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THE SYNTHESIS OF A MECHANISM FOR DRAWING SPECIAL CURVES OF TYPE FOLIUM

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ABSTRACT

Based on geometrical considerations for the bifolium curves we obtain a mechanism, witch has a point that draws a quartic named bifolium or double folium.
Calculus relations and examples are provided.

Keywords: Folium, Synthesis, Mechanism.

1. INITIAL DATA

A special plane curve, named folium (latin folium - leaf).

This paper presents the following folium type curves:
- Bifolium (double folium);
- Parabolic folium;
- Descartes's folium;
- Tetrafolium (four leaf folium).

1.1. Bifolium (double folium)

We consider the right triangle OAB ($A=90^0$) and N the terminus point of the B originated perpendicular on a variable secant d drawn trough O; N is orthogonal projected, on the OA cathetus in N_1. The P points geometrical place, of intersection between the d secant with the perpendicular drawn form N_1 on d, is the quartic name bifolium.(figure 1 and figure 2).

If the triangle OAB is an isosceles triangle (OA=AB), we will get a right bifolium [2].

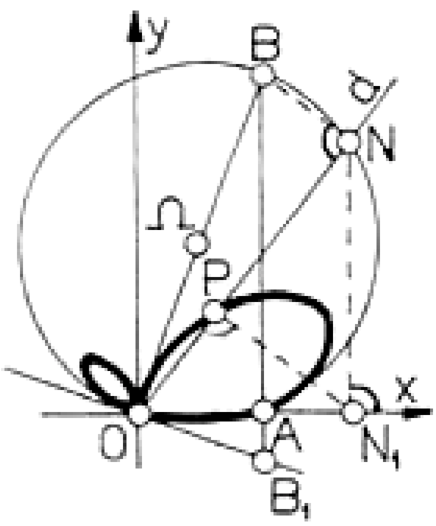

Fig. 1. Bifolium (double folium) – first variant.

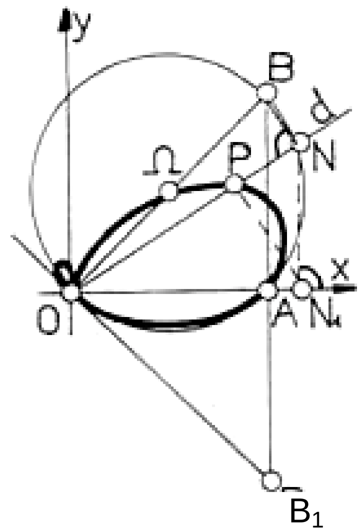

Fig. 2. Bifolium (double folium) – second variant.

1.2. Parabolic folium

We consider the rectangle OACB [2].

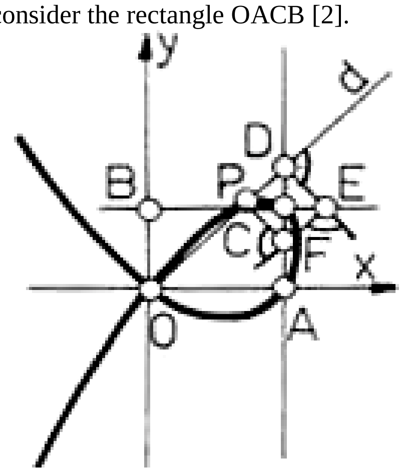

Fig. 3. Parabolic folium– first variant

A secant d drawn trough O, intersects AC in D; the perpendicular in D on OD intersects BC in E; the perpendicular in E on DE intersects AC in F and the perpendicular in F on EF intersects OD in P witch generates the plane curve names parabolic folium (figure 3 and figure 4).

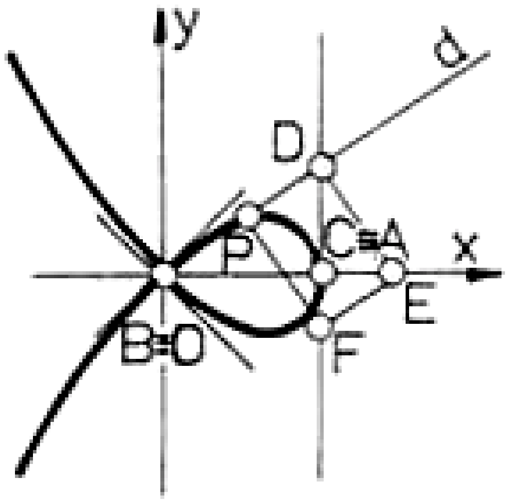

Fig. 4. Parabolic folium – second variant.

