CURVES AND FAMILIES OF ROD CURVES GENERATED BY A R-RRP-RRP-RPR TYPE MECHANISM

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Abstract. The synthesis of a mechanism of type R-RRP-RRP-RPR was made, starting from the rod-crank mechanism, completing it with two dyads. It was sought to obtain curves generated by points on a connecting rod that rests at the ends on other connecting curves. It resulted in a large range of connecting rod curves by modifying some parameters of the mechanism. The families of connecting rod curves were obtained by positioning the tracer point at different points on the analyzed connecting rod.

Key words: connecting rods, families of curves, mechanisms with bars

1. INTRODUCTION

The connecting rods generated by different mechanisms are of great diversity. They differ from mechanism to mechanism and depending on the dimensions of each mechanism analyzed. There has not yet been a classification of the types of curves specific to the types of mechanisms. In [1], the curves generated by points at a spherical mechanism are analyzed by using a spherical triangle, on the sphere, of which two points given by connections are known and the third is determined, obtaining systems of linear equations. In the synthesis of the mechanisms that generate connecting rod curves, the gradient method is used, i.e. an optimization, as in [2]. A method of synthesis of a mechanism for generating a connecting curve is given in [3]. The mechanism consists of bars and a cam, used in a profile cutting machine. The resulting errors and the dynamic stability are calculated.

In [4, 5] there were presented many connecting rods generated by some mechanisms, as well as the transfer functions of these mechanisms. In [6] have been studied connecting rod curves in different planes, as well as geometric locations generated by different mechanisms. The kinematics of some interesting mechanisms with connecting rod is also presented in the paper [7].

The following studies the connecting rod curves and the connecting rod families generated by a mechanism with three R-RRP-RRP-RPR type dyads. The authors of this work have also studied an interesting mechanism with three dyads, presented in [8].

2. MECHANISM SYNTHESIS

We left from the crank mechanism ABC (fig. 1), to which was added the CFF dyad and then the DEE dyad. Point D of the BCD dyad becomes an entry in the DEE dyad, and point C is the entry in the CFF dyad. The point M on the DE rod benefits from the curve of D and of the curve of E. The resulting mechanism is of type R-RRP-RRP-RPR.

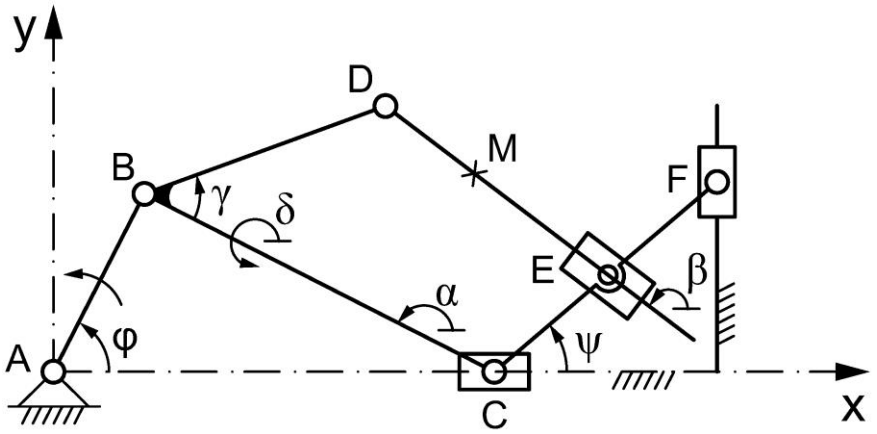

Fig. 1. The mechanism scheme

3. CALCULUS RELATIONS

Based on the outline method, the relationships are written:

$X_B=AB\cos\varphi$; $Y_B=AB\sin\varphi$ (1)

$X_C+BC\cos\alpha=X_B$ (2)

$BC\sin\alpha= Y_B$ (3)

$X_D= X_B+BD\cos(\delta+\gamma)$ (4)

$Y_D= Y_B+BD\sin(\delta+\gamma)$ (5)

