THE ANALYSIS OF A MECHANISM WITH CAM WHICH IS FUNCTION GENERATOR

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Keywords: mechanism, generating functions, associated positions, cam.

Abstract: It starts from the problem of generating functions by mechanisms with bars. It presents an original mechanism, with cam and rack-cog wheel gearing, which generates any desired function. This mechanism is analyzed. For a law imposed to the pusher, it is obtained the cam contour and the law of motion of the final leading element. The paper shows that it can be generated also laws for which the leading bar is running more revolutions. It is being studied the influence of modifying the gear on the law of motion achieved by the mechanism proposed in the work.

1.Introduction

The issue of associated positions appears at mechanisms with bars that for the φ positions of the lever (fig. 1) are obtained the ψ positions of the rocking. Thus, the mechanism is generating functions [1, 3, 5, 6].

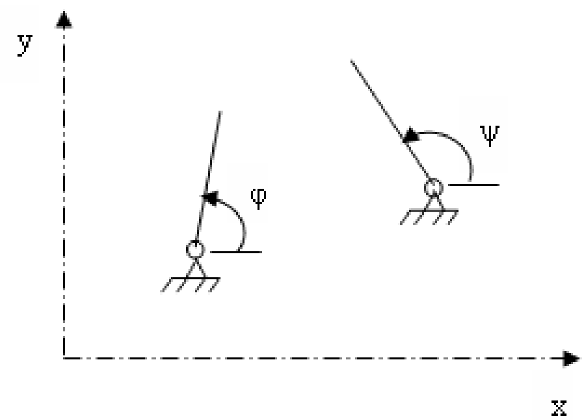

Fig. 1. Associated positions

It was studied in this respect the possibilities of 4-bars mechanism [5]. Thus, the mechanism of fig. 2, with sides of 22, 41, 37, 50 mm, traces with a point on the 40 mm segment of the rod, leaned from that with 120 degrees, a course like the distorted ellipse. Meanwhile, the mechanism generates a function which is given in fig. 3.
The diagram in figure 3 can be interpreted as a change of rocking positions in relation to crank position.
Summary of mechanism, so that it generates the law of fig. 3, is possible only for a total of 5 points imposed on this curve.
The cause, known in literature, is limited by solving nonlinear algebraic systems, and by the accuracy of reading the required data, which have to be perfectly identical to those realized by the mechanism [5, 6].

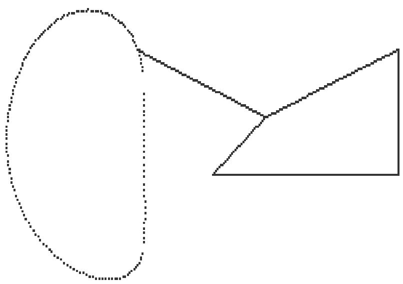

Fig. 2. Trajectory generated by the quadrilateral

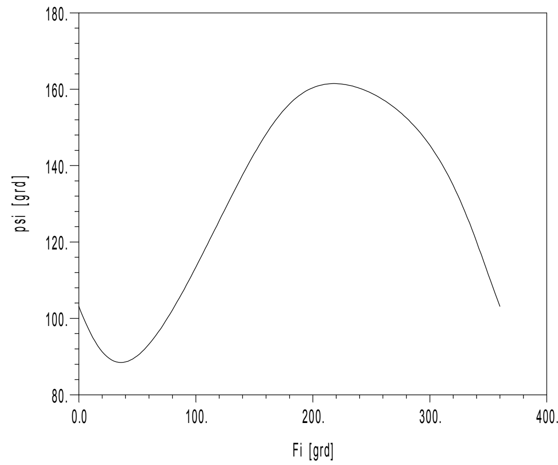

Fig. 3. $\psi(\varphi)$ law of motion

2. The designed mechanism

We left from the idea that the mechanisms with cams allow in general, the performance of any law of motion [2, 4, 6]. It was also considered that a more complicated problem can be solved meaning the rocking angle not being limited to 360 degrees.

Mechanism design is given in fig. 4. The flat disk cam is moving rectilinear the EBC peg, on which is a rack that rotates the cog wheel with the center in D. The DG bar will run turns into a part or the other, not limited to 360 degrees.

