OPTIMIZATION OF A MECHANISM WITH STOPS

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Abstract: *The optimization of the two angles of a mechanism with stops is done by repeated analysis sequences. We study every angle influence on the precision with which it is ensured the switching off of the final driven element on a subinterval on which the leading element rotates. It reaches optimal solutions by analyzing associated positions and diagrams of the races.*

Keywords: optimization of mechanisms with bars, precision of the mechanisms, mechanism with stops.

INTRODUCTION

Optimizing mechanisms was addressed in more detail since the 70s when computers were introduced in the calculation mechanisms. Earlier attempts are made by graphic optimization mechanisms and especially by designer intuition. Computers have allowed the development of algorithms of increasing performance optimization. The difficulty in optimizing the mechanisms is that the mechanism is a system with variable geometry, which means that optimization is not static, but a dynamic one, which complicates the algorithms and programs.

In [1] stepping mechanism was studied, using optimization techniques.

In [2] is done the optimal synthesis of the articulated quadrilateral through linear programming, for trajectories imposed. In [3] the Watt's mechanism is optimized for drawing a straight line by a connecting rod point, using genetic algorithms.

In [4] the optimization of several mechanisms with bars is studied for trajectories or required associated positions, using different algorithms from numerical analysis. Below, a mechanism from [5] is optimized to obtain maximum accuracy.

INITIAL DATA

It went from the kinematical diagram of FIG. 1 of a mechanism kinematical and structurally studied in a paper aside.

The following initial values were taken: AB=32:BC=43:CD=42:XE=40:YE=64:
ALFA=66: GAMA=66: BC=100:AB=15.

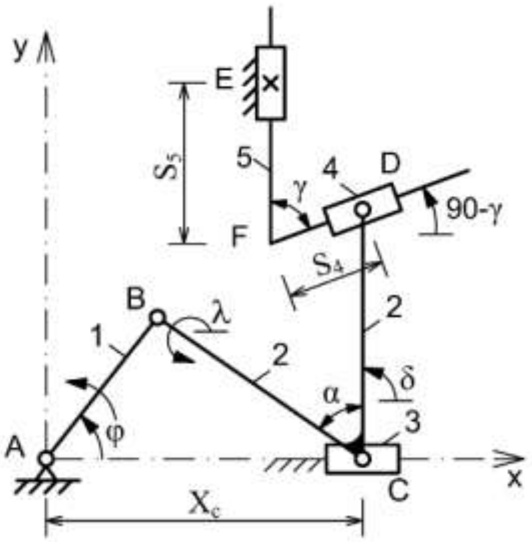


Fig.1

The purpose of the mechanism is to stop the movement of element 5 for a subinterval where the crank AB rotates further, so the mechanism is with stops. Optimizing aims to establish values for angles α and γ for which, in the subinterval φ = - 45 ... + 45 degrees, S5 to be minimal, to zero.

RESULTS

The optimization was done by a succession of repeated analysis sequences. The solutions have been verified by tracking the movement of segment FD, for the said sub domain, the good solutions being those where FD's positions are almost superimposed.

First, successive positions of the movement of the mechanism for the entire cycle were drawn, as follows: fig. 2 (γ=25), fig. 3 (γ=40), fig. 4 (γ=60), fig. 5 (γ=100), fig. 6 (γ=120). We observe the change in successive positions of the mechanism and S5 becomes negative for some values of γ. The angle γ positions the straight line FD to the vertical line FE. Referring to Fig. 2, it follows that S5 < 0.

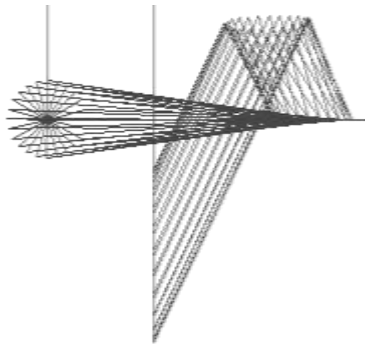


Fig. 2

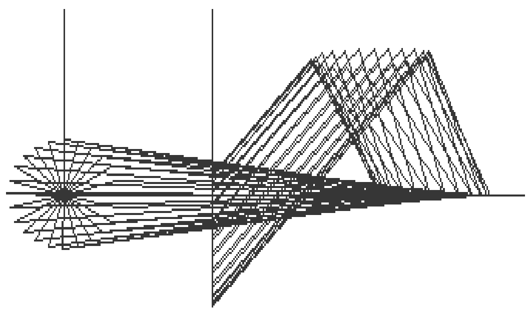


Fig. 3

Referring to Fig. 3, it follows that S5 has both positive and negative values.

