MODELLING THE MOVEMENT OF A MECHANISM OF THE FOURTH FAMILY, WITH M=2, SUCH AS R-R

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ABSTRACT : It is modelled the movement of a spatial mechanism of the 4th family, with two leading elements. The movements of these elements are correlated by a linear relation. The successive positions and the trajectories of the final point are represented in the three reference plans. There are many interesting trajectories.

KEY WORDS : mechanism of the 4th family, the R-R spatial chain

1. INTRODUCTION

The mechanisms of the fourth family have two possible movements of the elements. They may have connecting links, but also elements in the rotation movement. [Browser] indicates the constraints when projecting the mechanisms with M=2. There are several ways of linking the elements and the kinematics of some of them is studied. [Davitashvill] studies the synthesis of the RSSRR spatial mechanism with M=2, for imposed movement laws. There are the afferent analytic relations. [Popescu, 1997] structurally establishes the mechanisms of the fourth family, giving many examples for the case when there are only connecting links. Further on, we study the possibilities of a mechanism of the fourth family with elements in the rotation movement. Another type of a similar mechanism was studied in [Popescu, 2011].

2. THE STUDIED MECHANISM

The kinematic possibilities of the mechanism of fig. 1 are studied.

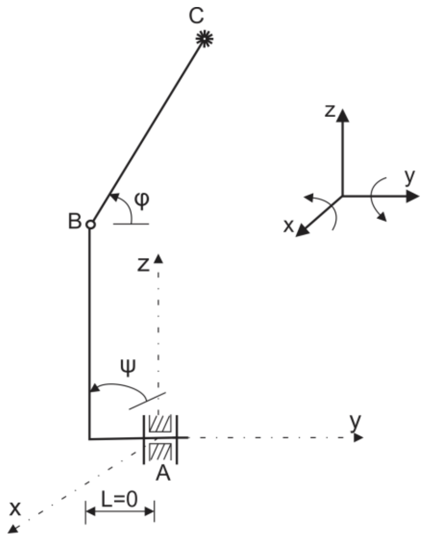


Fig. 1

Structurally, the mechanism elements have only two movements indicated on the angle, which means that it belongs to the fourth family, as a consequence the mobility degree is:

$M=2n - C5 = 2.2 - 2 = 2$,

Namely both of the elements are leading ones.

The following relations are written:

$X_B = Ab\cos\psi$

$Y_B = 0$

$z_B = AB \sin\Psi$

$x_C = x_B$

$y_C = y_B + BC \cos\varphi$

$z_C = z_B + BC\sin\varphi$

By using the reference angle of fig. 1.

3. THE OBTAINED RESULTS

The mechanism is spatial, therefore the movement is studied in the three reference plans. The following values were adopted: AB=35, BC=33. The two movements linearly correlated were considered, namely $\varphi = c1.\psi$, modelling the movement for different values of the c1 parameter.

The movement in the xy plan

In the xy plan, the AB element occupies positions only on the x axis and the B point moves as in fig. 2. Here c1's value does not interfere.

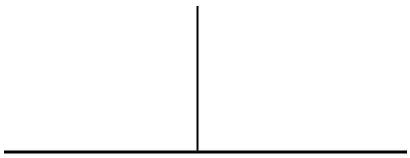


Fig. 2

The two elements AB and BC may be seen in the xy plan as in the following figures and they are different depending on c1's value. The first example is given in fig. 3, for c1=0,1. [Here and below, at the left of the figure, the successive positions are shown, and at right, C's trajectory, here in the xy plan].

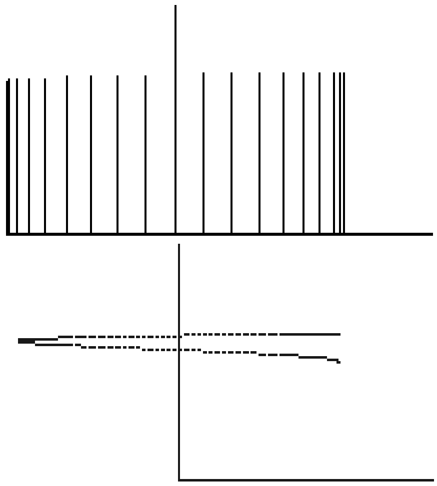


Fig. 3

The B point is placed on the x axis, and BC on the y axis, obtaining different length because BC is in rotation, so C's position is variable. Similarly, we obtained the following figures: fig. 4 (c1=0,2), fig. 5 (c1=0,3), fig. 6 (c1=0,5), fig. 7 (c1=0,6), fig. 8 (c1=0,8).

