

GEOMETRIC LOCUS GENERATED BY A MECHANISM WITH THREE DYADS

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Abstract. It started with a locus problem, which was solved by the methods of the Theory mechanisms. It was made the kinematic analysis of the mechanism (positions and trajectories), resulting the searched geometric locus. It was found that there are several types of curves obtained as geometric loci, depending on the size of the elements of the mechanism. It was also noted that these curves are open, since the conditions like Grashof prevent from the complete rotation of the crank.

Keywords: geometric locus; mechanism with three dyads

1. Introduction

In a doctoral dissertation [1, 2] it is studied the geometry of the parallel mechanisms with several degrees of freedom, showing that geometrical methods are more advantageous, being intuitive, so they are easy to be controlled compared to analytical methods. There are studied both planar and spatial mechanisms. There are detailed the singularities of these mechanisms. The author uses a new analytical method for the accurate indication on the angles of the spatial mechanisms, a method detailed in [3]. In [4] are given all the usual curves of geometry aesthetically analyzed, getting curves shapes and surfaces generated by turning these curves according to the axes x , y , z . In [5] it is shown how is obtained the cardioid, Pascal snail, curved conical

nefroid, Gherșgorin's curve, pantographs, generated by appropriate mechanisms. In [6] it is analyzed the sensitivity of the parallel planar mechanisms by geometrical considerations, giving examples, finding profitable methods of synthesis.

2. Problem of geometric locus

There are taken two straight fixed lines AC and DC (Fig. 1). A line segment AB moves on the AC line. A variable line as position, BE has the point B on the segment AB and point F on a fixed circle. Another variable line as position, AD has the point A on the segment AB and the point D on the line DC. It is required the geometrical locus of the point of intersection G between the lines AD and BE.

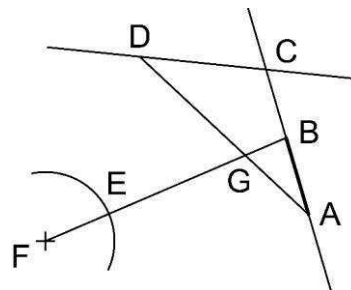


Fig. 1

3. Generator mechanism synthesis

There are run fixed lines HC and DC (Fig. 2), the line DC taking it parallel with the horizontal axis FH. It is adopted the length and position of the segment AB. AD has the end on AB and point D must move on

DC therefore it is positioned a slide in D related to AD via a rotating hitch. It is marked the radius

FE and the line EB. G's position can be determined by placing two slideways, articulated coupling, the center of rotation being the tracing point. This is the generator mechanism.

