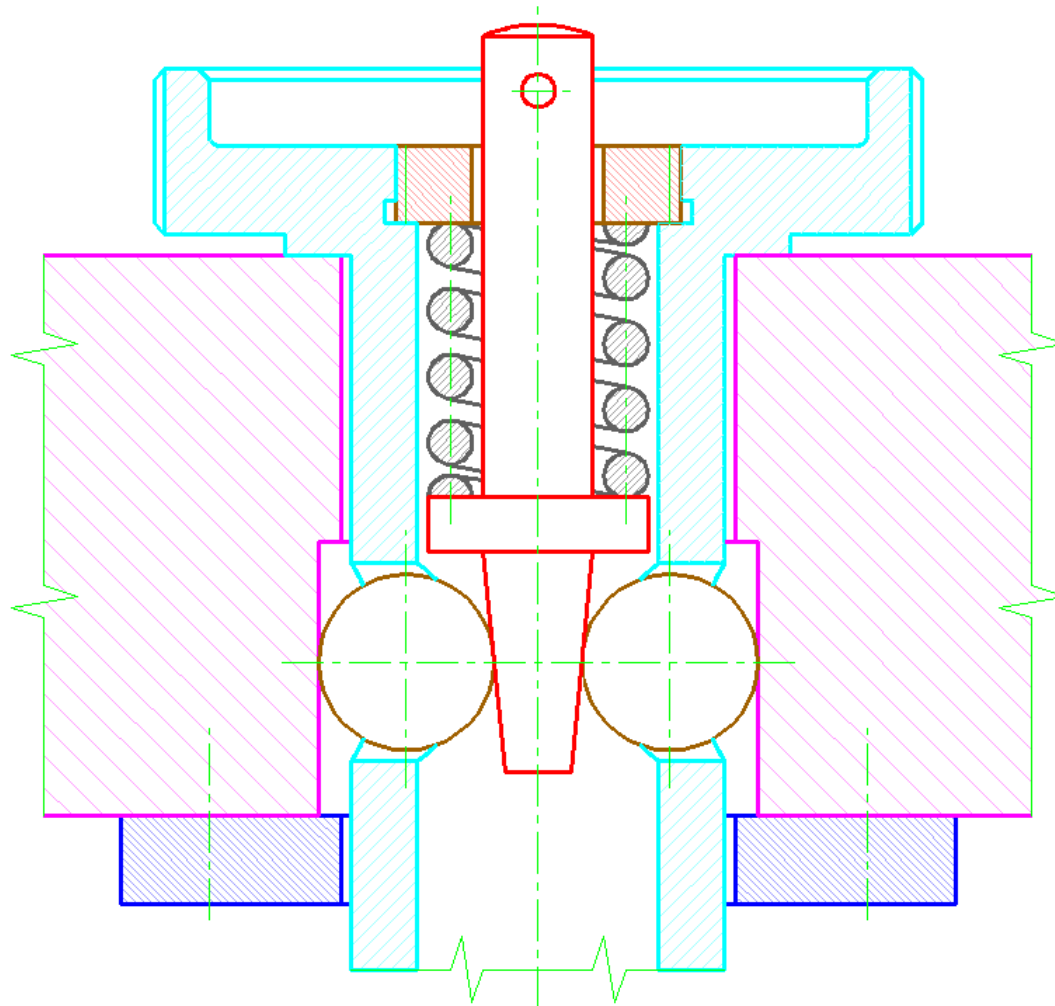
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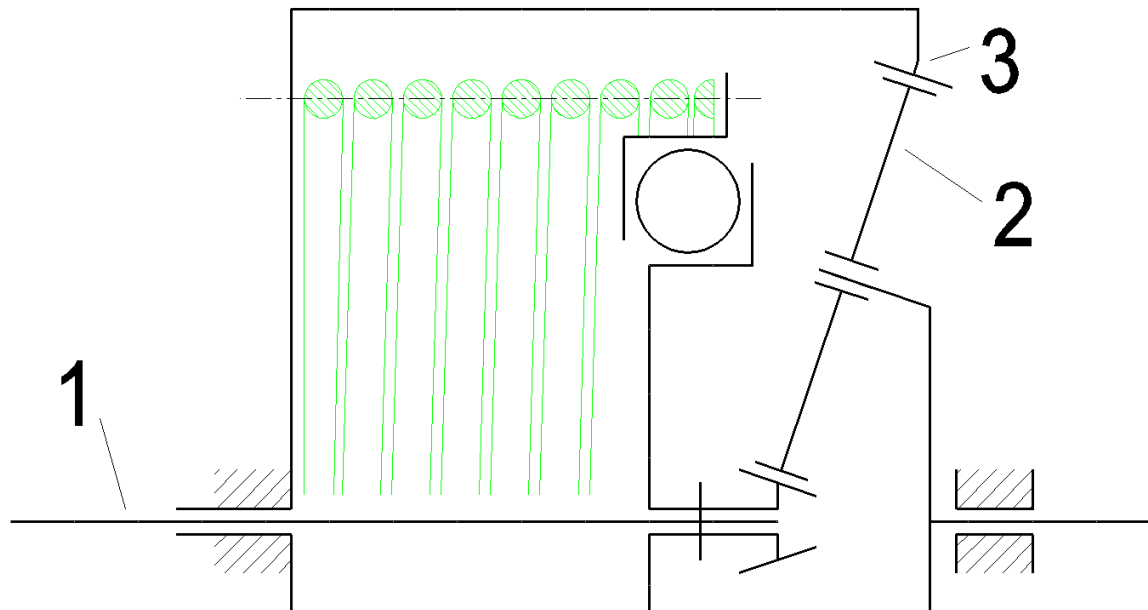
A NEW TYPE OF EPICYCLIC TRACTION DRIVE

- Epicyclic traction drives
- Clamping devices, free running clutches
- Helical spring bearing
- Systematic generation of helical torsion springs
- Production of the sun and annular wheels
- Mathematical formulation of the problem
- Summary
- Acknowledgement

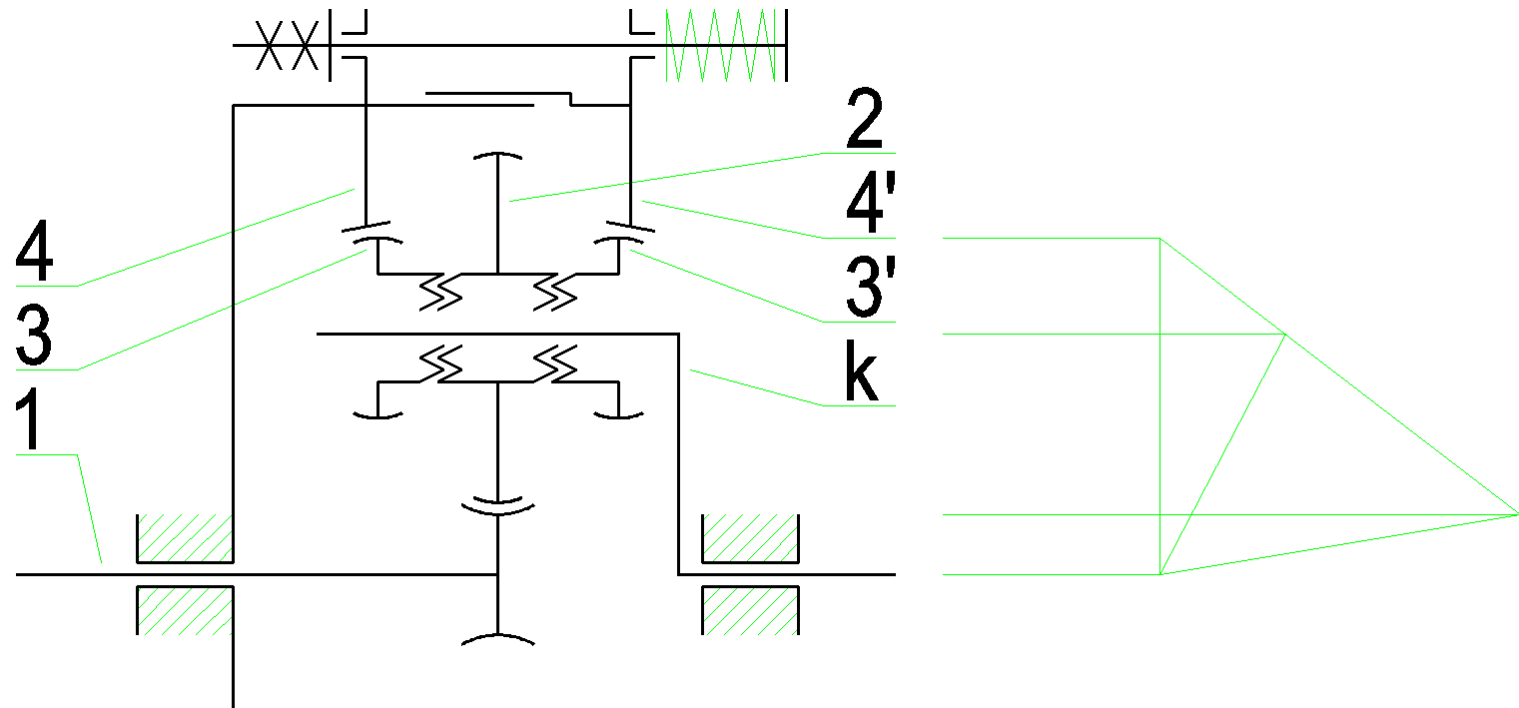
Epicyclic traction drives — axial clamping with tapered surfaces



