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THE MACHINE-TOOL FOR PROCESSING ELLIPTICAL PISTON BY MILLING AND GRINDING

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Abstract*:* Another method of processing elliptical piston engine hydraulic piston elliptical, it is possible to process by milling and grinding on a machine tool based on an operating principle of the mechanism kinematic motion plan-wise parallel running rotary piston chamber curvilinear triangular volume. It is known that the rolling motion of the piston centroidele elliptic and camera volumetric are running circles inside the 2:3 ratio. On this basis we designed a mechanism to replicate the movement of internal gearing the ratio 2:3.

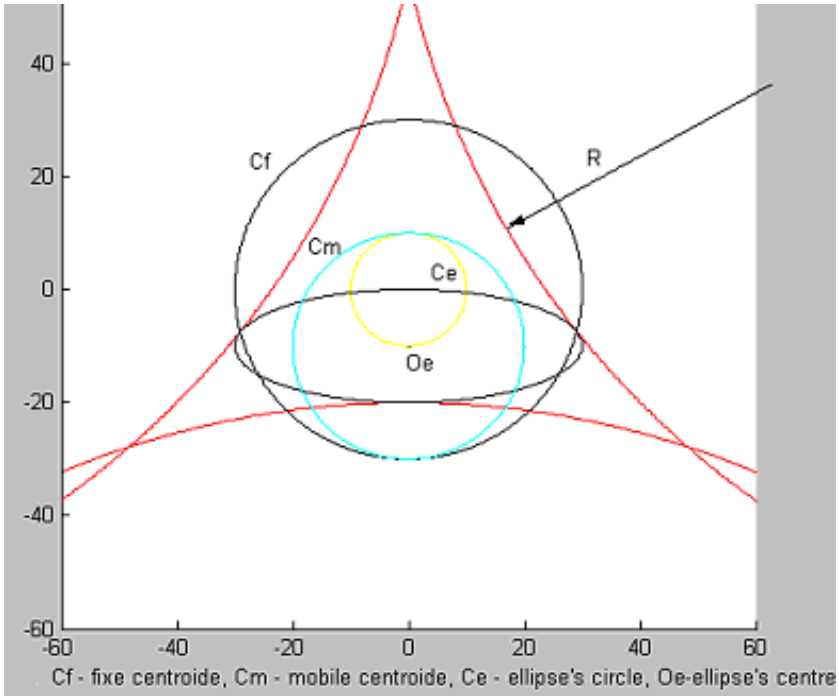

Fig. 1 Processing of the elliptical rotating piston machine tools, is based on mathematical properties of the mathematical ellipse, to rotate in a curvilinear equilateral triangle of three equal arcs, tangent or secant slightly

These kinematic properties are:
- Ellipse center moves on a circle called the center circle ellipse;
- The Centrodes plane-parallel movement of the running curvilinear equilateral triangle within the ellipse are circles, running inside the ratio 3/2;

Rays of the centrode fixed R_{c_1} and mobile R_{c_2} (fig. 1) are:

$$R_{c_1} = \frac{3}{2}(a-b),\ [\text{mm}] \tag{1}$$

that:

$$R_{c_2} = a-b,\ [\text{mm}] \tag{2}$$

Radius of the circles are made of curvilinear triangle sides, has the formula:

$$R = \frac{\sqrt{3}\left(2+\sqrt{3}\right)(a+b)}{2},\quad [\text{mm}] \tag{3}$$

where *a, b* are parameters elliptical, and other account data are numeric values.

This amount of elliptical parameters, allows an infinite number of ellipses with the sum
a + *b* = *const.* to register the same curvilinear triangle. Also included in the triangle radius curvilinear relationship is still calculating the sum: a + b:

$$R_0 = \frac{a+b}{2}, \text{ [mm]} \tag{3}$$

Only ellipse changes and other kinematic parameters, which have a difference in their relationships - b, as circles of the two centrodes rays, fixed and mobile. Radius R of the three arcs, constituting the curvilinear triangle sides, is the sum formula a + b and a correction factor of the game, the plunger elliptical and curvilinear triangular room. Contact ellipse with the cutting tool will describe an area of the arc AB, circle of radius R, the kinematic principle of operation of hydraulic piston elliptical engine. You can use this tool to process a form globoid (body of revolution generated by rotating an arc about an axis, the distance from the arc is less than the radius R of the arc of a circle) and must have main motion of cutting date fixed rotation axis of symmetry with angular velocity ω_S.