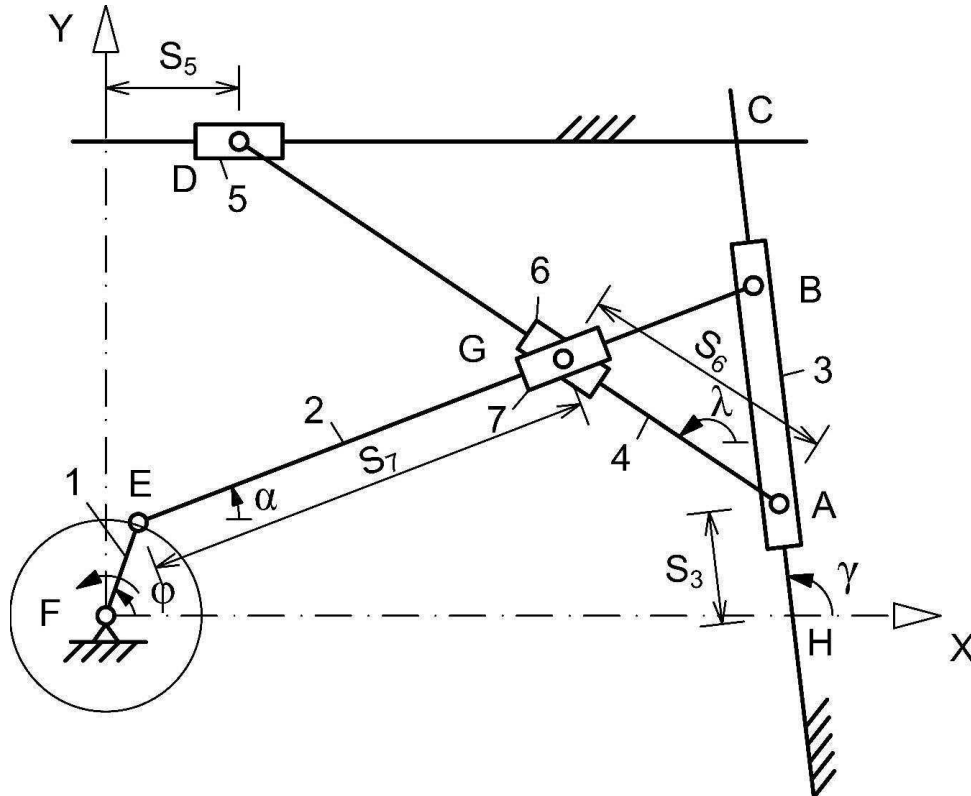


Fig. 2

4. Analysis of the mechanism.

The structure of the mechanism is given in fig. 3

The result is a driving element and three dyads, the mechanism being of RRP-R-RRP-PRP type.

Based on Fig. 2 there are written the equations by the contour method:

$$X_E = X_F + FE \cos \varphi; \quad Y_E = Y_F + FE \sin \varphi$$

$$\begin{aligned} X_B &= X_E + EB \cos \alpha = X_H + S_3 \cos \gamma + AB \cos \gamma \\ Y_B &= Y_E + EB \sin \alpha = Y_H + S_3 \sin \gamma + AB \sin \gamma \\ X_D &= X_H + S_3 \cos \gamma + AD \cos \lambda = S_5 \\ Y_D &= Y_H + S_3 \sin \gamma + AD \sin \lambda = \text{const.} \\ X_G &= X_H + S_3 \cos \gamma + S_6 \cos \lambda = X_E + S_7 \cos \alpha \\ Y_G &= Y_H + S_3 \sin \gamma + S_6 \sin \lambda = Y_E + S_7 \sin \alpha \end{aligned}$$

From (1) it is obtained the position of E, and from (2) and (3) it results S3 and alpha. From (4) and (5), it is obtained S5 and lambda, and from (6) and (7) S6 and S7.

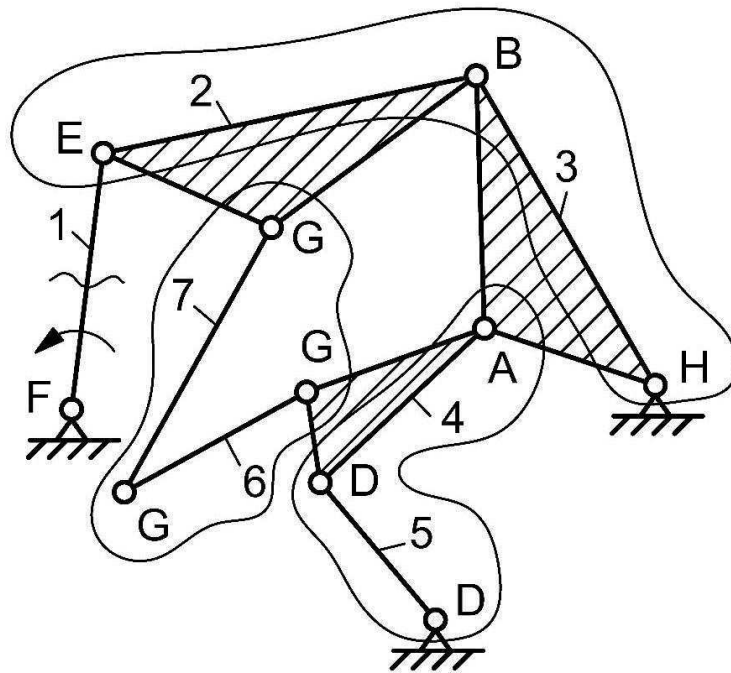


Fig. 3

5. Obtained results

There were taken the following initial data: $XH = 76$: $AB = 23$: $FE = 10$: $EB = 73$
 $AD = 71$: $YD = 53$: $GAM = 98$. In Fig. 4 it is

