ROD CURVES AND CURVE FAMILIES GENERATED BY A R-PRR-RPP-RPR TYPE MECHANISM

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ABSTRACT. An R-PRR-RPP-RPR type mechanism was obtained by binding two dyads to the oscillating slide mechanism. The aim was to obtain a mechanism with the final connecting rod supported on the connecting rod curves generated by the previous dyads, so that the shape of the connecting rod curves generated by the points on this connecting rod would be as interesting as possible. Many connecting rods were obtained by modifying some parameters of the mechanism. The families of curves were obtained by moving the tracer point to the final connecting rod.

Key words: connecting rods, three-dyad mechanism, families of curves

1. INTRODUCTION

The connecting rods drawn by the mechanisms with a dyad are known and widely studied. There have also been studied the connecting rod curves generated by two-dyad mechanisms and some cases for three-dyad mechanisms. Connecting rods are more complicated if the connecting rods are resting on other connecting rods. A family of curves is a set of curves in which one or more parameters are variable [1]. Many papers deal with the analysis and synthesis of the articulated quadrilateral for the visualization or synthesis of connecting rods, as is the case in [2]. In [3, 4, 5] we present studies of many mechanisms that generate rod curves. In the kinematics of the mechanisms, including the connecting rod curves, the polynomial expressions are solved by numerical methods, as in [6].

In [7] the connecting rod curves generated by two and three steering mechanisms were analyzed. Below are generated connecting rod curves and family curves for the R-PRR-RPP-RPR type mechanism. The authors of this work conducted several studies of three-dyad mechanisms, such as [8].

2.MECHANISM SYNTHESIS

We left from the ABCD oscillating slide mechanism and added the BFF dyad (fig. 1) to it. Considering the outputs D and E as inputs to the next DEE dyad, the trajectory of point M was determined, which will be defined by a dyad having inputs two connecting rod curves.

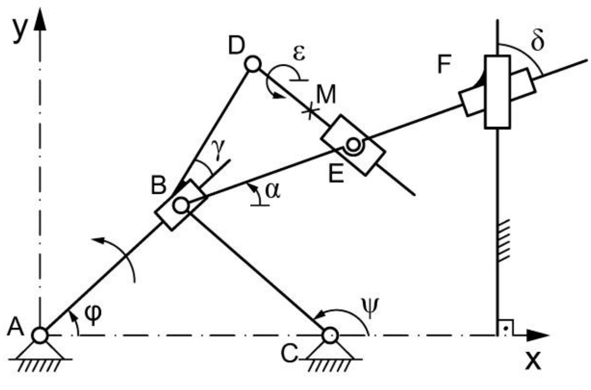

Fig. 1. The mechanism analyzed
The mechanism is type R-PRR-RPP-RPR.

3.CALCULUS RELATIONS

The following relationships are written using the projection method:

$X_B = AB\cos\varphi = X_C + BC\cos\Psi$
(1)
$Y_B = AB\sin\varphi = BC\sin\Psi$
(2)
$X_D = X_B + BD\cos(\varphi+\gamma)$
(3)
$Y_D = Y_B + BD\sin(\varphi+\gamma)$
(4)
$X_F = X_B + BF\cos\alpha = const.$
(5)
$Y_F = Y_B + BF\sin\alpha$
(6)
$\alpha = 90 - \delta$
(7)
$X_E = X_D + DE\cos\varepsilon = X_B + BE\cos\alpha$
(8)
$Y_E = Y_D + DE\sin\varepsilon = Y_B + BE\sin\alpha$
(9)
$BF = (X_F - X_B)/\cos\alpha$
(10)
$tg\varepsilon = (Y_E - Y_D)/(X_E - X_D)$
(11)
$DE = (X_E - X_D)/\cos\varepsilon$
(12)
$X_M = X_D + DM\cos\varepsilon$
(13)
$Y_M = Y_D + DM\sin\varepsilon$
(14)

From (1) and (2) we obtain AB and ψ, XB, YB, and from (3) and (4) XD and YD are obtained. Having α calculated with (7), from (5) and (6) we calculate BF and YF. From (8) and (9) we determine DE, ε, XE, YE. (10) shows the expression of BF, in (11) of ε and in (12) of DE. With (13) and (14), XM and YM are calculated.