1.3. Descartes's folium

Descartes's Folium - leaf. We will draw the circle(Ω,ΩA) and O the middle of the ΩA radius [2].

A variable straight line trough A intersects C in N and a given straight line d perpendicular on ΩA, in point N_1. The intersection place Γ of ON_1 with the parallel at d that runs trough N, is the plane curve described by point P, named Descartes's folium (figure 5). Descartes introduced this notion in 1638.

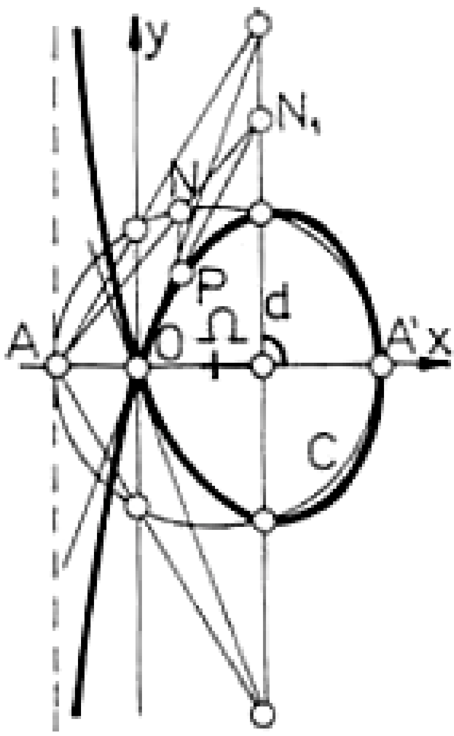

Fig. 5. Descartes's folium.

1.4. Tetrafolium (the four leaf clover)

The tetrafolium is a plane curve defined by the geometrical place of the M projection of a fixed point O, on a straight line PQ = 2a of constant size, that pivots with it's extremities P and Q on to perpendicular axes Ox and Oy (figure 6).

The curve is formed by four loops and is symmetrical against the axes and the pole [2].

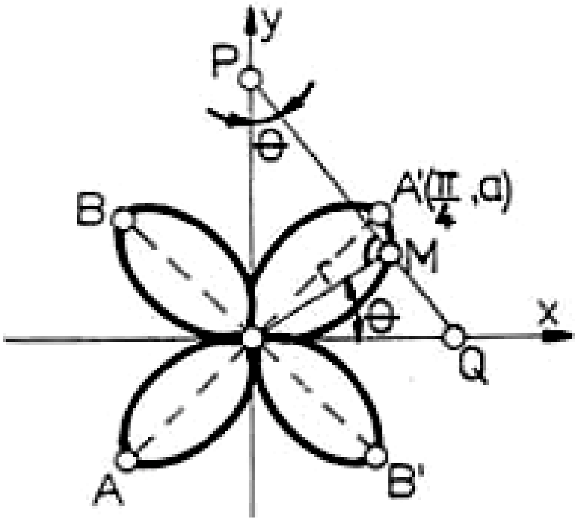

Fig. 6. Tetrafolium (the four leaf clover**)**

2. GENERATING MECHANISM

Using the folium's definition as a geometrical place generated from point D, in figure 7, the mechanism in figure 8 has been built [1]. It is considered that EAH is the diameter of the circle, and that HBE always equals 90, because it underlies half of the circle.

Only point B will be materialized, and it will always be on the circle.