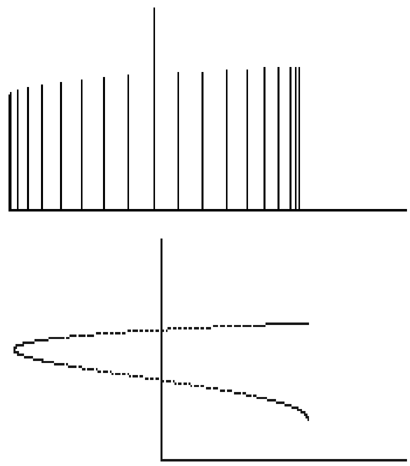
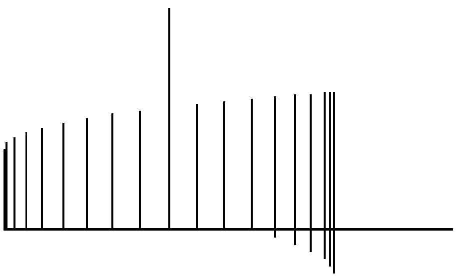


Fig. 4



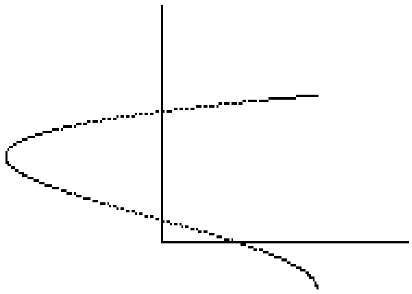


Fig. 5

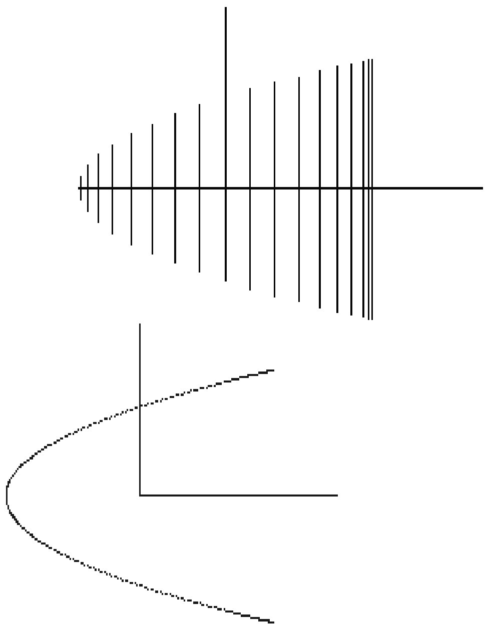


Fig. 6

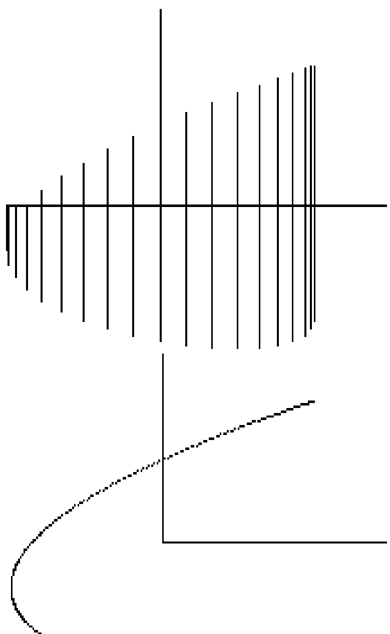


Fig. 7

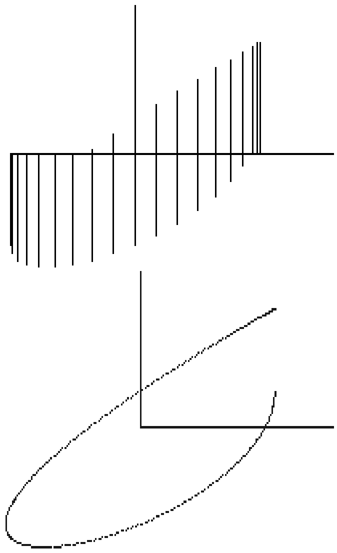


Fig. 8

We find that C’s trajectory is a curve whose shape depends on c1. The curve is open, but continuous. The φ angle has values in different dials (depending on c1), this is why C also gets under the x axis. The B point remains on the x axis, and the segments under the x axis are not the continuation of the ones above the x axis.

For c1>=1, we obtain other kinds of successive positions and other trajectories of C, and the values of φ become higher and higher. The examples are given in: fig. 9 (c1=1), fig. 10 (c1=2), fig. 11 (c1=5), fig. 12 (c=10).