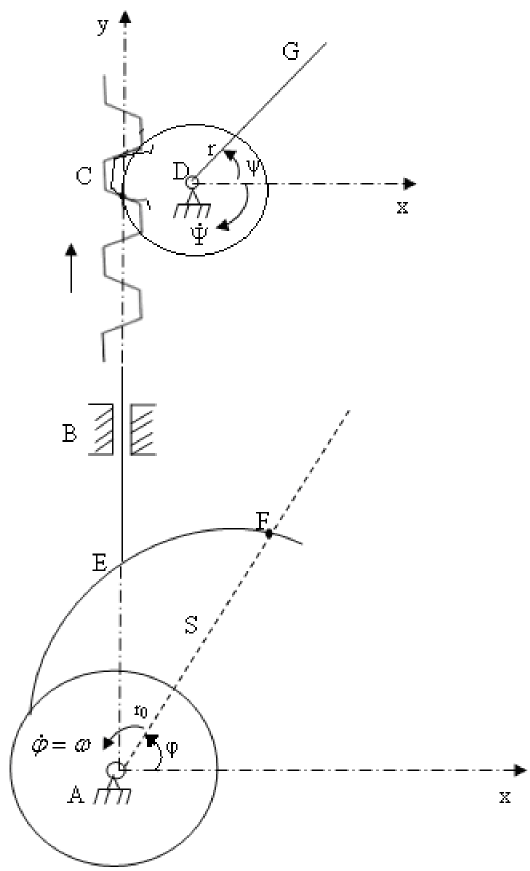

Fig. 4. The associated positions generating mechanism

Based on figure 4, we are writing the relations:

$$x_F = (r_o + S)\cdot \cos\varphi$$
$$y_F = (r_o + S)\cdot \sin\varphi \qquad (1)$$

In C area is rolling without slipping (fig. 5), so we can write:

$$\Psi = \frac{h}{r} = \frac{S}{r} \qquad (2)$$

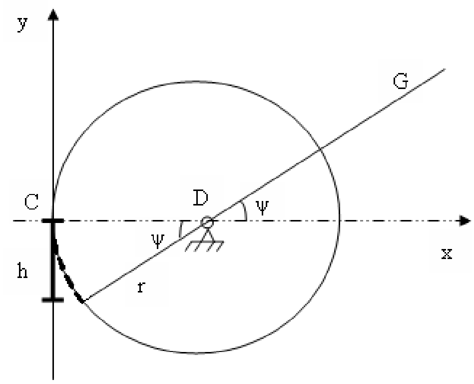

Fig. 5. Runnig without slipping

3. Mechanism analysis

It was adopted a law S (φ), then approximated with the polynomial:

$$S=-4.923498 +113.9026\,\varphi-193.0756\,\varphi^2+138.8942\,\varphi^3- -43.54428\,\varphi^4+6.128693\,\varphi^5-0.3201046\,\varphi^6 \qquad (3)$$

Fig. 6 shows that law. In fig. 7 are showed the diagrams: S(φ), S'=dS/dφ şi S''=d^{2}S/dφ^2, observing the discontinuities at the ends of the range, at S''.