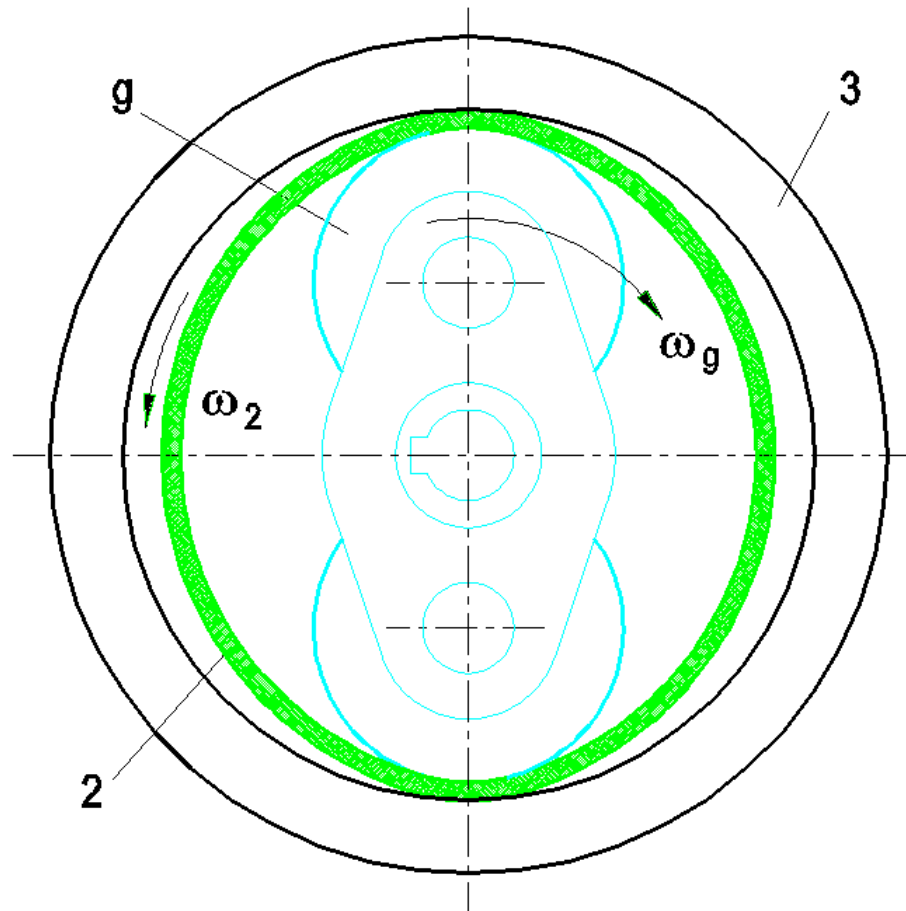
Epicyclic traction drives — axial clamping with tapered surfaces



Epicyclic traction drives— axial clamping with tapered surfaces



Infinitely variable epicyclic traction drive



Experimental drive that can be infinitely variable



It contains a relatively thick flexible ring made of elastomer.

$$d_3 = 92.34mm$$

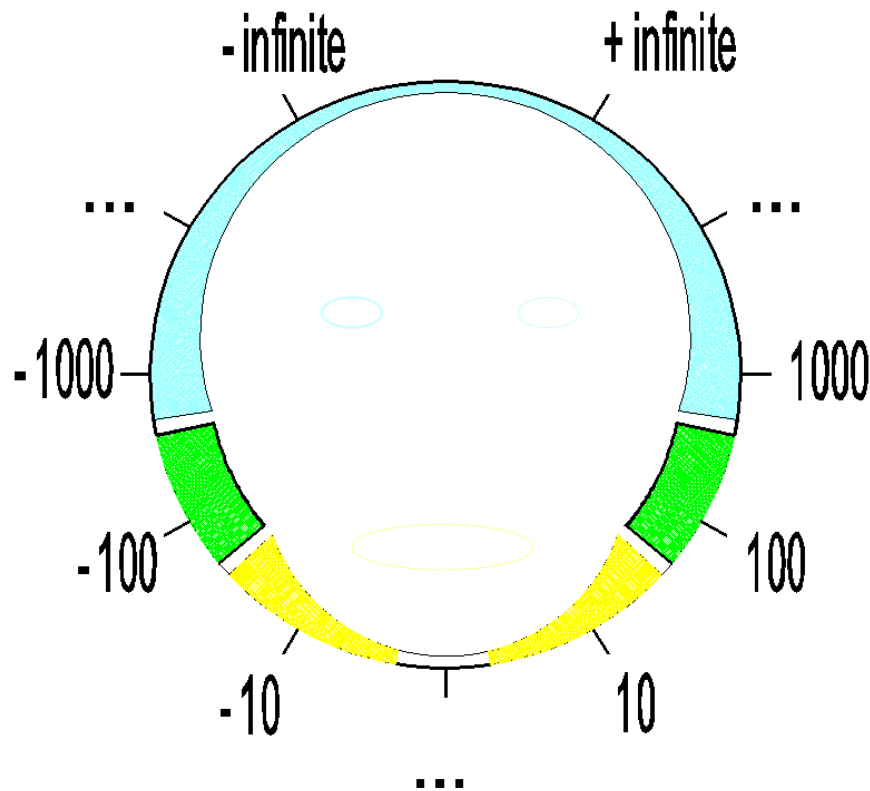
$$d_2 = 86mm$$

$$s_2 = 4mm$$

$$d_g = 30.4mm$$

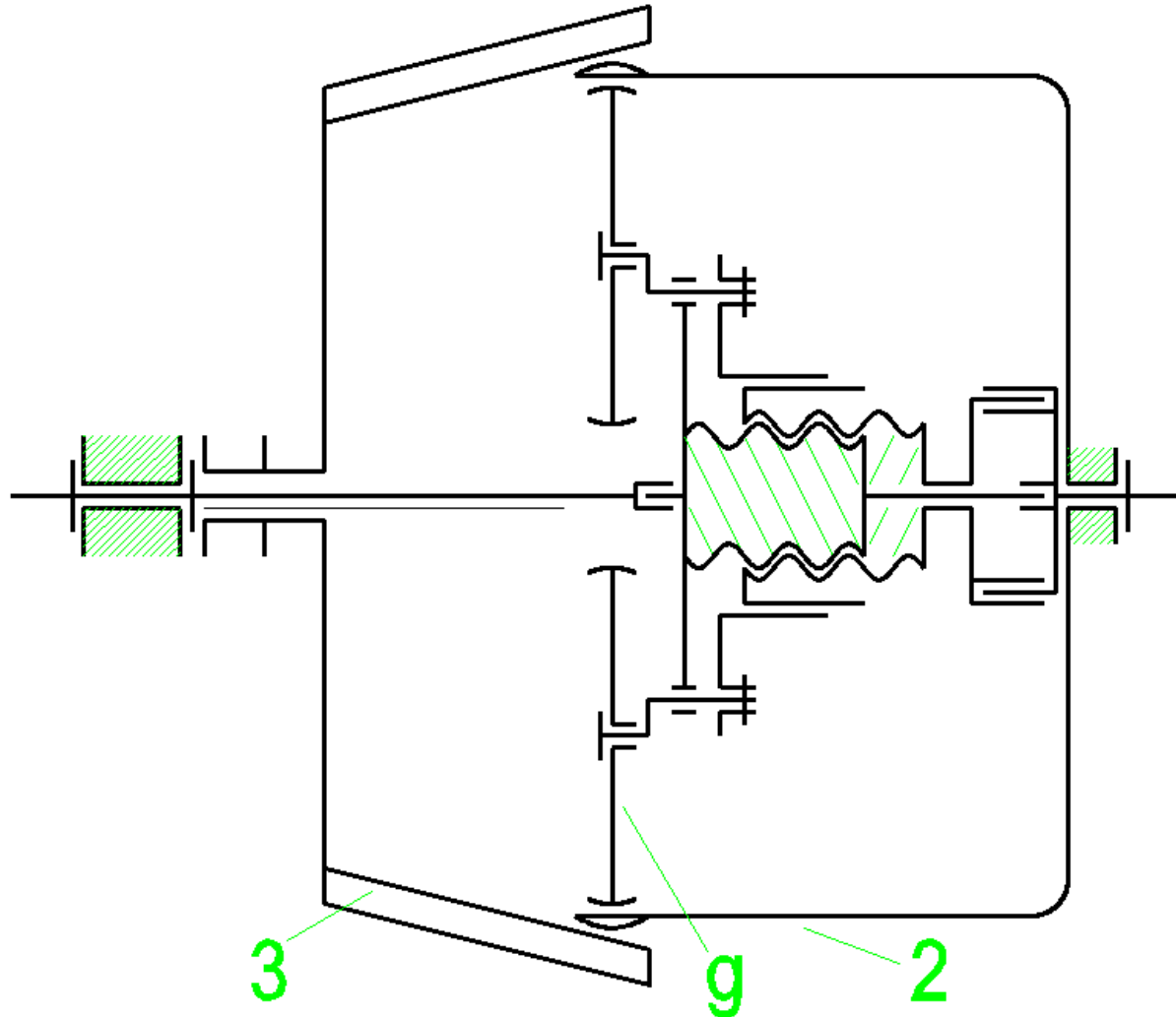
$$i_{g2}^3 = -\frac{c_2}{c_3 - c_2} = -13.5$$