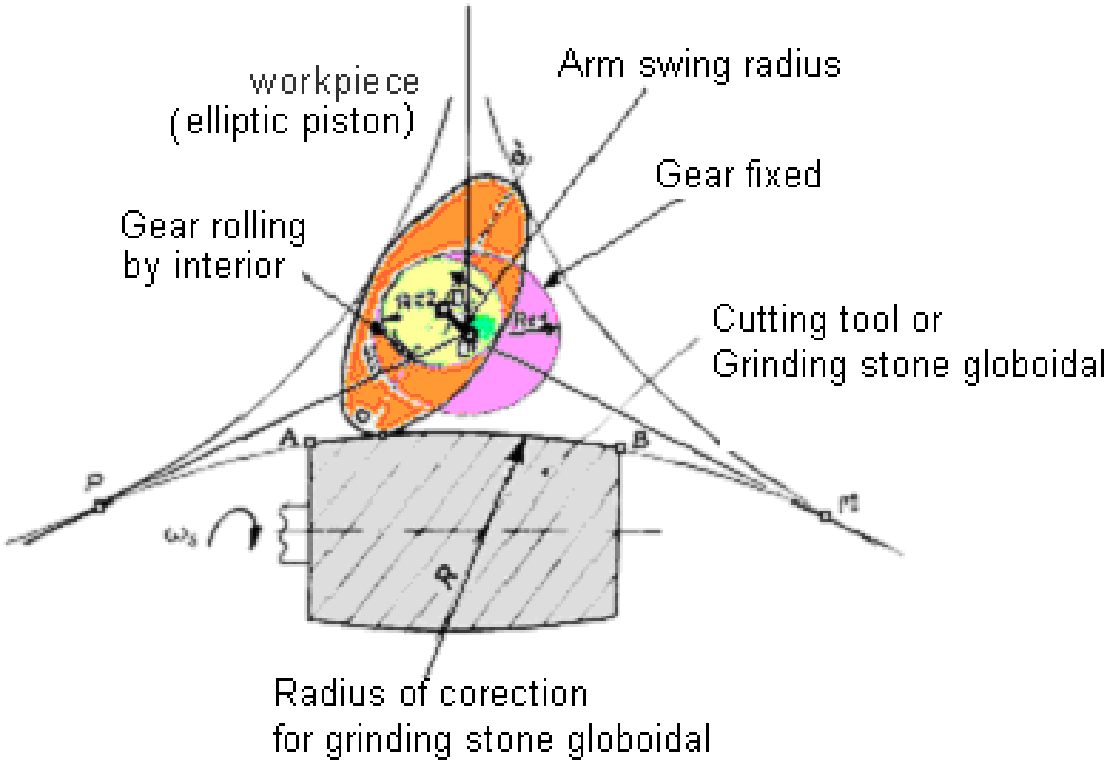

Fig. 2. Design the machine-tool to process trees by milling and grinding

From the properties of inner meshing gears with involute teeth, which materializes the two centroids will result in calculation methodology previously involute internal gear, the ratio 3/2, which will result in constructive parameters a and b of the ellipse of a processing section elliptical piston as close to original design data of an elliptical piston hydraulic motor. In general, you cannot adopt in advance as required semiaxele ellipse, because the module is standard involute gears with discrete values, but in many cases can take a gear ratio inside involute with 3/2, with a certain way and number of teeth that

will give then sizes a and b as close to the original data. It starts from the establishment of involute gear by formulas inside a gear ratio of 3/2, then reversed following calculations, it appears elliptical parameters determination.