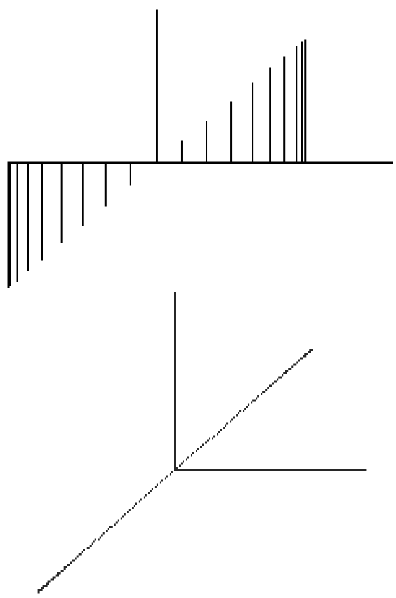


Fig. 9

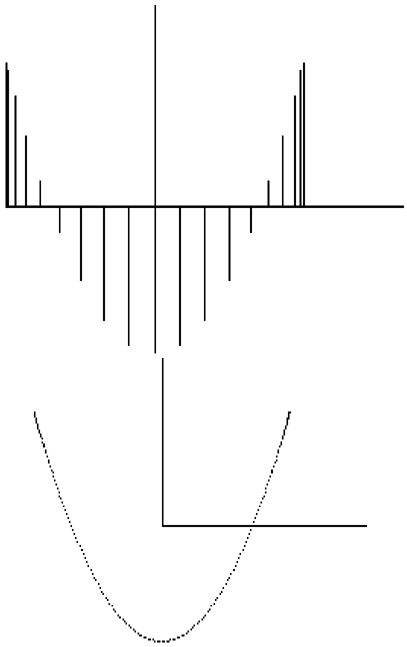


Fig. 10

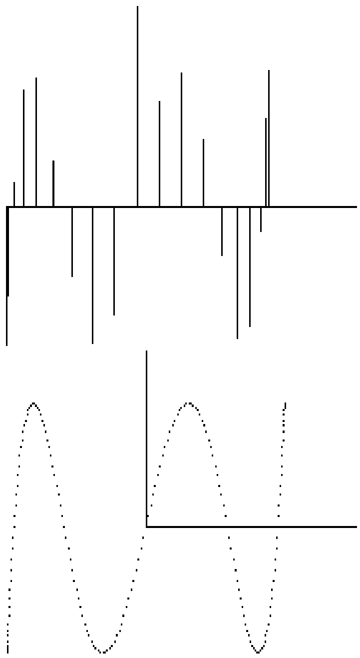


Fig. 11

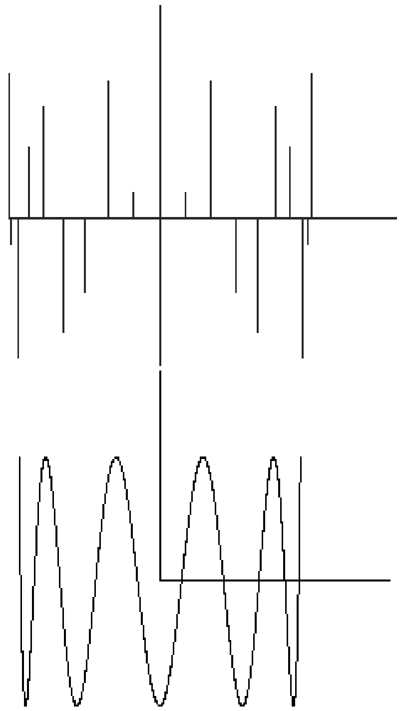


Fig. 12

We also analysed the cases with c1<0, finding that the results consist of the same positions as in the cases with c1>0.

For the case of fig. 12, fig. 13 shows the variations of C's coordinates. We may notice a symmetrical curve for XC and a succession of symmetrical curves for YC.

The movement in the yz plan

Further on, we modelled the movement in the yz plan.

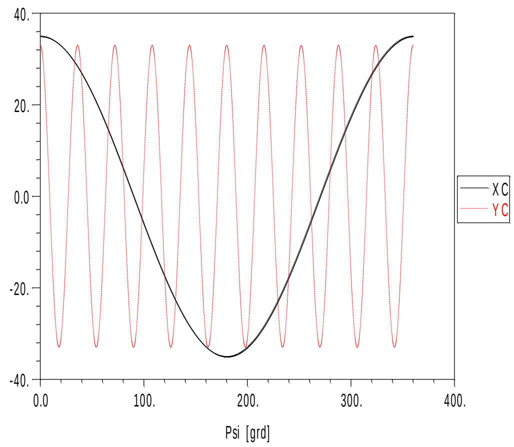


Fig. 13

Below, there are given the successive positions of AB and BC and C's trajectory. AB is overlapped on the z axis and the B point is variable on this axis, so B's trajectory is a straight line overlapped on the z axis. [It is specified that the system axes from the two images of the same figure are postponed, this is why it seems that C's position from successive positions is different from C's position on the trajectory]. We obtained the following results: fig. 14 (c1=0,1), fig. 15 (c1=0,2), fig. 16 (c1=0,3), fig. 17 (c1=0,5), fig. 18 (c1=0,7), fig. 19 (c1=1), fig. 20 (c1=2), fig. 21, (c1=3), fig. 22 (c1=5), fig. 23 (c1=6), fig. 24 (c1=8), fig. 25 (c1=30).