The ratio ranges of the infinitely variable drive

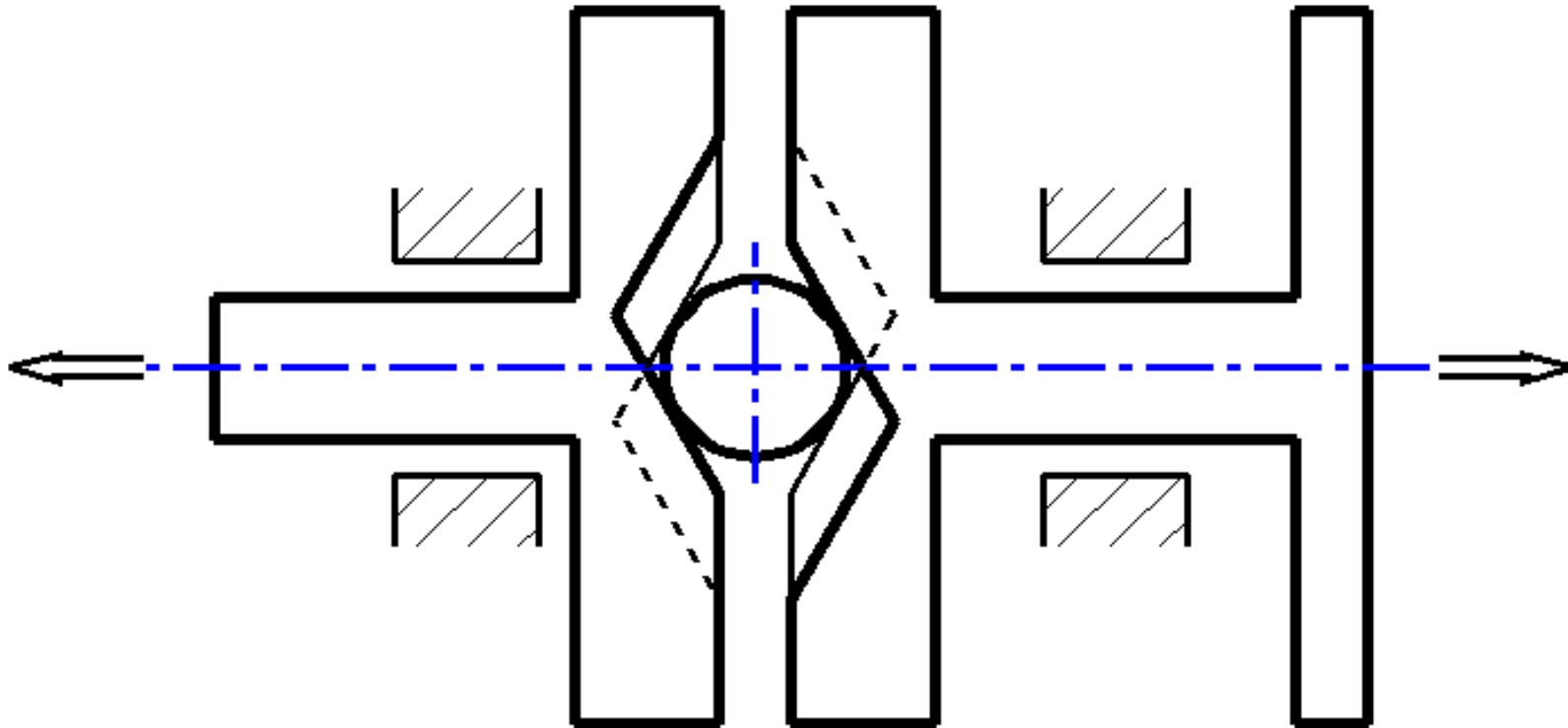


$$i_{g2}^3 = -\frac{c_2}{c_3 - c_2} = -\frac{c_2 / c_3}{1 - c_2 / c_3}$$

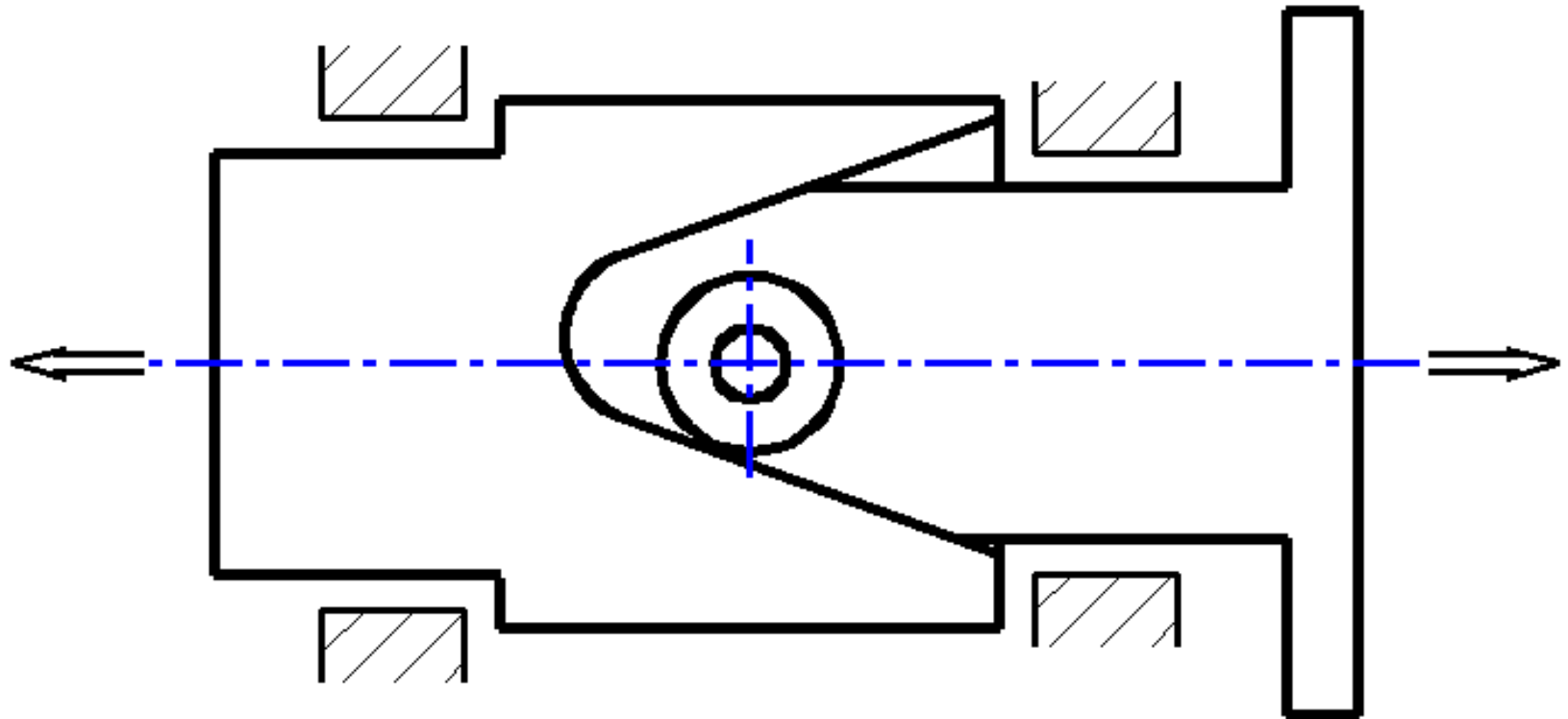
Continuously variable epicyclic traction drive