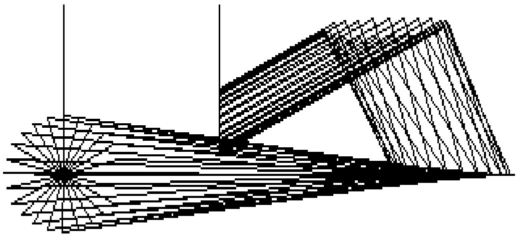


Fig. 4

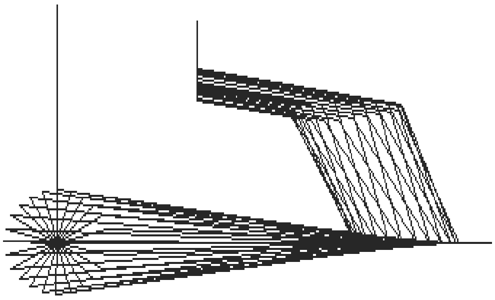


Fig. 5

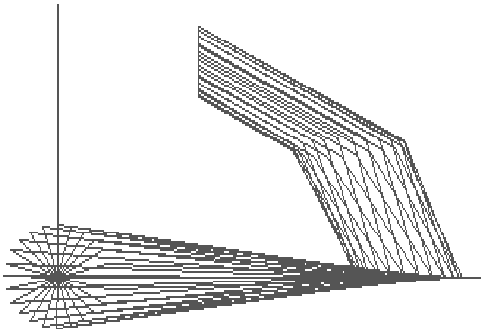


Fig. 6

Referring to Fig. 4, 5, 6, it appears that S5 > 0. Referring to Fig. 2…5, it is observed that at the increase of γ, the S5's variation decreases and at the increase of over 100 degrees, S5 starts to increase.

Further, angle α has been cycled, resulting in: fig. 7 (α =10), fig. 8 (α =20), fig. 9 (α =40), fig. 10 (α =60), fig. 11 (α =90), fig. 12 (α =120). For the case of Fig. 7, S5 has both positive and negative values.

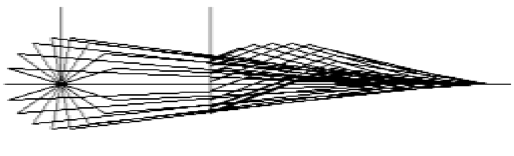


Fig. 7

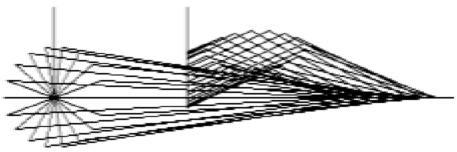
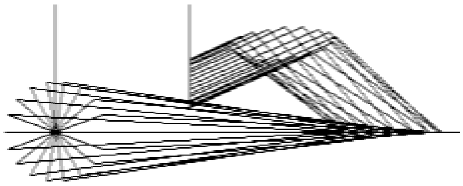


Fig. 8



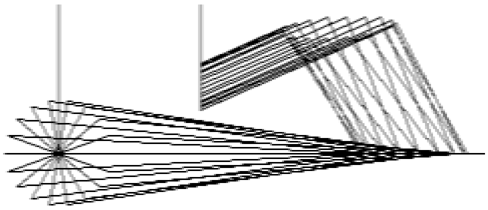
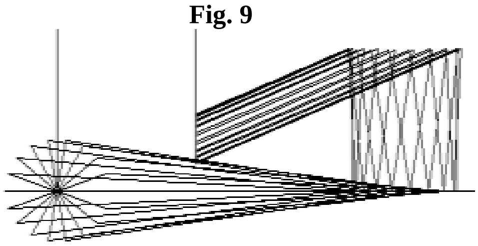


Fig. 9 **Fig. 10**



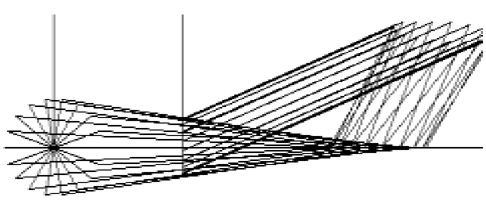
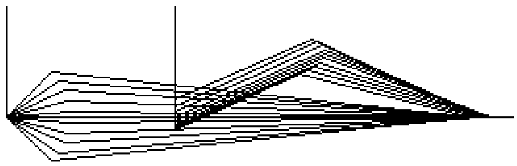


Fig. 11 **Fig. 12**

It is noted that only for α = 20 ... 40, the variation of S5 decreases, otherwise it increases.