4. INITIAL DATA AND RESULTS

The initial data were established according to the initial kinematic scheme of the mechanism (lengths in millimeters and angles in degrees): XC = 27; BC = 47; BD = 30; XF = 84;γ = 20;δ = 70; BE = 35, DM = 25.

The trajectory of D is a circle with the center in C, because the point B rotates around C, the points B and D being linked by the element BD. The successive positions of the BE rod are parallel to each other, only the angle δ is constant.

If BC <AC, point B cannot pass to the left of point A. The resulting mechanism is given in fig. 2, and the successive positions are shown in fig. 3.

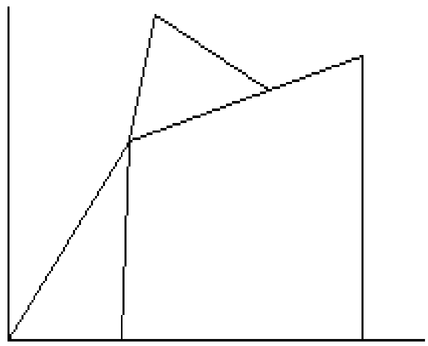

Fig. 2. The mechanism generated

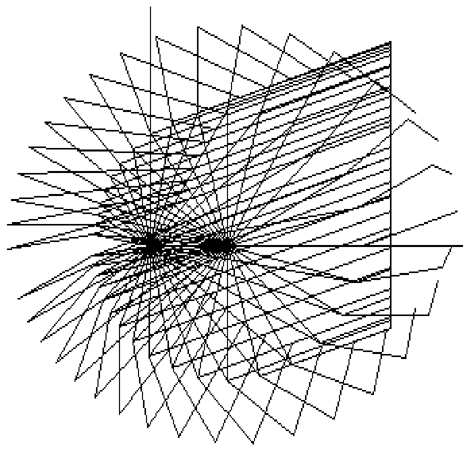

Fig. 3. Successive positions

The trajectories of points D and E are circles: B is on the circle CB, and E on the direction BF, with α constant and the segment BE constant, therefore describes a circle.

5. M POINT TRAJECTORIES

The trajectories of point M for different values of DM are given below (fig. 4…11).

