KINEMATIC POSSIBILITIES OF SOME MECHANISMS OF THE FOURTH FAMILY

Liliana Luca, *University Constantin Brancusi of Targu-Jiu, Targu-Jiu, ROMANIA*
Iulian Popescu, *University of Craiova , Craiova, ROMANIA*

ABSTRACT : We study the structure and the kinematics of two flat mechanisms of the fourth family, one of them having the mobility degree equal to 1, and the other one having the mobility degree equal to 2. We trace the successive positions and the trajectories of certain points. We find that there are straight trajectories and linear movement laws. We obtain unusual associated positions and trajectories.

KEY WORDS : mechanism of the 4th family, three successive connecting links

1. INTRODUCTION

When classifying the mechanisms in families, we get to the mechanisms of the 4th family which have only two possible moves. When classifying the dyads, we get to the last dyad type, with three prismatic couplers PPP or TTT (translations, establishing that there is no such dyad, resulting actually a mechanism of the damily f=4. Based on Lie group, [Chung] studies the movement of a mechanism with M=3 generating three translations and two rotations. [Harve] studies the structural synthesis of some robots providing spatial translations based on the group theory. There are many structural types of these mechanisms. Further on, we study the kinematic possibilities of some mechanisms of the 4th family with connecting links.

2. THE FIRST MECHANISM

We consider the mechanism of fig. 1, composed of three prismatic couplers, and one of them is the leading one (A). The races S1, S2 and S3 are variable, the CB length is constant and the angles are constant.According to fig. 2, any S2 translation movement may decompose in two translations according to the system axes, S1 and S.

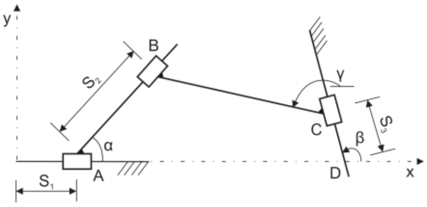


Fig.1.

Based on fig. 3 it results that the mechanism elements have only two possible movements: translations according to the x and y axes.

The mobility degree is:

M=2 n – C5 = 2.2 – 3 = 1, and the AB element is the leading one.

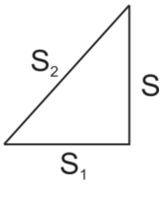


Fig. 2

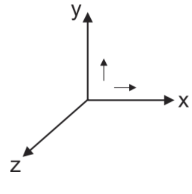


Fig. 3

The following relations are written:

$x_B=S_1+S_2\cos\alpha=x_D+S_3\cos\beta+Cb\cos\gamma$

$y_B=S_2\sin\alpha=S_3\sin\beta+Cb\sin\gamma$

$tg\alpha=(S_3\sin\beta+CB\sin\gamma)/$
$(x_D+S_3\cos\beta+CB\cos\gamma-S_1)$

$S_3=[CB\sin\gamma-tg\alpha(x_D+CB\cos\gamma-S_1)]/$
$(tg\alpha\cos\beta-\sin\beta)$

3.THE OBTAINED RESULTS

We adopted the following sizes: XD=97:CB=57: α =50: β =107; γ =168. For S1=12 we obtained the mechanism position of fig. 4.

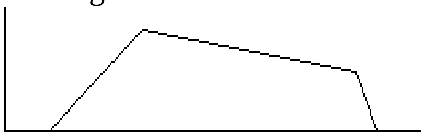


Fig. 4

The successive mechanism positions for S1= - 100… 100 with a 10 step, are given in fig. 5. It is find that the C point moves in the settled direction DC, A occupies successive positions on the abscissa, and the B point moves on an oblique line, illustrated in fig. 6 together with the C's position (the two straight lines are parallel because CB is constant).

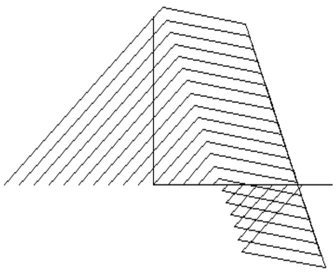


Fig. 5

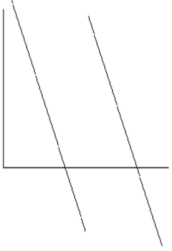


Fig. 6

The races S2 and S3, in report to the race S1, are given in fig. 7, and both of them have the diagrams of the straight line.

The mechanism executes only translation movements.