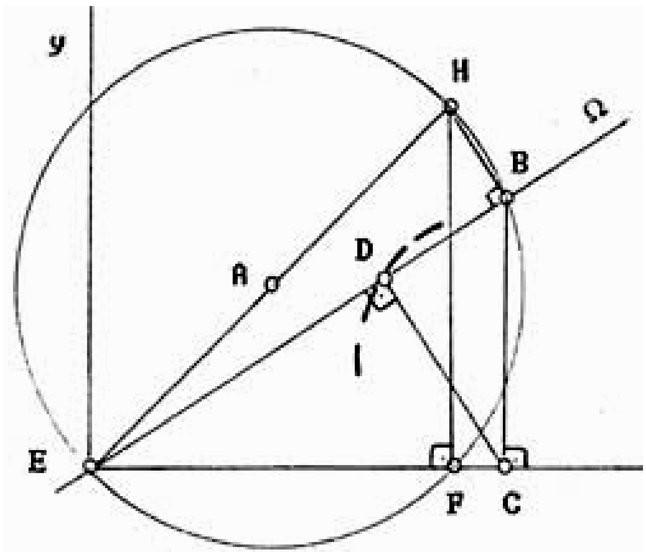

Fig. 7. Definition as a geometrical place generated from point D

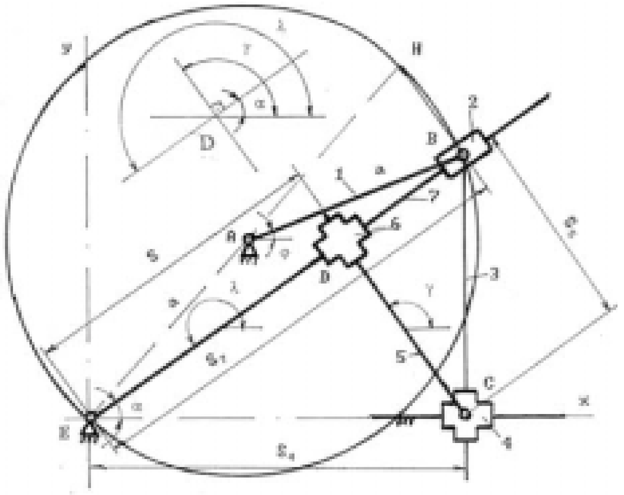

Fig. 8. Generating mechanism.

Structurally, the mechanism is analyzed in fig. 9.

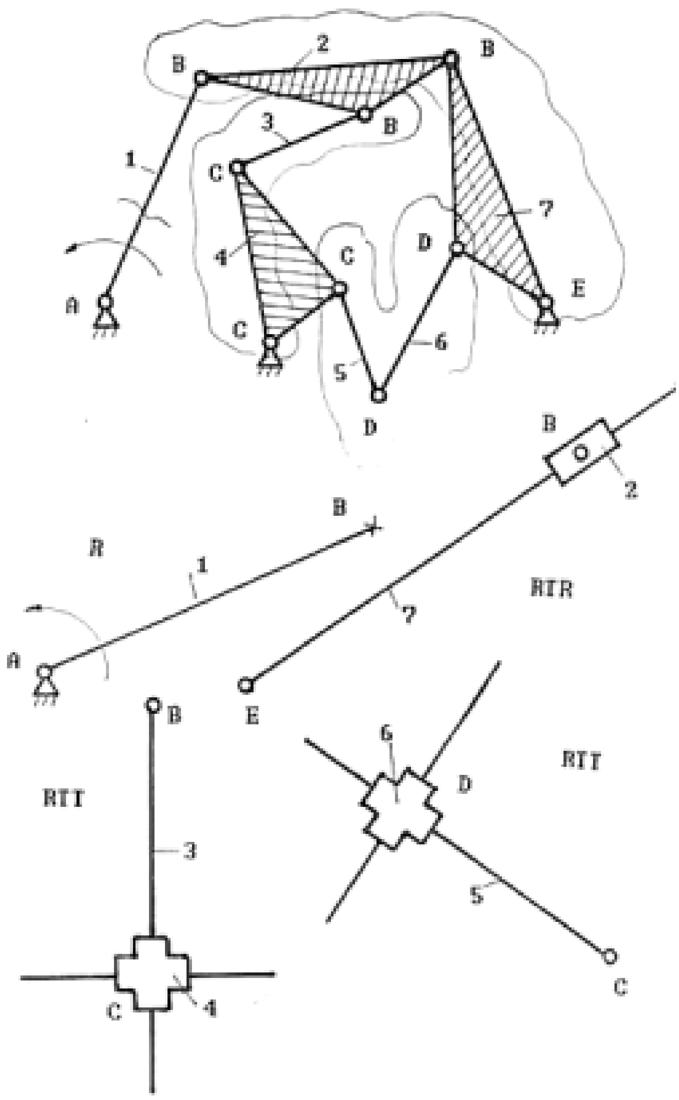

Fig. 9. Structural analyzes.