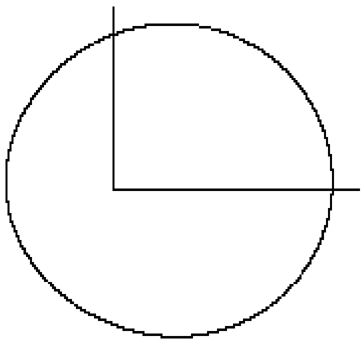

Fig. 4. DM=0

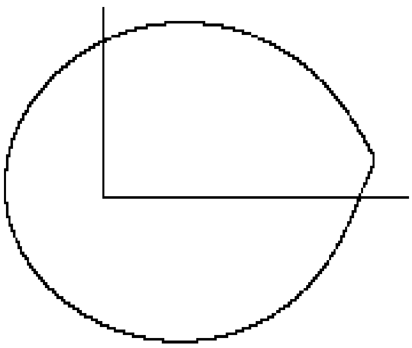

Fig. 5. DM=10

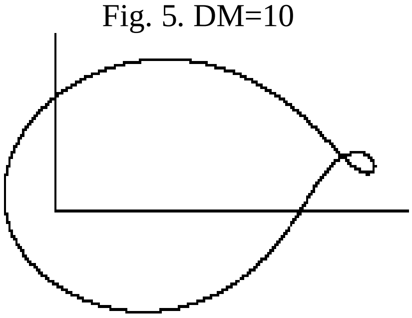

Fig. 6. DM=30

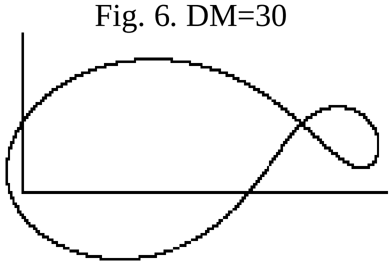

Fig. 7. DM=45

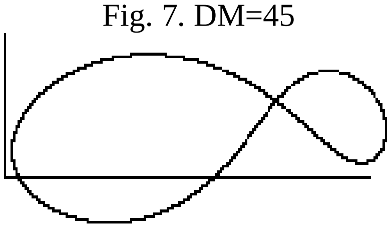

Fig. 8. DM=55

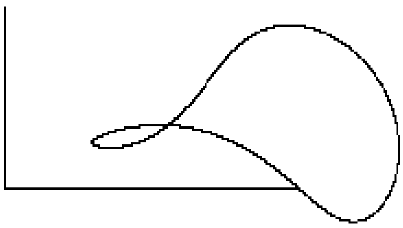

Fig. 9. DM=100

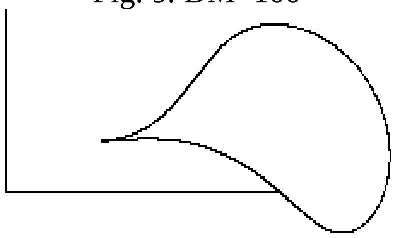

Fig. 10. DM=110

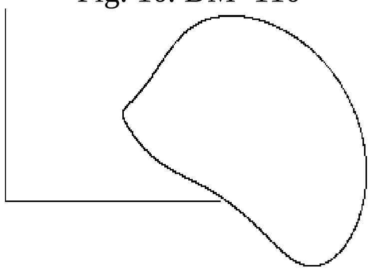

Fig. 11. DM=150

The curves start from a circle, then a second loop appears on the right side, which increases with DM growth, becoming predominant.

6. ANGLE MODIFICATIONS

Then the angle δ was changed, for DM = 25, obtaining fig. 12 ... 16.