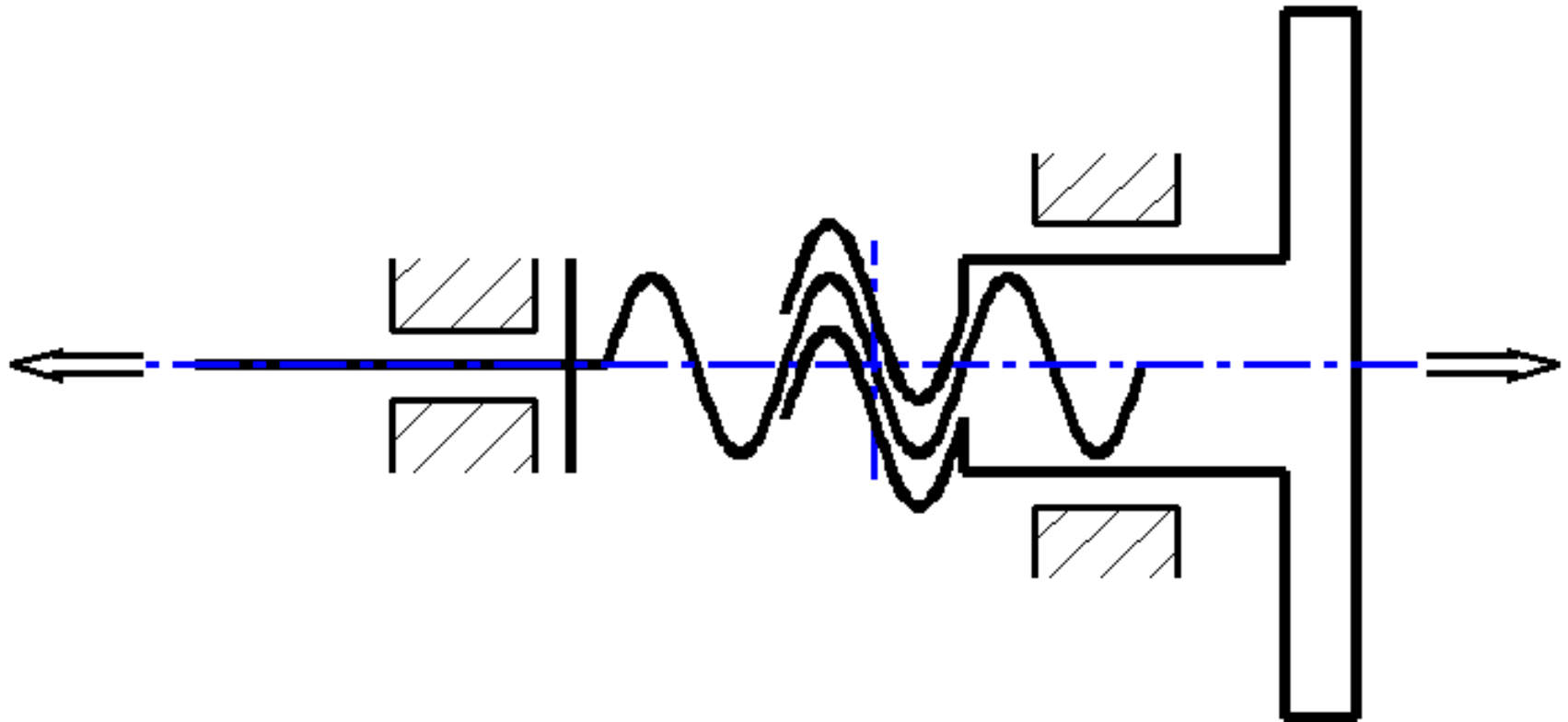
Axial clamping devices



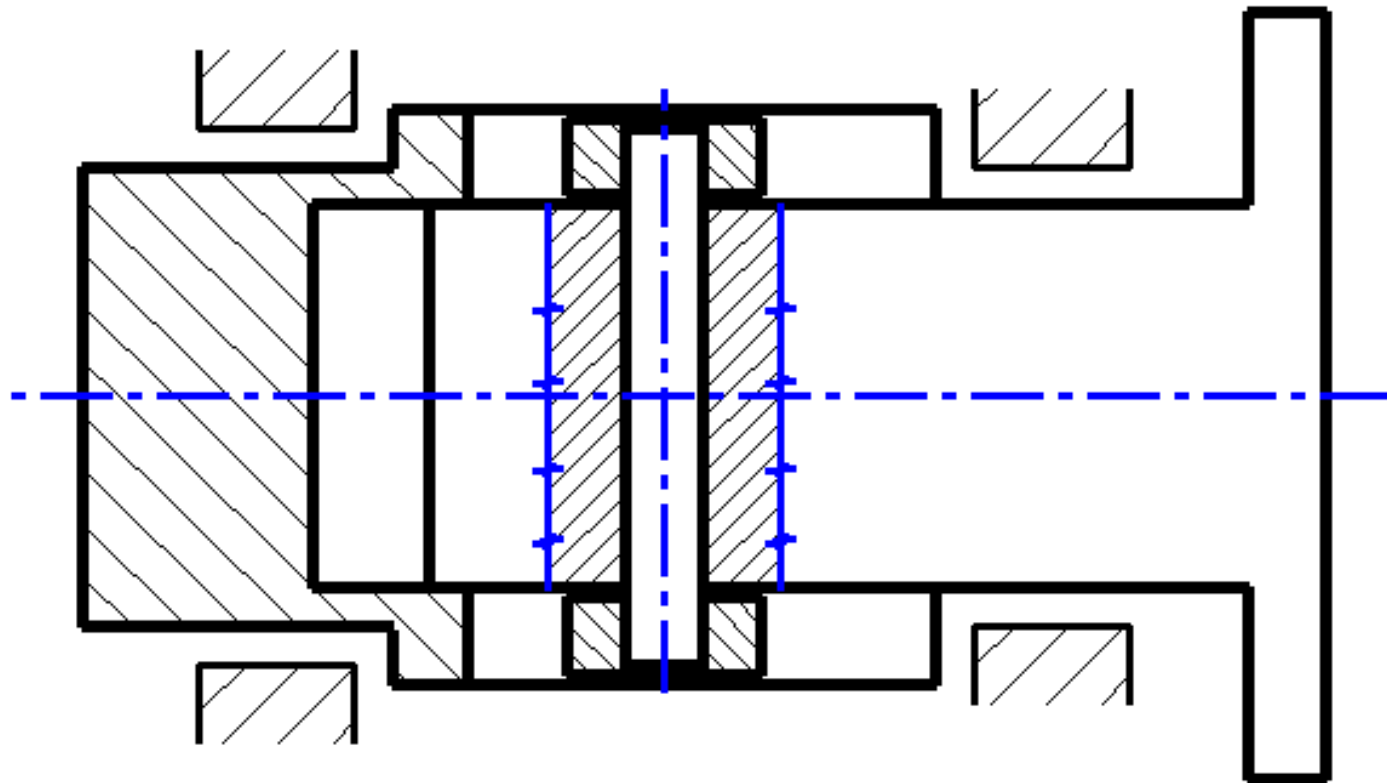
Axial clamping devices



Axial clamping devices



Axial clamping devices



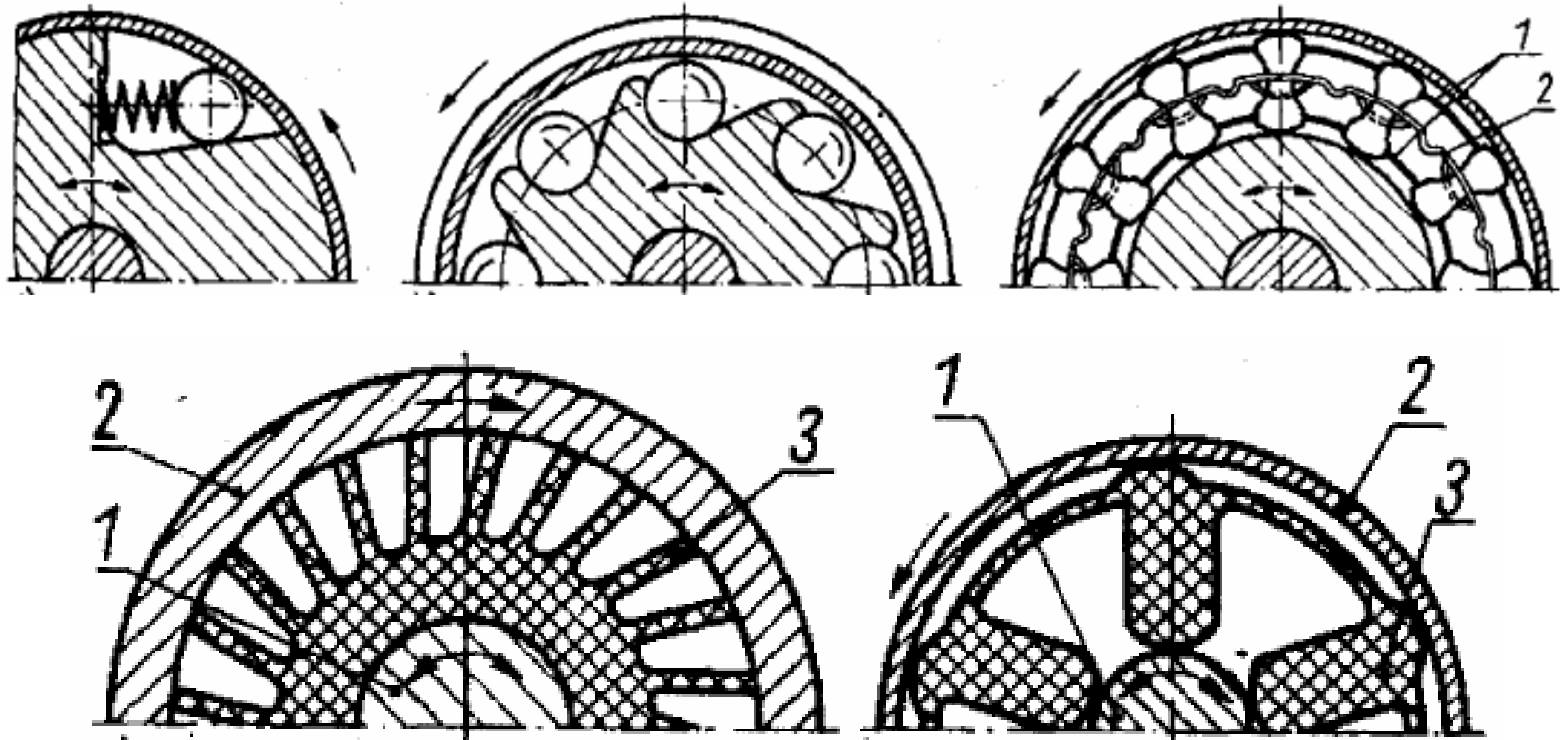
Free running clutches

Shape closing		Shape and force closing
Radial	Axial	
ratchet mechanisms	jaw type coupling driven through screw-nut join	

Free running clutches

Force closing			
Axial	Radial		
disk or cone type frictional coupling driven through screw-nut join	wedge roller type	locking body type	Other type

Free running clutches



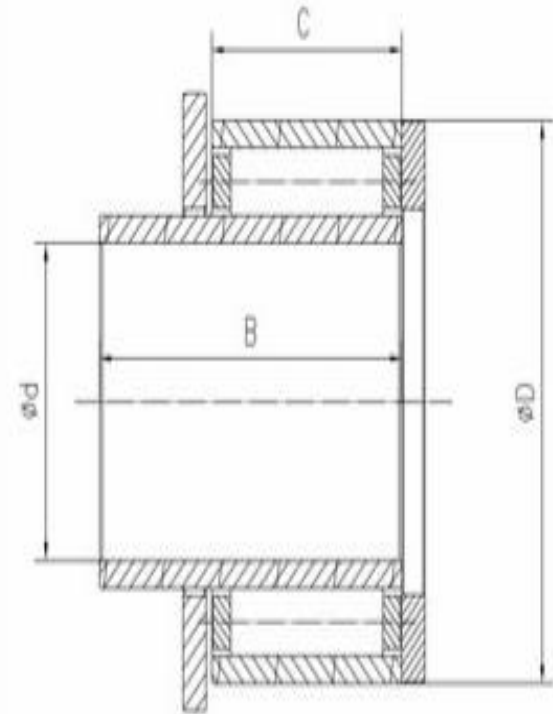
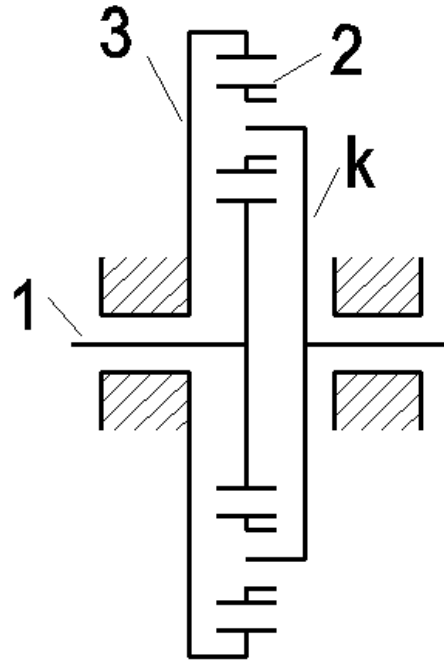