$\delta=\alpha+\pi$ (6)

$X_F= X_C+CF\cos\Psi=const.$ (7)

$Y_F= CF\sin\Psi$ (8)

$X_C+CE\cos\Psi+DE\cos\beta= X_D$ (9)

$CE\sin\Psi+DE\sin\beta= Y_D$ (10)

$X_E= X_C+CE\cos\Psi$; $Y_E= CE\sin\Psi$ (11)

From (1) XB and YB are obtained, and from (2) and (3) α and XC also result. From (4) and (5) XD and YD are obtained, having the angle δ given by (6). From (7) and (8) results ψ, XF, YF. By (9) and (10) we also determine β and DE, and (11) gives XE, YE.

4. Obtained results

The following initial data (lengths in millimeters and angles in degrees - and below) were adopted:

AB=28: BC=55: BD=35: φ =65: γ =47

grade: CF=100: XF=93: CE=20: XF=93: CE=19.

For φ = 75 the mechanism obtained in fig. 2.

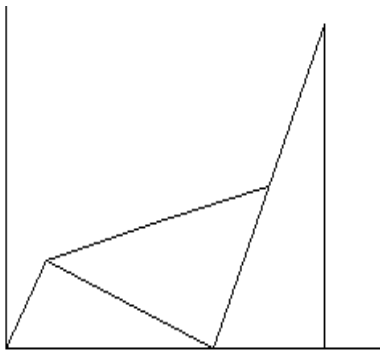

Fig. 2. The generated mechanism

The successive positions are shown in fig. 3.

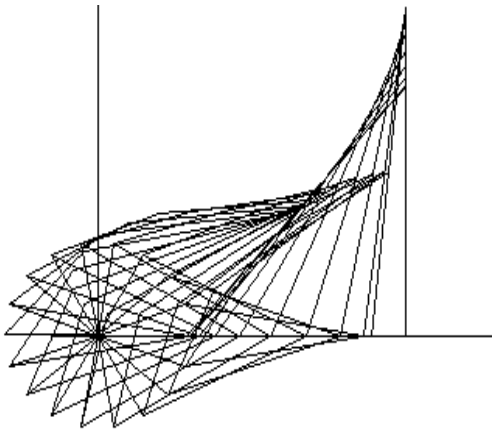

Fig.3. Successive positions

In fig. 4 we show the trajectory of D, known as the crank-mechanism.

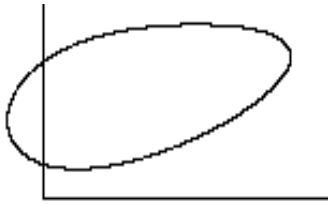

Fig. 4. The rod curve generated by D

The trajectory of E is given in fig. 5, it being traveled in two directions.

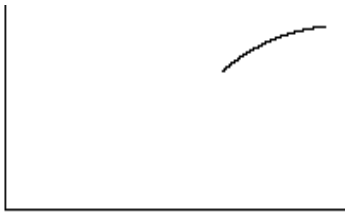

Fig. 5. The trajectory of E

The trajectory of the point M in fig. 6, having DM = 25 mm.

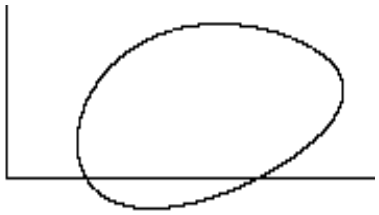

Fig. 6. The curve generated by M

Further, the M curves were drawn, for different combinations between the DM and CE lengths (fig. 7 ... 12).