Further, it took only successive positions for $\varphi = -45 ... +45$, resulting, at the cycling of α : fig. 13 (α =20), fig. 14 (α =40), fig. 15 (α =60), fig. 16 (α =70), fig. 17 (α =80), fig. 18 (α =90).



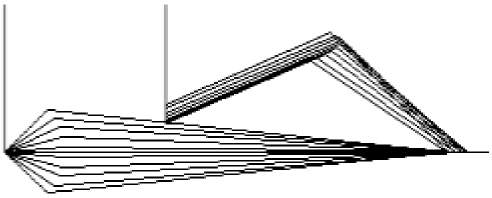
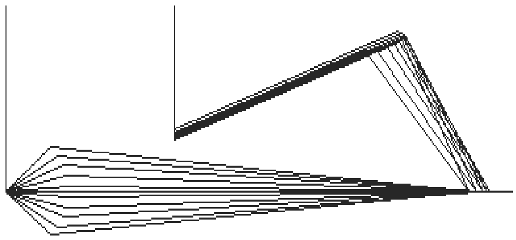


Fig. 13 **Fig. 14**



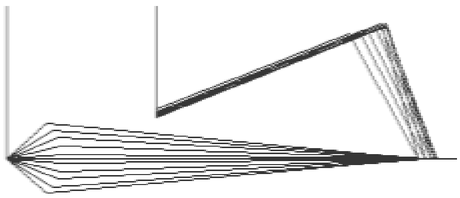


Fig. 15 **Fig. 16**

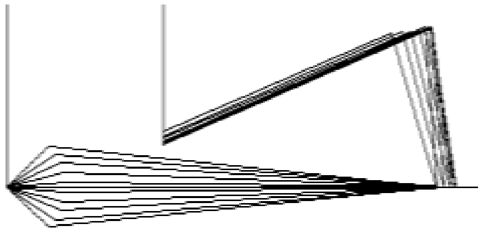


Fig. 17

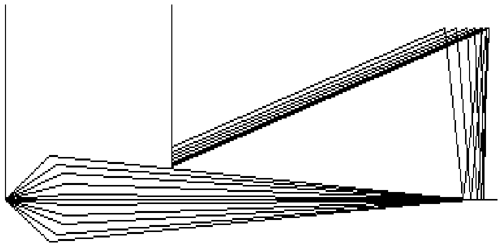


Fig. 18

Referring to Fig. 13…18, it is observed that the most convenient are the values for α = 60 ... 80 degrees.

Then, γ was cycled, resulting: fig. 19 (γ=35), fig. 20 (γ=45), fig. 21 (γ=60), fig. 22 (γ=65), fig. 23 (γ=70), fig. 24 (γ=80).