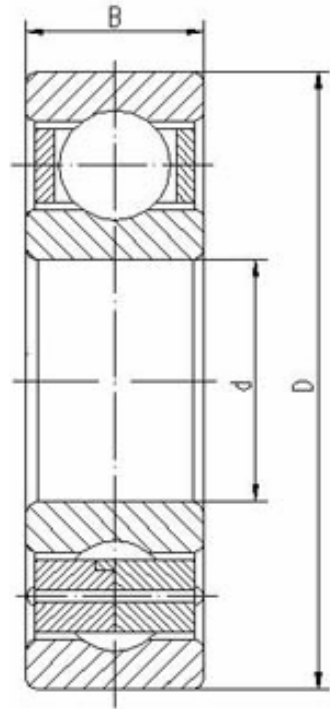
*wedging rigid roller type, closure body type
and elastomer disk type*

Free running clutches



*the torque is transmitted by
helical torsion spring*

Helical spring bearing



*Epicyclic traction drive (io type), as a possible
model of roller bearings*

Systematic generation of helical torsion springs

1. With of strip (and also the lead angle)	1.0 Constant 1.1 Changing
2. Number of starts of the thread	2.0 Single 2.1 Twin
3. Lead direction	3.0 Same along the spring 3.1 Changing

Diversity of helical torsion springs

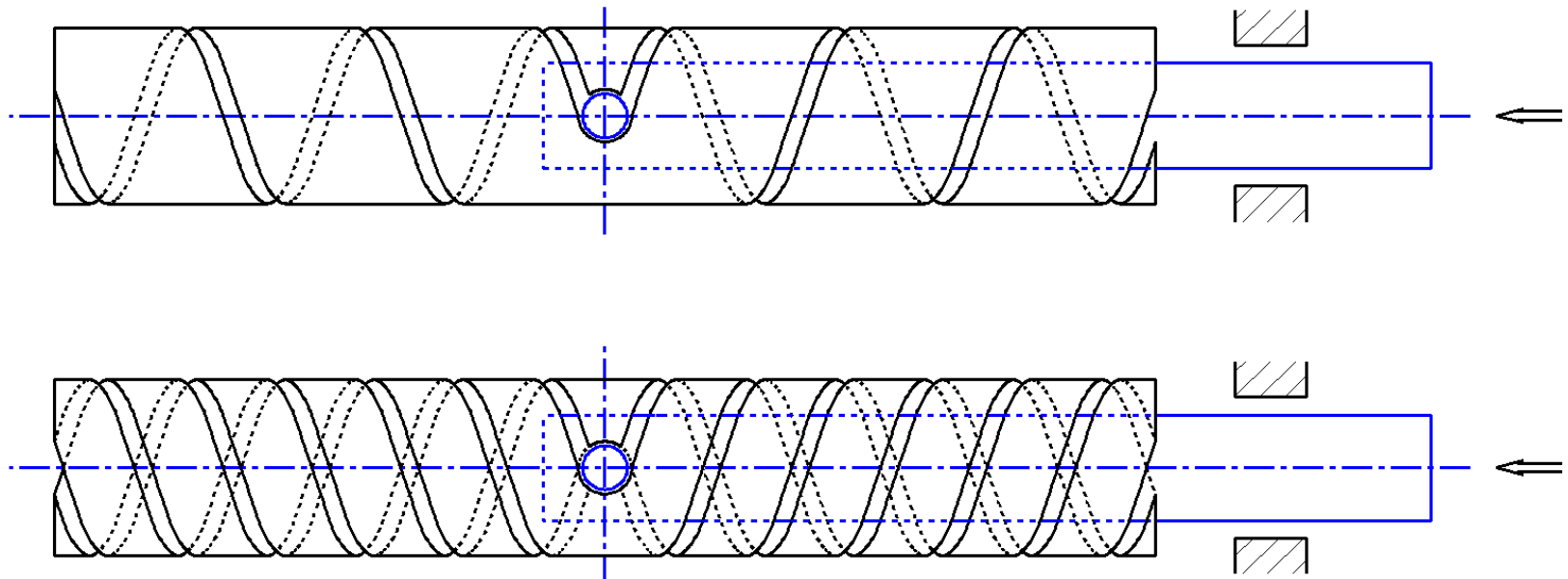
Systematic generation of helical torsion springs