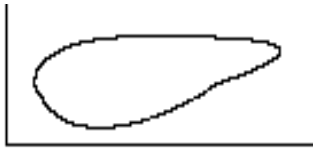

Fig. 7. DM=15; CE=15

Fig. 8. DM=60; CE=15

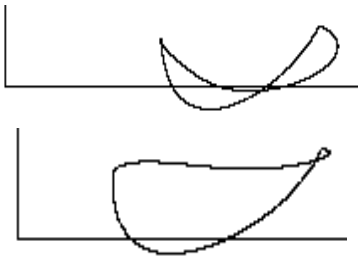

Fig. 9. DM=35; CE=25

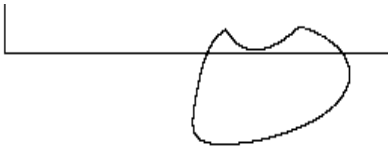

Fig. 10. DM=85; CE=10

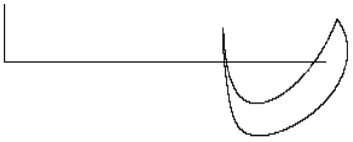

Fig. 11. DM=110; CE=20

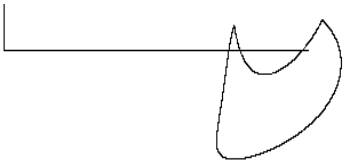

Fig. 12. DM=120; CE=15

It is found that interesting curves appear at high DM and small EC.

5. CURVE FAMILIES

DM was cycled from 0 to 100 with step 10 and for different values of DM we obtained families of curves on DE, for different values of CE (fig. 13 ... 22).

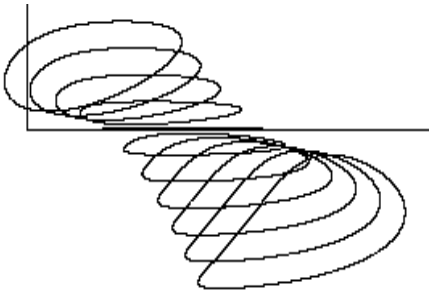

Fig. 13. CE=0

It can be seen that the curves start from the trajectory of D, always changing with increasing DM distance, resulting in a completely different curve at DM = 100, compared to DM = 10.

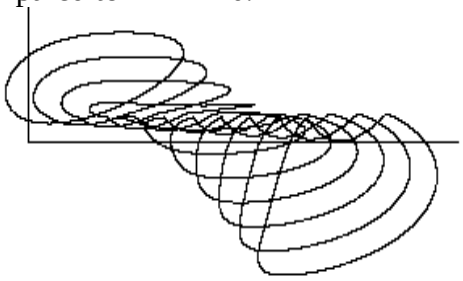

Fig. 14. CE=10

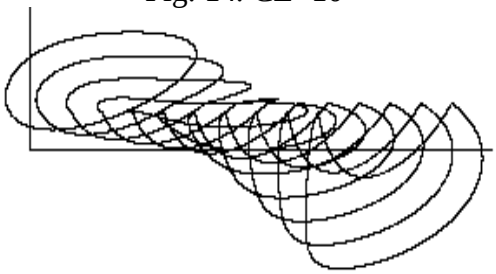

Fig. 15. CE=15

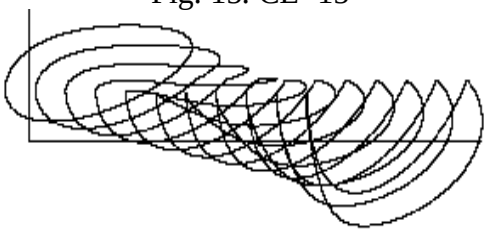

Fig. 16. CE=20

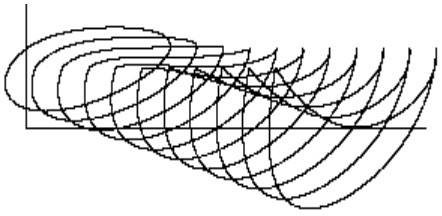

Fig. 17. CE=30

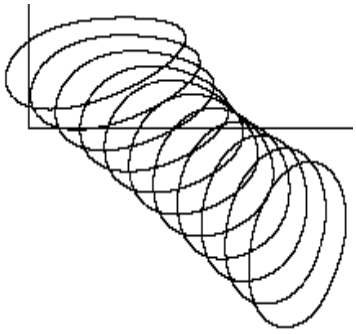

Fig. 18. CE=100

The following situations were also considered when E is below C, i.e. CE <0.