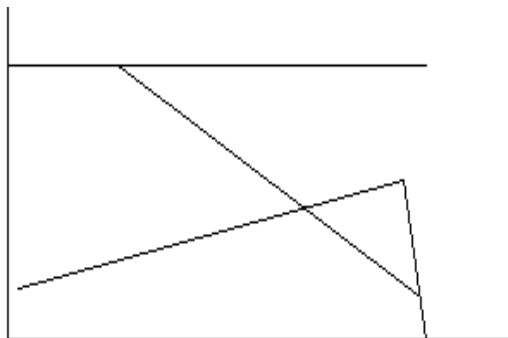


Fig. 4

There have been searched other values of some sides, so that the rotation of the crank to be as big as possible. Thus, for $FE = 30$ it

shown the mechanism for the position $\varphi = 80^\circ$ degrees, and in Fig. 5 there are indicated the successive positions, observing that due to the chosen sizes, the crank bar does not execute complete revolutions.

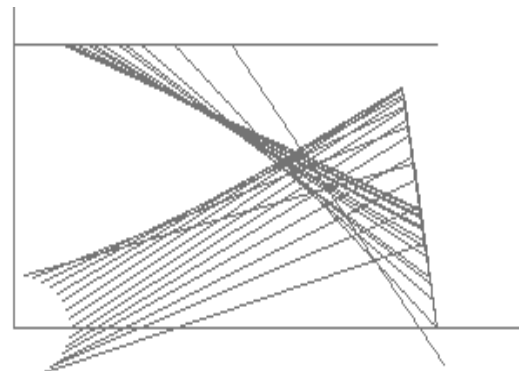


Fig. 5

has resulted the trajectory of G (the searched geometrical locus) from FIG. 6 and the successive positions shown in FIG. 7.

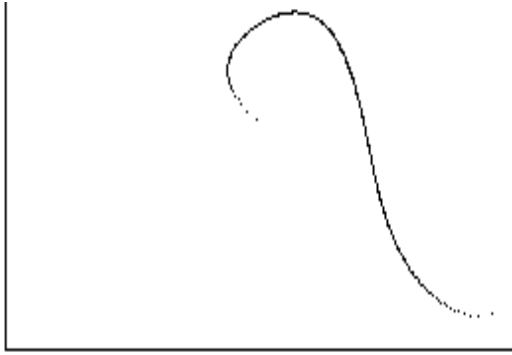


Fig. 6

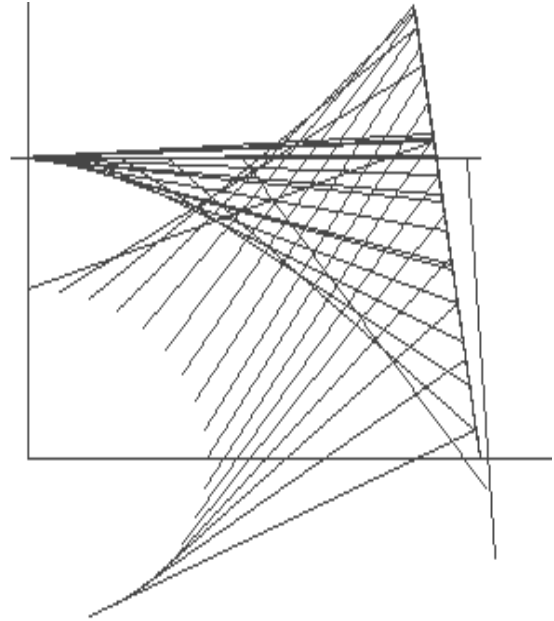


Fig. 7

Similarly, for $FE = 50$ it is obtained the trajectory presented in fig. 8. There have been changed some quotas resulting fig. 9 ...

16, below these ones being given the changed values.