Code	Symbol
000	
001	
010	
011	
100	
101	
110	
111	

Production of the sun and annular wheels

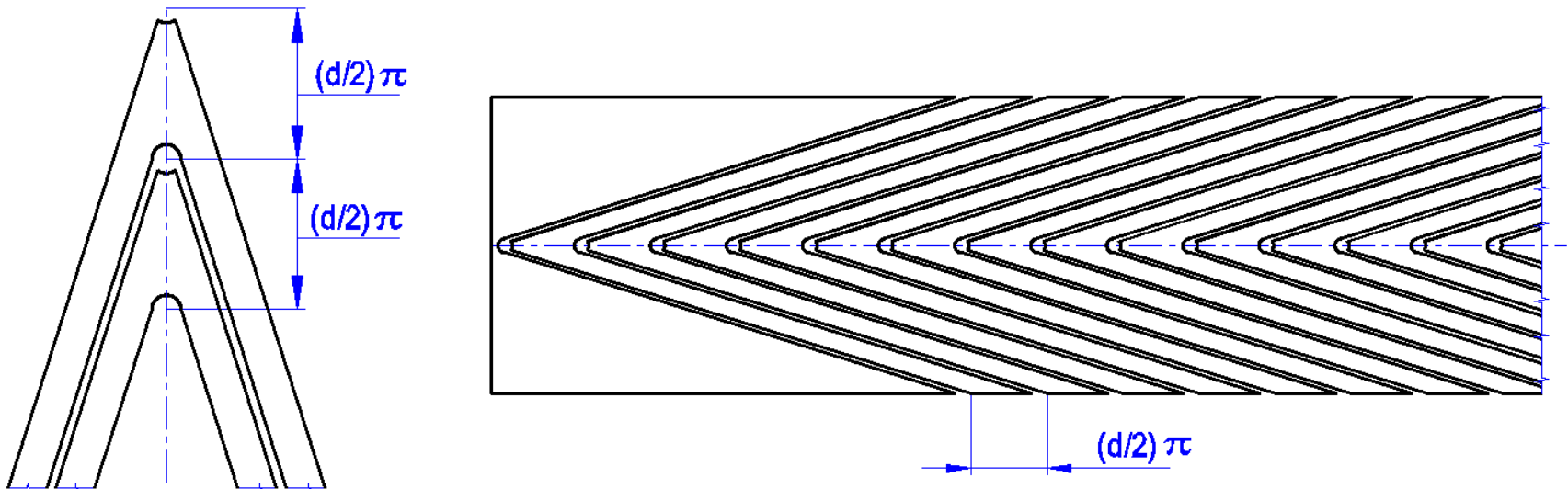
Pre-product	Hollow cylinder	Sheet metal
Technologies	turning	laser cutting
	milling	and winding
	spark cutting	

Production of the sun and annular wheels



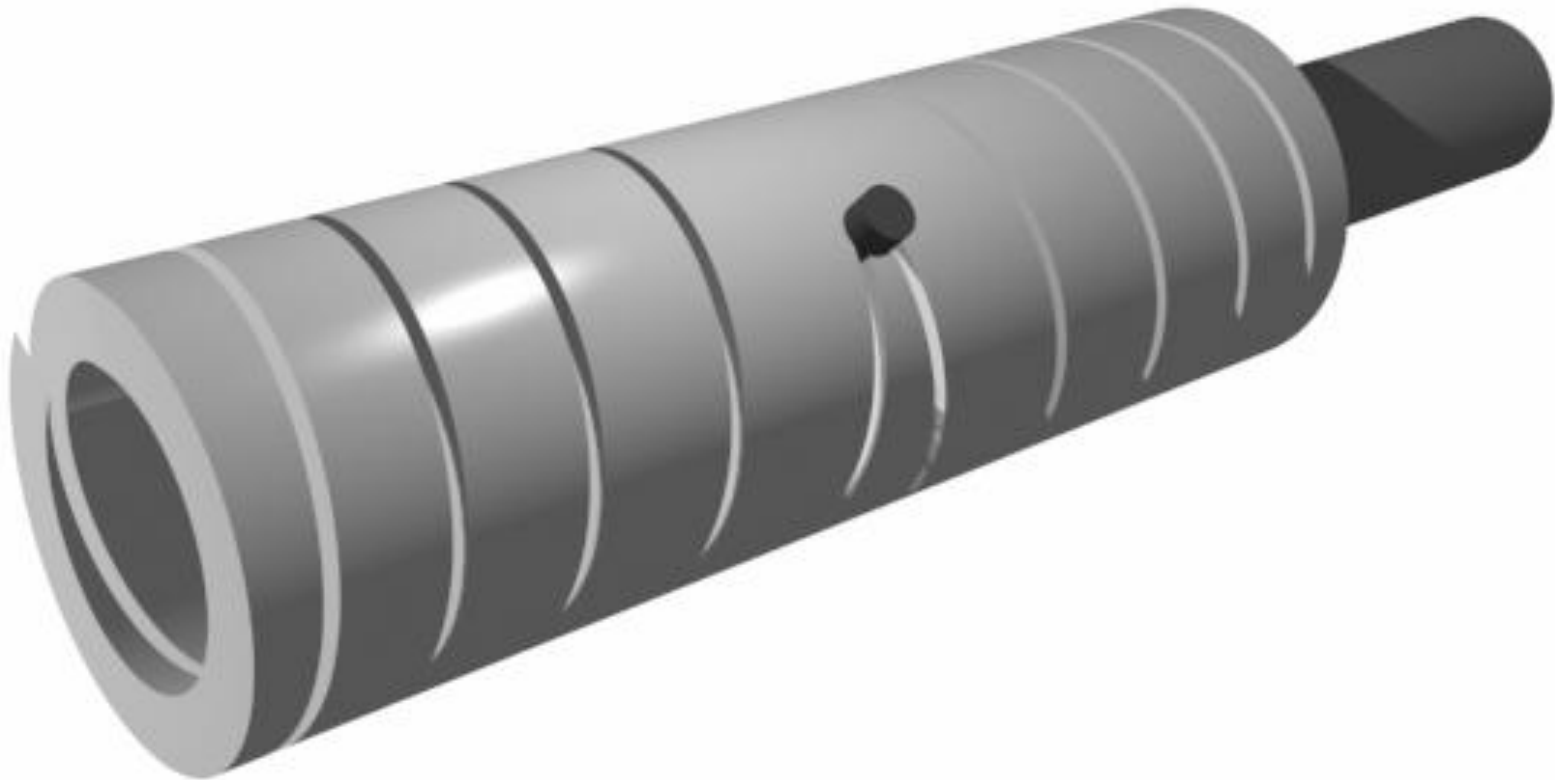
Symmetrical design helical torsion springs (single and double threads). Codes are 100 and 110.