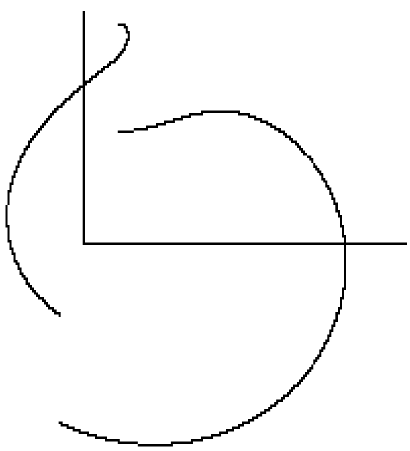

Fig. 12. δ =0

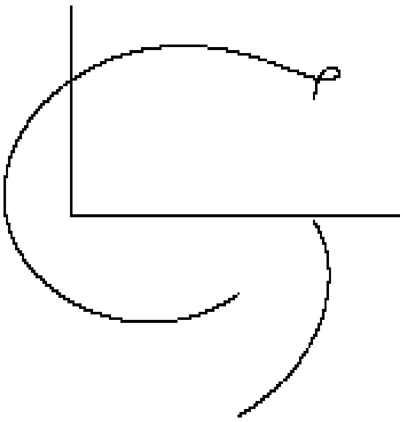

Fig. 13. δ =50

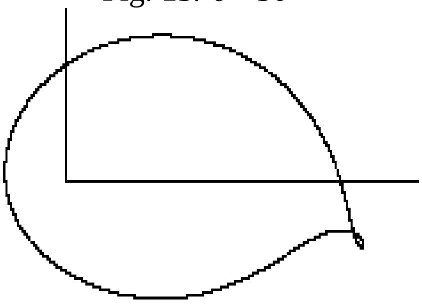

Fig. 14. δ =90

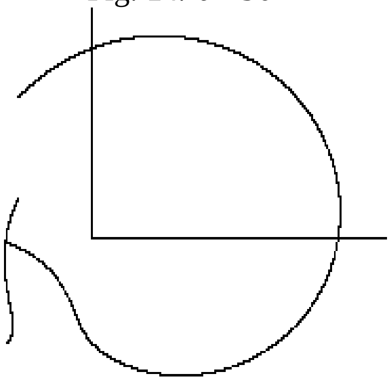

Fig. 15. δ =220

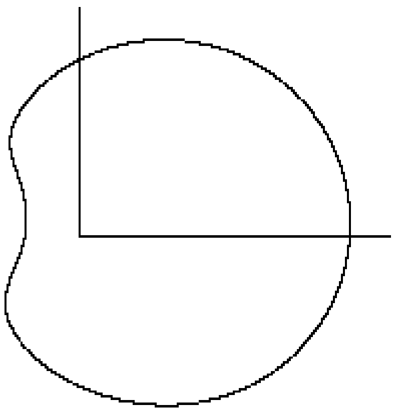

Fig. 16. δ =270

The crankshafts are some with two branches because for those values the mechanism is locked in certain subintervals of the complete crank rotation cycle. Further the angle γ was changed, resulting in the curves in fig. 17 ... 20.

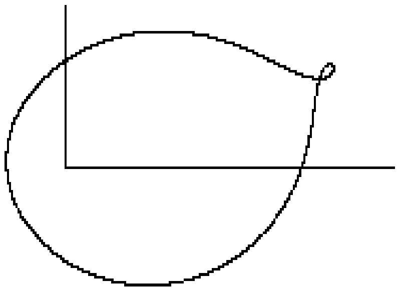

Fig. 17. γ =0

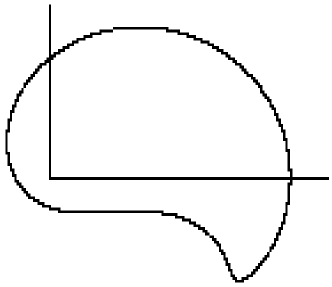

Fig. 18. γ =90

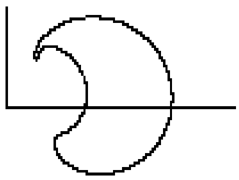

Fig. 19. γ =180

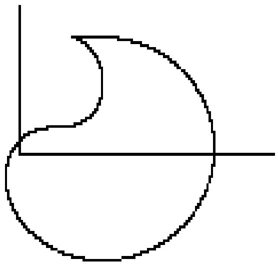

Fig. 20. γ =240

The resulting curves are some similar, but positioned differently and with other dimensions. Here all curves are closed, the angle γ depending only on the kinematic chain ABD.

7. CURVE FAMILIES

The curves on the DEM connecting rod can be grouped into families, by moving the point M from the length of - 100 to +100 with a 15 mm pitch. Aesthetic images were obtained. Thus, in fig. 21 is given the family of curves for the initial data.

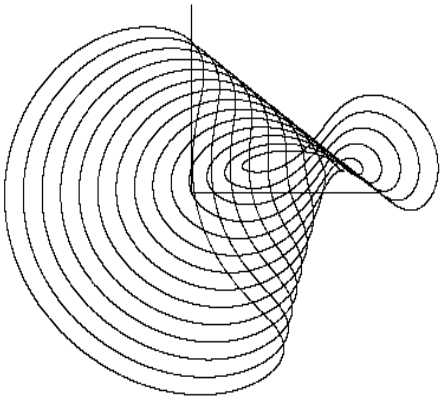

Fig. 21. Family of curves

In this family we find the individual curves drawn above. Further, the families of curves for different δ angle values were drawn (fig. 22 ... 24).

