HYDRAULIC PUMP OF HIGH PRESSURE

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ABSTRACT

In the paper is presented a new construction of a special simplificated hydraulic pump of high pressure, patented under nr.70799RO, as application of the famous conjectured of Kakeya, described by prof. I. J. Schoenberg, University Winconsin Madison USA, in Mathematical Time Exposures and translated by prof. Adolf Haimovici from University Al. I. Cuza Iaşi.

The special hydraulic pump is composed in the main from a metallic frame in which is mounted a rotative elliptical piston E, contained by a carcass with a cava room in the form of the astroid H3, with three seriatim, in which is rolled. The rotative elliptical piston E, is in permanent contact with three sides of the astroid, dividing the astroid room into three rooms of variable volumes seated to 120 degrees one from another, having each a variable volume starting from a minimal one, equaled to zero,ending with a maximal one, the dividing rooms being equipped with one admission and one evacuation valve.

The hidraulic pump is made as an experimental pattern at Oradea University.

KEYWORDS: Hydraulic pump_1, high pressure_2, piston rotativ elliptic_3, cameră interioară_4, hipocicloidă_5, puncte cuspidale de întoarcere_6.

1. INTRODUCTION

Hidraulic pump of high pressure is a practical paper in which is presented a simple and new construction of a volumical pump with non-circular pinion profile, being patterned under the NR.70799RO.

The problems solved in this paper are two.One as an aplication of the matematical conjecture of Kakeya [1,3] and the second as a constuction of a hidraulic pump useful in hidraulic driving with smooth operation without dinamic shocks, with a great stability in different rotation fields.

The constructive solution of the hidraulic pupm [5], presented in the paper, is different from the commun hidraulic pumps by the small number of constitutive elements and by their shape. By little constructive changes, the pump works also as a hidraulic engine.

2. HIDRAULIC PUMP WITH NON-CIRCULAR PISTONS

There are known hidraulic pupms or engines, useful in the driving hidraulic domain, compounded of special gearings [2,4], such as a rotativ piston of longed shape which intermitently rolls over a special structured carcass.

These pumps have some disadvantages: they run with hard shocks with low rotation; they don't have stability in different domains of rotations.

There are also known some other hidraulic non-circular piston pupms, such as the pump compounded of a metallic carcass in which is mounted stellated wheel. (fig.1)[4].

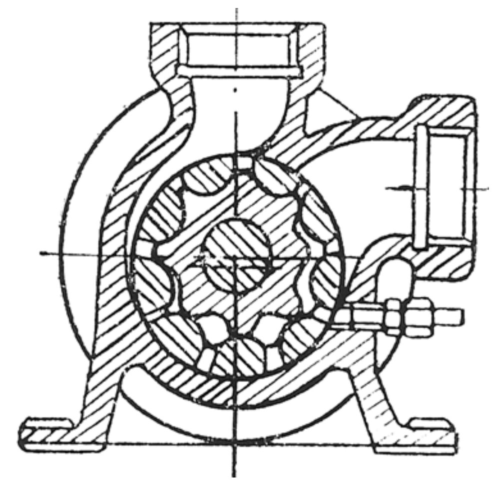

Fig. 1. Hidraulic pump with stellated wheel.

Eccentric with the stellar wheel, is disposed a cylinder rolling the stellar wheel, having a range of cuts which engages the inside pinion, as u can see in the photos in fig.2 and 3.

By rotating the stellar wheel the rolled cylinder is also obliged to rotate.

Because of the excentrical position of the unfolded cylinder, the space between it and the pinion increases, causing aspiration, and at covering is the reverse situation, causing compression.

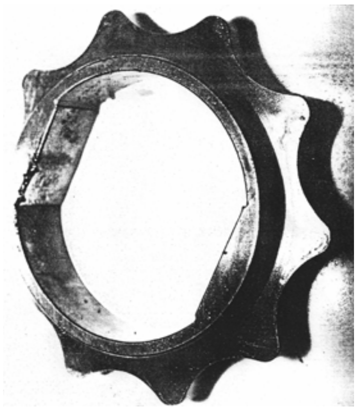

Fig. 2. Stellar wheel

Fig. 3. Rolled stellar cylinder

To stop the liquid pass through the compression area to the aspiration one, between the pinion and the cylinder is mounted a half-moon shaped piece.