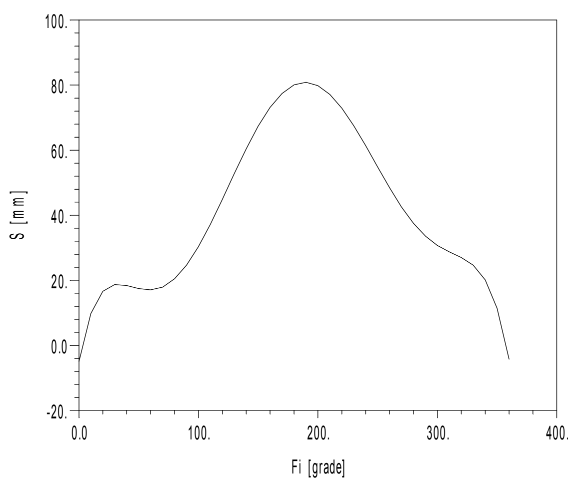

Fig. 6. The imposed law

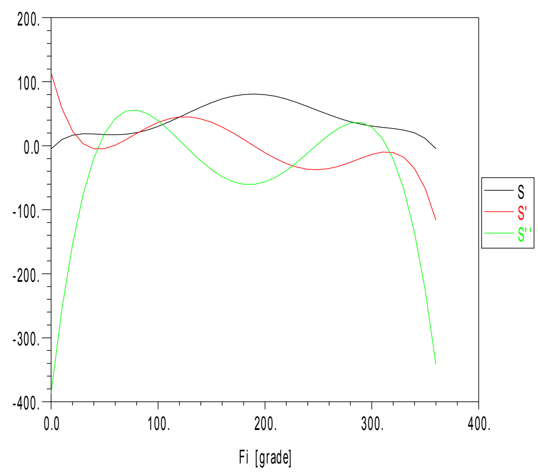

Fig. 7 . The curves: S(φ), S'=dS/dφ şi S''=d2S/dφ 2

The Cam that realizes this law is given in fig. 8. The base circle radius was taken equal to 40 mm. Here also are discontinuities at the ends of the range (the example was taken arbitrarily).

Coordinates variations on cam tracer point are given in fig. 9. Disturbances caused by the polynomial are observed at φ = 0 and 360 degrees.

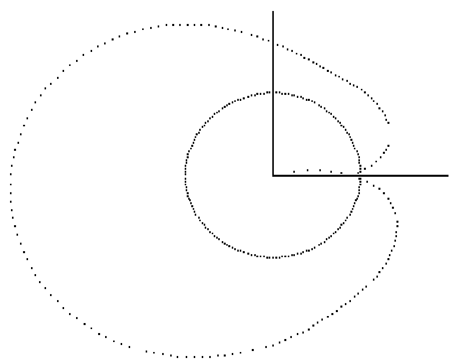

Fig. 8 Generating cam

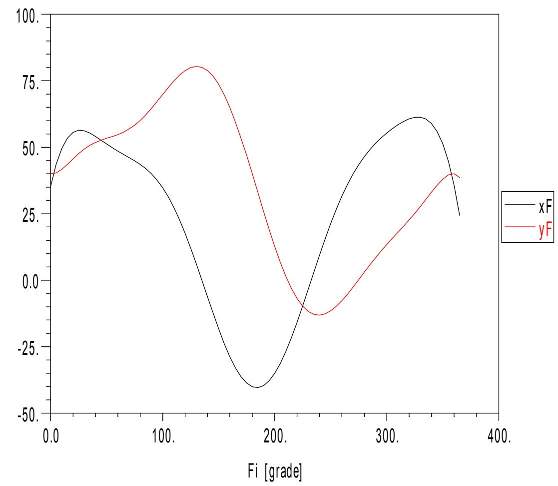

Fig. 9. Tracer point coordinates

Adopting the radius r = 30 mm, was obtained the law (φ), realized by the bar DG, given in fig. 10. We find the same aspect as the curve from fig. 6, but with other values on the ordinate. We found that the gear enhances the run, but does not change the shape of the curve.