Production of the sun and annular wheels



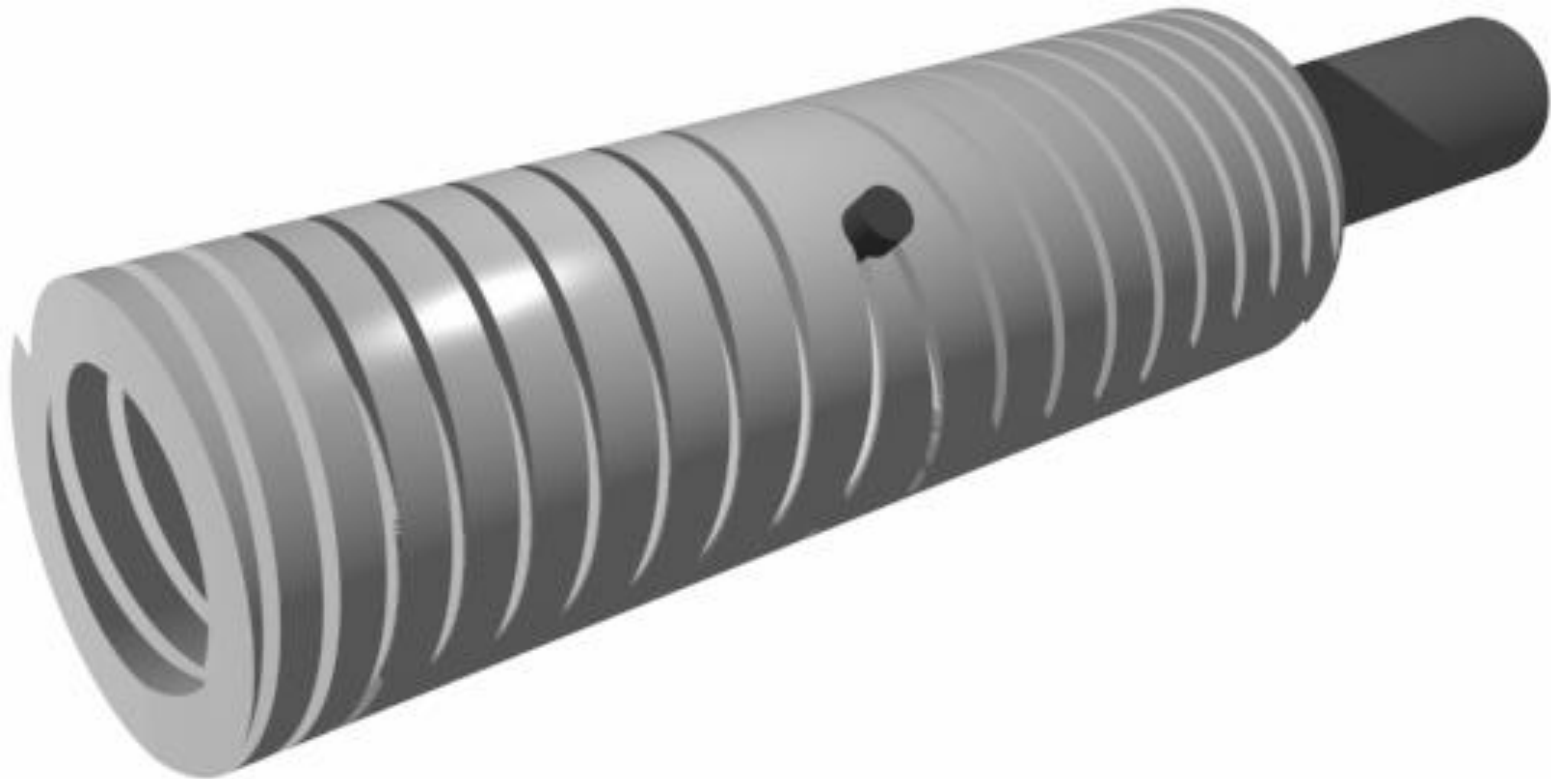
*The plate pre-product of
the double thread helical spring*

Production of the sun and annular wheels



*Model of single thread spring with
changing lead direction and changing strip width*

Production of the sun and annular wheels



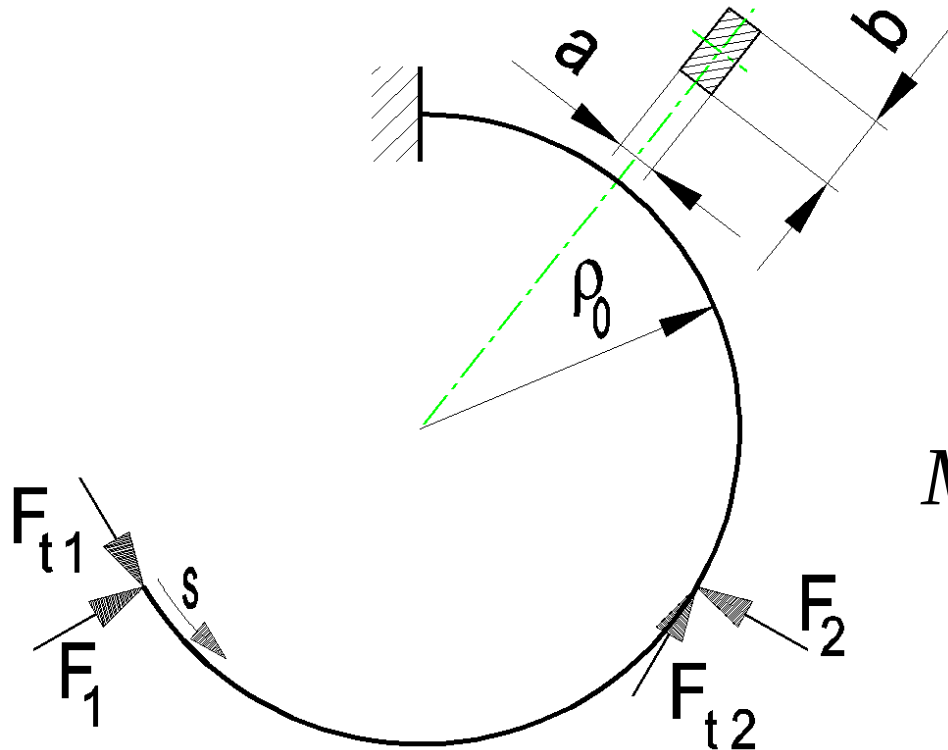
*Model of double thread spring with
changing lead direction and changing strip width*

Mathematical formulation of the problem

Conditions

- Uniformly stressed helical torsion spring made of sheet metal
- The pre-manufactured product made by laser cutting.
- The bending moment in the springs has a linear function