The disadvantage of such a structure is that the flow capacity and the pressure are low, the construction is complicated, with limited applicability field, intermittent flow with elevated frequency.

3. HIDRAULIC PUMP WITH ELLIPTICAL ROTATIVE PISTON AND ASTROIDAL INTERIOR ROOM

The pump is an application of the Kakeya's conjecture, example 3 [1,3], which refers to rotating straight-line piston U=AB, in an arbitrary small surface in a clockwise direction, so that the return to the original position is with its reversed extremities U=BA, the straight-line being the whole time tanged to the closed curve of the covered surface.

This surface in Kakeya opinion is a astroid with three seriatim H3.

At the conjecture is added a classical property of a asteroid H3, characterised by the fact that the interior tangent is a segment of constant length, independent of the position of the point tangent on curve (fig.4) and also the property of reduction of a mathematical ellipse to a straight-line and the reverse.

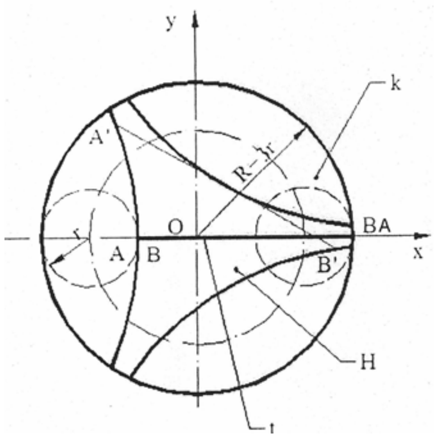

Fig. 4. Conjecture of Kakeya

To inscribe a mathematical ellipse in a closed astroidal H3 curve, you need to start from the ellipse.

$$\frac{X^2}{a^2}+\frac{Y^2}{b^2}-1=0 \qquad (1)$$

equation which intersects with a straight-line OP with the equation Y = Xtgθ (fig.5), obtaining the coordinates of point P, still tangent point with astroid H3.

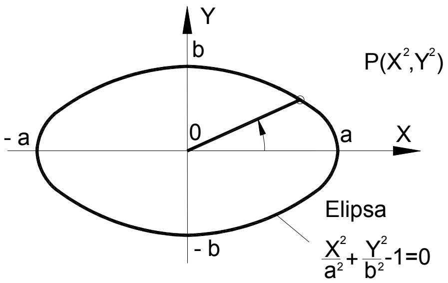

Fig. 5. The establishment of the coordinates of a point on the ellipse

$$\begin{cases} X_P = \dfrac{ab}{\sqrt{b^2+a^2\cdot tg^2\theta}} = \dfrac{3}{\sqrt{1+9tg^2\theta}} \\ Y_P = \dfrac{abtg\theta}{\sqrt{b^2+a^2\cdot tg^2\theta}} = \dfrac{3}{\sqrt{1+9tg^2\theta}} \end{cases} \qquad (2)$$

From fig.5, the segment p has the length:

$$\rho = \sqrt{X_p^2+Y^2P} = \sqrt{\frac{9(1+tg^2\theta)}{1+9tg^2\theta}} = \frac{3}{\sqrt{1+8\sin^2\theta}} \qquad (3)$$

And from the parametrical equations of the astroid:

$$\begin{cases} X_P = \cos\varphi + \rho\sin(\varphi+\dfrac{\pi}{2}+\theta) \\ Y_P = \sin\varphi + \rho\cos(\varphi+\dfrac{\pi}{2}+\theta) \end{cases} \qquad (4)$$

result:

$$\begin{cases} X_P = \cos\varphi + \dfrac{3}{\sqrt{1+8\sin^2\theta}}\cdot\sin(\varphi+\dfrac{\pi}{2}+\theta) \\ Y_P = \sin\varphi + \dfrac{3}{\sqrt{1+8\sin^2\theta}}\cdot\cos(\varphi+\dfrac{\pi}{2}+\theta) \end{cases} \qquad (5)$$