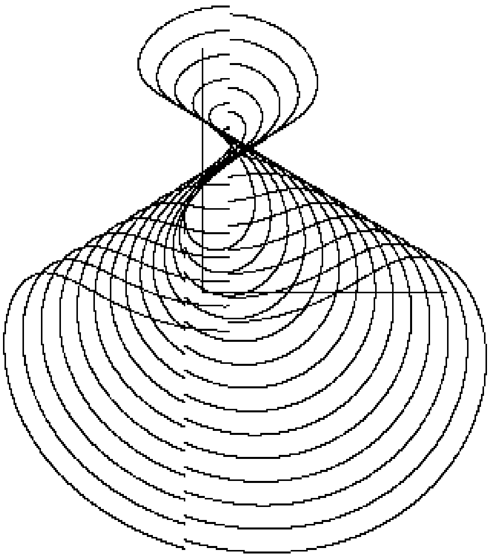

Fig. 22. δ =0

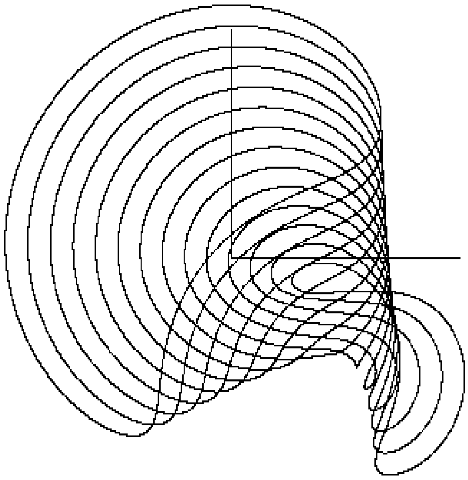

Fig. 23. δ =120

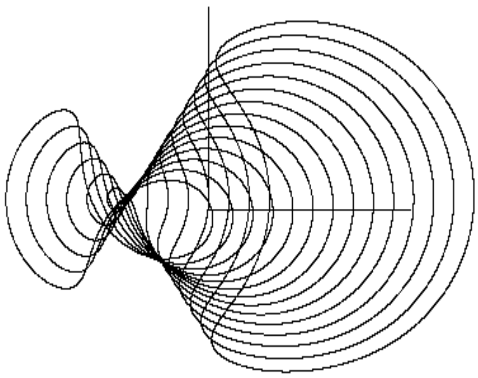

Fig. 24. δ =270

The curves above are found in these families, and some with two branches appear for the values of δ at which the mechanism locks.

Next, the influence of the angle γ on the families of curves was studied (fig. 25 ... 31).