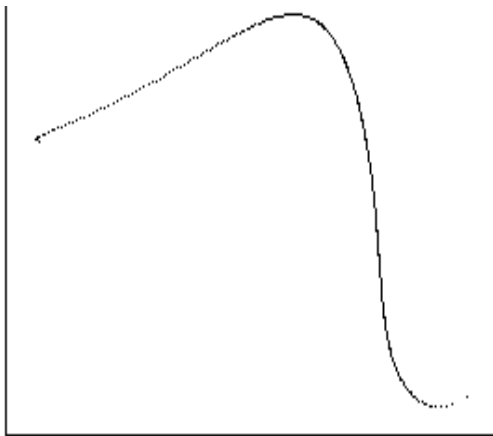


Fig. 8

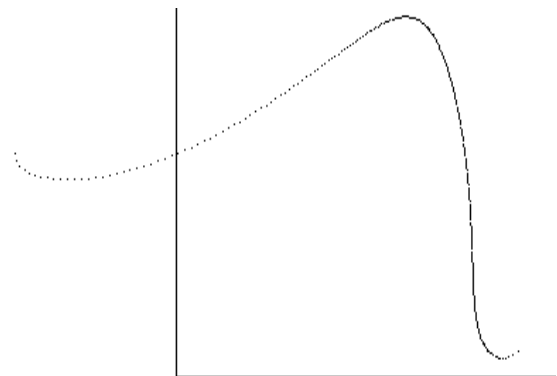


Fig. 9 (FE=60)

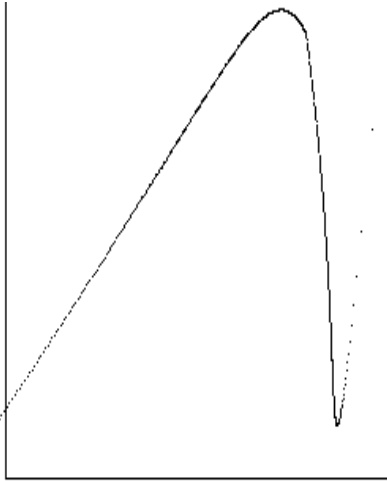


Fig. 10 (FE=75)

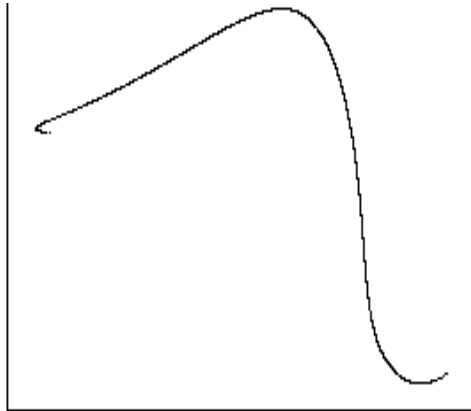


Fig. 11 (FE=50)

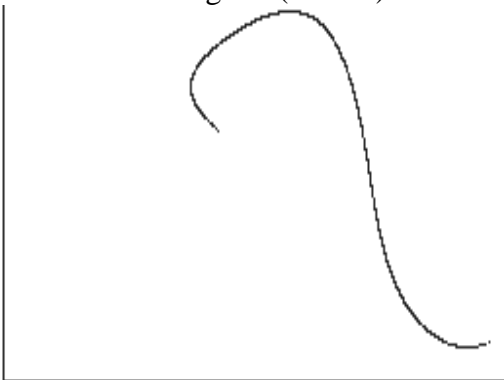


Fig. 12 (FE=35)

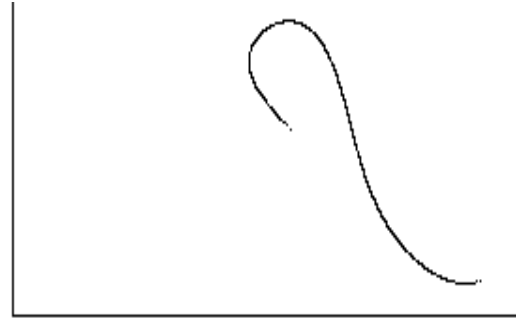


Fig. 13 (FE=25)