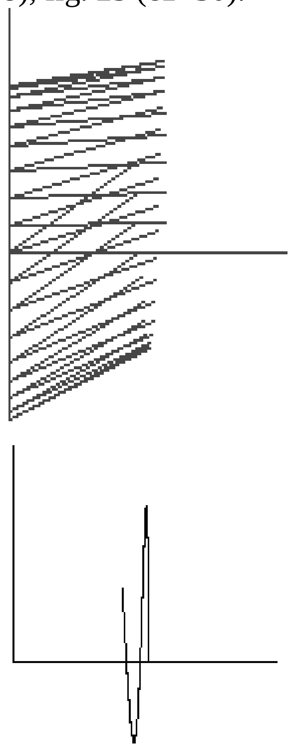
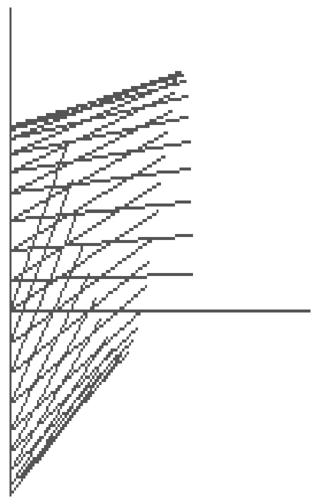


Fig. 14



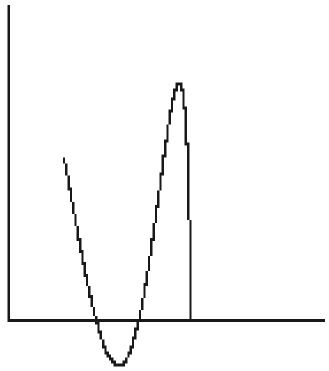


Fig. 15

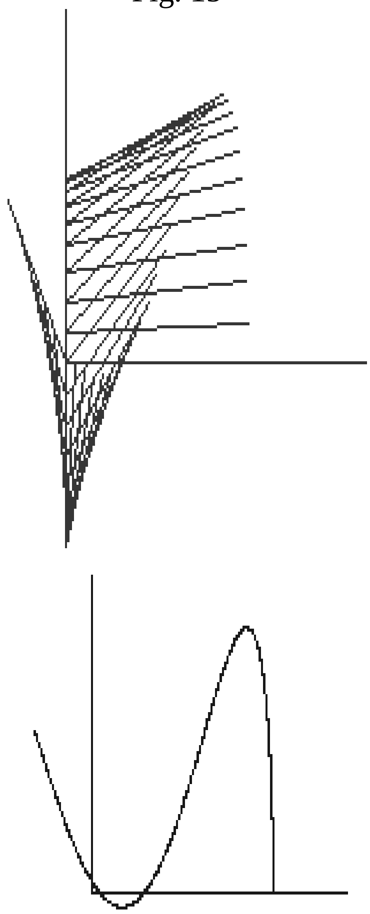
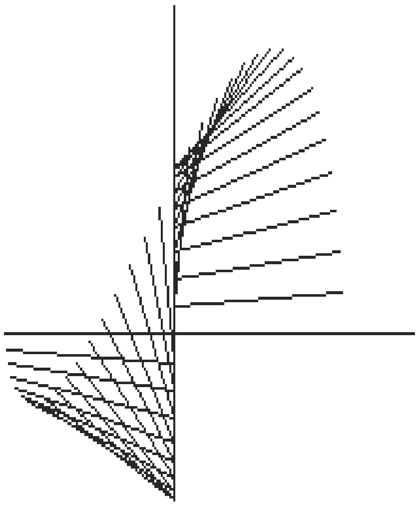


Fig. 16



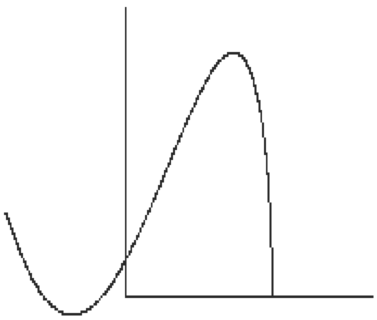
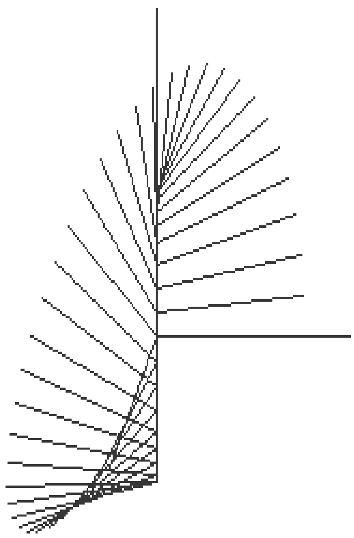