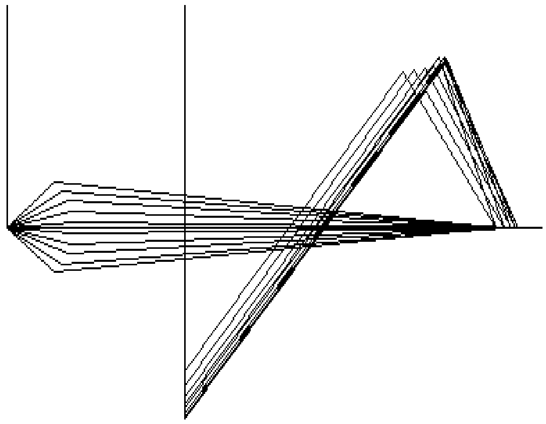


Fig. 19

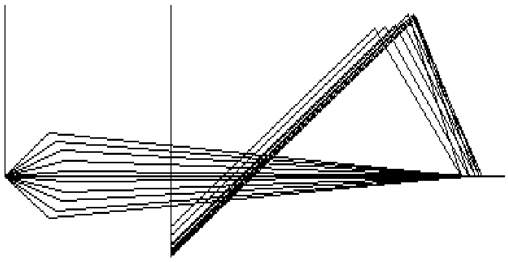


Fig. 20

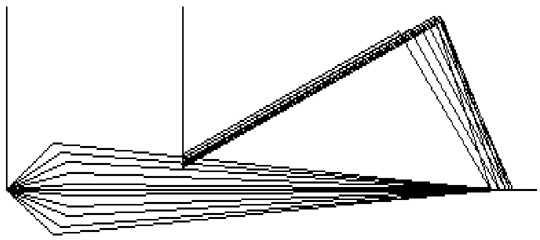


Fig. 21

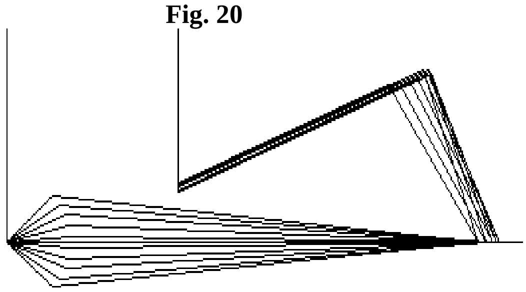


Fig. 22

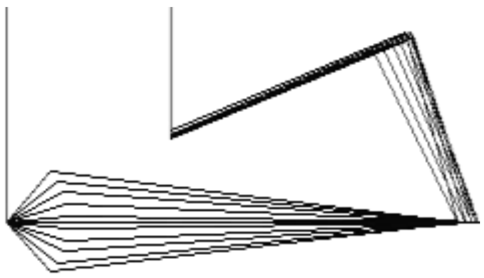


Fig. 23

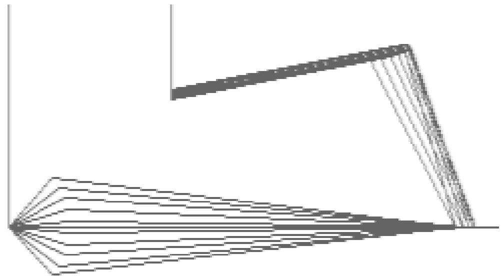


Fig. 24

The solutions with γ=60…80 and α=65…70 are convenient. As a result of these findings, the values of α and γ have been changed at the same time and, in suitable areas, resulting solutions close to the optimal solution: fig. 25 (α=60, γ=60), fig. 26 (α=65, γ=70), fig. 27 (α=70, γ=70), fig. 28 (α=70, γ=80).

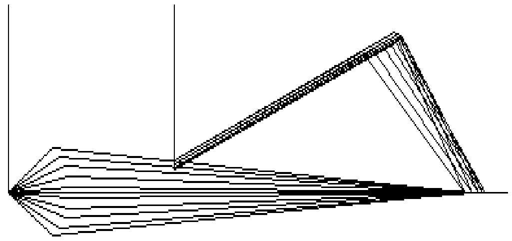


Fig. 25

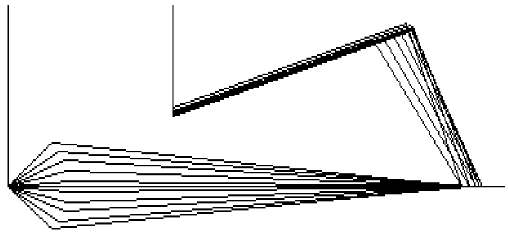


Fig. 26

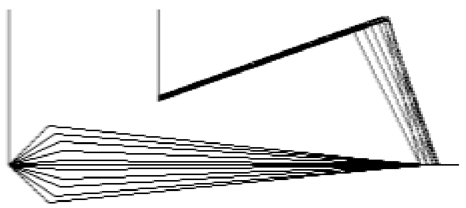


Fig. 27

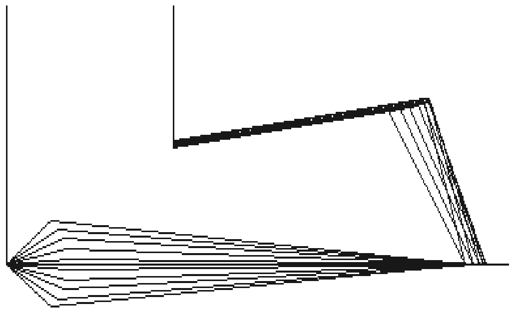


Fig. 28

New dimensions more convenient for the variation of S5 race were found. Referring to FIG. 29, corresponding to one complete revolution of the crank AB, with values $\alpha = 70; \gamma = 80$, the following is observed:

- The curve of S4 is symmetrical; when φ increases from 0-180 degrees, D goes left, then right;
- The variation of S5 is low, and in the ranges φ= 0 ... 45 and φ= 0 ... (- 45), the curve is flattened.