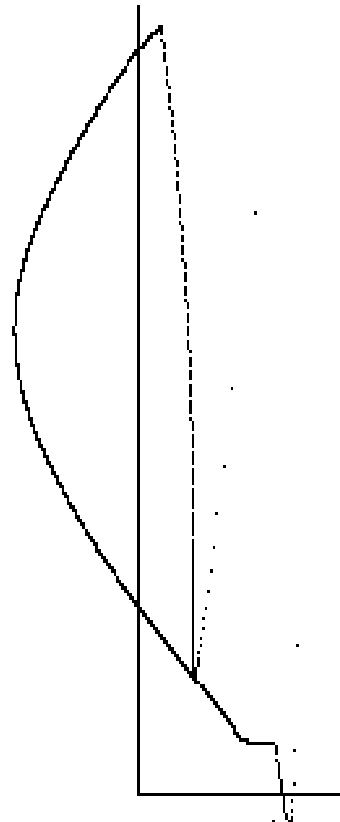


Fig. 14 (FE=50, XH=20)

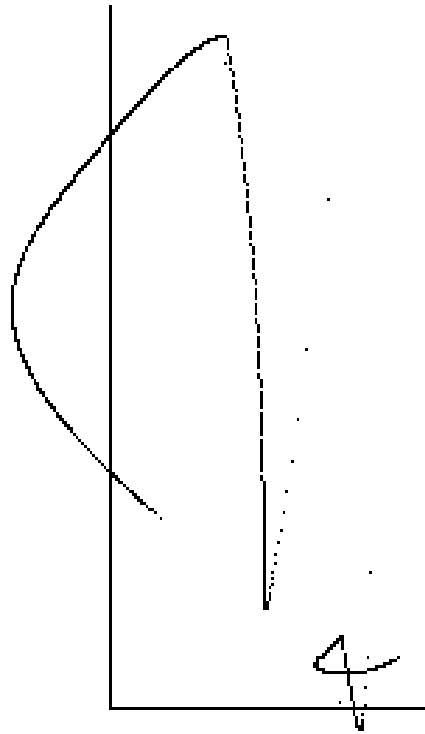


Fig. 15 (FE=50; XH=30)

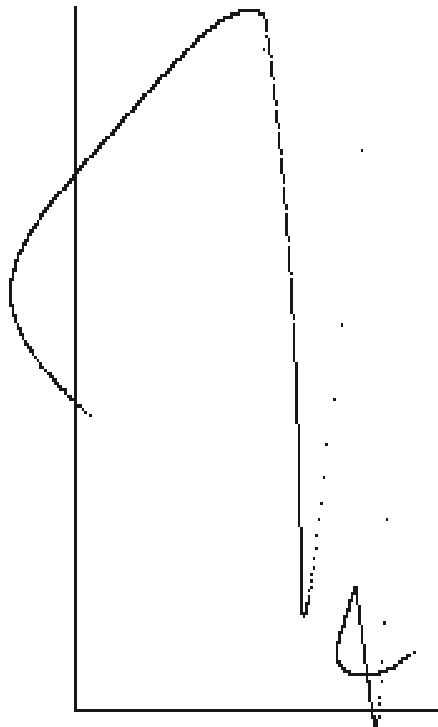


Fig. 16 (FE=50; XH=40)

It was further maintained $FE = 50$ and only XH was changed (fig. 17 ... 19).



Fig. 17 (XH=50)

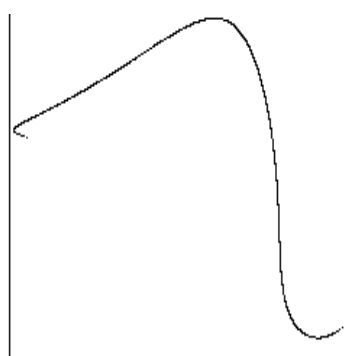


Fig. 18 (XH=70)



Fig. 19 (XH=100).