Fig. 17



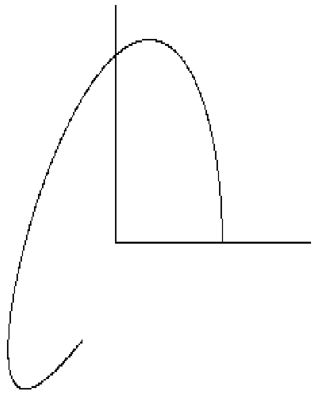
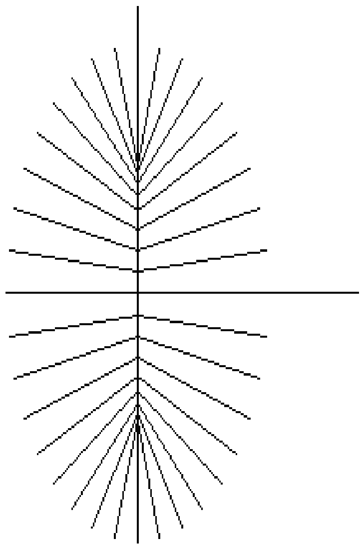


Fig. 18



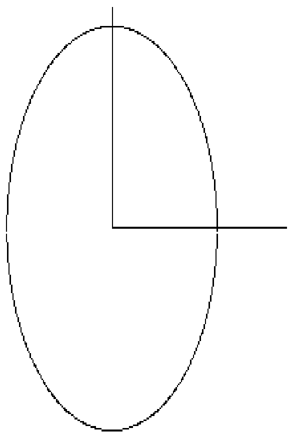
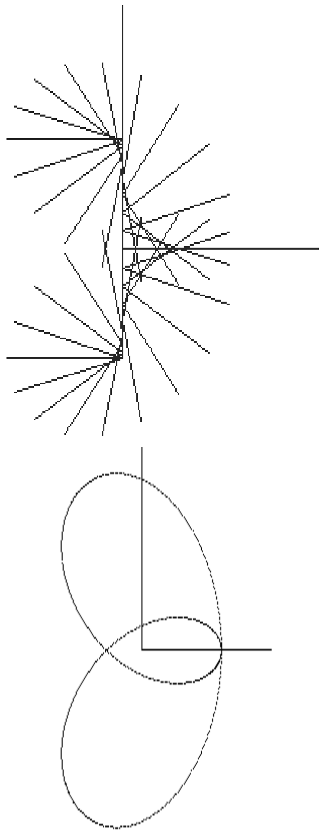


Fig. 19



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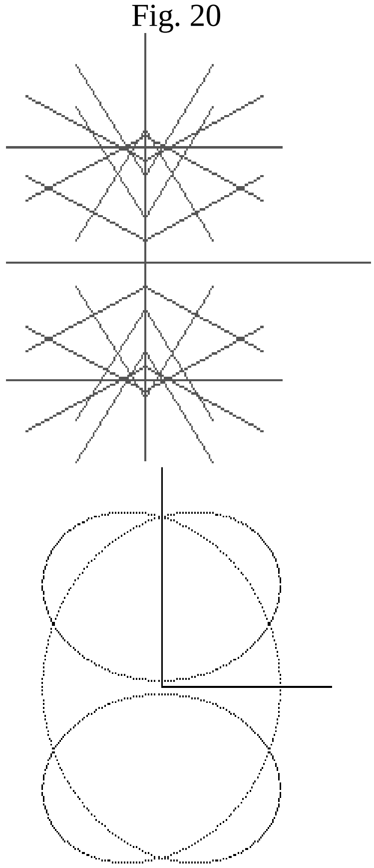

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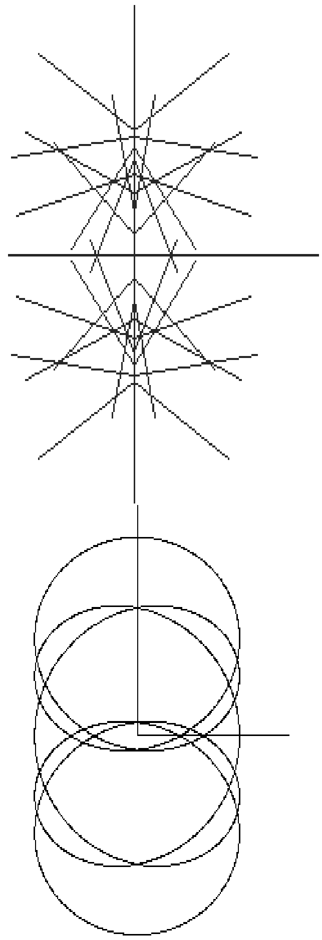