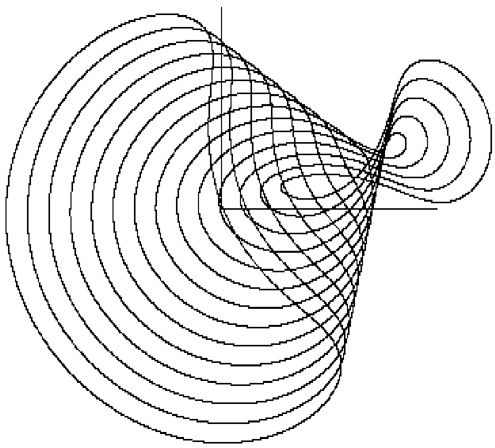

Fig. 25. γ =0

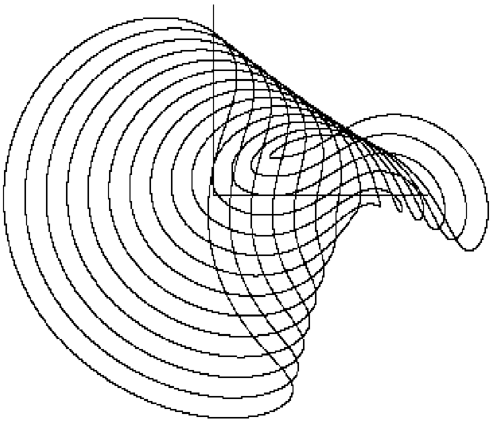

Fig. 26. γ =40

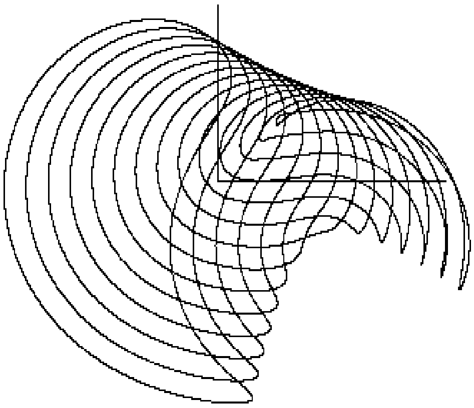

Fig. 27. γ =70

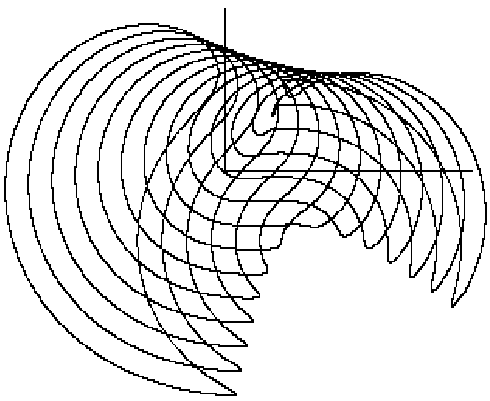

Fig. 28. γ =90

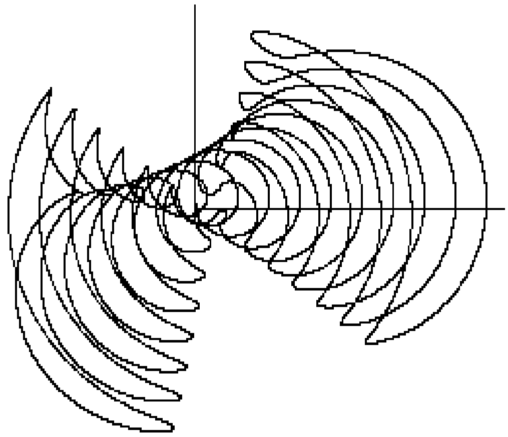

Fig. 29. γ =160

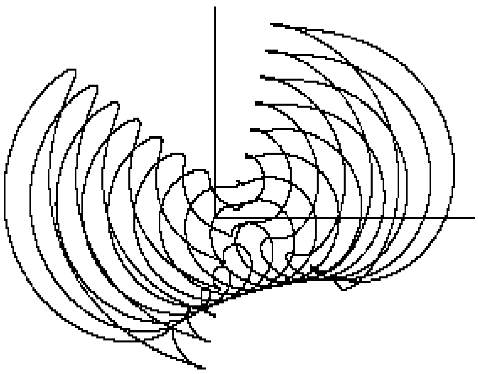

Fig. 30. γ =220

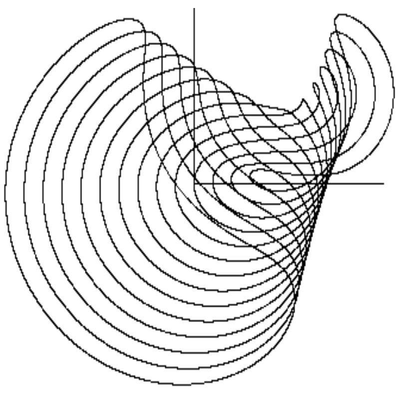

Fig. 31. γ =330

All the curves in these families are continuous, finding in them also the individual curves above.

Next, the influence of the position of C on the abscissa, that is, of the value XC, on the families of generated curves (fig. 32 ... 35) was followed.

