R-R-RTR MECHANISM PATHS

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Abstract. *Let's consider a mechanism with two conducting elements and a RTR dyad and the paths of a point on the connecting rod with variable length are determined. Let's consider the movements of the conducting elements correlated through linear relations. There are cases analysed when movement is intermittent or when a conducting element performs more rotations than the other.*

Key words: mechanisms paths, two conducting elements

1. INTRODUCTION.

The literature studies various mechanisms having their mobility level equal to 1. Paths, movement laws, successive positions are determined. In very few cases, M=2 mechanisms are analysed. [1] studies the movements of robots exemplifying with a manipulator plan with M=2 and M=3, determining the generalized coordinates so that the characteristic point reaches certain given points. [2] details the calculation of a micromechanism used in sensors based on rotation couplings, all conducting ones, therefore M=3. It describes the way in which the required path is achieved, point by point, by the characteristic point. [3] studies the paths generated by a space mechanisms with two conducting elements, that is two rotations after perpendicular directions. There is evidence for the possibility of using this mechanism in the researches of the cosmic space. Next there are the paths of the connecting rod centre of R-R-RTR mechanism, a connecting rod with a variable length.

2. R-R-RTR mechanism.

Fig. 1 indicates the kinematic diagram of this mechanism. It consists of conducting elements with rotation movement 1 and 4 and 2-3 RTR dyad. We notice that BC connecting rod length is variable during movement.

The path of E point located at the half of BC connecting rod length are looked for, with variable length.

The following expressions are written:

$$x_B = x_A + a\cos\varphi \qquad (1)$$

$$y_B = y_A + a\sin\varphi \qquad (2)$$

$$x_c = b\cos\psi \qquad (3)$$

$$y_c = b\sin\psi \qquad (4)$$

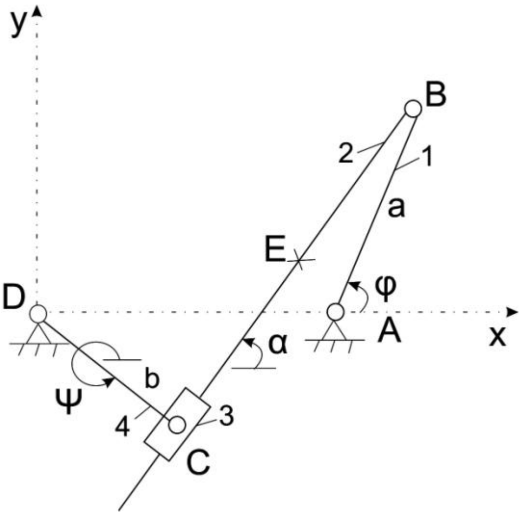

Fig. 1

$$BC = \sqrt{(x_C - x_B)^2 + (y_C - y_B)^2} \quad (5)$$

$$\cos\alpha = \frac{x_B - x_C}{BC} \quad (6)$$

$$\sin\alpha = \frac{y_B - y_C}{BC} \quad (7)$$

$$x_E = x_C + \frac{BC}{2}\cos\alpha \quad (8)$$

$$y_E = y_C + \frac{BC}{2}\sin\alpha \quad (9)$$

3.RESULTS ACHIEVED FOR A ROTATION OF DC HANDLE

Sizes of the mechanism were adopted: a=30; b=50; x_A=20; BE=25. . The movement laws of conducting elements were considered correlated through the relation: $\varphi = c\psi$. The following images indicate the system of axes in fig. 1. ψ was cycled and φ was determined through the above relation, therefore, for every value of ψ another value of φ results.

Fig. 2 indicates the path of E and the path of D, both being circles, for the case of c=0, therefore φ=0, that is the AB element stays on x axis, the mechanism transforming in a mechanism with M=1, R-RTR type. The sizes of the mechanism comply with the condition of avoiding the blockage, b=a+x_A, this is why the connecting rod BC has the length equal to zero when C superposes to B.

For c=0,5 fig. 3 resulted, concluding that E performs an Archimedes spiral.

In fig. 4 we can see the variations of the indicating point coordinates, E. Variations are not linear, based on trigonometric functions.