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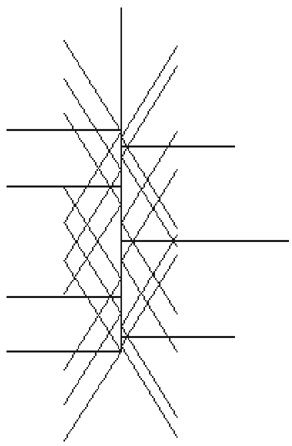


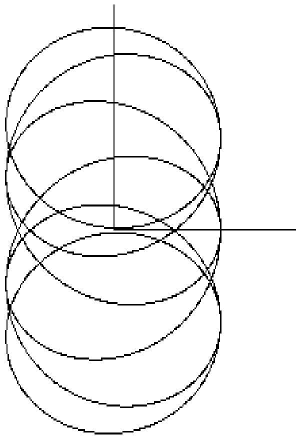
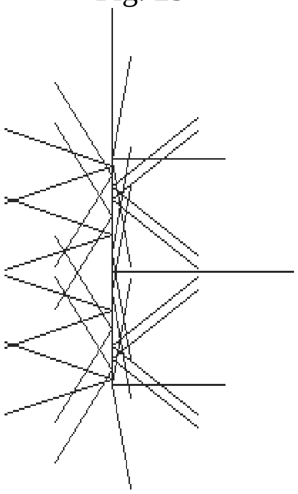


Fig. 23



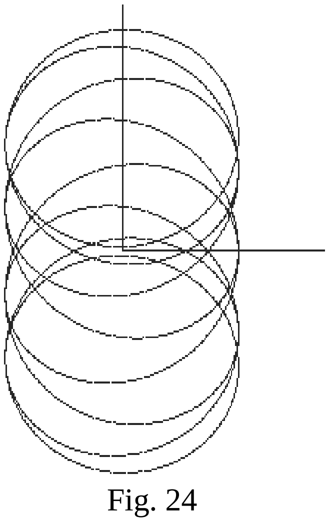
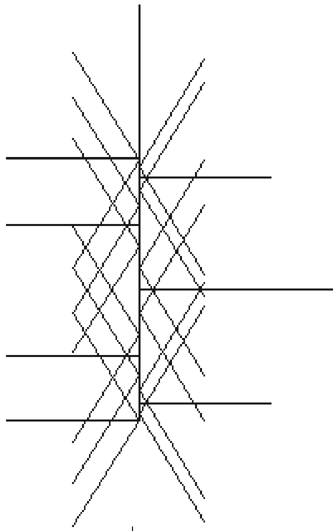


Fig. 24



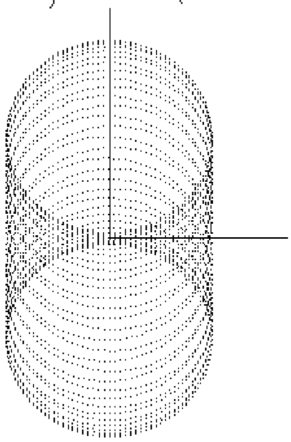


Fig. 25

Further on, we worked with c1<0. Fig. 26 shows the positions for c1= - 0,1; the figure is similar to the one where c1=0,1 (fig. 14), but the straight line segment are differently inclined, all of them having the same angle (fig. 26).

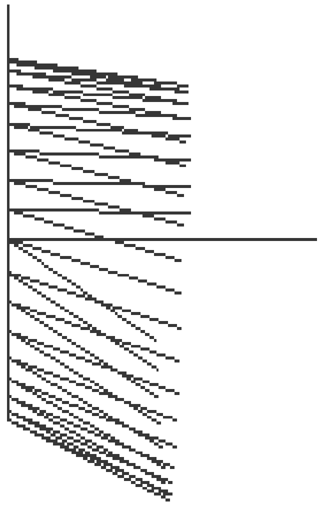


Fig. 26

The equivalent of fig. 16 emerges in fig. 27 (c1= - 3); the figures are similar, but postponed.

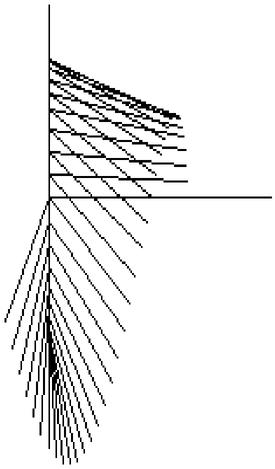


Fig. 27

It is also shown fig. 28 for c1= - 0,8 similar to fig. 24. In these cases, the only type of curves as trajectories are the ones similar to the previous, postponed ones.