By squre lift and by addition we get the implicit equation of the astroid:

$$X^2 + Y^2 = 1 + \frac{9}{1+8\sin^2\theta} + \frac{6\sin\left(\frac{3\varphi}{2} + \frac{\pi}{2} + \theta\right)}{\sqrt{1+8\sin^2\theta}}$$
(6)

Taking $\theta = \frac{\pi}{2}$ from the relation (6) results:

$$X^2 + Y^2 = 2\left(1 - \sin\frac{3\varphi}{2}\right) \quad (7)$$

For $\varphi = \pi$ obtained:

$$X^2 + Y^2 = 4 \quad (8)$$

And for the $\theta = 0^\circ$ equation of the astroid

$$X^2 + Y^2 = 10 - 6\cos\frac{3\varphi}{2} \quad (9)$$

From the equations (7),(8) and (9) results that point P from ellipsis determined by $\theta = 0^\circ$, be P(0,a) touched the arks of circles of the astroid H3 with spidale and for $\varphi = \frac{\pi}{3}$ (fig. 6).

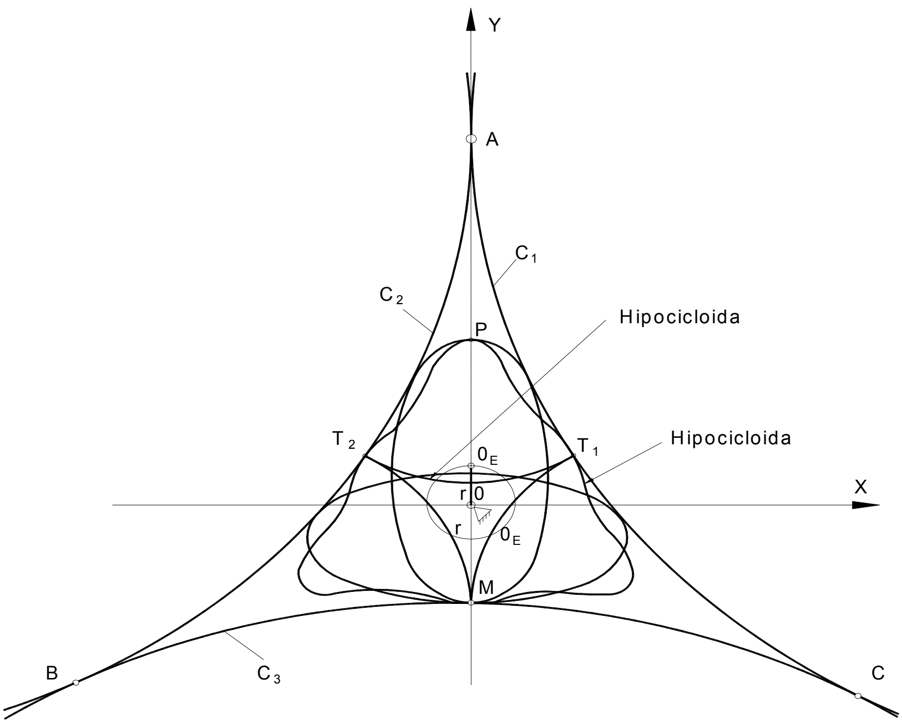

Fig. 6. The astroids ted by tow points from ellipsis

A mathematical eclipse inscribed in a astroid, will have always the points of tangent on the circles C_1, C_2 and C_3 bz the angles φ and θ.

Starting from observation presented, to Universitaty of Oradea he built a a new volume pump.

The new building consists in a special gearing with internal pinion non circular, with the minim report of transmission:

$$i_{2,1} = \frac{Z_1}{Z_2} = \frac{2}{3} \quad (10)$$

The hydraulic pump of building new in concordance with the patent Nr. 70799RO He is rendered in the figures 7 and 8.