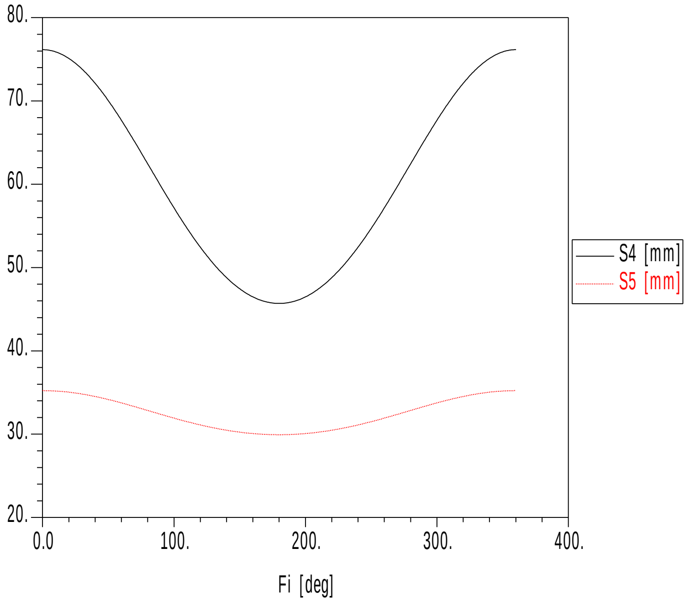


Fig. 29

From Table 1 and Fig. 30 of S5 is found that variations of S5 are very small, the curve is close to a straight line.

Table 1

Fi	S4	S5
-45	71.12304	34.35019
-40	72.12045	34.52339
-35	73.02592	34.68062
-30	73.8304	34.82031
-25	74.52571	34.94105
-20	75.10471	35.04159
-15	75.56146	35.1209
-10	75.89115	35.17815
-5	76.09037	35.21275
0	76.15701	35.22432
5	76.09037	35.21275
10	75.89115	35.17815
15	75.56146	35.1209
20	75.10471	35.04159
25	74.52571	34.94105
30	73.8304	34.82031
35	73.02592	34.68062
40	72.12045	34.52339
45	71.12304	34.35019

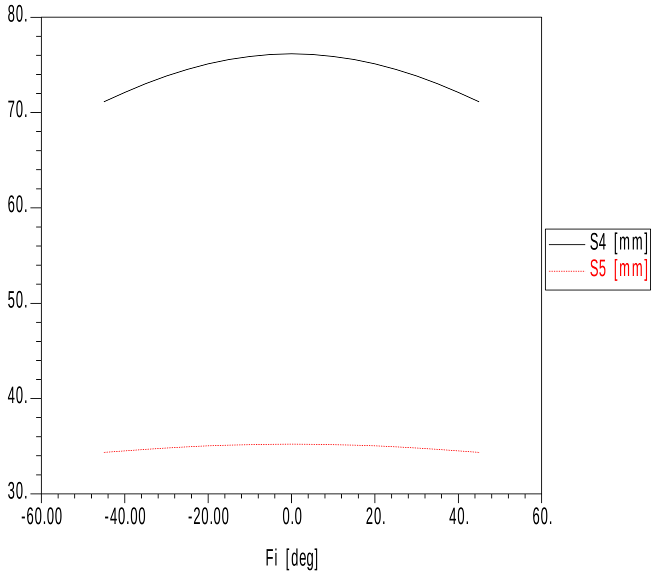


Fig. 30

CONCLUSION

- A mechanism with stops was studied.
- Its optimization was done through sequences of repeated analysis.
- - We studied the influence of the variations of two constant angles on race S5, which minimized.
- - We established the optimum values of these angles, checking the operation of the mechanism with the utmost precision.

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