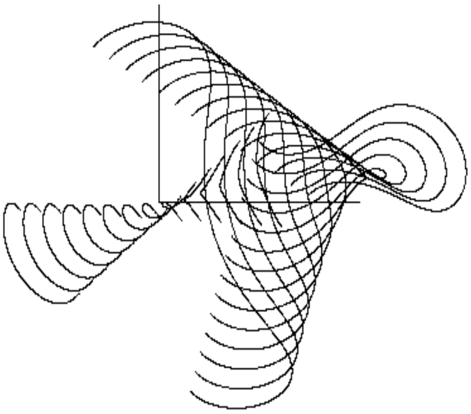

Fig. 32. XC=60

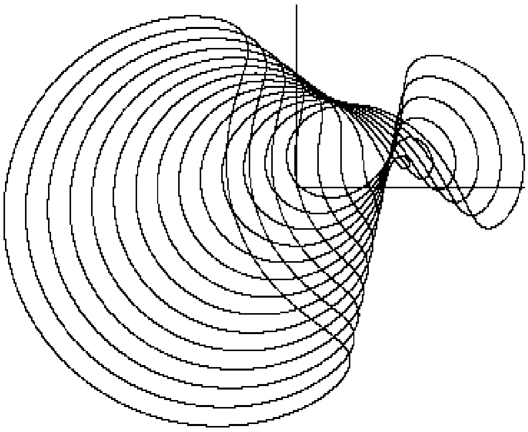

Fig. 33. XC=– 20

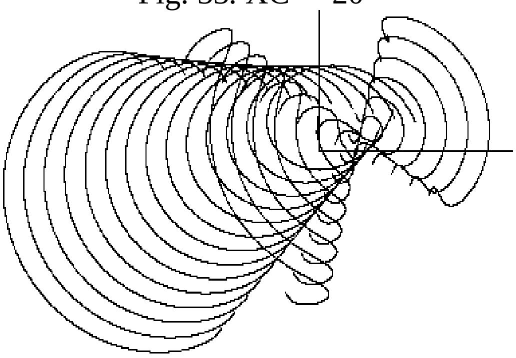

Fig. 34. XC=– 50

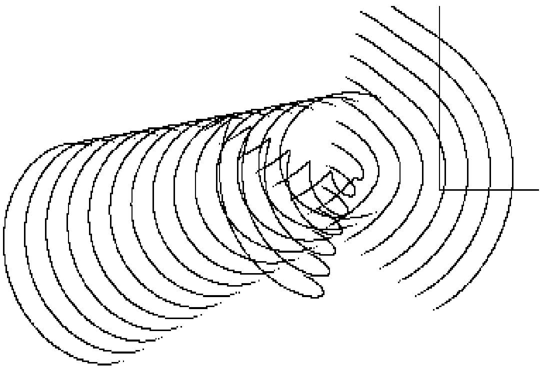

Fig. 35. XC=– 120

There are families with curves with two branches, which show that at certain values of XC the mechanism locks. It follows that the position of C significantly influences the shapes of the resulting curves.

8. CONCLUSIONS

We departed from the oscillating slide mechanism to which an RPP-type dyad and another RPR-type dyad were added, resulting in an R-PRR-RPP-RPR-type mechanism. The third dyad has a connecting rod which has the entries on the connecting rod curves of the other two dyads, so that the points on this connecting rod draw more special connecting curves. Such curves were generated for different values of some parameters of the mechanism, obtaining a wide variety of curves. Considering the generator point on the final connecting rod as mobile on it, families of connecting rods with aesthetic shapes were generated. Some parameters of the mechanism have also been modified, resulting in many families of curves, so this mechanism has many kinematic possibilities.

The authors of this work have also studied other mechanisms that generate aesthetic curves [9, 10, 11]. The studies of the aesthetic curves are important in many applications: industrial design, kinetic fountains, textile industry and other fields.

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