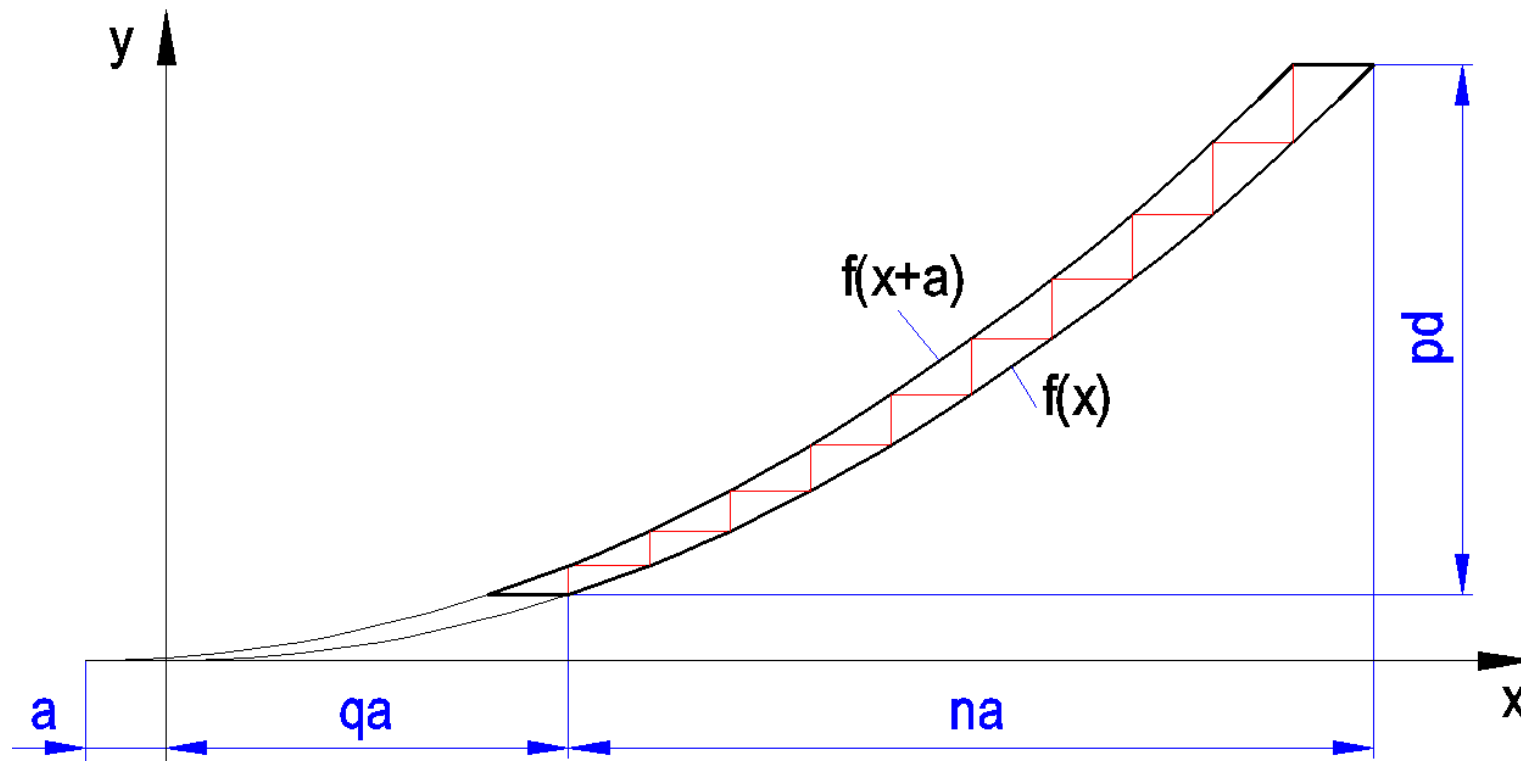
Mathematical formulation of the problem



The linearly changing bending moment

$$M_b = F\rho_0 \left(1 + \frac{Q \cdot s}{2\pi\rho_0} \mu_t \right)$$

Mathematical formulation of the problem



Mathematical formulation of the problem

The difference of the two border function of the ribbon is a linear function. The second derivatives should be equal to each other. The solution is for example a parabola. The factor k can be computed and q determining the start of the used domain is also available.

$$f(x+a) - f(x) = mx + b \qquad a = d \cdot \pi$$

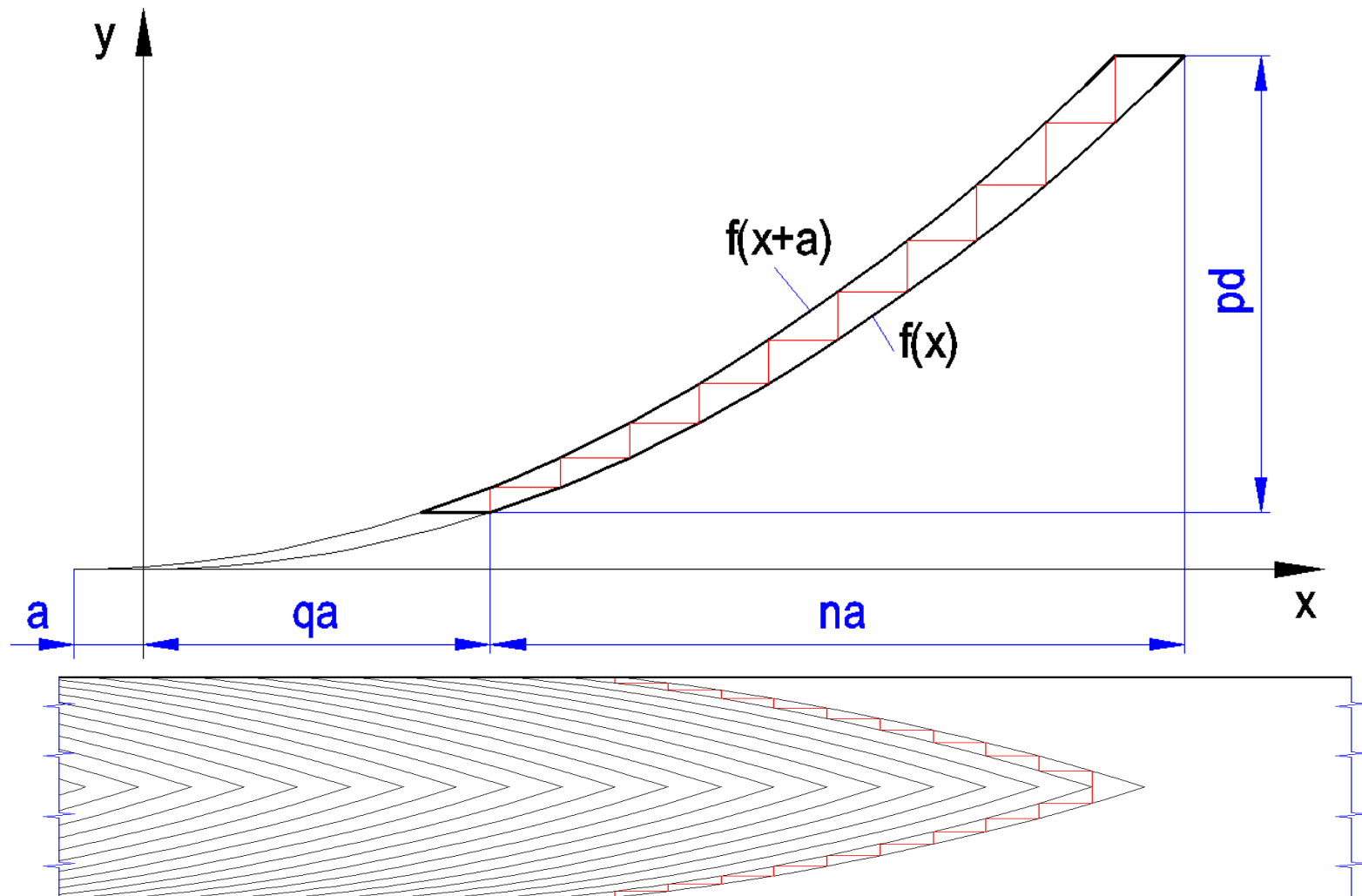
$$f''(x+a) = f''(x) \qquad d \approx 2 \cdot \rho_0$$

$$f(x) = kx^2$$

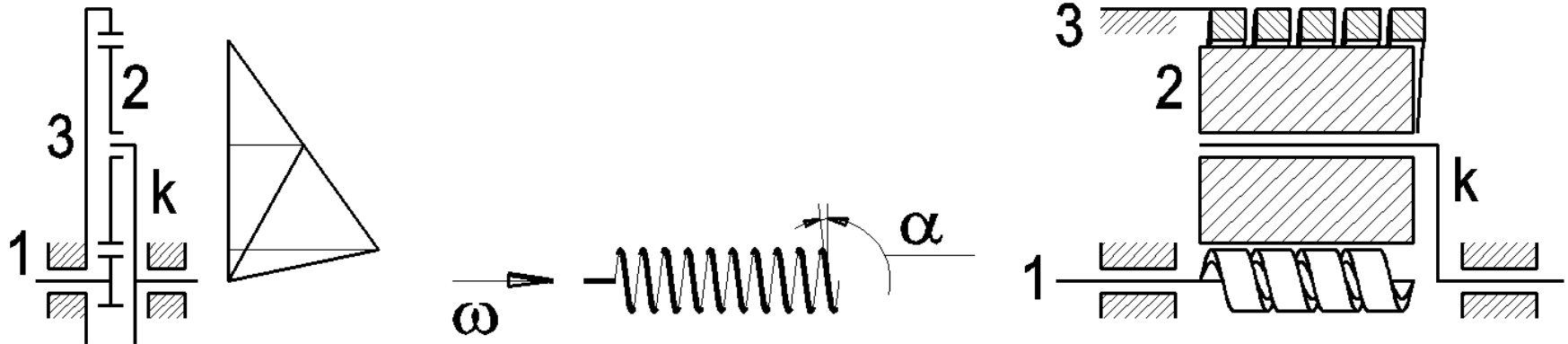
$$k = \frac{p}{(2q+n)n\pi^2} \frac{1}{d}$$

$$q = \frac{2(n-1) - \mu_t[n(Q-2)+1]}{2\mu_t(Qn-1)}$$

Mathematical formulation of the problem



Summary



- Starting from a conventional epicyclic traction drive and substituting some of the basic elements by helical torsion springs we obtain a more simple drive where the clamping force proportionally changing with the load, is produced by the basic elements.
- The springs are economical, due to the proportionally changing cross section, considering the principle of equal stress.
- We suggested an almost waste-free production technology for the helical springs.

Acknowledgement

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