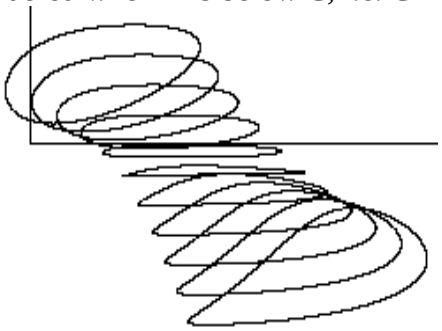

Fig. 19. CE=–5

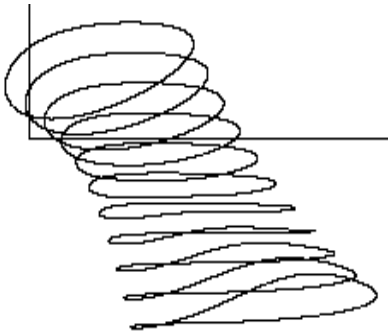

Fig. 20. CE=–15

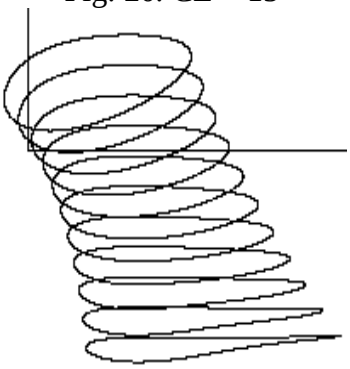

Fig. 21. CE=–25

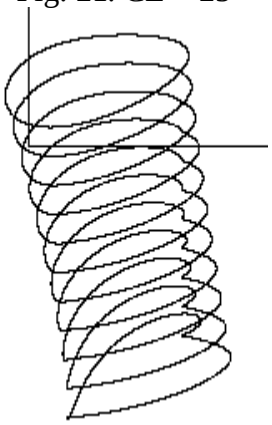

Fig. 22. CE=–100

The result was aesthetic images made up of sequences of different curves.
Then CE = 20 was maintained and the angle γ changed, resulting in the families of curves in fig. 23 ... 30.