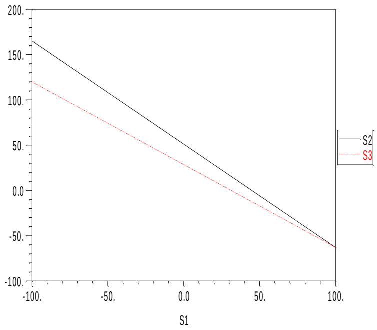


Fig. 7

4.THE SECOND MECHANISM

The considered mechanism is the one of fig. 8. In report to the angle of fig. 8, the mechanism elements only have two movements, namely translations according to the system axes, therefore f=4. The mobility degree results:

$$M= 2\,n - C5 = 2.3 - 4 = 2,$$

Having two leading elements, A and C, namely the races S1 and S2 are given.

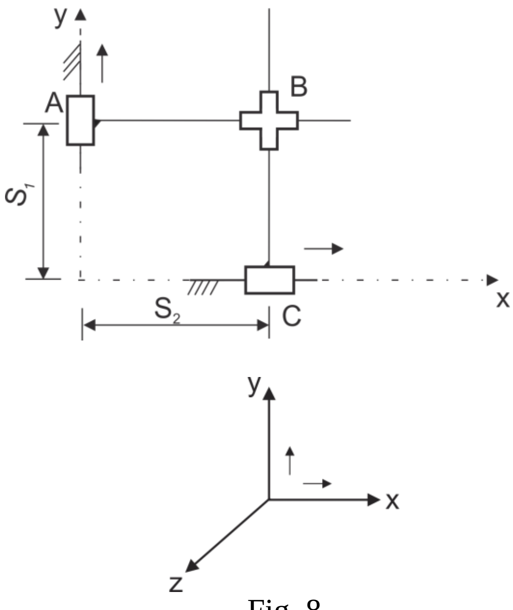


Fig. 8

The following relations are written:

$x_B=S_2$

$Y_B = S_1$

We consider the two input movements as correlated by the relation: S2=c1*S1, and we should always introduce c1's value to the program, and the c1 field was established as c1 = – 5…5, with a 1 step.

In fig. 9 it is shown the mechanism for the position of S1= 35:S2=41.

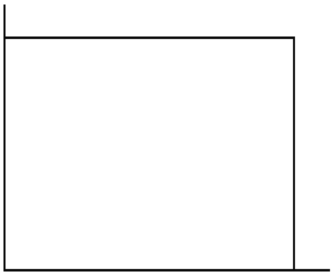


Fig. 9

The successive positions of the mechanism are given in fig. 10 for S1= -100…100 with a 10 step and S2=c1*S1.

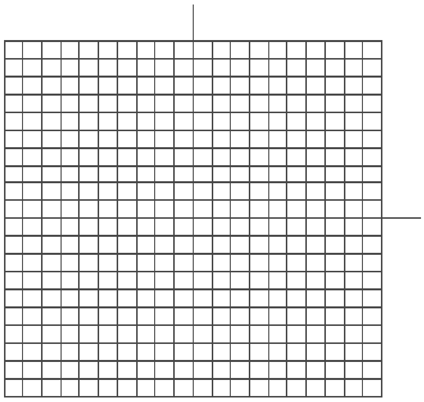


Fig. 10

In the same conditions, we obtain B's trajectory of fig. 11, namely a succession of points representing the right corners of the squares of fig. 10. We found thus a mechanism tracing points which finally form squares.

B's trajectories for the different values of c1, cycling S1 with a 1 step, are given in: fig. 12 (c1=0,1), fig. 13 (c1=1), fig. 14 (c1=5), fig. 15 (c1= - 5).

Fig. 16 gives B's trajectory for c1= -5…5, with a 1 step.