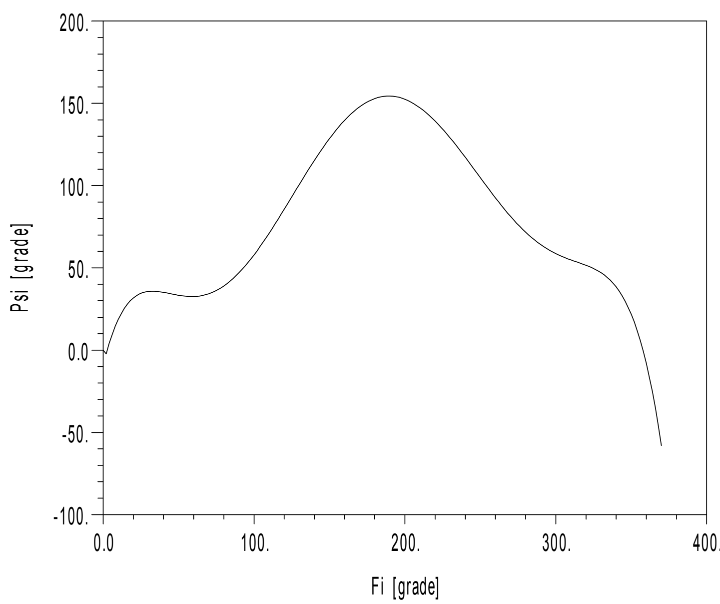

Fig. 10. The realised ψ (φ) law

In Table 1 are given the values of the working beam angle and the peg race, S, in the field of variation of the cam rotation angle. From the diagram in fig. 10 and from Table 1, we can see the variation of ψ with φ, meaning the positions occupied by DG bar:

- ψ increase at growth of φ up to φ= 195 degrees;
- For φ= 195 ... 360 degrees, ψ reduces;
- Variations of ψ are nonlinear; there are areas of very low growth of ψ, even a small return in some areas (at φ= 80 and 40 ... 300 ... 340), as shown in fig. 10 (in the table were taken strides).

Table 1

φ [rad]	φ [grd]	S [mm]	ψ [rad]	ψ [grd]
0	0	0	0	0
.2617992	15	13.95805	.4652685	26.65794
.5235984	30	18.68267	.6227557	35.6813
.7853975	45	17.91481	.5971603	34.21479
1.047197	60	17.05782	.568594	32.57806
1.308996	75	18.97289	.6324295	36.23557
1.570795	90	24.62383	.8207944	47.02809
1.832594	105	33.64749	1.121583	64.26203
2.094394	120	44.85022	1.495007	85.65767
2.356193	135	56.63	1.887667	108.1554
2.617992	150	67.32422	2.244141	128.5799
2.879791	165	75.48376	2.516126	144.1635
3.14159	180	80.072	2.669067	152.9264
3.403389	195	80.59051	2.686351	153.9167
3.665188	210	77.12928	2.570976	147.3062
3.926987	225	70.34668	2.34489	134.3524
4.188787	240	61.36573	2.045524	117.2
4.450586	255	51.61035	1.720345	98.56858
4.712385	270	42.55493	1.418498	81.274
4.974185	285	35.40723	1.180241	67.62287
5.235984	300	30.70654	1.023551	58.64522
5.497783	315	27.86524	.9288412	53.21872
5.759583	330	24.63184	.8210612	47.04338
6.021382	345	16.44043	.5480143	31.39893
6.283181	360	-4.238282	-.1412761	-8.094528

It was successively changed the r radius (figure 5), resulting the diagrams of figure 11. It notes that at increasing the diameter, it shrinks the field of motion of DG bar, and the curves become flat.
If the race from the diagram in figure 6 is increased 5 times, it result the curves of figure 12, from which is observed that the DG bar is running more rotations, ψ reaching over 1500 degrees. Such motion law cannot be achieved with mechanisms having bars.