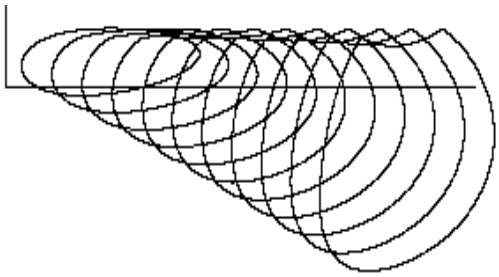

Fig. 23. γ =15

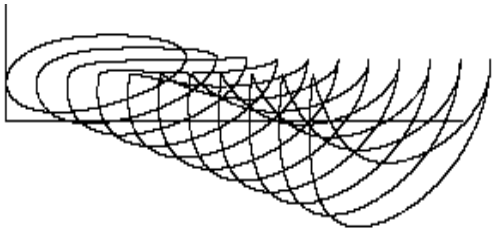

Fig. 24. γ =30

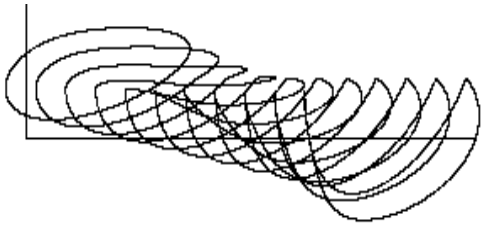

Fig. 25. γ =45

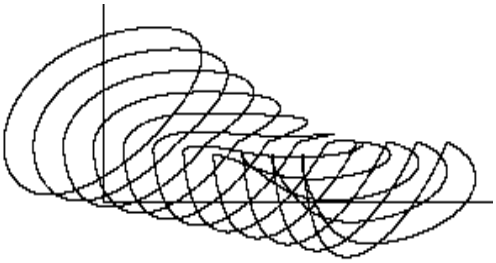

Fig. 26. γ =90

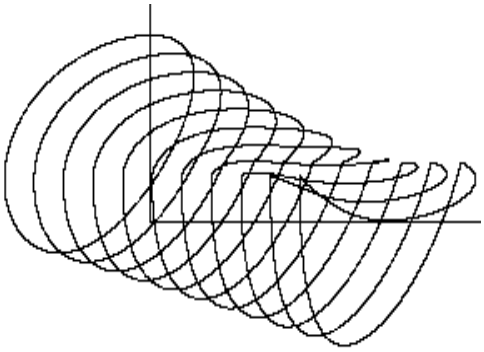

Fig. 27. γ =120

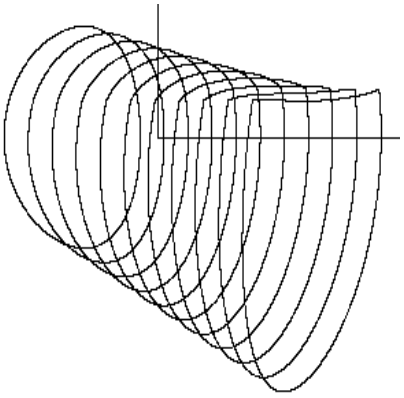

Fig. 28. γ =180

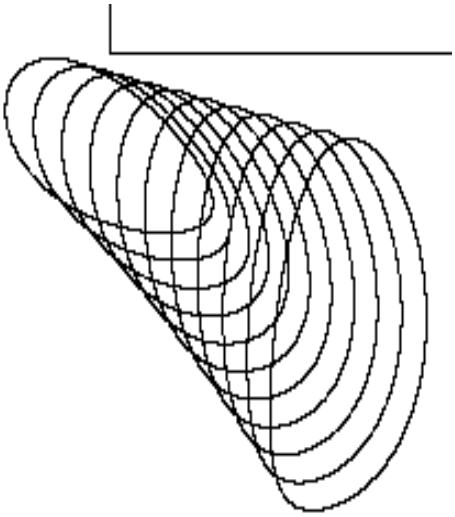

Fig. 29. γ =270

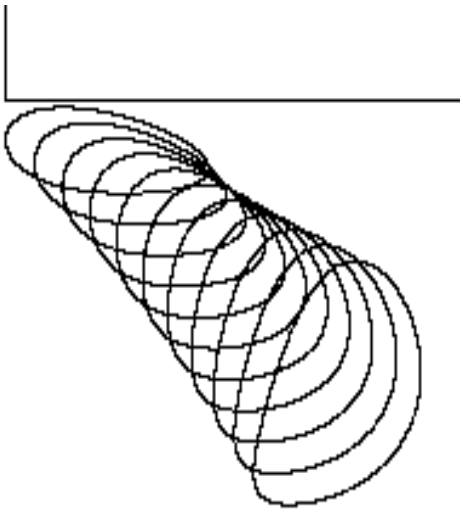

Fig. 30. γ =330

It is found that the angle γ influences the dimensions of the curves, as well as their positioning with respect to the axis system.

6. CONCLUSIONS

It departed from a rod-crank mechanism that extended with two dyads, resulting in a R-RRP-RRP-RPR type mechanism and connecting rod curves were obtained when changing some dimensions. The range of curves is very diversified because the tracer point is on a connecting rod that has the entries on two completely different connecting rod curves. There were also drawn families of connecting rod curves resulting in the positioning of the tracer point at different points on the connecting rod, always changing the length of an element of the mechanism. It has been found that the mechanism can generate many types of connecting rods. The result was aesthetic images made up of sequences of different curves. Studies regarding generation of aesthetics surfaces with mechanisms have been carried out by the authors of this work and published in the articles [9, 10, 11].

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