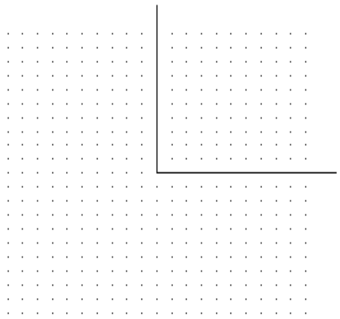


Fig. 11

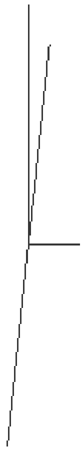


Fig. 12

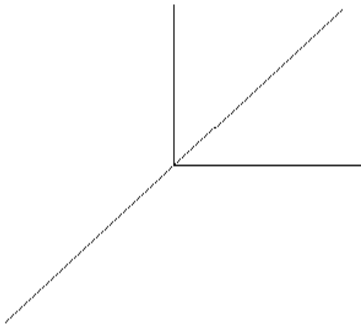


Fig. 13

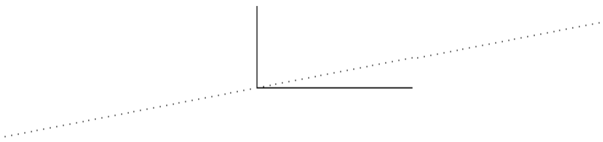


Fig. 14

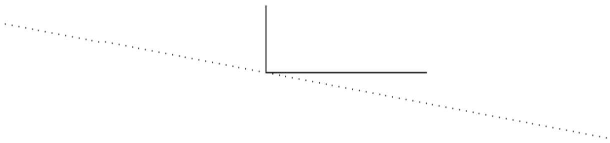


Fig. 15

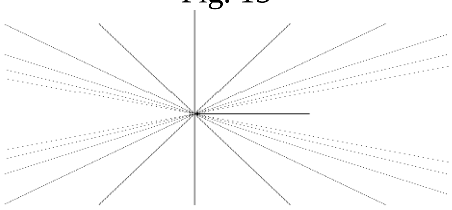
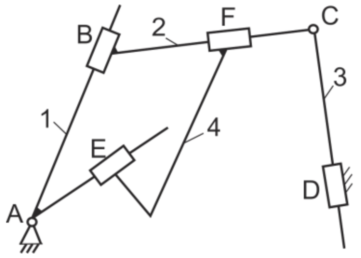
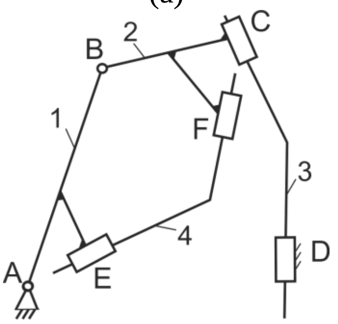


Fig. 16

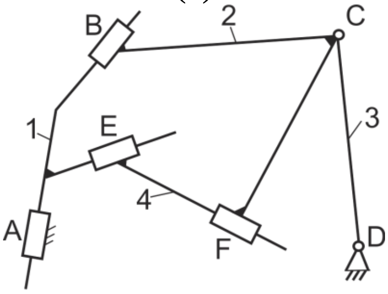
Other types of mechanisms only with connecting links, of the fourth family, are given in fig. 17, and many others are given in [Popescu]. These are calculated similarly to the ones above, by the outlining method.



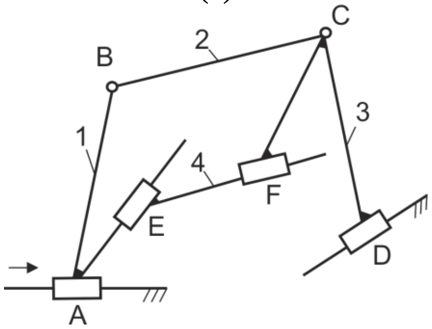
(a)



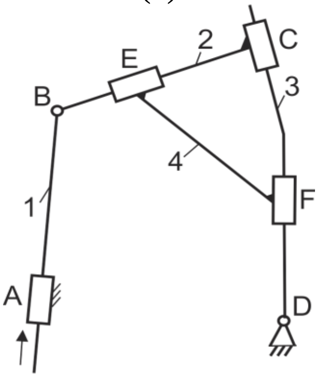
(b)



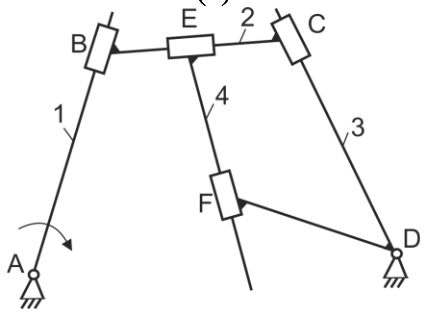
(c)



(d)



(e)



(f)

Fig. 17 a, b, c,d, e ,f.

5. CONCLUSIONS

- The PPP (TTT) mechanism, with f=4 and M=1, traces only straight line segments as trajectories.
- The output races are linear.
- The mechanism with f=4 and M=2, with 4 connecting links, has successive positions similar to the squares of an arithmetic notebook.
- The trajectories of this mechanism are points of the squares (at a big step from the cycling), respectively straight line segments at different values of the c1 parameter correlating the two input movements.

REFERENCES

[1]. Chung-Ching Lee, Herve, J. M. – Translational parallel manipulators with doubly planar limbs. Elsevier, Volume 41, Issue 4, aprilie 2006, pp. 433-455.

[2]. Herve, J. M., Sparacino, F. – Structural sunthesis of parallel robots generating spatial translation. În: 5-the Int. Conf. on Adv. Robotics, IEEE nr. 91TH0367-4, vol. 1, pp. 808-813, 1991.

[3]. Popescu, I. – Mecanisme. Noi algoritmi şi programe, Reprografia Universităţii din Craiova, 1997.