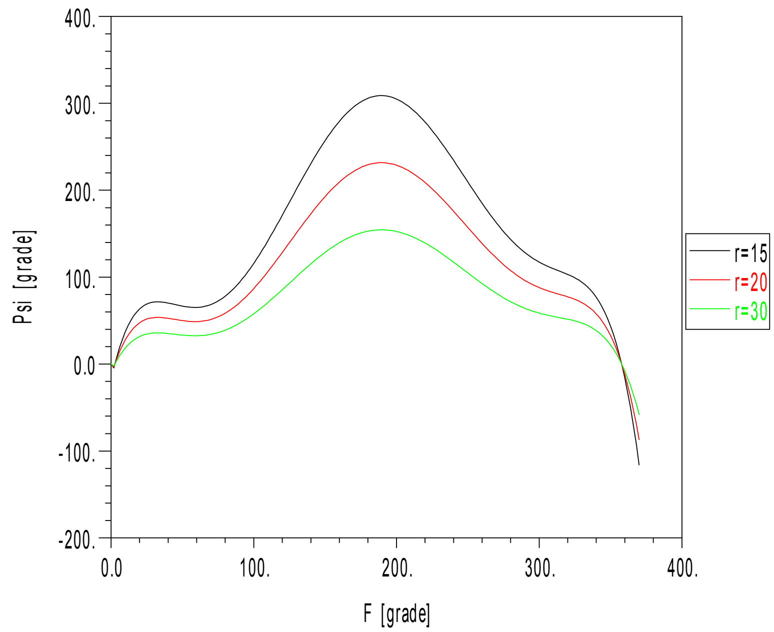

Fig. 11. R radius influence

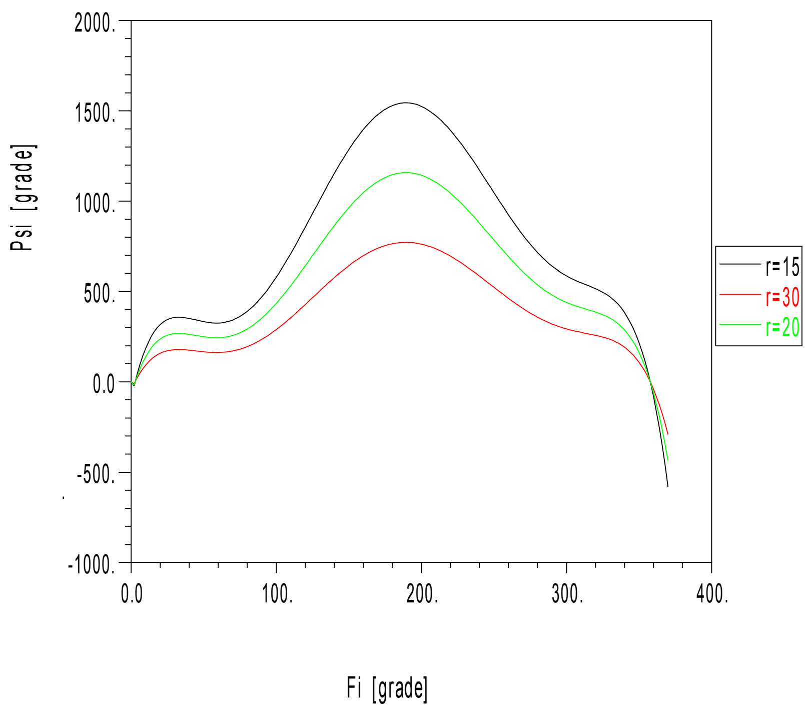

Fig. 12. The law for more rotations of the crank

For the curve in Fig. 12 with r = 30 mm, were obtained the successive positions of a fixed vector radius of the cam, and properly, the DG bar positions (Fig. 4), given in:

- figure 13, for φ = 0 ... 100;

- figure 14, for φ = 100 ... 200;
- figure 15 for φ = 200 ... 360.