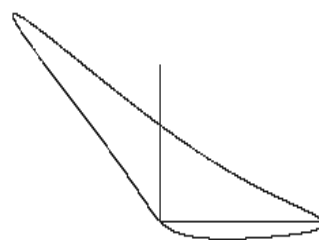


Fig. 20 ($\gamma=0$)

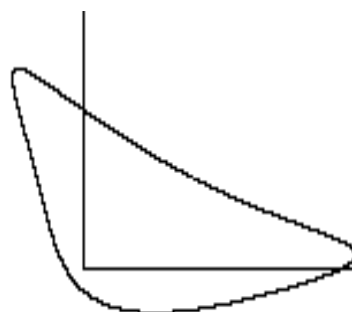


Fig. 21 ($\gamma=10$)

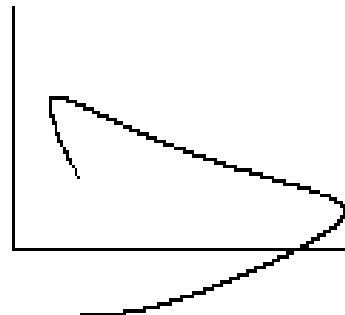


Fig. 22 ($\gamma=20$)

Further there were established the values FE = 50, XH = 70, by modifying them γ (Fig. 20 ... 29).

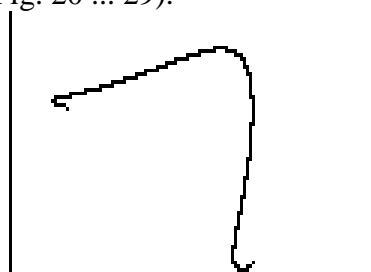


Fig. 23 ($\gamma=85$)

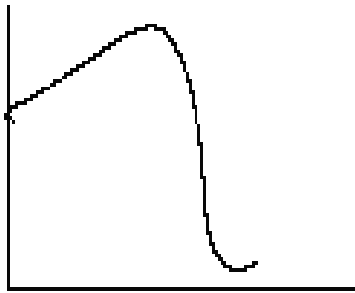


Fig. 24 ($\gamma=100$)

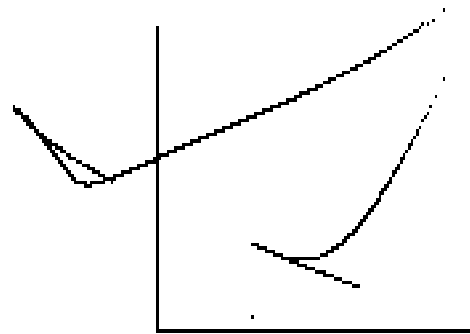


Fig. 26 ($\gamma=140$)

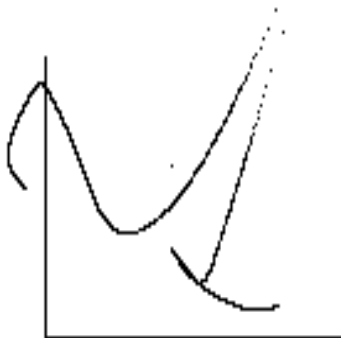


Fig. 25 ($\gamma=120$)

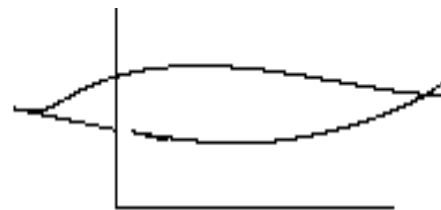


Fig. 27 ($\gamma=160$)

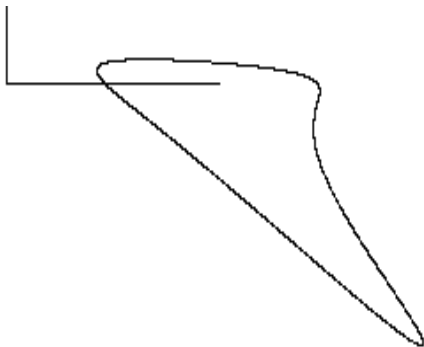


Fig. 28 ($\gamma=180$)



Fig. 29 ($\gamma=300$)

It is found that the geometrical locus is modified according to changing lengths of the elements of the mechanism. It results a wide variety of curves, most of them being open, some of them with jumps, so with discontinuities.

6. Conclusion

It was started from a problem of geometrical locus, which was translated into an equivalent mechanism, whose synthesis

was done. Further it was done the structural analysis and the mechanism positions, determining the searched geometrical locus . Many curves were obtained for this geometrical locus, their shape being influenced more by the lengths of some elements. The mechanism ensures the full rotation of the crank only for certain geometrical dimensions of the mechanism, resulting closed curves; In the analyzed cases, the curves are open.

References

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