Table. 1.
The kinematic parameters of the machine-tool for processing trees by milling and grinding

No.	Relationship Name	Symbol	Parameter calculation [mm]
1.	Three arcs of equal radius curvilinear triangle	R	$R = \frac{\sqrt{3}\left(2+\sqrt{3}\right)(a+b)}{2}, [mm]$
2.	Centrode radius fixed	R_{C_1}	$R_{C_1} = \frac{3}{2}(a - b)$
3.	Centrode radius mobile	R_{C_2}	$R_{C_2} = a - b$
4.	Eccentricity ellipse center - center curvilinear triangle	OO_e	$OO_e = \frac{a - b}{2}$

The calculation for functional dimensions a and b of the ellipse of the elliptical section of the piston and kinematic quantities of plane-parallel movement, were listed in Table 1 and will be used to design engines and hydraulic pumps piston elliptical. For irrational numbers in the expression for calculating the radius R, we consider only three decimal places. Depending on how your teeth, which is standardized, the calculated diameter of a wheel running gear with involute teeth, without moving the profile, the relationship:

$$D_r = m \cdot z \ \ [\text{mm}] \tag{4}$$

where m - module teeth [mm] and z - number of teeth..

Therefore, if we need a large number of manufacturing a hydraulic piston type rotary engine is adopted in home interior gear ratio 3:2, the rolling circles, and then calculate the other quantities dimensional processing machine elliptical piston, which are:

- Overhang:

$$OO_e = \frac{a-b}{2} = \frac{m\left(z_1 - z_2\right)}{2}, \ \ [\text{mm}] \tag{5}$$

The pass in calculation parts and subassemblies machine-tools (fig. 3), are:

$$a - b = m\left(z_1 - z_2\right), \ [\text{mm}] \tag{6}$$

where: z1, z2 - number of internal teeth serrated crown and pinion that the inner-working jointly with the ellipse.

In (6) we have two variables *a* and *b*, the ellipse parameters, which must satisfy the equality convenient practical value ratio a / b, the condition:

$$\frac{a}{b} \in (1{,}3...4) \tag{7}$$

The analysis of the principle of processing the machine-tool piston elliptical machines

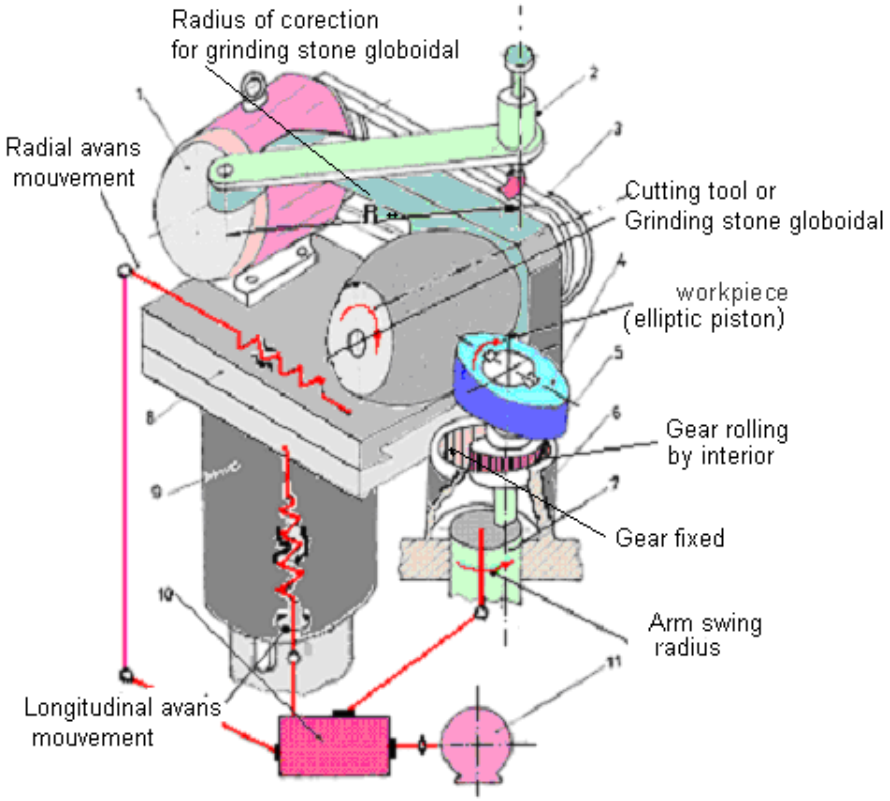

Fig. 3. Machine tool machines milling and grinding elliptical piston (Patent no. 77503/1979 - OSIM, Bucharest, Inventor Muresan Nicodim), (kinematic design)