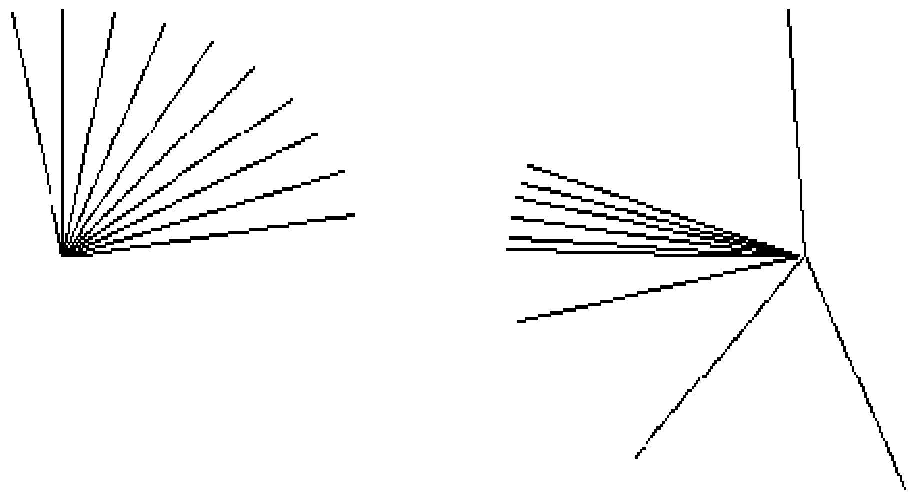

Fig. 13. Related positions for φ ***=0 ... 100***

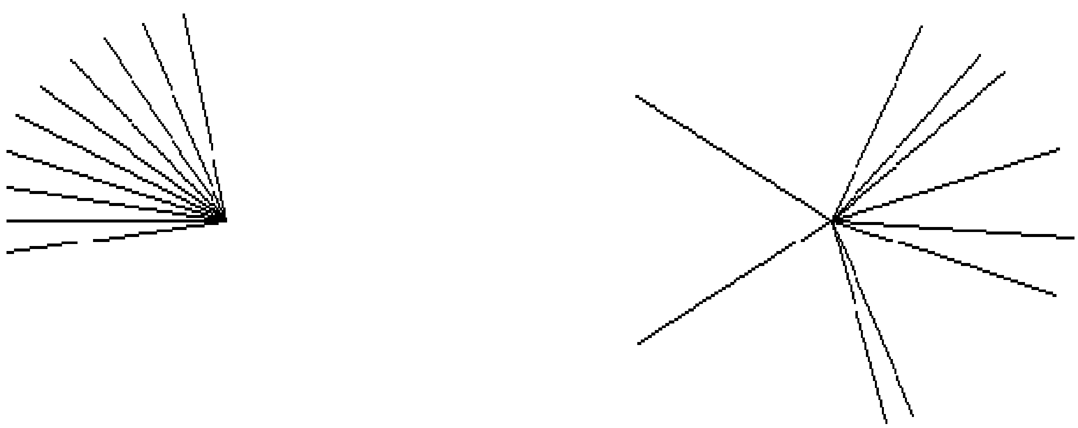

Fig. 14. Related positions for φ ***=100 ... 200***

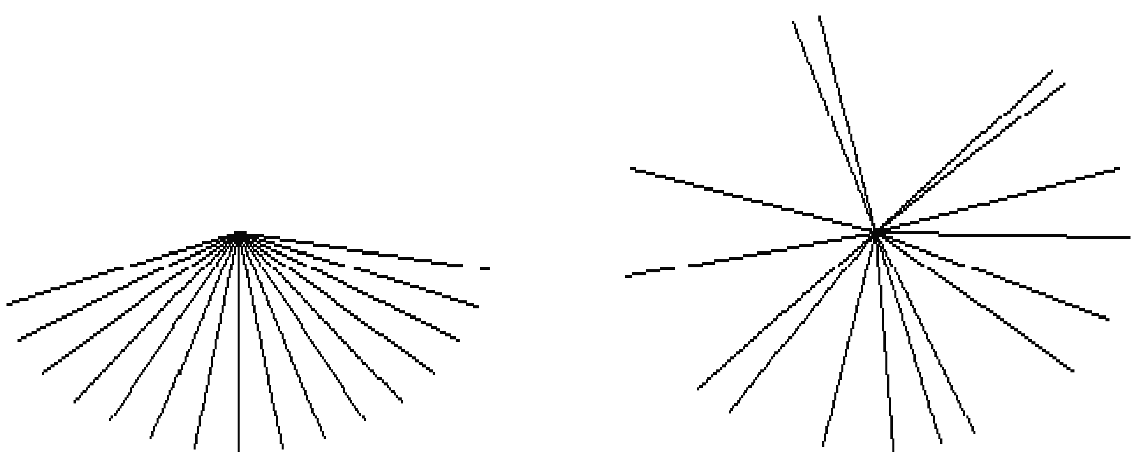

Fig. 15. Related positions for φ ***=200 ... 360***

It is noted that at equally spaced positions of the crank, the DG bar has positions located at unequal angles; the DG bar does more than one complete rotation, which cannot be achieved with mechanisms having bars.

4. Conclusions

For a law imposed to the peg, it is obtained the cam contour and the law of motion of the final guided element.

The designed mechanism can achieve positions associated, respective laws of motion, after complex laws.

It can be generated also laws for which the leaded bar is running several rotations.

By changing the gearing, we obtain laws of motion of the same aspect, but with different domains of ψ angle variation.

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