But if c= - 0,5, meaning the conducting elements rotate in opposite directions, fig. 5 results which is completely different from fig.3, where E performs another curve.

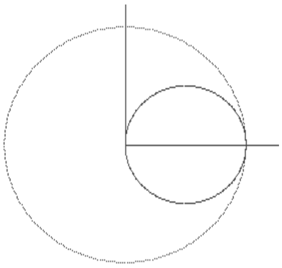

Fig. 2

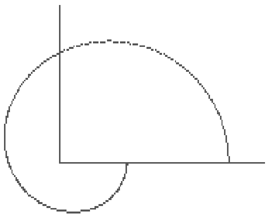

Fig. 3

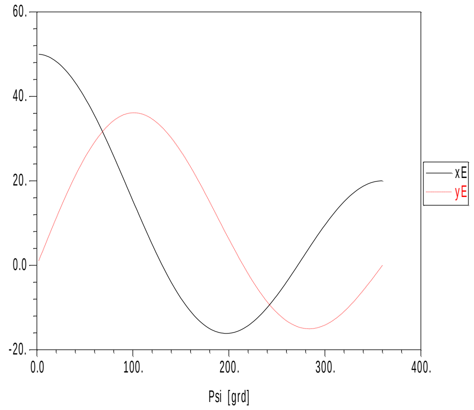

Fig. 4

The variations of E coordinates in the diagram from fig. 6 are similar to those in fig. 4, except that they have other domains as numeric values.

Similar cases can be found in fig. 7 and 8, resulted for c=1 (the path is a circle) and c= -1, (the path is an ellipse), that is the angles of the two handles are identical in value and direction (fig. 7) or with opposite directions (fig. 8).

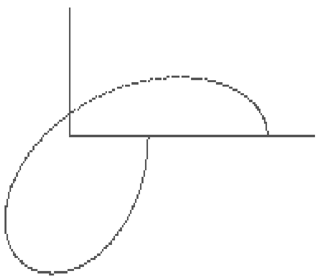

Fig. 5

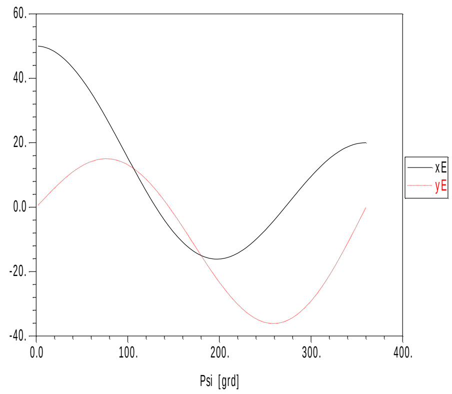

Fig. 6

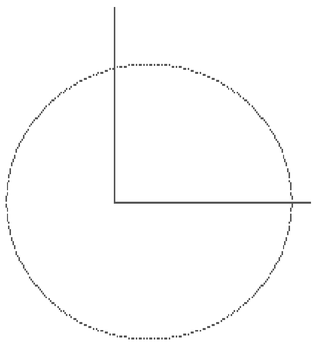

Fig. 7

Fig. 9 describes the path of E for c=1,5. Here φ = 1,5ψ, therefore AB performs half of rotation in addition to DC. E path is an Archimedes spiral.

Fig. 10 is given by E path for c= - 1,5, resulting a part of a hypocycloid.

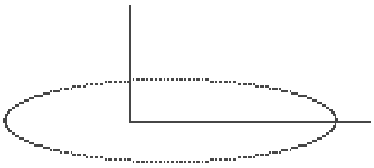

Fig. 8

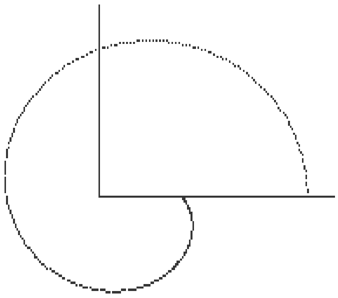

Fig. 9

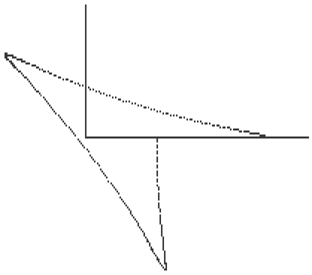

Fig. 10

In fig. 11 E path appears for c=2 (a Pascal worm), and in fig. 12 for c= - 2 (an elongated hypocycloid, with 3 branches), noticing completely different paths, due to the change of the rotation directions.