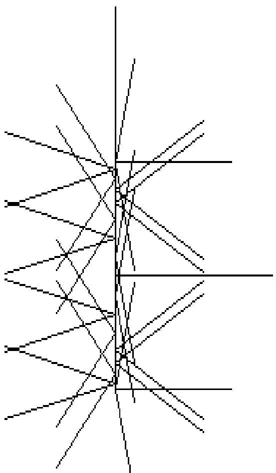


Fig. 28

The movement in the xz plan

In the xz plan, B’s trajectory is a cercle and in the following figures there are its radiuses. BC’s projections in the xz plan are straight lines segments oriented according to the z axis, with different lengths depending on c1. Here are some examples: fig. 29 (c1=0,5), fig. 30 (c1=5), fig. 31 (c1= - 0,5), fig. 32 (c1= - 5). C’s trajectories are also given, finding that they are completely different from the ones from above. It is also found that for c1<0, the trajectories are different, for the same c1 from the ones of c1>0.

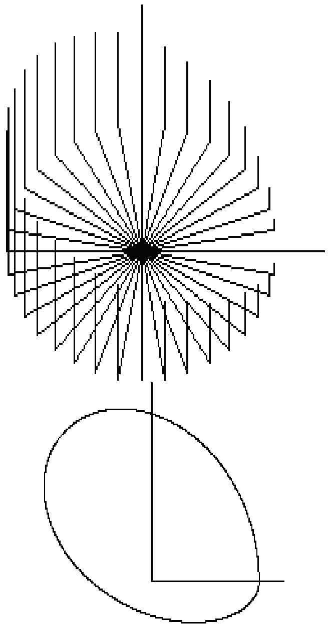


Fig. 29

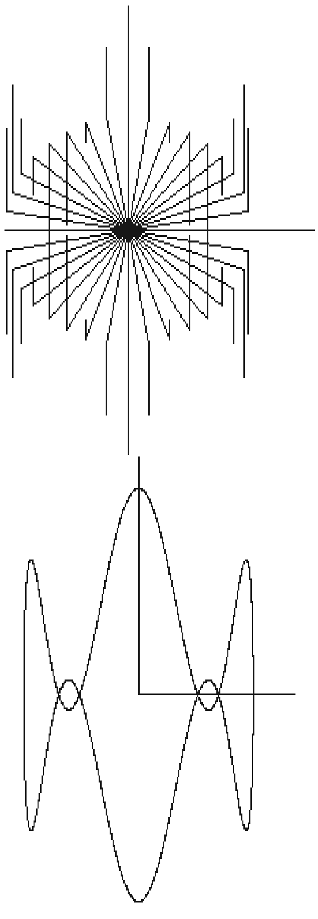


Fig. 30

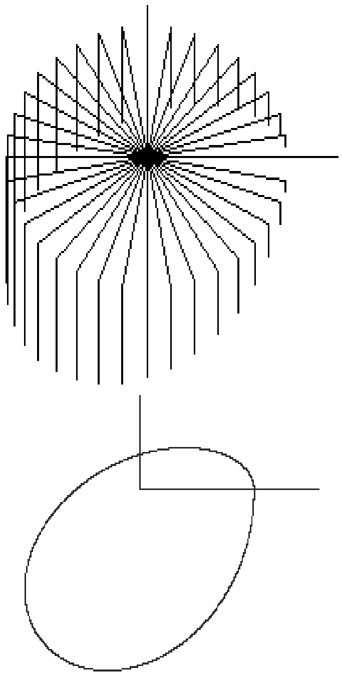


Fig. 31

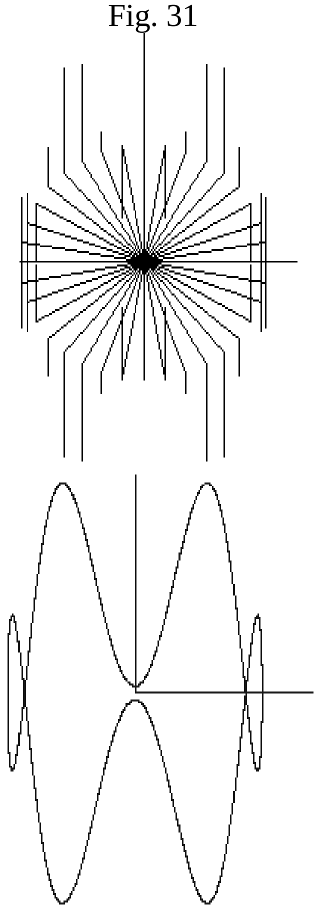


Fig. 32

Further on, other C’s trajectories are given for different c1: fig. 33 (c1=0,1), fig. 34 (c1=1), fig. 35 (c1=2), fig. 36 (c1=3), fig. 37 (c1=4), fig. 38 (c1=8), fig. 39 (c1=30).