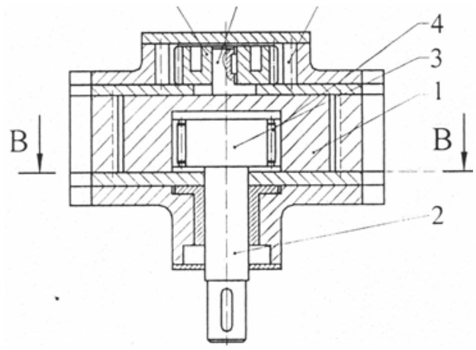

Fig. 7. The section A-A in vertical plan through pump.

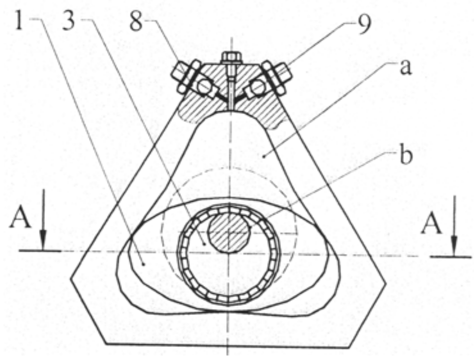

Fig. 8. The section after plan B-B through pump.

The new hidraulic pump is compounded of one piston 1, with the elliptical section, which rolls without sliding into a cavity in an astroidal H3 shape with the seriatim tops connected to after an identical bow to the margins of the big centre of the ellipse.

The rotating movement of piston 1 is imposed by an exterior source through a rod 2, which drives into a cylindrical inner cavity of the elliptic piston 1, through eccentric 3, whose eccentricity is equal with half of the difference between the semi axes of pistons' 1 ellipse, excentrical 3 rotating over some bearings 4 with circular rolls.

Piston 1, situated in the opposite side of rod 2, has a rod 5, on which is mounted a planetary pinion 6, which has the rolling diameter equal to the double of the difference of ellipses' semi axes, with a ratio reduction of 2/3, and a gear 7 with internally toothed ring.

Piston 1 elliptical during functioning is in permanent contact with three commune tangent points on the three curve bows of the asteroid, C_1,C_2,C_3, fig.6 and 8, dividing the astroidal cavity into three variable volume rooms, disposed at 120 degrees one from another.

In fig.9, 10, 11, 12 are shown photos of the pump and the main structure of its elements.

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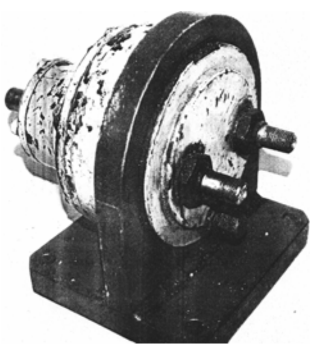

Fig. 9. Hydraulic pump of high pressure .

Experimental test.Oradea University.

Fig.10.Pump's carcass

Fig.11.Elliptical rotating piston.

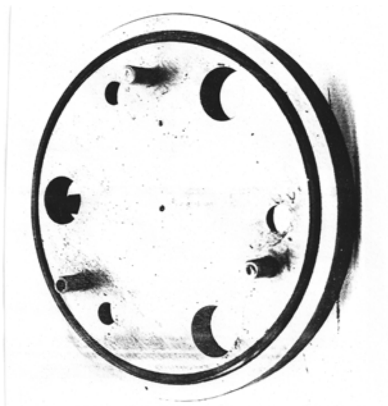

Fig.12.Connecting and distribution element.

The pressures obtained are between 250-500 barri or even higher.

The subsequent searching of the functional parameters of the pump leaded to the construction of an installation of an experimental force, by using the pump as a hydraulic engine of high pressure.

3. CONCLUSION

1. The volumical hydraulic pump with astroidal room and elliptical rotating piston has some andvantages.

- Has a simple and robust construction;
- Offeres great flow capacity at a low rotation;
- Gives stability in different fields of rotations;

- Can be obtained high or even higher pressures;

2.The pump can function as a hydraulic engine with minimal construction changes
3.The construction presented after the pattern NR. 70799RO, confirms the authenticity of Kakeya's conjecture.
4. The new hydraulic

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