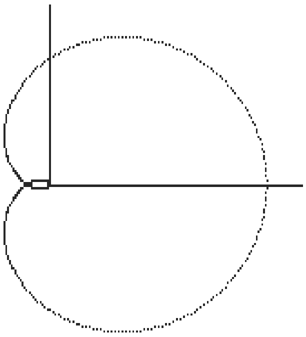

Fig. 11

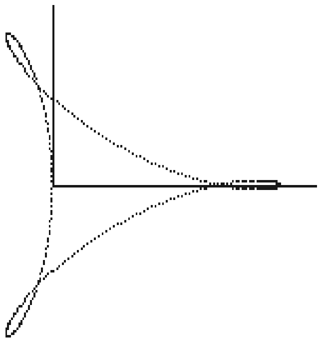

Fig. 12

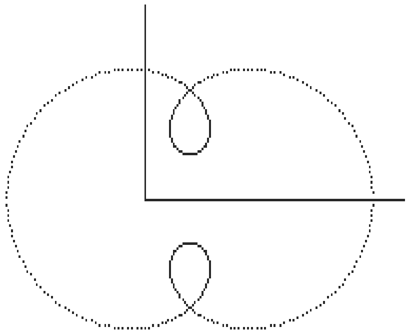

Fig. 13

For c=3 the path in fig 13. Resulted, that is a curve with two inner loops, and for c= - 3 the path in fig. 14 resulted, that is an elongated hypocycloid, with 4 loops.

The path in fig. 15 resulted for c=5, being an elongated epicycloid, with 4 lobs, and the one in fig. 16 (an elongated hypocycloid, with 6 lobs) resulted for c= - 5.

The curve in fig. 16 can be used for longitudinal turning, concluding that a polygon can be generated inside only by using rotation movements.

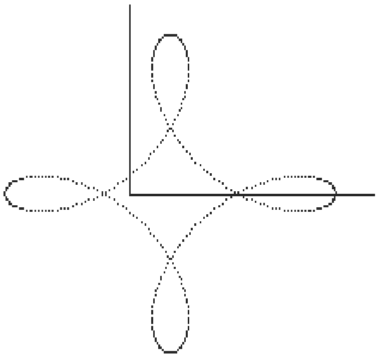

Fig. 14

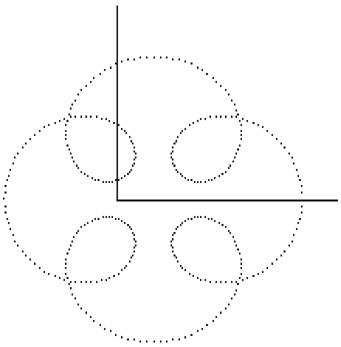

Fig. 15

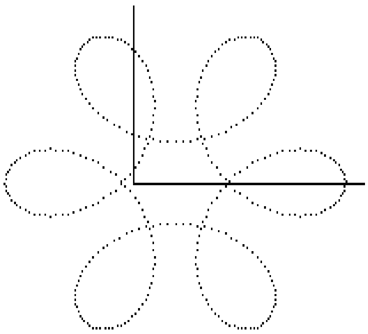

Fig. 16

Next, at the increase of c the same types of curves can be achieved, but with more loops, as it results from fig. 17 and 18, for c=10, respectively c= - 10.