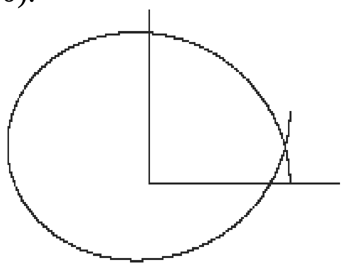


Fig. 33

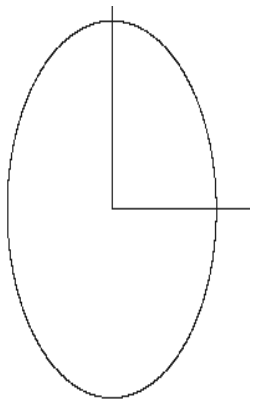


Fig. 34

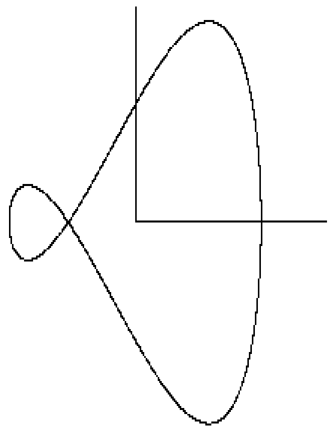


Fig. 35

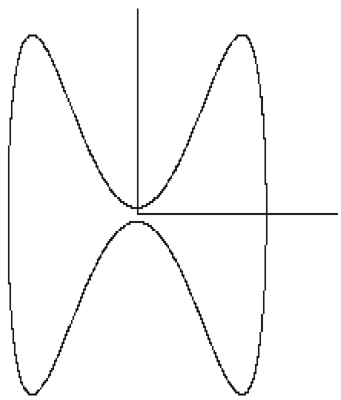


Fig. 36

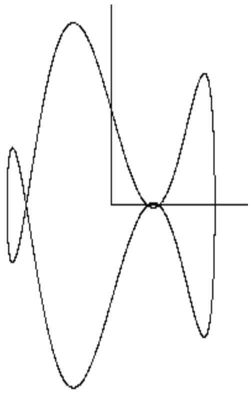


Fig. 37

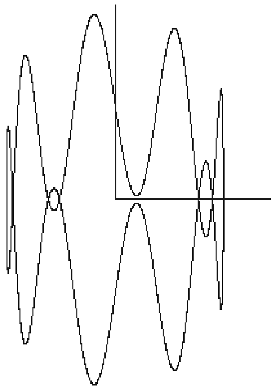


Fig. 38

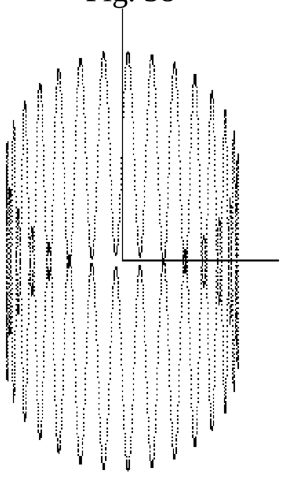


Fig. 39

There are also trajectories for C1<0: fig. 40 (c1 = - 3), fig. 41 (c1= - 8).

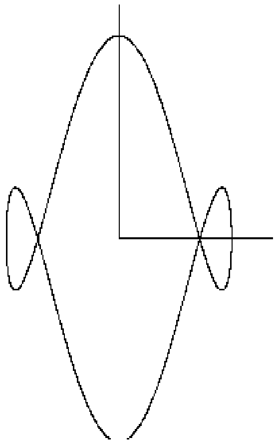


Fig. 40

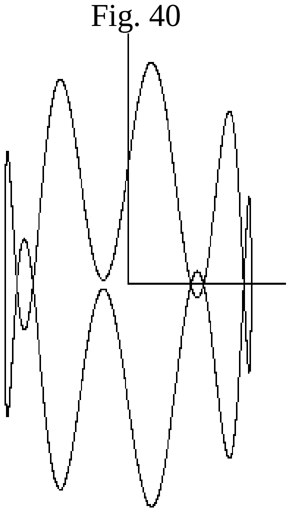


Fig. 41

It is found that there are very many trajectories in different plans with a great variety.

4. CONCLUSIONS

A mechanism of the fourth family was studied, with two elements with a rotation movement, both of them are leading elements.

The movement laws of the two elements correlated by a linear relation were considered. The successive positions of the mechanism in the three plans of the reference system were represented. The projections of the C point's trajectories were traced in the three plans, obtaining a great variety of curves some of them were already known, and others were new.

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