3. COMPUTATIONAL FORMULAS

Based on figure 6 one can write the following relations:

$$\begin{cases} x_A = a.\cos\dfrac{\pi}{4} \\ y_A = x_A \end{cases} \tag{1}$$

$$\begin{cases} x_B = x_A + a.\cos\varphi = S_7.\cos\alpha \\ y_B = y_A + a.\sin\varphi = S_7.\sin\alpha \end{cases} \tag{2}$$

$$\operatorname{tg}\alpha = \frac{y_B}{x_B} = \frac{S_5.\sin\gamma}{x_C + S_5.\cos\gamma} \tag{3}$$

$$\begin{cases} x_C = S_4 = x_B \\ y_C = 0 \end{cases} \tag{4}$$

$$\begin{cases} x_D = S.\cos\alpha = x_C + S_5.\cos\gamma = x_B + (S_7 - S).\cos\lambda \\ y_D = S.\sin\gamma = S_5.\sin\gamma = y_B + (S_7 - S).\sin\lambda \end{cases} \tag{5}$$

$$\gamma = \alpha + \frac{\pi}{2} \tag{6}$$

$$\lambda = \gamma + \frac{\pi}{2} \tag{7}$$

$$S_5 = \frac{\operatorname{tg}\alpha.x_C}{\sin\gamma - \operatorname{tg}\alpha.\cos\gamma} \tag{8}$$

$$S = \frac{S_5.\sin\gamma}{\sin\alpha} \tag{9}$$

4. OBTAINED RESULTS

It was realized a program and with it there were obtained numerous curves for different values of the dimensions of the mechanism.

In figures 10, 11 and 12 are presented three examples of the obtained curves.

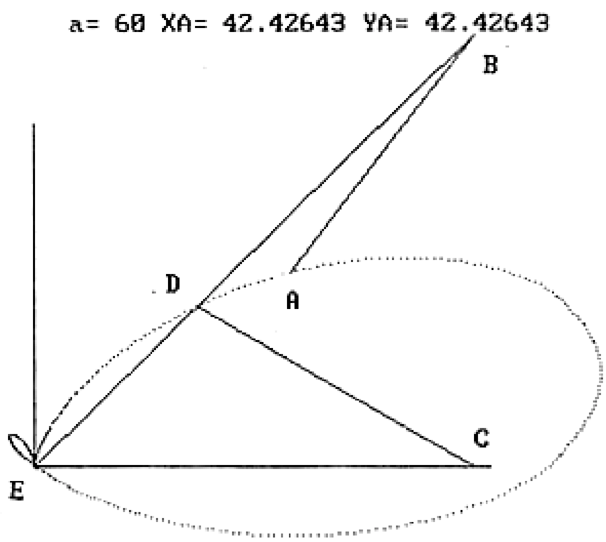

Fig. 10. Obtained curve.

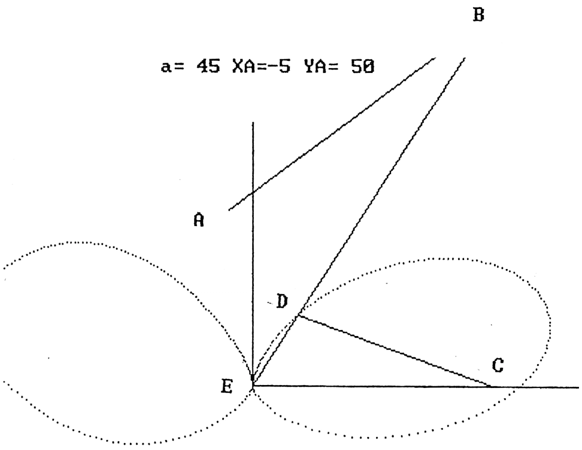

Fig. 11. Obtained curve.

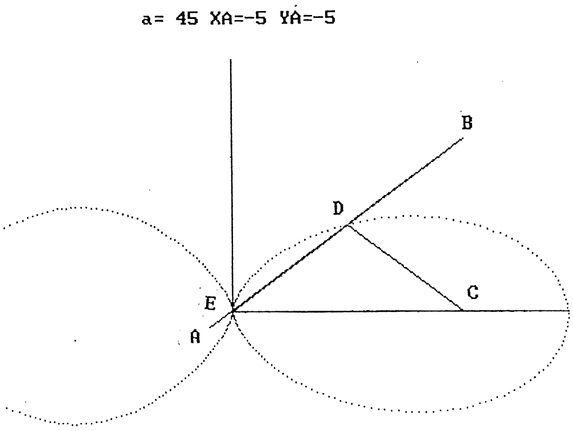

Fig. 12. Obtained curve

5. CONCLUSIONS

Based on several geometrical considerations, a mechanism that generates quartics that can be double foliums or other variants based on the mechanism's parameters.

The complexity of the mechanism(R+3 diads*), results as a follow up of the imposed geometrical conditions.

Using the same methods there can be created mechanisms for the other curves in the folium.

6. REFERENCES

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7. NOMENCLATURE

Symbol	Meaning	Unit
a, S, x, y	Dimensions	(mm)
φ, α, γ, λ	Angles	(grad S^0)