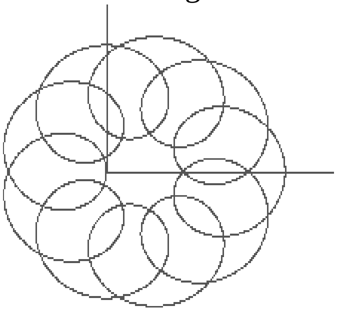

Fig. 17

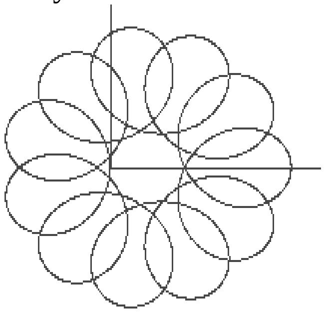

Fig. 18

4. RESULTS ACHIEVED IN LESS OR MORE THAN A ROTATION OF DC CONNECTING ROD

Coefficient c as well as the number of rotations, n of DC connecting rod were altered, therefore drawing E path. Therefore, fig. 19 indicates the image for c=0,5 and n=2, that is DC performs two complex rotations, and AB performs only one rotation. We notice a Pascal worm. If we consider c= - 0,the curve in fig. 20 results with three lobs, completely different from the previous one.

For c=1,5 and n=2, the path in fig. 21 resulted, that is a Pascal worm combined with a cardioid, therefore a very interesting curve.

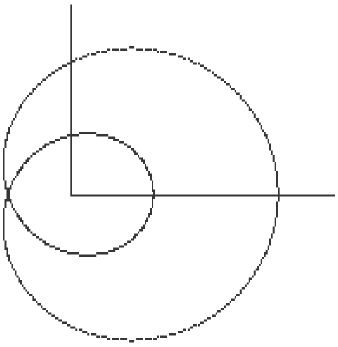

Fig. 19

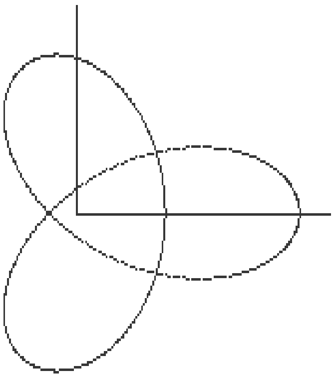

Fig. 20

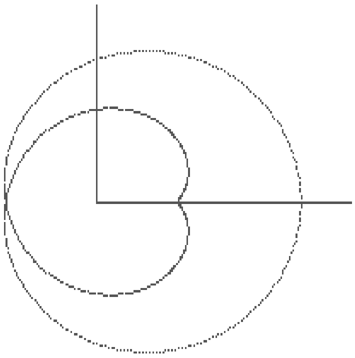

Fig. 21

Altering c to value c= - 1,5, for the same n=2, the hypocycloid with 5 branches from fig. 22 resulted. This curve is also useful from technologic point of view, noticing a pentagon inside.
We notice a wide range of paths and that there are possible more solutions depending on c and n.

5. THE VARIANT OF INTERMITTENT MOVEMENT

The above cases consider the conducting elements in *simultaneous* movement, with input parameters correlated through a linear relation. We can also consider the case of intermittent movement, that is a conducting element is moving, remains in that position, and the second conducting element performs complete rotation. An example is given in fig. 2, when c=0, therefore AB stays, resulting the movement of R-RTR mechanism. Fig. 23 indicates the path of E, that is a circle, for the case in which DC handle is inclined to (– 60) degrees, and AB handle performs a complete rotation. For all the values established for the angle of DC handle, a succession of circles is achieved as E paths.

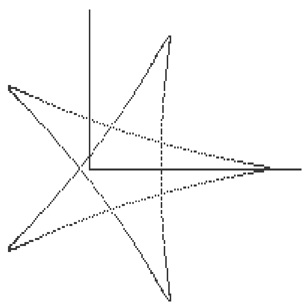

Fig. 22

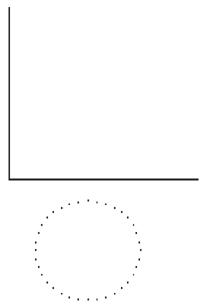

Fig. 23

6. CONCLUSIONS

- Mechanisms with M=2 have several possibilities regarding paths than those with M=1, because one can conveniently choose the relations between generalized coordinates.
- Many paths were achieved, rarely occurred in mechanisms with M=1, and only in some complicated ones.
- Various paths result if the directions of conducting elements rotations are the same or opposite.
- If movement are performed intermittently, mechanisms with M=1 result, with smaller possibilities.
- Many of the resulted images have aesthetic forms.

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