Legend:
1 - electric motor for driving the tool (grinding stone globoidală), 2 - arm swing radius [mm] fitted with peak correction for stone abrasive, 3 - grinding stone with generator globoidală the arc radius [mm] , 4 - piston elliptical (the workpiece) of section ellipse, 5 - Gear rolling radius [mm], 6 - Crown inner toothing rolling radius [mm], 7 - shaft with eccentricity, [mm], 8 - Sledge radial advance of the cutting tool, 9 - sliders cylindrical axial advance of the cutting tool, 10 - Publisher cinematic for rotary motion, 11 - the main electric drive motor

Elliptical profiles shown in (fig. 3), on the following advantages:

1 - ease of construction and operation, with only two expensive mobile components for high accuracy is required for construction and operation, which is involute internal gear rolling radius fixed crown and pinion rolling radius inside the report 3 / 2.

2 - High rigidity due to massive construction elements (lead screw mechanisms, sliding guides, shafts rotating on roller bearings, etc.) that makes machine tools.

3 - high precision processing of the mathematics section of the piston elliptical ellipse, both milling and stripping, as this process continued throughout the elliptical contour and longitudinal advance of entry and mechanisms are best achieved by screw - nut , precise and rigid

. 4 - correct grinding wheel is a simple way using a rotary lever rotation radius equal to [mm], which has a numeric value irrational, will take into account values (3 ... 4) decimal accurate .

5 - can also easy and precise correction, profile grinding, grinding up durability, the multiple uses of a initial grinding stones, while a final correction phase correction, the process of finishing stripping elliptic piston (reduced ignition).

6 - piston elliptical productivity and high precision processing, milling and rectification due to continuous elliptical profile.

7 - processing on the same piston elliptical machine tool both by continuous milling operation and the continuous grinding operation, using milling and grinding heads mounted on the machine tool.

8 - relatively low price to manufacture machine tools.

Of correlating relationships (6 and 7) determine the parameters a and b, ie semiaxele ellipse, then we can calculate the radius R of the active portion of the generator processing cutting tool, which can be a bit globoidală or globoidală grinding stone, with the generating radius body of revolution globoidal R:

$$R = \frac{\sqrt{3}\left(2+\sqrt{3}\right)(a+b)}{2}, \quad [\text{mm}] \tag{8}$$

Radius R can be corrected for tool grinding stone, with a diamond pen, which has a hinge point at the rate R, according to relation (8). Movement along the generatrix advance of the elliptical cylinder piston is given by a screw mechanism. Training globoidal shaped cutter or grinding globoidal shaped, is made from an electric motor through a transmission belt V-belts or serrated. Electric motor-tool subassembly is placed on a sled driven by a screw that will ensure the advance of entry. A differential mechanism will achieve and rolling motion of the piston elliptical before grinding through a planetary gear mechanism inside the 2:3 ratio, driven by an eccentric shaft eccentricity:

$$e = \frac{a - b}{2}, [\text{mm}] \tag{9}$$

Machine-tool for milling and grinding elliptical piston is provided with the opportunity to process and elliptical pistons with other parameters a and b, in this group should be changed rotating shaft with eccentricity e = (a - b) / 2 and inner gear ratio 3/2 calculated with the relations in Table 1. Also be changed globoidală milling tool cutting and grinding stone globoidală, whose range correction is calculated with (8).

References:

[1] Muresan Nicodim, Teza de doctorat la University of Oradea, 2009.